



NATIONAL TEXTILE UNIVERSITY, FAISALABAD  
INNOVATE AND LEAD

# ECAT ENTRY TEST

## COMPLETE PREPARATION & MODEL PAPERS BOOK

— A Complete Guide to Success —



### For Admission in Undergraduate Programs:

- BS Textile Engineering
- BS Textile Engineering Technology
- BS Garment Engineering Technology
- BS Industrial Engineering Technology
- BS Polymer Engineering
- BS Computer Engineering Technology
- BS Computer Science
- BS Software Engineering
- BS Artificial Intelligence
- BS Data Analytics

### NTU ENTRY TEST (ECAT)

**90 MCQs | 120 Minutes**

- 20 English
- 20 Analytical Reasoning
- 20 Mathematics-based Quantitative Reasoning
- 30 Subject Section (10 each)

### Why This Book?



Complete  
Syllabus Coverage



Concepts with  
Examples



Extensive Practice  
with Explanations



Time Management  
Strategies



Model Papers  
(10 per Group)

### IMPORTANT INFORMATION

- NTU conducts three Entry Tests (ECAT) in a year for admission to all undergraduate programs.
- Candidates can appear in any one test.
- Merit is calculated on the best attempt.
- Admissions are strictly on merit.

### GROUPS & SUBJECTS (10 MCQs EACH)

- Pre-Medical Group: Biology, Chemistry, Physics
- Pre-Engineering/DAE Group: Physics, Chemistry, Mathematics
- ICS (Physics) Group: Physics, Mathematics, Computer Science
- ICS (Statistics) Group: Statistics, Mathematics, Computer Science

### USEFUL PORTALS

- NTU Admission Portal  
<https://admissions.ntu.edu.pk>
- NTU Entry Test Portal  
<https://entrytest.ntu.edu.pk>
- NTU Official Website  
<https://www.ntu.edu.pk>

### FAISALABAD ADMISSIONS OFFICE

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☎ 041-9230081-85 (Ext: 125, 127)  
✉ +923007608464 / +923007695540  
✉ admissions@ntu.edu.pk

### NTU GENERAL CONTACT

☎ 041-9230081-85  
✉ info@ntu.edu.pk  
🌐 www.ntu.edu.pk

### NTU KARACHI CAMPUS

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Near Hakeem Saeed Ground,  
Gulistan-e-Jauhar, Karachi.  
☎ 021-36492102

# CONTENTS

A single-book roadmap from concept learning to full-length timed practice

| SECTION / PAPER                                 | COVERAGE                                                                    | PAGE |
|-------------------------------------------------|-----------------------------------------------------------------------------|------|
| <b>About This Book</b>                          | Purpose, users and maximum-benefit study plan                               | 4    |
| <b>NTU Entry Test Information</b>               | Test format, candidate groups, eligibility, merit and bubble-sheet guidance | 5    |
| <b>General ECAT Strategy</b>                    | Two-hour plan, three-pass method and error-control tactics                  | 9    |
| <b>English</b>                                  | Grammar rules, worked examples and three practice sets                      | 11   |
| <b>Analytical Reasoning</b>                     | Arrangements, scheduling, deductions, blood relations and practice          | 40   |
| <b>Mathematics-Based Quantitative Reasoning</b> | Arithmetic, ratios, rates, algebra, geometry, probability and data          | 78   |
| <b>Mathematics</b>                              | Detailed concepts, formulas, worked examples and practice                   | 96   |
| <b>Physics</b>                                  | Concepts, laws, formulas, examples and practice                             | 145  |
| <b>Chemistry</b>                                | Core concepts, calculations, reactions and practice                         | 184  |
| <b>Computer Science</b>                         | Systems, programming, logic, networks, databases and practice               | 229  |
| <b>Biology</b>                                  | Cellular, physiological, genetic, ecological and classification topics      | 270  |
| <b>Statistics</b>                               | Descriptive statistics, probability, distributions and inference            | 311  |
| <b>Full-Length Model Papers</b>                 | Forty 90-MCQ papers with keys and score records                             | 340  |
| <b>Pre-Medical Model Papers</b>                 | Model Papers 1-10; answer key and score record follow each paper            | 340  |
| <b>Pre-Engineering Model Papers</b>             | Model Papers 1-10; answer key and score record follow each paper            | 391  |
| <b>ICS-Physics Model Papers</b>                 | Model Papers 1-10; answer key and score record follow each paper            | 442  |
| <b>ICS-Statistics Model Papers</b>              | Model Papers 1-10; answer key and score record follow each paper            | 493  |

# OFFICIAL PORTALS AND CONTACT INFORMATION

Use the official portals for applications, entry-test registration, result updates and current admission notices.

| RESOURCE              | DETAILS                                                                     |
|-----------------------|-----------------------------------------------------------------------------|
| NTU Admission Portal  | <a href="https://admissions.ntu.edu.pk/">https://admissions.ntu.edu.pk/</a> |
| NTU Entry Test Portal | <a href="https://entrytest.ntu.edu.pk/">https://entrytest.ntu.edu.pk/</a>   |
| NTU Main Website      | <a href="https://www.ntu.edu.pk/">https://www.ntu.edu.pk/</a>               |

## Admissions Office - Faisalabad

National Textile University, Sheikhpura Road, Faisalabad 37610, Pakistan

Phone: +92 (041) 9230081-90, Extensions 125 and 127

Email: [admissions@ntu.edu.pk](mailto:admissions@ntu.edu.pk)

## General University Contact

Phone: +92 (041) 9230081-90, Extension 158

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Email: [info@ntu.edu.pk](mailto:info@ntu.edu.pk)

## Admission Office - Karachi Campus

National Textile University Karachi Campus, St-2/1, Sector 30, Korangi Industrial Area, Karachi 74900, Pakistan

Phone: +92 (21) 99333894

Email: [kcae@ntu.edu.pk](mailto:kcae@ntu.edu.pk)

**Important: Admission schedules, active test cycles, eligibility rules and deadlines may be updated. Candidates should confirm the latest information through the official portals before applying or appearing in a test.**

## ABOUT THIS BOOK

This complete NTU ECAT book follows one continuous learning path: it begins with entry-test information, study strategy, detailed subject notes, worked examples and section-wise practice, and then advances to forty full-length model papers for the four candidate groups. The book is designed so that candidates first understand the concepts, next practise them with guidance, and finally test speed, accuracy and endurance under timed conditions.

**WHO CAN BENEFIT:** Prospective NTU students, candidates preparing for engineering, computing and related undergraduate entry tests, teachers, tutors and counsellors can use this book for structured preparation and revision.

**PREPARED BY:** Admission Office, National Textile University, Faisalabad. **Director:** Dr. Naseer Ahmad.

**NTU ENTRY-TEST OPPORTUNITIES:** NTU conducts three undergraduate entry-test opportunities during the year for admission pathways that include Textile Engineering, Polymer Engineering, Computer Science and computer-engineering-related programs. Candidates should use repeated test opportunities strategically and confirm the announced dates, registration deadlines and active test cycle through the official NTU Entry Test Portal.

**HOW TO GET MAXIMUM BENEFIT:** First study the notes and worked examples without rushing. Next attempt each section-wise practice set and record every error by type. After completing the required subjects for your group, attempt the model papers under the full two-hour limit. Review not only wrong answers but also correct answers obtained by guessing, and repeat weak topics before taking the next paper.



## NTU ENTRY TEST INFORMATION - 90-MCQ FORMAT

This section consolidates the important admission, merit, test-structure and answer-sheet guidance for the four candidate groups. The 90-MCQ structure below is used consistently in all forty full-length model papers in this book.

### Revised test structure used throughout this book

| Area                                     | Questions | Question Range |
|------------------------------------------|-----------|----------------|
| English                                  | 20        | 1-20           |
| Analytical Reasoning                     | 20        | 21-40          |
| Mathematics-Based Quantitative Reasoning | 20        | 41-60          |
| Subject 1                                | 10        | 61-70          |
| Subject 2                                | 10        | 71-80          |
| Subject 3                                | 10        | 81-90          |
| TOTAL                                    | 90        |                |

Time allowed: 120 minutes. Each question carries one mark. The full-length model papers contain four options (A-D). English, Analytical Reasoning and Mathematics-Based Quantitative Reasoning carry 20 marks each. The 30-mark subject section contains 10 questions from each of the three subjects assigned to the candidate group. Section-wise learning exercises elsewhere in the book may retain five options to provide broader practice.

### Candidate groups and subject sections

| Candidate Group       | Subject 1 (10) | Subject 2 (10) | Subject 3 (10)   |
|-----------------------|----------------|----------------|------------------|
| Pre-Medical           | Biology        | Chemistry      | Physics          |
| Pre-Engineering / DAE | Physics        | Chemistry      | Mathematics      |
| ICS Physics           | Physics        | Mathematics    | Computer Science |
| ICS Statistics        | Statistics     | Mathematics    | Computer Science |

## NTU Undergraduate Programs

The following undergraduate programs are listed by National Textile University. Availability, eligibility, merit formula, entry-test requirement and drawing-test requirement may vary by program and campus. Candidates should confirm the latest details through the official NTU admission portal.

| NTU UNDERGRADUATE PROGRAMS                  |                                           |                                                 |
|---------------------------------------------|-------------------------------------------|-------------------------------------------------|
| BS Textile Engineering                      | BS Artificial Intelligence                | Bachelor of Digital Marketing & Creative Design |
| BS Polymer Engineering                      | BS Data Analytics                         | Bachelor of Business Administration             |
| BS Technical Textiles                       | BS Chemistry                              | BS Textile Management & Marketing               |
| BS Textile Engineering Technology           | Bachelor of Fashion Design                | BS Textile & Apparel Merchandising              |
| BS Garment Engineering Technology           | Bachelor of Textile Design                | BS Quality & Supply Chain Management            |
| BS Industrial Engineering Technology        | Bachelor of Visual Arts                   | BS Accounting & Finance                         |
| Bachelor of Computer Engineering Technology | Bachelor of Animation & Multimedia Design | BS Business Analytics                           |
| BS Computer Science                         | Bachelor of Interior Design               | BS English                                      |
| BS Software Engineering                     |                                           |                                                 |

General guidance: candidates with A-Level qualifications require IBCC equivalence. DAE and Pre-Medical candidates may need program-specific eligibility or foundation/deficiency courses. Design programs may require the NTU Drawing Test. The latest official admission notice and portal instructions take precedence over this guide.

### Merit calculation summarized in the 2026 guides

| Programme Group              | Merit Formula                                         |
|------------------------------|-------------------------------------------------------|
| Textile-related programmes   | Matric 15% + Intermediate Part-I 50% + Entry Test 35% |
| Computing-related programmes | Matric 10% + Intermediate Part-I 60% + Entry Test 30% |

#### Important Note for Candidates

The concepts, topics, examples and practice questions in this book are designed to support entry-test preparation, but candidates should not limit their study only to the topics highlighted here. A thorough revision of the complete relevant Intermediate/FSc/ICS curriculum is recommended. Admission rules, merit weightages, programme names and test arrangements may be revised; the latest official NTU admission advertisement and portal instructions take precedence.

## Bubble Sheet and Test-Day Guidance

- Use an HB or No. 2 pencil when a machine-readable bubble sheet is provided; do not use a pen unless the invigilator specifically instructs otherwise.
- Fill the selected circle completely and remain inside the circle. Do not use ticks, crosses, partial marks or dots.
- Mark only one answer for each question. Multiple marks may be read as an incorrect response.
- Match every response with the correct question number and check the numbering frequently to avoid a shifted answer sequence.
- Erase a changed response completely. Partial erasures or stray marks may be detected by the scanner.
- Keep the answer sheet clean, flat and undamaged. Do not fold, crumple or write unnecessary notes on it.
- Before submission, confirm your name and roll number, count the attempted questions, check for accidental double marks, and ensure every intended mark is dark enough.

### NTU Entry-Test Opportunities

NTU provides three undergraduate entry-test opportunities during the year for admission pathways that include Textile Engineering, Polymer Engineering and relevant computing programmes. Candidates should use the opportunities strategically: attempt an early test after concept preparation, review weaknesses through the practice sets and model papers, and use a later opportunity to improve performance where permitted. Confirm current dates, registration requirements and applicable programmes through the official NTU admissions portal.

## Why this book is useful

- It explains the reason behind rules and formulas instead of presenting isolated facts.
- It teaches a repeatable method for English grammar, analytical diagrams, quantitative calculations and subject questions.
- It highlights common traps so that students learn why tempting distractors are wrong.
- It places the answer and explanation directly after every guided-practice question, making the book suitable for self-study.
- It develops both accuracy and speed through short tactics, estimation, elimination and checking routines.

## How to study each section

1. Read the topics-and-contents paragraphs to see the complete scope of the section.
2. Study one topic at a time and rewrite important rules, formulas, diagrams or relationships in a personal notebook.
3. Cover the solution to each worked example and try it independently before reading the reasoning.
4. In guided practice, answer the question first; then read the explanation immediately and correct the method, not only the answer.
5. Keep an error log with five labels: concept, reading, calculation, memory and time management.
6. Reattempt difficult questions after two days and again after one week.



## GENERAL ECAT RULES AND MAXIMUM-MARKS STRATEGY

**READ THE TASK WORD:** Underline words such as NOT, EXCEPT, incorrect, closest, immediately, opposite, must, could and cannot. Many errors occur because the candidate solves a different question from the one asked.

**USE THREE PASSES:** In the first pass answer direct knowledge and one-step questions. In the second pass complete calculations and multi-clue items. In the third pass return to marked questions, use elimination and make final decisions.

**PROTECT EASY MARKS:** A difficult question should not consume the time of several easy questions. Mark it, leave enough rough work to restart quickly, and return later.

**ELIMINATE ACTIVELY:** Reject choices with wrong units, impossible signs, broken grammar, violated clues, incorrect order of magnitude or an irrelevant definition.

**USE THE OPTIONS INTELLIGENTLY:** Back-substitute possible answers, compare differences, test boundary values and estimate. Multiple-choice options are part of the information provided.

**CHECK ANSWER TRANSFER:** Match the question number before marking. Reserve final minutes to locate blanks, shifted responses and accidental double marks.

**REVIEW THE CAUSE OF ERRORS:** When an answer is wrong, write the correct rule and the reason for the mistake. Re-reading the same question without identifying the cause gives little improvement.

### A practical 2-hour plan

Use the first five minutes to scan the paper, identify the most familiar section and settle into a steady rhythm. Use about the next 40 minutes for direct questions and familiar one-step calculations. Use the following 45 minutes for analytical sets, longer calculations and questions requiring careful rough work. Reserve about 20 minutes for marked items, option testing and elimination. Keep the final 10 minutes for answer transfer, question numbering, accidental blanks, unit checks and a final review. The order may be adjusted to personal strengths, but review time must remain protected in the two-hour paper.

**THREE-SECOND RESET:** When anxiety rises, stop, exhale slowly, read only the current stem, and write the first useful fact. A short reset is better than repeatedly reading the same line without processing it.

# COMPLETE BOOK STRUCTURE AND RECOMMENDED STUDY ORDER

## COMPLETE PREPARATION SECTIONS AND SECTION-WISE PRACTICE

1. English: grammar rules, contrasts, examples and guided practice.
2. Analytical Reasoning: linear and circular arrangements, scheduling, deductions and family relations.
3. Mathematics-Based Quantitative Reasoning: arithmetic, fractions, percentages, ratios, averages, rates, algebra, geometry, sets, probability, counting and data interpretation.
4. Mathematics: complete topic-by-topic explanations, formulas, examples and practice.
5. Physics: concepts, units, laws, diagrams, calculations and practice.
6. Chemistry: matter, structure, bonding, calculations, reactions, trends, organic chemistry and practical reasoning.
7. Computer Science: systems, logic, programming, networks, data, databases, ethics and practice.
8. Biology: cellular, physiological, genetic, ecological and classification concepts with practice.
9. Statistics: descriptive methods, probability, distributions, sampling, inference, regression and time series.

**RECOMMENDED PATH:** Complete English, Analytical Reasoning and Mathematics-Based Quantitative Reasoning first. Then study Mathematics and the three subjects required for your group. Return to the relevant explanation whenever a repeated weakness appears in practice.

## FORTY FULL-LENGTH MODEL PAPERS

Ten 90-MCQ model papers are provided for each of the four candidate groups. Attempt these papers only after completing the related preparation sections. Begin with an untimed diagnostic paper, then move to strict two-hour conditions, and use the score record to plan revision.

# ENGLISH

## Topics and contents

The English section develops grammar through recognition, contrast and application. The learner should be able to identify the structure being tested before considering the options.

This section covers Tenses: Simple Present, Present Continuous, Present Perfect, Present Perfect Continuous, Simple Past, Past Continuous, Past Perfect, Past Perfect Continuous, Simple Future, Future Continuous, Future Perfect, Future Perfect Continuous, Time clauses, since/for, and sequence of actions; Subject-Verb Agreement: Head noun agreement, Compound subjects, Correlative conjunctions, Indefinite pronouns, Collective nouns and quantities, Special nouns, Relative-clause agreement, Inverted and there-constructions, Clauses, gerunds and titles, Fractions and quantifiers; Conditional Sentences: Zero conditional, First conditional, Second conditional, Third conditional, Mixed conditionals, Unless, provided that, as long as, in case, Wish and if only; Active and Passive Voice: Simple and continuous tenses, Perfect tenses, Future and modal passives, Interrogatives, Imperatives, Verbs with two objects, Agent omission; Direct and Indirect Narration: Statements, Modal and future forms, Universal truths, Yes/no questions, Wh-questions, Commands and requests, Exclamations and wishes, Pronoun, time and place changes; Prepositions: Time, Place, Movement, Adjective-preposition combinations, Verb-preposition combinations, Noun-preposition combinations, Fixed prepositional phrases.

**FAST GRAMMAR ROUTINE:** Locate the time or relationship word; identify the true subject and verb; name the grammar rule; eliminate options with the wrong auxiliary, tense, agreement or preposition; then read the complete sentence for meaning.

**ADDITIONAL EXAMPLE 1 - Tense recognition:** By the time the bus arrived, the students had reached the gate. The phrase “by the time” establishes two past actions; the earlier completed action takes the past perfect.

**ADDITIONAL EXAMPLE 2 - Agreement:** The quality of the answers is more important than the quantity. The head noun is “quality”; the plural noun inside the phrase “of the answers” does not control the verb.

**ADDITIONAL EXAMPLE 3 - Conditional meaning:** If I had known about the change, I would have arrived earlier. Both parts refer to an unreal past situation, so the third conditional pattern is required.

**ADDITIONAL EXAMPLE 4 - Voice:** The committee approved the plan becomes “The plan was approved by the committee.” The active object moves to subject position, while the tense remains simple past.

**ADDITIONAL EXAMPLE 5 - Narration:** Ali said, “I am revising my notes” becomes “Ali said that he was revising his notes.” The pronoun changes according to the speaker and the present continuous normally shifts to past continuous.

**ADDITIONAL EXAMPLE 6 - Prepositions:** The principal was pleased with the students and proud of their result. Fixed combinations such as pleased with and proud of must be learned as complete units.

# 1. TENSES

**EXAMPLE A:** The laboratory opens at 8:00 a.m. Although the meaning is future, a fixed timetable normally uses the simple present.

**EXAMPLE B:** She has written three pages, but she has been writing for two hours. The present perfect emphasizes the completed amount; the present perfect continuous emphasizes duration.

**EXAMPLE C:** When the supervisor arrived, the team was testing the device. The past continuous gives the background action, while the simple past marks the interrupting event.

Tense combines time with aspect. Time places an action in the present, past or future. Aspect shows whether the action is viewed as simple, continuing, completed, or continuing over a duration. The correct choice must fit both the time reference and the intended viewpoint.

## 1. Simple Present

Form: base / s-es. Negative: do/does not + base verb. Question: Do/Does + subject + base verb?. Main use: habits, facts, schedules. Common signals include usually, every, often.

Use it for routines, permanent situations, scientific facts and fixed schedules. It does not normally describe an action happening at this exact moment.

**EXAMPLE:** She revises every day.

## 2. Present Continuous

Form: am/is/are + V-ing. Negative: am/is/are not + V-ing. Question: Am/Is/Are + subject + V-ing?. Main use: action now; temporary situation. Common signals include now, at present.

Use it for an action in progress, a temporary situation or a developing change. Stative verbs such as know, believe and belong are not normally used in this form.

**EXAMPLE:** She is revising now.

## 3. Present Perfect

Form: has/have + V3. Negative: has/have not + V3. Question: Has/Have + subject + V3?. Main use: past action linked to present. Common signals include already, yet, ever.

Use it when the past action has present relevance, the time is unfinished, or life experience is being discussed. A finished time such as yesterday normally requires simple past.

**EXAMPLE:** She has completed the test.

**CONTRAST:** “She completed the test yesterday” uses simple past because yesterday is finished. “She has completed the test” focuses on the present result and gives no finished past time.

## 4. Present Perfect Continuous

Form: has/have been + V-ing. Negative: has/have not been + V-ing. Question: Has/Have + subject + been + V-ing?. Main use: activity continuing from past. Common signals include since, for.

Use it to emphasize duration or repeated activity continuing to the present. The present perfect may emphasize completion; this form emphasizes the activity.

**EXAMPLE:** She has been studying for two hours.

## 5. Simple Past

Form: V2. Negative: did not + base verb. Question: Did + subject + base verb?. Main use: completed past action. Common signals include yesterday, last, ago.

Use it for a completed action at a definite past time, a sequence of past events, or a past habit. After did, the main verb returns to base form.

**EXAMPLE:** She revised yesterday.

## 6. Past Continuous

Form: was/were + V-ing. Negative: was/were not + V-ing. Question: Was/Were + subject + V-ing?. Main use: ongoing past action. Common signals include while, at 8 p.m..

Use it for an action continuing at a past moment, background description, or an interrupted action. The shorter interrupting event often uses simple past.

**EXAMPLE:** She was studying when I called.

## 7. Past Perfect

Form: had + V3. Negative: had not + V3. Question: Had + subject + V3?. Main use: earlier of two past actions. Common signals include by the time, before.

Use it for the earlier of two past actions when the order is not already unmistakable. Do not use it for every action in a past narrative.

**EXAMPLE:** She had left before noon.

**SEQUENCE TEST:** Ask which past action happened first. The earlier action may use had + V3; the later action normally remains in simple past.

## 8. Past Perfect Continuous

Form: had been + V-ing. Negative: had not been + V-ing. Question: Had + subject + been + V-ing?. Main use: duration before a past point. Common signals include for, before.

Use it for duration continuing up to a past reference point. It explains how long an activity had been happening before another event.

**EXAMPLE:** She had been waiting for an hour.

## 9. Simple Future

Form: will + base. Negative: will not + base verb. Question: Will + subject + base verb?. Main use: prediction, decision, promise. Common signals include tomorrow, soon.

Use it for predictions, promises, spontaneous decisions and neutral future statements. Planned arrangements may use present continuous; timetables may use simple present.

**EXAMPLE:** She will revise tomorrow.

## 10. Future Continuous

Form: will be + V-ing. Negative: will not be + V-ing. Question: Will + subject + be + V-ing?. Main use: ongoing at a future time. Common signals include this time tomorrow.

Use it for an action that will be in progress at a future time or as a polite way to ask about plans.

**EXAMPLE:** She will be travelling at noon.

## 11. Future Perfect

Form: will have + V3. Negative: will not have + V3. Question: Will + subject + have + V3?. Main use: completed before future point. Common signals include by, before.

Use it for an action completed before a stated future point. The phrase by + future time is a common clue.

**EXAMPLE:** She will have finished by 5.

## 12. Future Perfect Continuous

Form: will have been + V-ing. Negative: will not have been + V-ing. Question: Will + subject + have been + V-ing?. Main use: duration up to future point. Common signals include for...by.

Use it to emphasize duration continuing up to a future point. It combines future reference, completion point and ongoing duration.

**EXAMPLE:** By June, she will have been teaching for ten years.

## Time clauses, since, for and sequence

After when, before, after, until, as soon as and unless, a future meaning is normally expressed with a present form in the time or condition clause: “When the test begins, we will start.” Since introduces a starting point; for introduces a duration. By the time often marks a completion boundary and helps distinguish perfect forms. Always read both clauses because the relationship between events is more important than a single signal word.

**COMMON TENSE TRAPS:** Do not use present perfect with a clearly finished past time; do not use will after a future time conjunction; do not confuse since with for; and do not choose a continuous form merely because the sentence contains the word now if the verb is stative.

## 2. SUBJECT-VERB AGREEMENT

**EXAMPLE A:** Neither the students nor the teacher is absent. With neither...nor, the verb normally agrees with the nearer subject.

**EXAMPLE B:** A number of candidates are waiting, but the number of candidates is increasing. “A number of” is plural; “the number of” is singular.

**EXAMPLE C:** Mathematics is useful, and ten kilometres is a long distance to walk. Some subjects and measurements are treated as singular units.

Agreement questions often hide the true subject behind a phrase, a relative clause or an inverted structure. Reduce the sentence to its grammatical core. The verb agrees with the controlling subject, not with the nearest noun unless a special correlative rule applies.

### 1. Head noun

The verb agrees with the head noun, not a nearby noun.

**EXAMPLE:** The list of candidates is ready.

Cover the interrupting phrase: “The list [of candidates] is ready.” Candidates is plural, but it belongs to the phrase beginning with of; list is the head noun and controls the singular verb.

### 2. And

Two subjects joined by and normally take a plural verb.

**EXAMPLE:** Ali and Hamza are present.

### 3. One idea

A compound expression naming one unit may be singular.

**EXAMPLE:** Bread and butter is my usual breakfast.

### 4. Either/or; neither/nor

The verb normally agrees with the nearer subject.

**EXAMPLE:** Either the teacher or the students are ready.

With either...or and neither...nor, check the subject closest to the verb. When one subject is singular and the other plural, placing the plural subject nearer often produces a more natural sentence.

### 5. Each/every

Each, every, either and neither are normally singular.

**EXAMPLE:** Each applicant has a time slot.

### 6. Indefinite pronouns

Everyone, someone, anybody, nobody are singular.

**EXAMPLE:** Everyone is prepared.



## 7. Collective nouns

Use singular for the group as a unit; plural when members act separately in varieties allowing it.

**EXAMPLE:** The committee has reached its decision.

## 8. Quantities and titles

A single amount, distance, title or subject name may be singular.

**EXAMPLE:** Ten kilometres is a long walk. Physics requires practice.

## 9. There-construction

The verb agrees with the real subject after the verb.

**EXAMPLE:** There are three errors.

## 10. Relative clause

Agreement follows the noun represented by who/that.

**EXAMPLE:** She is one of the students who have qualified.

Find the noun to which who or that refers. In “one of the students who have qualified,” who refers to students, so have is plural. In “the only one of the students who has qualified,” who refers to one, so has is singular.

**AGREEMENT CHECKLIST:** Find the complete subject; remove interrupting phrases; identify the head noun; check special words such as each, every, either, neither and none; then choose the verb.

# 3. CONDITIONAL SENTENCES

**EXAMPLE A:** If water reaches 100°C at standard pressure, it boils. This is a zero conditional expressing a general fact.

**EXAMPLE B:** If the weather improves, we will hold the test outside. The first conditional describes a real future possibility.

**EXAMPLE C:** If she had followed the schedule, she would be less worried now. This mixed conditional links an unreal past cause with a present result.

A conditional sentence links a condition to a result. The verb pattern indicates whether the relationship is a fact, a real possibility, an imagined present situation, an unreal past situation, or a mixed relationship between past and present.

### 1. Zero conditional

Pattern: if + present, present. Meaning: general truth.

Both clauses describe a regular result, rule or scientific relationship. Either clause may often come first; use a comma when the if-clause comes first.

**EXAMPLE:** If water reaches 100 C, it boils.

### 2. First conditional

Pattern: if + present, will + base. Meaning: real future possibility.

The condition is realistic or possible. The if-clause uses a present form even though the meaning is future; the result commonly uses will, may, can or an imperative.

**EXAMPLE:** If it rains, we will stay inside.

### 3. Second conditional

Pattern: if + past, would + base. Meaning: unreal present/future.

The past form signals distance from reality, not necessarily past time. With formal hypothetical meaning, were may be used with all subjects: “If I were you...”

**EXAMPLE:** If I knew, I would tell you.

## 4. Third conditional

Pattern: if + had + V3, would have + V3. Meaning: unreal past.

Both the condition and result refer to a past situation that did not happen. It is used for regret, criticism or imagined alternatives.

**EXAMPLE:** If we had left, we would have caught the train.

## 5. Mixed conditional

Pattern: if + had + V3, would + base. Meaning: past cause, present result.

Check the time of each clause separately. A past condition may explain a present result, or a present state may explain a past result.

**EXAMPLE:** If I had studied medicine, I would be a doctor now.

## 6. Unless conditional

Pattern: unless = if not. Meaning: negative condition.

Unless already contains a negative meaning. Avoid adding another not unless a double negative is genuinely intended. Provided that and as long as emphasize a necessary condition; in case introduces a precaution.

**EXAMPLE:** You cannot enter unless you show the card.

## 7. Wish / if only conditional

Pattern: past for present regret; past perfect for past regret. Meaning: regret or desired change.

For present regret use a past form; for regret about an earlier action use past perfect; for a desired change in another person or situation, would is common.

**EXAMPLE:** I wish I knew. I wish I had studied.

**CONDITIONAL SKELETONS:** Fact: present-present. Real future: present-will. Unreal present: past-would. Unreal past: had + V3 - would have + V3. Name the time and reality before choosing the verb.

# 4. ACTIVE AND PASSIVE VOICE

**EXAMPLE A:** They are repairing the road becomes “The road is being repaired.” The continuous passive uses be + being + past participle.

**EXAMPLE B:** Someone has stolen the files becomes “The files have been stolen.” The agent is omitted because it is unknown.

**EXAMPLE C:** They gave Sara a certificate may become “Sara was given a certificate” or “A certificate was given to Sara.”

The active voice focuses on the doer; the passive focuses on the receiver or result. To form the passive, move the active object to subject position, keep the original tense in the appropriate form of be, and change the main verb to the past participle. The agent may be omitted when unknown, obvious or unimportant.

## 1. Simple present

Passive pattern: am/is/are + V3. Active form: The coach selects the team. Passive form: The team is selected by the coach.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

## 2. Present continuous

Passive pattern: am/is/are being + V3. Active form: The nurse is checking records. Passive form: Records are being checked.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

### 3. Present perfect

Passive pattern: has/have been + V3. Active form: They have installed equipment. Passive form: Equipment has been installed.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

### 4. Simple past

Passive pattern: was/were + V3. Active form: Researchers analysed data. Passive form: Data were analysed.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

### 5. Past continuous

Passive pattern: was/were being + V3. Active form: The guard was opening the gate. Passive form: The gate was being opened.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

### 6. Past perfect

Passive pattern: had been + V3. Active form: They had completed the work. Passive form: The work had been completed.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

### 7. Future

Passive pattern: will be + V3. Active form: They will announce results. Passive form: Results will be announced.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

### 8. Modal

Passive pattern: modal + be + V3. Active form: You must submit the form. Passive form: The form must be submitted.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

### 9. Imperative

Passive pattern: let + object + be + V3 / object should be + V3. Active form: Close the door. Passive form: Let the door be closed.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

### 10. Two objects

Passive pattern: Either object may become subject, depending on emphasis.. Active form: They gave Ali a prize. Passive form: Ali was given a prize / A prize was given to Ali.

Check subject-verb agreement in the new passive sentence. The past participle does not carry tense by itself; the auxiliary be carries the tense and must agree with the new subject.

**THREE-STEP CONVERSION:** Identify object; choose be in the original tense; use V3. Add by + agent only when it adds useful information.

**VOICE TRAPS:** Do not change the tense, do not use been where being is required, and do not form a passive from an intransitive verb that has no object.

## 5. DIRECT AND INDIRECT NARRATION

**EXAMPLE A:** He said, “Do you understand?” becomes “He asked whether I understood.” A yes/no question takes if or whether and statement word order.

**EXAMPLE B:** She said, “Where are you going?” becomes “She asked where I was going.” The question mark disappears and the auxiliary no longer comes before the subject.

**EXAMPLE C:** The teacher said, “The Earth moves around the Sun” normally remains unchanged because it expresses a universal truth.

Reported speech changes viewpoint while preserving meaning. First identify the sentence type: statement, question, command, request, exclamation or wish. Then adjust pronouns and references to time and place. Apply tense backshift when the reporting verb and context require it.

## 1. Present simple -> past simple

Direct form: She said, “I work.” Reported form: She said that she worked.

Backshift is a change in viewpoint, not a mechanical replacement in every sentence. Consider whether the fact is still true and whether the reporting time is past.

## 2. Present continuous -> past continuous

Direct form: He said, “I am reading.” Reported form: He said that he was reading.

Backshift is a change in viewpoint, not a mechanical replacement in every sentence. Consider whether the fact is still true and whether the reporting time is past.

## 3. Present perfect -> past perfect

Direct form: He said, “I have finished.” Reported form: He said that he had finished.

Backshift is a change in viewpoint, not a mechanical replacement in every sentence. Consider whether the fact is still true and whether the reporting time is past.

## 4. Past simple -> past perfect

Direct form: She said, “I solved it.” Reported form: She said that she had solved it.

Backshift is a change in viewpoint, not a mechanical replacement in every sentence. Consider whether the fact is still true and whether the reporting time is past.

## 5. will -> would; can -> could; may -> might

Direct form: He said, “I can come.” Reported form: He said that he could come.

Backshift is a change in viewpoint, not a mechanical replacement in every sentence. Consider whether the fact is still true and whether the reporting time is past.

## 6. Universal truth usually unchanged

Direct form: The teacher said, “Earth moves around the Sun.” Reported form: The teacher said that Earth moves around the Sun.

A statement that remains universally true usually keeps its present tense, even after a past reporting verb.

## 7. Yes/no question

Direct form: He said, “Are you ready?” Reported form: He asked whether I was ready.

Reported questions use statement word order and no question mark inside the reported clause. Yes/no questions take if or whether; wh-questions retain the question word.

## 8. Wh-question

Direct form: She said, “Where do you live?” Reported form: She asked where I lived.

Reported questions use statement word order and no question mark inside the reported clause. Yes/no questions take if or whether; wh-questions retain the question word.

## 9. Command/request

Direct form: He said, “Please wait.” Reported form: He requested me to wait.

Commands and requests normally use tell, order, request, advise or ask followed by an object and to-infinitive. Negative commands use not to.

## 10. Time/place changes

Direct form: She said, "I will come tomorrow." Reported form: She said that she would come the next day. Common changes: now->then, today->that day, tomorrow->the next day, here->there.

Backshift is a change in viewpoint, not a mechanical replacement in every sentence. Consider whether the fact is still true and whether the reporting time is past.

**NARRATION ROUTINE:** Name the sentence type; choose a suitable reporting verb; change pronouns; change time/place expressions; apply backshift if needed; restore statement order.

## 6. PREPOSITIONS

**EXAMPLE A:** Use at for a precise time, on for a day or date, and in for a month, year or longer period: at 9:00, on Monday, in June.

**EXAMPLE B:** Use between for two distinct persons or items and among for a group: between Ali and Sara; among the candidates.

**EXAMPLE C:** Distinguish beside, meaning next to, from besides, meaning in addition to.

Prepositions show relationships of time, place, movement, cause, method and connection. Some choices follow general rules; others are fixed combinations that must be learned as complete phrases.

### 1. Time

At for clock time; on for days/dates; in for months, years and longer periods.

**EXAMPLES:** at 8:30, on Monday, in June, in 2026

Use at for precise clock time, on for a day or date, and in for longer periods. Use by for a deadline, until for continuation to a point, during for an event or period, and within for completion before a period ends.

### 2. Place

At for point; in for enclosed/large area; on for surface.

**EXAMPLES:** at the gate, in the room, on the table

At treats a location as a point, in places something inside an area, and on places it on a surface. Context may change the choice: at school can refer to attendance, while in the school emphasizes being inside the building.

### 3. Movement

To, into, onto, through, across, along, past.

**EXAMPLES:** walk to the lab; move into the room; go across the road

Distinguish destination from path: to shows destination, into shows movement from outside to inside, through shows movement within an enclosed path, and across shows movement from one side to another.

### 4. Duration and starting point

For + duration; since + starting point.

**EXAMPLES:** for two hours; since Monday

Learn the complete combination as a single unit. Replacing the preposition with a literal spatial choice often creates an unidiomatic sentence.

### 5. Adjective combinations

Proud of, interested in, responsible for, capable of.

**EXAMPLES:** Ali is proud of his result.

Learn the complete combination as a single unit. Replacing the preposition with a literal spatial choice often creates an unidiomatic sentence.

## 6. Verb combinations

Depend on, belong to, consist of, comply with, apply for.

**EXAMPLES:** Success depends on practice.

Learn the complete combination as a single unit. Replacing the preposition with a literal spatial choice often creates an unidiomatic sentence.

## 7. Noun combinations

Reason for, solution to, increase in, demand for.

**EXAMPLES:** There is no reason for delay.

Learn the complete combination as a single unit. Replacing the preposition with a literal spatial choice often creates an unidiomatic sentence.

## 8. Fixed phrases

In time, on time, by chance, at risk, in charge of.

**EXAMPLES:** He arrived at the centre in time.

Learn the complete combination as a single unit. Replacing the preposition with a literal spatial choice often creates an unidiomatic sentence.

**COLLOCATION NOTEBOOK:** Record depend on, proud of, reason for and solution to as complete phrases. Revise them in short sentences rather than isolated lists.

## ENGLISH - PRACTICE EXERCISES

Three independent sets are provided. Attempt each question before reading the answer, explanation and quick tactic immediately below it. Each set contains 25 MCQs with five options (A–E).

### Practice Set 1 - 25 MCQs

1. Complete the conditional sentence: If only we \_\_\_\_ the instructions earlier!

- A. read tomorrow
- B. will read
- C. would read now
- D. have read later
- E. had read

**Answer: E. had read. Explanation:** If only about regret in the past takes the past perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

2. Choose the correct preposition: The candidate walked \_\_\_\_ the examination hall.

- A. at
- B. since
- C. into
- D. for
- E. above

**Answer: C. into. Explanation:** Into expresses movement from outside to inside. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

3. Choose the correct passive form of “The committee has approved the plan.”

- A. The plan had been approved by the committee.
- B. The plan has approved the committee.
- C. The plan has been approved by the committee.
- D. The plan is been approved by the committee.
- E. The committee has been approved by the plan.

**Answer: C. The plan has been approved by the committee.. Explanation:** Present perfect passive uses has/have been + past participle. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

4. Choose the correct indirect narration: The supervisor said to the assistant, “Check the figures.”

- A. The supervisor said the assistant check the figures.
- B. The supervisor asked that the assistant checked the figures.
- C. The supervisor told the assistant to check the figures.
- D. The supervisor told the assistant checking the figures.
- E. The supervisor said to check the figures by assistant.



**Answer: C. The supervisor told the assistant to check the figures.. Explanation:** A command is commonly reported with told/ordered + object + to-infinitive. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**5. Choose the correct indirect narration: The examiner said, "Where is your admission card?"**

- A. The examiner asked where was my admission card.
- B. The examiner asked where my admission card was.
- C. The examiner said where my admission card is.
- D. The examiner told where is your admission card.
- E. The examiner asked if where my admission card was.

**Answer: B. The examiner asked where my admission card was.. Explanation:** A wh-question keeps the wh-word but changes to statement word order. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**6. Choose the correct verb: Ten kilometres \_\_\_\_ a long walk in this heat.**

- A. are
- B. is
- C. were
- D. have been
- E. be

**Answer: B. is. Explanation:** A distance considered as one quantity takes a singular verb. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**7. Choose the correct verb: The news \_\_\_\_ encouraging.**

- A. is
- B. are
- C. were
- D. have
- E. be

**Answer: A. is. Explanation:** News is grammatically singular. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**8. Choose the correct indirect narration: Sara said, "I have completed the task."**

- A. Sara told that she has completed the task.
- B. Sara said that I had completed the task.
- C. Sara said that she had completed the task.
- D. Sara said that she completed the task tomorrow.
- E. Sara asked that she had completed the task.

**Answer: C. Sara said that she had completed the task.. Explanation:** Present perfect normally shifts to past perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**9. Complete the conditional sentence: If I knew the answer, I \_\_\_\_ you.**

- A. will tell
- B. would have told
- C. would tell
- D. told
- E. had told

**Answer: C. would tell. Explanation:** An unreal present condition uses past simple with would + base verb. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**10. Choose the best completion: Ali \_\_\_\_ the application already.**

- A. submitted
- B. has submitted
- C. had submitted
- D. is submitted
- E. will submitted

**Answer: B. has submitted. Explanation:** An unfinished time or a present result calls for the present perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**11. Complete the sentence: At this moment, Sara \_\_\_\_ the presentation.**

- A. preparing
- B. is preparing
- C. was preparing
- D. has preparing
- E. will preparing

**Answer: B. is preparing. Explanation:** The phrase “at this moment” shows an action in progress, so the present continuous is required. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**12. Choose the correct verb: The list of selected candidates \_\_\_\_ on the notice board.**

- A. are
- B. is
- C. were
- D. be
- E. have been

**Answer: B. is. Explanation:** The head noun is list, not candidates; therefore the verb is singular. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**13. Complete the conditional sentence: If they had checked the figures, they \_\_\_\_ the error.**

- A. will find
- B. would find
- C. found
- D. would have found
- E. had found

**Answer: D. would have found. Explanation:** An unreal past condition uses had + V3 and would have + V3. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**14. By the end of the term, she \_\_\_\_ the course.**

- A. will completed
- B. has completed
- C. will have completed
- D. had completed
- E. is completed

**Answer: C. will have completed. Explanation:** "By" followed by a future deadline normally requires the future perfect for an action completed before that time. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**15. Choose the correct verb: A number of students \_\_\_\_ waiting outside.**

- A. is
- B. was
- C. are
- D. has
- E. be

**Answer: C. are. Explanation:** A number of means several and takes a plural verb. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**16. Choose the correct verb: Every student and every teacher \_\_\_\_ an identity card.**

- A. need
- B. needs
- C. are needing
- D. have needed
- E. were needing

**Answer: B. needs. Explanation:** Every makes each coordinated subject singular in meaning. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**17. Choose the correct indirect narration: Bilal said, "I am preparing the chart."**

- A. Bilal told that he is preparing the chart.
- B. Bilal said that he was preparing the chart.

- C. Bilal said that I was preparing the chart.
- D. Bilal said that he had prepared the chart now.
- E. Bilal asked whether he was preparing the chart.

**Answer: B. Bilal said that he was preparing the chart.. Explanation:** Present continuous normally shifts to past continuous. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**18. By the time the supervisor arrived, the staff \_\_\_\_ checked the room.**

- A. checked the room
- B. had checked the room
- C. have checked the room
- D. were checked the room
- E. will have checked the room

**Answer: B. had checked the room. Explanation:** The earlier of two past actions is expressed by the past perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**19. Complete the sentence: At this moment, the students \_\_\_\_ the sample paper.**

- A. solving
- B. were solving
- C. are solving
- D. have solving
- E. will solving

**Answer: C. are solving. Explanation:** The phrase "at this moment" shows an action in progress, so the present continuous is required. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**20. Complete the conditional sentence: You may use the calculator provided that it \_\_\_\_ permitted.**

- A. was
- B. is
- C. will be
- D. would be
- E. has being

**Answer: B. is. Explanation:** After provided that in a real condition, use the present simple. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**21. Choose the correct indirect narration: Usman said, "Alas! I have lost the key."**

- A. Usman said alas that he loses the key.
- B. Usman exclaimed with joy that he had lost the key.
- C. Usman asked whether he had lost the key.

D. Usman told that alas he lost the key.

E. Usman exclaimed with sorrow that he had lost the key.

**Answer: E. Usman exclaimed with sorrow that he had lost the key.. Explanation:** The interjection alas expresses sorrow, and the tense is backshifted appropriately. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**22. Choose the correct verb: Neither the teacher nor the students \_\_\_\_ ready.**

A. is

B. was

C. are

D. be

E. has

**Answer: C. are. Explanation:** With neither...nor, the verb normally agrees with the nearer subject, students. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**23. By the time the bell rang, we \_\_\_\_ completed the calculation.**

A. completed the calculation

B. have completed the calculation

C. had completed the calculation

D. were completed the calculation

E. will have completed the calculation

**Answer: C. had completed the calculation. Explanation:** The earlier of two past actions is expressed by the past perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**24. Choose the best completion: The team \_\_\_\_ its score this month.**

A. improved

B. had improved

C. is improved

D. has improved

E. will improved

**Answer: D. has improved. Explanation:** An unfinished time or a present result calls for the present perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**25. Complete the sentence: At this moment, the technician \_\_\_\_ the software.**

A. updating

B. was updating

C. has updating

D. is updating

E. will updating

**Answer: D. is updating. Explanation:** The phrase “at this moment” shows an action in progress, so the present continuous is required. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

## Practice Set 2 - 25 MCQs

1. Choose the correct verb: Bread and butter \_\_\_\_ his usual breakfast.

- A. is
- B. are
- C. were
- D. have
- E. be

**Answer: A. is. Explanation:** The phrase represents one combined item or meal. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

2. Choose the correct verb: The committee \_\_\_\_ reached its final decision.

- A. have
- B. are
- C. has
- D. were
- E. be

**Answer: C. has. Explanation:** The committee is acting as one unit, so a singular verb is appropriate. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

3. Choose the correct passive form of "The team will announce the result."

- A. The result will be announced by the team.
- B. The result will announced by the team.
- C. The result is announced by the team tomorrow.
- D. The team will be announced by the result.
- E. The result will have announce by the team.

**Answer: A. The result will be announced by the team.. Explanation:** Future passive uses will be + past participle. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

4. By noon, the technician \_\_\_\_ the device.

- A. will repaired
- B. will have repaired
- C. has repaired
- D. had repaired
- E. is repaired

**Answer: B. will have repaired. Explanation:** "By" followed by a future deadline normally requires the future perfect for an action completed before that time. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

5. Choose the correct indirect narration: Hamza said, "I will call tomorrow."

- A. Hamza said that he will call tomorrow.
- B. Hamza told that he would call tomorrow yesterday.
- C. Hamza said that I would call the next day.
- D. Hamza said that he would call the next day.
- E. Hamza asked if he would call tomorrow.

**Answer: D. Hamza said that he would call the next day.. Explanation:** Will changes to would and tomorrow commonly changes to the next day. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**6. Choose the correct passive form of “The guard opened the gate.”**

- A. The gate is opened by the guard.
- B. The gate was being opened by the guard.
- C. The gate had opened the guard.
- D. The gate was opened by the guard.
- E. The guard was opened by the gate.

**Answer: D. The gate was opened by the guard.. Explanation:** Simple past passive uses was/were + past participle. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**7. By the time the interview started, the panel \_\_\_\_ reviewed the files.**

- A. reviewed the files
- B. have reviewed the files
- C. were reviewed the files
- D. had reviewed the files
- E. will have reviewed the files

**Answer: D. had reviewed the files. Explanation:** The earlier of two past actions is expressed by the past perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**8. Choose the best completion: The candidates \_\_\_\_ their roll-number slips.**

- A. received
- B. had received
- C. are received
- D. will received
- E. have received

**Answer: E. have received. Explanation:** An unfinished time or a present result calls for the present perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**9. Complete the conditional sentence: You cannot enter \_\_\_\_ you show the admission card.**

- A. unless



- B. if
- C. because
- D. although
- E. since

**Answer: A. unless.** **Explanation:** Unless means if not. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**10. Choose the correct passive form of “The office gave the candidate a receipt.”**

- A. The candidate gave a receipt by the office.
- B. A receipt was giving the candidate.
- C. The office was given by the candidate.
- D. The candidate was given a receipt by the office.
- E. The candidate is given a receipt yesterday.

**Answer: D. The candidate was given a receipt by the office..** **Explanation:** With two objects, the indirect object can become the passive subject. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**11. By next Friday, the team \_\_\_\_ the survey.**

- A. will have finished
- B. will finished
- C. has finished
- D. had finished
- E. is finished

**Answer: A. will have finished.** **Explanation:** “By” followed by a future deadline normally requires the future perfect for an action completed before that time. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**12. Choose the correct verb: Mathematics \_\_\_\_ careful reasoning.**

- A. require
- B. are requiring
- C. have require
- D. were required
- E. requires

**Answer: E. requires.** **Explanation:** Mathematics is treated as a singular subject when it names a field of study. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**13. Choose the correct form: Every afternoon, The laboratory assistant \_\_\_\_ the equipment.**

- A. check
- B. checks
- C. is checking

D. has checks

E. reviewed

**Answer: B. checks. Explanation:** A repeated routine takes the simple present; the singular subject requires the -s/-es form. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**14. By the time the lecture began, the students \_\_\_\_ taken their seats.**

A. had taken their seats

B. taken their seats

C. have taken their seats

D. were taken their seats

E. will have taken their seats

**Answer: A. had taken their seats. Explanation:** The earlier of two past actions is expressed by the past perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**15. Choose the correct indirect narration: The teacher said, "The earth revolves around the sun."**

A. The teacher said that the earth revolved around the sun yesterday.

B. The teacher told that the earth revolves around the sun.

C. The teacher asked whether the earth revolves around the sun.

D. The teacher said that the earth had revolved around the sun.

E. The teacher said that the earth revolves around the sun.

**Answer: E. The teacher said that the earth revolves around the sun.. Explanation:** A universal scientific truth normally remains in the present tense. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**16. Choose the correct passive form of "The workers were painting the hall."**

A. The hall was painted by the workers.

B. The hall is being painted by the workers.

C. The hall had been painted by the workers.

D. The workers were being painted by the hall.

E. The hall was being painted by the workers.

**Answer: E. The hall was being painted by the workers.. Explanation:** Past continuous passive uses was/were being + past participle. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**17. Choose the correct form: Every afternoon, Hassan \_\_\_\_ his study notes.**

A. organize

B. is organizeing

C. has organizes

D. organizes

E. reviewed

**Answer: D. organizes. Explanation:** A repeated routine takes the simple present; the singular subject requires the -s/-es form. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**18. Choose the correct form: Every afternoon, The librarian \_\_\_\_ new arrivals.**

- A. record
- B. is recording
- C. has records
- D. reviewed
- E. records

**Answer: E. records. Explanation:** A repeated routine takes the simple present; the singular subject requires the -s/-es form. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**19. Choose the correct verb: There \_\_\_\_ several reasons for the delay.**

- A. is
- B. was
- C. has
- D. are
- E. be

**Answer: D. are. Explanation:** In a there-construction, the verb agrees with the real subject reasons. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**20. Choose the correct form: Every afternoon, Nida \_\_\_\_ the formula sheet.**

- A. reviews
- B. review
- C. is reviewing
- D. has reviews
- E. reviewed

**Answer: A. reviews. Explanation:** A repeated routine takes the simple present; the singular subject requires the -s/-es form. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**21. Complete the conditional sentence: I wish I \_\_\_\_ more time for revision.**

- A. have
- B. will have
- C. would have had yesterday
- D. had
- E. am having

**Answer: D. had.** **Explanation:** Wish about a present situation commonly uses a past form. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**22. Choose the best completion: The researchers \_\_\_\_ three trials so far.**

- A. have completed
- B. completed
- C. had completed
- D. are completed
- E. will completed

**Answer: A. have completed.** **Explanation:** An unfinished time or a present result calls for the present perfect. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**23. Choose the correct passive form of “The staff checks every application.”**

- A. Every application is checked by the staff.
- B. Every application was checked by the staff.
- C. Every application is checking the staff.
- D. The staff is checked by every application.
- E. Every application has checked by the staff.

**Answer: A. Every application is checked by the staff..** **Explanation:** Simple present passive uses am/is/are + past participle. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**24. Choose the correct verb: Neither of the two answers \_\_\_\_ correct.**

- A. are
- B. were
- C. have
- D. be
- E. is

**Answer: E. is.** **Explanation:** Neither is singular in formal agreement. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**25. Complete the conditional sentence: Take an umbrella in case it \_\_\_\_.**

- A. will rain
- B. would rain
- C. rains
- D. rained yesterday
- E. had rained

**Answer: C. rains.** **Explanation:** In case normally takes a present tense for a possible future event. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

## Practice Set 3 - 25 MCQs

1. Complete the conditional sentence: If the weather improves tomorrow, we \_\_\_\_ the match.

- A. would play
- B. will play
- C. played
- D. would have played
- E. play yesterday

**Answer: B. will play. Explanation:** A real future possibility uses present simple in the if-clause and will in the result.

**Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

2. Choose the correct verb: Either the assistants or the manager \_\_\_\_ the key.

- A. have
- B. are having
- C. were having
- D. has
- E. hold

**Answer: D. has. Explanation:** The nearer subject manager is singular. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

3. Choose the correct verb: Each of the machines \_\_\_\_ a separate power supply.

- A. requires
- B. require
- C. are requiring
- D. have required
- E. were requiring

**Answer: A. requires. Explanation:** Each is singular, so it takes a singular verb. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

4. Choose the correct verb: The number of applications \_\_\_\_ increased.

- A. have
- B. are
- C. were
- D. has
- E. be

**Answer: D. has. Explanation:** The number is the singular head noun. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

5. Choose the correct form: Every afternoon, Our coach \_\_\_\_ the training session.

- A. plan

- B. is planing
- C. plans
- D. has plans
- E. reviewed

**Answer: C. plans. Explanation:** A repeated routine takes the simple present; the singular subject requires the -s/-es form. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**6. Complete the conditional sentence: If water reaches 100°C at standard pressure, it \_\_\_\_.**

- A. boils
- B. will boil
- C. would boil
- D. boiled
- E. would have boiled

**Answer: A. boils. Explanation:** A scientific fact uses the zero conditional: present simple in both clauses. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**7. Complete the conditional sentence: If she had taken the earlier bus, she \_\_\_\_ here now.**

- A. will be
- B. would have been
- C. is
- D. had been
- E. would be

**Answer: E. would be. Explanation:** This mixed conditional links a past condition with a present result. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**8. Choose the correct passive form of “You must follow the instructions.”**

- A. The instructions must follow.
- B. The instructions must be followed.
- C. The instructions are must followed.
- D. You must be followed by the instructions.
- E. The instructions must have following.

**Answer: B. The instructions must be followed.. Explanation:** A modal passive uses modal + be + past participle. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**9. Choose the correct passive form of “The engineers are testing the bridge.”**

- A. The bridge is tested by the engineers.
- B. The bridge is being tested by the engineers.

- C. The bridge was being tested by the engineers.
- D. The bridge has been tested by the engineers.
- E. The engineers are being tested by the bridge.

**Answer: B. The bridge is being tested by the engineers..** **Explanation:** Present continuous passive uses am/is/are being + past participle. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**10. Choose the correct verb: One of the applicants who \_\_\_\_ qualified has withdrawn.**

- A. is
- B. was
- C. has
- D. be
- E. are

**Answer: E. are.** **Explanation:** Who refers to applicants, so the relative-clause verb is plural. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**11. Complete the sentence: At this moment, the engineers \_\_\_\_ the safety system.**

- A. are testing
- B. testing
- C. were testing
- D. have testing
- E. will testing

**Answer: A. are testing.** **Explanation:** The phrase “at this moment” shows an action in progress, so the present continuous is required. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**12. Complete the sentence: At this moment, the committee members \_\_\_\_ the proposal.**

- A. discussing
- B. were discussing
- C. have discussing
- D. will discussing
- E. are discussing

**Answer: E. are discussing.** **Explanation:** The phrase “at this moment” shows an action in progress, so the present continuous is required. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**13. By the time the rain began, the workers \_\_\_\_ covered the equipment.**

- A. covered the equipment
- B. have covered the equipment
- C. were covered the equipment

D. will have covered the equipment

E. had covered the equipment

**Answer: E. had covered the equipment. Explanation:** The earlier of two past actions is expressed by the past perfect.

**Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**14. Choose the correct preposition: She has worked here \_\_\_\_ January.**

A. for

B. during

C. at

D. since

E. by

**Answer: D. since. Explanation:** Since introduces the starting point of a period continuing to the present. **Quick tactic:**

Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**15. Choose the best completion: We \_\_\_\_ the laboratory twice.**

A. visited

B. had visited

C. have visited

D. are visited

E. will visited

**Answer: C. have visited. Explanation:** An unfinished time or a present result calls for the present perfect. **Quick tactic:**

Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**16. Choose the correct indirect narration: Mother said to me, "Please open the window."**

A. Mother said me please open the window.

B. Mother requested that open the window.

C. Mother told me that I opened the window.

D. Mother requested me to open the window.

E. Mother asked whether I open the window.

**Answer: D. Mother requested me to open the window.. Explanation:** A polite request can be reported with

requested/asked + object + to-infinitive. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**17. Choose the correct indirect narration: Ayesha said, "I revise every evening."**

A. Ayesha said that she revised every evening.

B. Ayesha told that she revises every evening.

C. Ayesha said that I revised every evening.

D. Ayesha said that she had revise every evening.



E. Ayesha asked that she revised every evening.

**Answer: A. Ayesha said that she revised every evening..** **Explanation:** With a past reporting verb, a present simple statement normally shifts to past simple and pronouns change. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**18. Choose the correct preposition: The seminar begins \_\_\_\_ 9:00 a.m.**

- A. at
- B. on
- C. in
- D. since
- E. for

**Answer: A. at.** **Explanation:** Use at with an exact clock time. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**19. By 6 p.m., the office \_\_\_\_ the forms.**

- A. will processed
- B. has processed
- C. had processed
- D. will have processed
- E. is processed

**Answer: D. will have processed.** **Explanation:** "By" followed by a future deadline normally requires the future perfect for an action completed before that time. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**20. By tomorrow morning, they \_\_\_\_ the hall.**

- A. will prepared
- B. has prepared
- C. had prepared
- D. is prepared
- E. will have prepared

**Answer: E. will have prepared.** **Explanation:** "By" followed by a future deadline normally requires the future perfect for an action completed before that time. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**21. Choose the correct indirect narration: Ali said to Sana, "Are you ready?"**

- A. Ali asked Sana if she was ready.
- B. Ali said Sana that she was ready.
- C. Ali asked Sana was she ready.
- D. Ali asked Sana that are you ready.
- E. Ali told Sana if she was ready.

**Answer: A. Ali asked Sana if she was ready.. Explanation:** A yes/no question is reported with asked + if/whether and statement word order. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**22. Choose the correct preposition: Success depends \_\_\_\_ disciplined practice.**

- A. to
- B. from
- C. with
- D. at
- E. on

**Answer: E. on. Explanation:** The fixed verb-preposition combination is depend on. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**23. Choose the correct passive form of “People speak English in many countries.”**

- A. English speaks in many countries.
- B. English was speaking in many countries.
- C. People are spoken by English.
- D. English has spoke in many countries.
- E. English is spoken in many countries.

**Answer: E. English is spoken in many countries.. Explanation:** The agent may be omitted when it is general or unimportant. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**24. Choose the correct preposition: The students are interested \_\_\_\_ data analytics.**

- A. on
- B. in
- C. at
- D. for
- E. with

**Answer: B. in. Explanation:** The fixed adjective-preposition combination is interested in. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

**25. Choose the correct passive form of “Close the laboratory door.”**

- A. Let the laboratory door closed.
- B. The laboratory door is close.
- C. Let the laboratory door be closed.
- D. The laboratory door has closing.
- E. Close is the laboratory door.

**Answer: C. Let the laboratory door be closed.. Explanation:** One standard imperative passive pattern is let + object + be + past participle. **Quick tactic:** Name the grammar rule before comparing the options; then reject any choice with the wrong tense, agreement, auxiliary or fixed preposition.

# ANALYTICAL REASONING

## Topics and contents

Analytical Reasoning becomes manageable when verbal clues are converted into visible structures. The section teaches how to construct, verify and modify those structures before answering linked questions.

This section covers Linear Seating Arrangements: One row facing north/south, Fixed positions and immediate neighbours, Relative positions, Conditional swaps and removals; Circular Arrangements: Facing centre/outward, Clockwise/anticlockwise order, Reference fixing, Opposite positions; Scheduling and Calendar Problems: Time slots and days, Before/after constraints, Consecutive blocks, Capacity and exclusivity; Logical Deductions: Conditional statements, Contrapositive, Only if/if and only if, Either-or and neither-nor, Valid and invalid conclusions; Blood Relations: Generation levels, Gender marking, Maternal/paternal sides, Coded relations and family trees.

**CORE HABIT:** Build one verified base diagram from all shared clues. Do not solve each question independently. Keep the base diagram and apply any temporary change on a separate line or sketch.

# 1. LINEAR SEATING ARRANGEMENTS

## Linear arrangement model

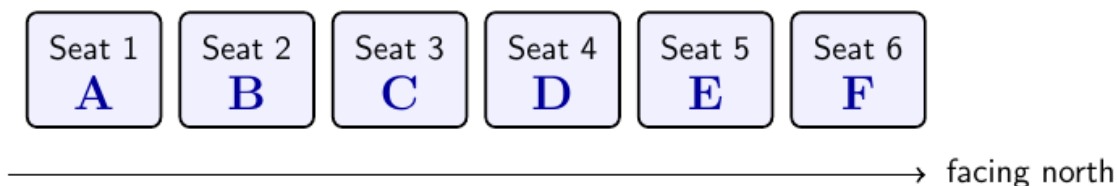


Figure: Numbered slots make left, right and distance clues visible.

**SECOND WORKED SCENARIO:** Six students A, B, C, D, E and F sit in a row facing north. A is at the extreme left, F is at the extreme right, C sits immediately to the right of B, D sits second to the right of B, and E sits immediately to the left of F.

**STEP 1 - Fix certain positions:** Place A in seat 1 and F in seat 6. Because E is immediately left of F, E must occupy seat 5.

**STEP 2 - Build the block:** C is immediately right of B, while D is second to the right of B. Therefore the three-seat pattern is B-C-D.

**STEP 3 - Fit and verify:** The only available consecutive positions are seats 2, 3 and 4. The final order is A-B-C-D-E-F. Check every clue before answering any related question.

**EXAM TACTIC:** Place exact seats and end positions first, then lock immediate pairs or blocks, and use weaker “somewhere left/right” clues last.

Linear arrangement problems place people or objects in numbered slots. Direction matters: for a person facing north, left/right matches the page; facing south reverses it.

A row is an ordered set of positions. Number the seats from left to right before using any clue. If everyone faces north, the person’s left and right match the page. If everyone faces south, the person’s left and right are reversed from the reader’s view.

Clues differ in strength. An exact position or end position is strongest. An immediate-neighbour clue creates a block. A clue such as “two places to the right” fixes a distance. A broad clue such as “somewhere left of” is weaker and should normally be used after stronger clues.

When a question introduces a swap, removal or reversal, keep the original arrangement visible and make the change on a second line. This prevents accidental damage to the base solution.

## Reliable method

7. Draw slots 1 to n.
8. Place fixed ends and exact positions first.
9. Join immediate blocks, e.g., A-B-C.
10. Translate “second to the right” into a two-slot gap.
11. Fill remaining names only after all strong clues are placed.
12. For a swap/removal question, modify the completed base arrangement rather than rebuilding from memory.

**WORKED SCENARIO:** Six students A, B, C, D, E, F face north. A is at the far left, F at far right, C immediately right of B, D second right of B, and E immediately left of F. Who is third?

**REASONING:** Slots: 1 A, 6 F, 5 E. The only block satisfying B-C and B \_ D is B at 2, C at 3, D at 4. Therefore C is third. Verify the final arrangement or relation against every clue before using it for the questions.

**SECOND GUIDED EXAMPLE:** Seven people P, Q, R, S, T, U and V face north. P is at the left end. Q is immediately right of P. S is third from the left. V is at the right end. T is immediately left of V. If R is left of U, determine the remaining order.

**DETAILED SOLUTION:** Write slots 1-7. P=1, Q=2, S=3, V=7 and T=6. The open seats are 4 and 5 for R and U. Since R is left of U, R=4 and U=5. The order is P-Q-S-R-U-T-V.

**FINAL CHECK:** Ask whether the answer depends on direction, facing, exact distance, generation, gender, necessary/sufficient language, or a temporary change introduced only in the question.

## 2. CIRCULAR ARRANGEMENTS

### Circular arrangement model

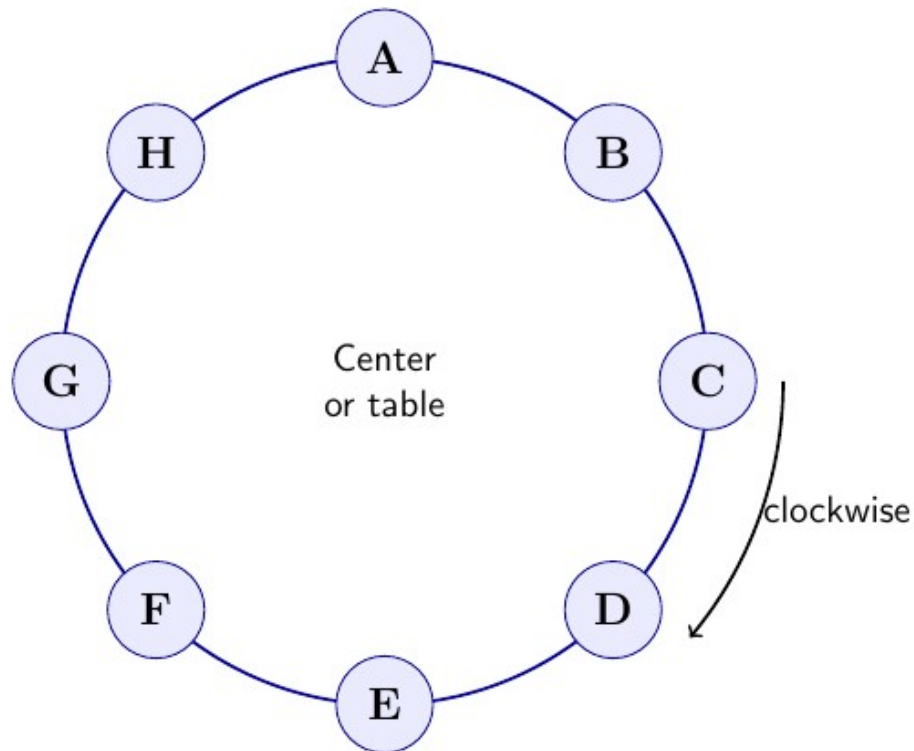


Figure: Fix one reference person to remove rotational ambiguity.

**SECOND WORKED SCENARIO:** Eight friends sit around a circular table facing the centre. Adeel is fixed at the top. Bushra is immediately clockwise from Adeel. Chetan sits opposite Adeel. Dalia is immediately anticlockwise from Chetan. Ehsan sits opposite Bushra.

**STEP 1 - Choose an anchor:** Circular arrangements can rotate without changing relationships, so fix Adeel at a convenient position.

**STEP 2 - Place exact relations:** Put Bushra one seat clockwise from Adeel and Chetan four seats away, directly opposite Adeel.

**STEP 3 - Complete dependent clues:** Place Dalia one seat anticlockwise from Chetan and Ehsan opposite Bushra. Fill remaining names only after all fixed relations are secure.

**EXAM TACTIC:** When everyone faces the centre, a person's left is clockwise and right is anticlockwise. When everyone faces outward, these directions reverse.

Circular arrangements have rotational symmetry. Fix one person at the top to remove equivalent rotations, then place all others clockwise or anticlockwise.

A circle has no natural first seat. Fix one person at the top to remove rotationally equivalent arrangements. Number the remaining seats clockwise. Never redraw the circle from a different orientation while solving linked questions.

Facing direction controls left and right. For people facing the centre, immediate left is clockwise and immediate right is anticlockwise when viewed from above. For people facing outward, the relationship reverses. Clockwise and anticlockwise clues are independent of facing direction.

With an even number of seats, the opposite position is half the circle away. Place opposite pairs early because they sharply reduce possibilities. Then place immediate neighbours and longer relative positions.

### Reliable method

13. Fix one reference person.

14. Mark whether everyone faces centre or outward.
15. For centre-facing people, left is clockwise and right anticlockwise when viewed from above; for outward-facing people the relation reverses.
16. Place opposite pairs next.
17. Use adjacency blocks and count positions around the circle.

**WORKED SCENARIO:** Six people sit around a circle facing the centre. A is fixed at the top; B is immediately right of A; C is opposite A. Where is B relative to A?

**REASONING:** For centre-facing people, immediate right is anticlockwise. Place B in the anticlockwise adjacent seat and C three seats from A. Verify the final arrangement or relation against every clue before using it for the questions.

**SECOND GUIDED EXAMPLE:** Eight people A-H face the centre. Fix A at the top. B is immediately clockwise from A, C is opposite A, D is immediately anticlockwise from C, and E is opposite B. How should the fixed positions be marked?

**DETAILED SOLUTION:** Number seats clockwise with A at 1. B=2. C is four seats away, so C=5. D is immediately anticlockwise from C, so D=4. E is opposite B, so E=6. The remaining people occupy seats 3, 7 and 8 subject to later clues.

**FINAL CHECK:** Ask whether the answer depends on direction, facing, exact distance, generation, gender, necessary/sufficient language, or a temporary change introduced only in the question.

### 3. SCHEDULING AND CALENDAR PROBLEMS

**SECOND WORKED SCENARIO:** Five subjects are studied from Monday to Friday. Mathematics is before Physics. Chemistry is immediately after English. Computer Science is on Friday. Physics is not on Thursday.

**STEP 1 - Draw time slots:** Write Monday, Tuesday, Wednesday, Thursday and Friday as fixed columns. Put Computer Science on Friday.

**STEP 2 - Use blocks:** Treat English-Chemistry as a two-day block because Chemistry is immediately after English.

**STEP 3 - Test remaining orders:** Place Mathematics before Physics while preventing Physics from occupying Thursday. Reject any arrangement that breaks even one clue.

**EXAM TACTIC:** Translate “before” into an inequality of positions and “immediately before” into a locked adjacent block. Keep fixed and optional placements visually different.

Scheduling problems allocate tasks to ordered time slots, days or rooms while respecting precedence, duration and capacity.

A schedule is a row or grid of ordered slots. Write every day, period, room or machine before placing events. A fixed slot is entered first. A before/after clue becomes an inequality; an immediately-before/after clue becomes a block.

Duration and capacity must be made visible. If a task takes two consecutive periods, write it as a two-cell block. If a room can hold only one event, cross out the occupied slot for all other events. If an event cannot occur on certain days, record exclusions directly in the grid.

When several possibilities remain, branch carefully. Write Case 1 and Case 2 rather than mixing alternatives. Reject a case as soon as it violates any clue. At the end, verify every clue against the completed schedule.

#### Reliable method

18. Create a grid with all slots.
19. Place fixed events and blocked times.
20. Translate before/after into inequalities.
21. Treat consecutive events as a block.
22. Use remaining capacity to force placements.
23. Check every clue against the final schedule.

**WORKED SCENARIO:** Four talks A-D occupy 9,10,11,12. A is before C; B is at 10; D is immediately after C. Find the schedule.

**REASONING:** C-D must be consecutive. It cannot be 9-10 because B occupies 10, nor 10-11. Therefore C=11,D=12. A=9 and B=10. Verify the final arrangement or relation against every clue before using it for the questions.

**SECOND GUIDED EXAMPLE:** Five workshops A-E are held Monday-Friday. A is before C. B is immediately after A. D is Friday. C is not Thursday. Determine the schedule.

**DETAILED SOLUTION:** A-B is a consecutive block. It cannot be Thursday-Friday because D is Friday. If A-B were Tuesday-Wednesday, C would need to be Thursday, which is forbidden. Therefore A=Monday and B=Tuesday. C must be Wednesday or Thursday, but not Thursday, so C=Wednesday. E=Thursday and D=Friday.

**FINAL CHECK:** Ask whether the answer depends on direction, facing, exact distance, generation, gender, necessary/sufficient language, or a temporary change introduced only in the question.



## 4. LOGICAL DEDUCTIONS

**SECOND WORKED EXAMPLE:** If a candidate submits the form, then the candidate receives a tracking number. Sana did not receive a tracking number. What follows?

**REASONING:** Let P mean “Sana submitted the form” and Q mean “Sana received a tracking number.” The rule is  $P \rightarrow Q$ . Its valid contrapositive is not  $Q \rightarrow$  not P. Therefore Sana did not submit the form.

**INVALID MOVE TO AVOID:** From  $P \rightarrow Q$  and Q, you cannot conclude P. Receiving a tracking number might have another cause; this mistaken reverse inference is called affirming the consequent.

**EXAM TACTIC:** Write every conditional as an arrow. Use the forward arrow and the contrapositive only; do not assume the converse or inverse.

Logical deduction converts verbal conditions into symbolic rules and asks what must, could or cannot follow.

Logical questions test what must follow from stated conditions, not what is usually true in real life. Translate each condition into a compact symbol. “If P, then Q” means P is sufficient for Q and Q is necessary for P.

The contrapositive of  $P \rightarrow Q$  is not-Q  $\rightarrow$  not-P and is logically equivalent. The converse  $Q \rightarrow P$  and inverse not-P  $\rightarrow$  not-Q are not guaranteed. “P only if Q” means  $P \rightarrow Q$ . “P if Q” means  $Q \rightarrow P$ . “P if and only if Q” allows both directions.

For must/could/cannot questions, distinguish certainty from possibility. A conclusion must be true in every valid case. It could be true if at least one valid case allows it. It cannot be true if every valid case rejects it. Do not strengthen either/or into exactly one unless the wording excludes both.

### Reliable method

24. Write  $P \rightarrow Q$  for “if P, then Q.”
25. Use the contrapositive not  $Q \rightarrow$  not P.
26. Do not assume converse  $Q \rightarrow P$ .
27. Translate “P only if Q” as  $P \rightarrow Q$ .
28. Translate “P if Q” as  $Q \rightarrow P$ .
29. For either/or, check whether the context is inclusive or exclusive.

**WORKED SCENARIO:** If a student takes Physics, the student takes Mathematics. Sara does not take Mathematics. What follows?

**REASONING:**  $P \rightarrow M$ . Contrapositive: not M  $\rightarrow$  not P. Sara does not take Mathematics, so she does not take Physics. Verify the final arrangement or relation against every clue before using it for the questions.

**SECOND GUIDED EXAMPLE:** Rules: If a candidate studies Physics, the candidate studies Mathematics. Only candidates who study Mathematics may take the advanced test. Sara did not take the advanced test. What can be concluded?

**DETAILED SOLUTION:** Physics  $\rightarrow$  Mathematics, and Advanced  $\rightarrow$  Mathematics. From not Advanced, nothing definite follows about Mathematics because Advanced  $\rightarrow$  Mathematics cannot be reversed. Therefore we cannot conclude that Sara did not study Mathematics or Physics. The safe conclusion is only the fact already stated: she did not take the advanced test.

### Essential translations

- If P, then Q:  $P \rightarrow Q$ . P guarantees Q; not-Q guarantees not-P.
- P only if Q:  $P \rightarrow Q$ . Q is necessary for P.
- P if Q:  $Q \rightarrow P$ . Q is sufficient for P.
- P if and only if Q:  $P \rightarrow Q$  and  $Q \rightarrow P$ .
- Either P or Q: at least one is true unless “but not both” is stated.
- Neither P nor Q: both P and Q are false.

**FINAL CHECK:** Ask whether the answer depends on direction, facing, exact distance, generation, gender, necessary/sufficient language, or a temporary change introduced only in the question.

## 5. BLOOD RELATIONS

**SECOND WORKED EXAMPLE:** Ayesha is the sister of Bilal. Bilal is the son of Kamran. Kamran is the brother of Nadia. How is Nadia related to Ayesha?

**STEP 1 - Mark generations:** Ayesha and Bilal are on the same generation. Kamran is one generation above them.

**STEP 2 - Mark gender and link:** Kamran is male and Nadia is his sister, so Nadia is also one generation above Ayesha.

**CONCLUSION:** Nadia is Ayesha's paternal aunt.

**EXAM TACTIC:** Draw generations on separate horizontal levels and mark M/F before naming the final relationship. Do not rely on verbal memory alone.

Blood-relation questions are best solved with a family tree rather than verbal chaining.

Use a family tree with horizontal generation levels. Place grandparents above parents, parents above children, and siblings on the same level. Mark gender immediately because uncle, aunt, nephew and niece depend on gender.

Distinguish blood relations from relations by marriage. A person's father's brother is a paternal uncle; the mother's brother is a maternal uncle. The spouse of an aunt or uncle is related by marriage unless the clues also establish a blood link.

For coded relations, translate one symbol at a time and draw each link. Start from the person named after "How is X related to Y?" and travel from Y to X. Reversing the direction changes relations such as parent/child and uncle/nephew.

### Reliable method

30. Put generations on horizontal levels.
31. Mark male/female immediately.
32. Use marriage lines and child branches consistently.
33. Start from the person named in the question, not necessarily the first clue.
34. Separate maternal and paternal sides.
35. For coded relations, translate one symbol at a time.

**WORKED SCENARIO:** A is the mother of B. C is the brother of A. How is C related to B?

**REASONING:** A is one generation above B. C is A's male sibling on the same generation, so C is B's maternal uncle. Verify the final arrangement or relation against every clue before using it for the questions.

**SECOND GUIDED EXAMPLE:** M is the mother of N. P is the brother of M. Q is the daughter of P. How is Q related to N?

**DETAILED SOLUTION:** M and P are siblings. N is M's child; Q is P's child. Children of siblings are cousins, so Q is N's cousin.

**GENERATION CODE:** Same level: siblings, cousins and spouses. One level above: parents, uncles and aunts. Two levels above: grandparents. Always mark gender before naming the relation.

**FINAL CHECK:** Ask whether the answer depends on direction, facing, exact distance, generation, gender, necessary/sufficient language, or a temporary change introduced only in the question.

## ANALYTICAL REASONING - PRACTICE EXERCISES

Three independent sets are provided. Attempt each question before reading the answer, explanation and quick tactic immediately below it. Each set contains 25 MCQs with five options (A–E).

### Practice Set 1 - 25 MCQs

#### Shared information for the following question(s):

A seven-day workshop runs from Monday to Sunday. One session is held each day: Logic, English, Mathematics, Physics, Chemistry, Computer, and Review.

1. Logic is on Monday.
2. Review is on Sunday.
3. English is immediately after Logic.
4. Physics is immediately after Mathematics.
5. Chemistry is on Friday.
6. Computer is immediately before Review.

#### 1. How many sessions occur between English and Chemistry?

- A. Three
- B. Two
- C. One
- D. None
- E. Four

**Answer: B. Two. Explanation:** Step 1: English is on Tuesday and Chemistry on Friday.

Step 2: Mathematics and Physics occur on Wednesday and Thursday.

Step 3: So, two sessions lie between English and Chemistry. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

#### Shared information for the following question(s):

Six students—Amina, Bilal, Camil, Danish, Eman, and Farah—sit in a straight row, all facing north.

1. Amina sits at the extreme left.
2. Farah sits at the extreme right.
3. Camil sits immediately to the right of Bilal.
4. Danish sits second to the right of Bilal.
5. Eman sits immediately to the left of Farah.

#### 2. How many students sit between Bilal and Eman?

- A. Two
- B. One
- C. None
- D. Four
- E. Three

**Answer: A. Two. Explanation:** Step 1: Bilal is in seat 2 and Eman is in seat 5.

Step 2: Seats 3 and 4 lie between them.

Step 3: So, two students sit between Bilal and Eman. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

#### Shared information for the following question(s):

Rashid and Mariam are married. Their children are Sameer, a son, and Nadia, a daughter.

Sameer is married to Huma; their children are Taimur, a son, and Rida, a daughter.

Nadia is married to Asif; their son is Zain.

#### 3. How is Huma related to Nadia?

- A. Maternal aunt
- B. Sister-in-law
- C. Cousin
- D. Daughter-in-law
- E. Sister

**Answer: B. Sister-in-law. Explanation:** Step 1: Huma is married to Nadia's brother, Sameer.

Step 2: The wife of one's brother is a sister-in-law.

Step 3: Therefore, Huma is Nadia's sister-in-law. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight friends—Umar, Vaneeza, Wasif, Xara, Yasir, Zara, Adil, and Bushra—sit around a circular table facing the centre. Umar is fixed at the top.

1. Yasir sits opposite Umar.
2. Vaneeza sits immediately clockwise from Umar.
3. Wasif sits immediately clockwise from Vaneeza.
4. Xara sits immediately anticlockwise from Yasir.
5. Zara sits immediately clockwise from Yasir.
6. Adil sits immediately clockwise from Zara.

**4. Who sits immediately anticlockwise from Bushra?**

- A. Umar
- B. Yasir
- C. Adil
- D. Zara
- E. Xara

**Answer: C. Adil. Explanation:** Step 1: The clockwise order is Umar, Vaneeza, Wasif, Xara, Yasir, Zara, Adil, Bushra.

Step 2: Adil comes immediately before Bushra clockwise.

Step 3: Therefore, Adil is immediately anticlockwise from Bushra. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six students—Owais, Parsa, Qasim, Rida, Saad, and Tania—sit around a circular table facing the centre. Owais is fixed at the top.

1. Qasim sits second clockwise from Owais.
2. Rida sits opposite Owais.
3. Saad sits immediately clockwise from Rida.
4. Parsa sits between Owais and Qasim on the clockwise side.

**5. If everyone moves two seats clockwise, who occupies Owais's original seat?**

- A. Saad
- B. Tania
- C. Qasim
- D. Rida
- E. Parsa

**Answer: A. Saad. Explanation:** Step 1: Owais's original seat is the top position.

Step 2: After everyone moves two seats clockwise, the person originally two seats anticlockwise from the top moves into it.

Step 3: Two seats anticlockwise from Owais is Saad, so Saad takes the top seat. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight friends—Umar, Vaneeza, Wasif, Xara, Yasir, Zara, Adil, and Bushra—sit around a circular table facing the centre. Umar is fixed at the top.

1. Yasir sits opposite Umar.
2. Vaneeza sits immediately clockwise from Umar.
3. Wasif sits immediately clockwise from Vaneeza.
4. Xara sits immediately anticlockwise from Yasir.
5. Zara sits immediately clockwise from Yasir.
6. Adil sits immediately clockwise from Zara.

**6. How many people sit between Vaneeza and Yasir along the shorter route?**

- A. Four
- B. Two
- C. None
- D. One
- E. Three

**Answer: B. Two. Explanation:** Step 1: Vaneeza is at position 2 and Yasir at position 5.

Step 2: Along the shorter clockwise route, Wasif and Xara lie between them.

Step 3: Therefore, two people sit between Vaneeza and Yasir. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. If the library is open (L), the guard is present (G).
2. If the guard is present (G), the cameras are on (C).
3. If the power fails (P), the cameras are off.
4. If the cameras are on (C), the alarm is active (A).

**7. If the alarm is not active, what must be true about the library?**

- A. The library is open
- B. The guard is present
- C. The power is normal
- D. The library is not open
- E. The cameras are on

**Answer: D. The library is not open. Explanation:** Step 1: Alarm not active implies cameras are not on by contrapositive of Rule 4.

Step 2: Cameras not on implies the guard is not present by contrapositive of Rule 2.

Step 3: Guard not present implies the library is not open by contrapositive of Rule 1.

Step 4: Hence, the library is not open. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

In a particular year, 1 March falls on a Tuesday. Use the ordinary seven-day weekly cycle for all four questions.

**8. What day is 1 April?**

- A. Monday
- B. Sunday

- C. Saturday
- D. Friday
- E. Thursday

**Answer: D. Friday. Explanation:** Step 1: 31 March is Thursday.

Step 2: The next calendar day is 1 April.

Step 3: Therefore, 1 April falls on Friday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Five applicants—Areeba, Bilal, Celine, Dawood, and Eman—are interviewed from Monday to Friday, one per day.

1. Celine is interviewed on Wednesday.
2. Areeba is interviewed on Monday.
3. Bilal is interviewed after Areeba but before Celine.
4. Dawood is interviewed immediately after Celine.
5. Eman is interviewed on Friday.

**9. Which applicant is interviewed exactly two days after Bilal?**

- A. Eman
- B. Areeba
- C. No applicant
- D. Celine
- E. Dawood

**Answer: E. Dawood. Explanation:** Step 1: Bilal is on Tuesday.

Step 2: Two days after Tuesday is Thursday.

Step 3: Dawood is scheduled on Thursday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

A seven-day workshop runs from Monday to Sunday. One session is held each day: Logic, English, Mathematics, Physics, Chemistry, Computer, and Review.

1. Logic is on Monday.
2. Review is on Sunday.
3. English is immediately after Logic.
4. Physics is immediately after Mathematics.
5. Chemistry is on Friday.
6. Computer is immediately before Review.

**10. If Mathematics is cancelled and Physics moves one day earlier, what session remains on Thursday?**

- A. Review
- B. No session
- C. Physics
- D. Computer
- E. Chemistry

**Answer: B. No session. Explanation:** Step 1: Originally, Mathematics is Wednesday and Physics Thursday.

Step 2: Cancelling Mathematics leaves Wednesday empty.

Step 3: Moving Physics one day earlier places it on Wednesday, so Thursday becomes vacant. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight friends—Umar, Vaneeza, Wasif, Xara, Yasir, Zara, Adil, and Bushra—sit around a circular table facing the centre.

Umar is fixed at the top.

1. Yasir sits opposite Umar.
2. Vaneeza sits immediately clockwise from Umar.
3. Wasif sits immediately clockwise from Vaneeza.
4. Xara sits immediately anticlockwise from Yasir.
5. Zara sits immediately clockwise from Yasir.
6. Adil sits immediately clockwise from Zara.

**11. If Umar and Yasir swap seats, who will be immediately clockwise from Umar?**

- A. Vaneeza
- B. Xara
- C. Bushra
- D. Adil
- E. Zara

**Answer: E. Zara. Explanation:** Step 1: Yasir originally sits at position 5, with Zara immediately clockwise at position 6. Step 2: After swapping, Umar moves to Yasir's old position 5. Step 3: Zara remains in position 6 and is immediately clockwise from Umar. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight delegates—Omer, Pari, Qasim, Rabia, Salman, Tehmina, Usman, and Warda—sit in a row facing north.

1. Omer and Warda sit at the left and right ends respectively.
2. Pari sits immediately to the right of Omer.
3. Rabia sits immediately to the right of Qasim.
4. Salman sits immediately to the right of Rabia.
5. Tehmina sits immediately to the right of Salman.
6. Usman sits immediately to the left of Warda.

**12. Who is fifth from the left?**

- A. Tehmina
- B. Qasim
- C. Rabia
- D. Usman
- E. Salman

**Answer: E. Salman. Explanation:** Step 1: Omer and Pari take seats 1 and 2. Step 2: Usman and Warda take seats 7 and 8. Step 3: The four-person chain Qasim-Rabia-Salman-Tehmina fills seats 3 to 6. Step 4: Salman is therefore in seat 5. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. If the library is open (L), the guard is present (G).
2. If the guard is present (G), the cameras are on (C).
3. If the power fails (P), the cameras are off.
4. If the cameras are on (C), the alarm is active (A).

**13. The guard is present and the power has not failed. What follows from the rules?**

- A. The alarm is active
- B. The cameras are off

- C. The library is open
- D. The guard is absent
- E. The alarm is inactive

**Answer: A. The alarm is active. Explanation:** Step 1: Guard present directly implies cameras on.

Step 2: Cameras on directly implies alarm active.

Step 3: The library need not be open because Rule 1 cannot be reversed.

Step 4: Thus, the alarm is active. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Ahmed and Sara are married. They have two children: Bilal, a son, and Hina, a daughter.

Bilal is married to Nida, and their son is Owais.

Hina is married to Kamran, and their daughter is Laiba.

**14. What is Kamran's relation to Bilal?**

- A. Cousin
- B. Son-in-law
- C. Maternal uncle
- D. Brother-in-law
- E. Paternal uncle

**Answer: D. Brother-in-law. Explanation:** Step 1: Kamran is married to Bilal's sister, Hina.

Step 2: The husband of one's sister is a brother-in-law.

Step 3: Therefore, Kamran is Bilal's brother-in-law. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

A seven-day workshop runs from Monday to Sunday. One session is held each day: Logic, English, Mathematics, Physics, Chemistry, Computer, and Review.

1. Logic is on Monday.
2. Review is on Sunday.
3. English is immediately after Logic.
4. Physics is immediately after Mathematics.
5. Chemistry is on Friday.
6. Computer is immediately before Review.

**15. Which session is held on Saturday?**

- A. Computer
- B. Chemistry
- C. Review
- D. English
- E. Physics

**Answer: A. Computer. Explanation:** Step 1: Review is on Sunday.

Step 2: Computer is immediately before Review.

Step 3: Therefore, Computer is on Saturday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

A student studies one subject each day from Monday to Saturday: Mathematics, Physics, Chemistry, English, Computer Science, and Biology.

1. Mathematics is studied on Monday.



2. Biology is studied on Saturday.
3. Physics is studied immediately after Mathematics.
4. English is studied immediately after Chemistry.
5. Computer Science is studied on Friday.

**16. On which day is Chemistry studied?**

- A. Monday
- B. Tuesday
- C. Thursday
- D. Friday
- E. Wednesday

**Answer: E. Wednesday. Explanation:** Step 1: Mathematics and Physics occupy Monday and Tuesday.

Step 2: Computer Science is on Friday and Biology on Saturday.

Step 3: The only consecutive days left for Chemistry followed by English are Wednesday and Thursday.

Step 4: Therefore, Chemistry is on Wednesday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. If the library is open (L), the guard is present (G).
2. If the guard is present (G), the cameras are on (C).
3. If the power fails (P), the cameras are off.
4. If the cameras are on (C), the alarm is active (A).

**17. The power fails. Which statement is forced if all rules remain consistent?**

- A. The library is open
- B. The guard is present
- C. The library is not open
- D. The alarm is active
- E. The cameras are on

**Answer: C. The library is not open. Explanation:** Step 1: Power failure makes the cameras off.

Step 2: If the library were open, the guard would be present and the cameras would have to be on.

Step 3: That would contradict the cameras being off.

Step 4: Therefore, the library cannot be open. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

A student studies one subject each day from Monday to Saturday: Mathematics, Physics, Chemistry, English, Computer Science, and Biology.

1. Mathematics is studied on Monday.
2. Biology is studied on Saturday.
3. Physics is studied immediately after Mathematics.
4. English is studied immediately after Chemistry.
5. Computer Science is studied on Friday.

**18. Which subject is studied immediately before Biology?**

- A. English
- B. Computer Science
- C. Mathematics
- D. Chemistry

## E. Physics

**Answer: B. Computer Science. Explanation:** Step 1: Biology is fixed on Saturday.

Step 2: The day immediately before Saturday is Friday.

Step 3: Computer Science is scheduled on Friday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six students—Amina, Bilal, Camil, Danish, Eman, and Farah—sit in a straight row, all facing north.

1. Amina sits at the extreme left.
2. Farah sits at the extreme right.
3. Camil sits immediately to the right of Bilal.
4. Danish sits second to the right of Bilal.
5. Eman sits immediately to the left of Farah.

**19. Which pair sits next to each other in that left-to-right order?**

- A. Camil and Eman
- B. Bilal and Danish
- C. Amina and Camil
- D. Danish and Eman
- E. Eman and Camil

**Answer: D. Danish and Eman. Explanation:** Step 1: The completed order is Amina, Bilal, Camil, Danish, Eman, Farah.

Step 2: Danish is directly followed by Eman.

Step 3: Hence, Danish and Eman are adjacent in the stated order. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Five applicants—Areeba, Bilal, Celine, Dawood, and Eman—are interviewed from Monday to Friday, one per day.

1. Celine is interviewed on Wednesday.
2. Areeba is interviewed on Monday.
3. Bilal is interviewed after Areeba but before Celine.
4. Dawood is interviewed immediately after Celine.
5. Eman is interviewed on Friday.

**20. If Wednesday is declared a holiday and all later interviews move one working day forward, on which day is Eman interviewed?**

- A. Monday of the next week
- B. Saturday of the same week
- C. Tuesday of the next week
- D. Friday of the same week
- E. Thursday of the same week

**Answer: A. Monday of the next week. Explanation:** Step 1: The interviews originally on Wednesday, Thursday, and Friday shift to the next available working days.

Step 2: Celine moves to Thursday and Dawood to Friday.

Step 3: The next working day after Friday is Monday of the following week, so Eman moves there. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. If a candidate qualifies (Q), the candidate passes Mathematics (M).
2. If a candidate qualifies (Q), the candidate passes the interview (I).
3. If the interview is passed (I), the documents are complete (D).
4. If the documents are complete (D), verification is approved (V).

**21. A candidate did not pass Mathematics. Which conclusion is forced?**

- A. The interview was passed
- B. The candidate qualified
- C. Verification was approved
- D. Documents were complete
- E. The candidate did not qualify

**Answer: E. The candidate did not qualify. Explanation:** Step 1: Rule 1 says qualification implies passing Mathematics. Step 2: By contrapositive, failure to pass Mathematics implies no qualification. Step 3: Other outcomes are not fixed by this fact alone. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Seven candidates—Haris, Iqra, Junaid, Kiran, Lubna, Moiz, and Nadia—sit in a row facing north.

1. Kiran occupies the middle seat.
2. Haris and Nadia sit at the two ends, with Haris on the left.
3. Iqra sits immediately to the left of Junaid.
4. Lubna sits immediately to the right of Kiran.
5. Moiz sits immediately to the left of Nadia.

**22. Who sits second from the right end?**

- A. Lubna
- B. Kiran
- C. Moiz
- D. Nadia
- E. Junaid

**Answer: C. Moiz. Explanation:** Step 1: With seven seats, Kiran is in seat 4. Step 2: Haris is in seat 1 and Nadia in seat 7. Step 3: Moiz must be in seat 6 because he is immediately left of Nadia. Step 4: Thus, Moiz is second from the right. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use the following rules:

1. If A is true, then B is true.
  2. If B is true, then C is true.
  3. If C is true, then D is true.
  4. If D is false, then E is true.
- A conclusion is valid only when it must follow from the rules.

**23. If A is true, which statement must also be true?**

- A. D is true
- B. C is false
- C. E is false
- D. D is false
- E. A is false

**Answer: A. D is true. Explanation:** Step 1: A true gives B true by Rule 1. Step 2: B true gives C true by Rule 2. Step 3: C true gives D true by Rule 3.

Step 4: Therefore, D must be true. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight officers—Gohar, Hina, Imran, Javeria, Kamal, Laila, Musa, and Noreen—sit around a circular table facing the centre. Gohar is fixed at the top.

1. Hina sits immediately clockwise from Gohar.
2. Javeria sits third clockwise from Gohar.
3. Kamal sits immediately clockwise from Javeria.
4. Imran sits between Hina and Javeria.
5. Laila sits opposite Hina.
6. Musa sits immediately clockwise from Laila.

**24. Who sits opposite Gohar?**

- A. Noreen
- B. Laila
- C. Kamal
- D. Musa
- E. Javeria

**Answer: C. Kamal. Explanation:** Step 1: With eight seats, the opposite position is four places away.

Step 2: The clockwise order begins Gohar, Hina, Imran, Javeria, Kamal.

Step 3: Therefore, Kamal is opposite Gohar. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Farooq and Ayesha are married. Their children are Hamza, a son, and Iman, a daughter.

Hamza is married to Zara; their daughters are Kiran and Mehak.

Iman is married to Usman; their son is Danish.

**25. How is Ayesha related to Danish?**

- A. Paternal aunt
- B. Mother-in-law
- C. Paternal grandmother
- D. Maternal grandmother
- E. Maternal aunt

**Answer: D. Maternal grandmother. Explanation:** Step 1: Danish is Iman's son.

Step 2: Ayesha is Iman's mother.

Step 3: A mother's mother is the maternal grandmother.

Step 4: Therefore, Ayesha is Danish's maternal grandmother. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

## Practice Set 2 - 25 MCQs

### Shared information for the following question(s):

Five applicants—Areeba, Bilal, Celine, Dawood, and Eman—are interviewed from Monday to Friday, one per day.

1. Celine is interviewed on Wednesday.
2. Areeba is interviewed on Monday.
3. Bilal is interviewed after Areeba but before Celine.
4. Dawood is interviewed immediately after Celine.
5. Eman is interviewed on Friday.

### 1. Who is interviewed on Tuesday?

- A. Eman
- B. Bilal
- C. Dawood
- D. Areeba
- E. Celine

**Answer: B. Bilal. Explanation:** Step 1: Areeba is on Monday and Celine on Wednesday.

Step 2: Bilal must be after Areeba but before Celine.

Step 3: The only available day is Tuesday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

### Shared information for the following question(s):

Use these rules:

1. Exactly one of P and Q is true.
2. If P is true, R is true.
3. If Q is true, S is true.
4. If R is false, T is true.

### 2. If P is true, which statement must be false?

- A. R is true
- B. R may be true
- C. P is true
- D. Q is true
- E. Q is false

**Answer: D. Q is true. Explanation:** Step 1: Exactly one of P and Q can be true.

Step 2: Since P is true, Q must be false.

Step 3: Rule 2 also makes R true, but the question asks for the statement that must be false.

Step 4: Therefore, 'Q is true' must be false. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

### Shared information for the following question(s):

A student studies one subject each day from Monday to Saturday: Mathematics, Physics, Chemistry, English, Computer Science, and Biology.

1. Mathematics is studied on Monday.
2. Biology is studied on Saturday.
3. Physics is studied immediately after Mathematics.
4. English is studied immediately after Chemistry.
5. Computer Science is studied on Friday.

### 3. How many days occur between Physics and Computer Science?

- A. Four
- B. Two

- C. None
- D. Three
- E. One

**Answer: B. Two. Explanation:** Step 1: Physics is on Tuesday and Computer Science on Friday.

Step 2: Wednesday and Thursday lie between them.

Step 3: Hence, there are two days between the two subjects. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Farooq and Ayesha are married. Their children are Hamza, a son, and Iman, a daughter.

Hamza is married to Zara; their daughters are Kiran and Mehak.

Iman is married to Usman; their son is Danish.

**4. What is Danish's relation to Hamza?**

- A. Uncle
- B. Nephew
- C. Son
- D. Cousin
- E. Brother

**Answer: B. Nephew. Explanation:** Step 1: Danish is the son of Hamza's sister, Iman.

Step 2: A sister's son is a nephew.

Step 3: Thus, Danish is Hamza's nephew. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Seven candidates—Haris, Iqra, Junaid, Kiran, Lubna, Moiz, and Nadia—sit in a row facing north.

1. Kiran occupies the middle seat.
2. Haris and Nadia sit at the two ends, with Haris on the left.
3. Iqra sits immediately to the left of Junaid.
4. Lubna sits immediately to the right of Kiran.
5. Moiz sits immediately to the left of Nadia.

**5. Which candidate sits exactly between Junaid and Lubna?**

- A. Haris
- B. Nadia
- C. Moiz
- D. Iqra
- E. Kiran

**Answer: E. Kiran. Explanation:** Step 1: The fixed placements give Haris \_ \_ Kiran Lubna Moiz Nadia.

Step 2: Iqra and Junaid must fill seats 2 and 3 in that order.

Step 3: Junaid is in seat 3 and Lubna in seat 5, so Kiran in seat 4 is exactly between them. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**6. Which pair is NOT adjacent in the final arrangement?**

- A. Iqra and Junaid
- B. Junaid and Lubna
- C. Moiz and Nadia

D. Haris and Iqra

E. Kiran and Lubna

**Answer: B. Junaid and Lubna. Explanation:** Step 1: The order is Haris, Iqra, Junaid, Kiran, Lubna, Moiz, Nadia.

Step 2: Junaid and Lubna have Kiran between them.

Step 3: Every other listed pair occupies consecutive seats. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Five applicants—Areeba, Bilal, Celine, Dawood, and Eman—are interviewed from Monday to Friday, one per day.

1. Celine is interviewed on Wednesday.
2. Areeba is interviewed on Monday.
3. Bilal is interviewed after Areeba but before Celine.
4. Dawood is interviewed immediately after Celine.
5. Eman is interviewed on Friday.

**7. Whose interview is immediately before Eman's?**

A. Areeba

B. No applicant

C. Bilal

D. Dawood

E. Celine

**Answer: D. Dawood. Explanation:** Step 1: Eman is on Friday.

Step 2: Dawood is immediately after Celine, who is on Wednesday, so Dawood is on Thursday.

Step 3: Thursday is immediately before Friday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. If a candidate qualifies (Q), the candidate passes Mathematics (M).
2. If a candidate qualifies (Q), the candidate passes the interview (I).
3. If the interview is passed (I), the documents are complete (D).
4. If the documents are complete (D), verification is approved (V).

**8. A candidate qualifies. Which final result must occur?**

A. Verification is rejected

B. Verification is approved

C. Documents are incomplete

D. The interview is failed

E. Mathematics is failed

**Answer: B. Verification is approved. Explanation:** Step 1: Qualification gives a passed interview by Rule 2.

Step 2: A passed interview gives complete documents by Rule 3.

Step 3: Complete documents give approved verification by Rule 4.

Step 4: Therefore, verification must be approved. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. If the library is open (L), the guard is present (G).
2. If the guard is present (G), the cameras are on (C).
3. If the power fails (P), the cameras are off.
4. If the cameras are on (C), the alarm is active (A).

**9. The library is open. Which condition must be present?**

- A. The guard is absent
- B. The library is closed
- C. The alarm is active
- D. The power has failed
- E. The cameras are off

**Answer: C. The alarm is active. Explanation:** Step 1: Open library implies the guard is present.

Step 2: Guard present implies cameras are on.

Step 3: Cameras on implies the alarm is active.

Step 4: Therefore, the alarm must be active. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six students—Amina, Bilal, Camil, Danish, Eman, and Farah—sit in a straight row, all facing north.

1. Amina sits at the extreme left.
2. Farah sits at the extreme right.
3. Camil sits immediately to the right of Bilal.
4. Danish sits second to the right of Bilal.
5. Eman sits immediately to the left of Farah.

**10. Who occupies the third seat from the left?**

- A. Bilal
- B. Camil
- C. Eman
- D. Farah
- E. Danish

**Answer: B. Camil. Explanation:** Step 1: Place Amina in seat 1 and Farah in seat 6.

Step 2: Eman must be in seat 5 because she is immediately left of Farah.

Step 3: The Bilal-Camil pair, with Danish two seats right of Bilal, fits seats 2, 3, and 4.

Step 4: Therefore, Camil is in seat 3. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Farooq and Ayesha are married. Their children are Hamza, a son, and Iman, a daughter.

Hamza is married to Zara; their daughters are Kiran and Mehak.

Iman is married to Usman; their son is Danish.

**11. How is Zara related to Iman?**

- A. Sister
- B. Niece
- C. Sister-in-law
- D. Cousin
- E. Maternal aunt

**Answer: C. Sister-in-law. Explanation:** Step 1: Zara is married to Iman's brother, Hamza.

Step 2: A brother's wife is a sister-in-law.

Step 3: Therefore, Zara is Iman's sister-in-law. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.



**Shared information for the following question(s):**

Seven candidates—Haris, Iqra, Junaid, Kiran, Lubna, Moiz, and Nadia—sit in a row facing north.

1. Kiran occupies the middle seat.
2. Haris and Nadia sit at the two ends, with Haris on the left.
3. Iqra sits immediately to the left of Junaid.
4. Lubna sits immediately to the right of Kiran.
5. Moiz sits immediately to the left of Nadia.

**12. If Iqra and Lubna swap places, who will be immediately to the right of Kiran?**

- A. Lubna
- B. Moiz
- C. Iqra
- D. Nadia
- E. Junaid

**Answer: C. Iqra. Explanation:** Step 1: Initially, Lubna is immediately right of Kiran.

Step 2: Swapping Iqra and Lubna moves Iqra into Lubna's seat 5.

Step 3: Kiran remains in seat 4, so Iqra becomes his immediate right neighbour. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Ahmed and Sara are married. They have two children: Bilal, a son, and Hina, a daughter.

Bilal is married to Nida, and their son is Owais.

Hina is married to Kamran, and their daughter is Laiba.

**13. What is Nida's relation to Hina?**

- A. Sister
- B. Daughter-in-law
- C. Aunt
- D. Sister-in-law
- E. Cousin

**Answer: D. Sister-in-law. Explanation:** Step 1: Nida is married to Hina's brother, Bilal.

Step 2: The wife of one's brother is a sister-in-law.

Step 3: Hence, Nida is Hina's sister-in-law. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six students—Owais, Parsa, Qasim, Rida, Saad, and Tania—sit around a circular table facing the centre.

Owais is fixed at the top.

1. Qasim sits second clockwise from Owais.
2. Rida sits opposite Owais.
3. Saad sits immediately clockwise from Rida.
4. Parsa sits between Owais and Qasim on the clockwise side.

**14. Who sits immediately clockwise from Qasim?**

- A. Parsa
- B. Rida
- C. Saad
- D. Tania
- E. Owais

**Answer: B. Rida. Explanation:** Step 1: Parsa must be immediately clockwise from Owais because she lies between Owais and Qasim.

Step 2: Qasim is next, in the second clockwise position.

Step 3: Rida is opposite Owais and therefore immediately clockwise from Qasim. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six people—Adeel, Bushra, Chetan, Dalia, Ehsan, and Farah—sit around a circular table facing the centre.

Adeel's seat is taken as the top reference point.

1. Bushra sits immediately clockwise from Adeel.
2. Dalia sits opposite Adeel.
3. Ehsan sits immediately clockwise from Dalia.
4. Chetan sits immediately clockwise from Bushra.

**15. Which person sits opposite Bushra?**

- A. Chetan
- B. Ehsan
- C. Farah
- D. Dalia
- E. Adeel

**Answer: B. Ehsan. Explanation:** Step 1: In a six-seat circle, the opposite seat is three positions away.

Step 2: Bushra is one step clockwise from Adeel.

Step 3: Three steps from Bushra lands on Ehsan. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

A student studies one subject each day from Monday to Saturday: Mathematics, Physics, Chemistry, English, Computer Science, and Biology.

1. Mathematics is studied on Monday.
2. Biology is studied on Saturday.
3. Physics is studied immediately after Mathematics.
4. English is studied immediately after Chemistry.
5. Computer Science is studied on Friday.

**16. If English and Computer Science exchange days, what is studied on Thursday?**

- A. Physics
- B. Chemistry
- C. Computer Science
- D. Biology
- E. English

**Answer: C. Computer Science. Explanation:** Step 1: The original schedule is Mathematics, Physics, Chemistry, English, Computer Science, Biology.

Step 2: English is on Thursday and Computer Science on Friday.

Step 3: After exchanging their days, Computer Science moves to Thursday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight friends—Umar, Vaneeza, Wasif, Xara, Yasir, Zara, Adil, and Bushra—sit around a circular table facing the centre. Umar is fixed at the top.

1. Yasir sits opposite Umar.
2. Vaneeza sits immediately clockwise from Umar.
3. Wasif sits immediately clockwise from Vaneeza.
4. Xara sits immediately anticlockwise from Yasir.

5. Zara sits immediately clockwise from Yasir.
6. Adil sits immediately clockwise from Zara.

**17. Which friend sits opposite Wasif?**

- A. Bushra
- B. Xara
- C. Zara
- D. Yasir
- E. Adil

**Answer: E. Adil. Explanation:** Step 1: Wasif is in the third clockwise seat from Umar.

Step 2: The opposite seat is four positions farther, which is occupied by Adil.

Step 3: Thus, Adil sits opposite Wasif. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six students—Owais, Parsa, Qasim, Rida, Saad, and Tania—sit around a circular table facing the centre.

Owais is fixed at the top.

1. Qasim sits second clockwise from Owais.
2. Rida sits opposite Owais.
3. Saad sits immediately clockwise from Rida.
4. Parsa sits between Owais and Qasim on the clockwise side.

**18. Who sits opposite Parsa?**

- A. Owais
- B. Rida
- C. Qasim
- D. Tania
- E. Saad

**Answer: E. Saad. Explanation:** Step 1: The clockwise order is Owais, Parsa, Qasim, Rida, Saad, Tania.

Step 2: In a six-seat circle, opposite seats are three positions apart.

Step 3: Three places from Parsa is Saad. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use the following rules:

1. If A is true, then B is true.
2. If B is true, then C is true.
3. If C is true, then D is true.
4. If D is false, then E is true.

A conclusion is valid only when it must follow from the rules.

**19. When B is true, which outcome is guaranteed?**

- A. E is true
- B. B is false
- C. A is true
- D. D is true
- E. C is false

**Answer: D. D is true. Explanation:** Step 1: B true leads to C true by Rule 2.

Step 2: C true then leads to D true by Rule 3.

Step 3: A true is not guaranteed because the converse of Rule 1 is invalid.

Step 4: Thus, D is guaranteed. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six students—Owais, Parsa, Qasim, Rida, Saad, and Tania—sit around a circular table facing the centre.

Owais is fixed at the top.

1. Qasim sits second clockwise from Owais.
2. Rida sits opposite Owais.
3. Saad sits immediately clockwise from Rida.
4. Parsa sits between Owais and Qasim on the clockwise side.

**20. Which two students are immediate neighbours of Tania?**

- A. Rida and Saad
- B. Qasim and Rida
- C. Saad and Owais
- D. Parsa and Qasim
- E. Owais and Parsa

**Answer: C. Saad and Owais. Explanation:** Step 1: Tania is the only unfilled seat after placing the others.

Step 2: The order closes as Saad, Tania, Owais.

Step 3: Hence, Tania's neighbours are Saad and Owais. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

In a particular year, 1 March falls on a Tuesday. Use the ordinary seven-day weekly cycle for all four questions.

**21. What day of the week is 8 March?**

- A. Wednesday
- B. Friday
- C. Tuesday
- D. Thursday
- E. Monday

**Answer: C. Tuesday. Explanation:** Step 1: 8 March is exactly seven days after 1 March.

Step 2: A seven-day shift returns to the same weekday.

Step 3: Therefore, 8 March is Tuesday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight officers—Gohar, Hina, Imran, Javeria, Kamal, Laila, Musa, and Noreen—sit around a circular table facing the centre.

Gohar is fixed at the top.

1. Hina sits immediately clockwise from Gohar.
2. Javeria sits third clockwise from Gohar.
3. Kamal sits immediately clockwise from Javeria.
4. Imran sits between Hina and Javeria.
5. Laila sits opposite Hina.
6. Musa sits immediately clockwise from Laila.

**22. Starting at Javeria and moving clockwise, who is the third person reached?**

- A. Musa

- B. Kamal
- C. Noreen
- D. Gohar
- E. Laila

**Answer: A. Musa. Explanation:** Step 1: From Javeria, the first person clockwise is Kamal.

Step 2: The second is Laila.

Step 3: The third is Musa. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Farooq and Ayesha are married. Their children are Hamza, a son, and Iman, a daughter.

Hamza is married to Zara; their daughters are Kiran and Mehak.

Iman is married to Usman; their son is Danish.

**23. What is Kiran's relation to Danish?**

- A. Sister
- B. Cousin
- C. Niece
- D. Sister-in-law
- E. Aunt

**Answer: B. Cousin. Explanation:** Step 1: Kiran is Hamza's daughter and Danish is Iman's son.

Step 2: Hamza and Iman are siblings.

Step 3: Children of siblings are cousins.

Step 4: Hence, Kiran and Danish are cousins. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six friends—Ali, Beenish, Chaman, Dua, Ehsan, and Fiza—stand in a line facing north.

1. Fiza is at the extreme right.
2. Ehsan is immediately to the left of Fiza.
3. Chaman is two places to the right of Ali.
4. Beenish sits immediately between Ali and Chaman.
5. Dua is immediately to the right of Chaman.

**24. Who stands at the extreme left?**

- A. Chaman
- B. Ehsan
- C. Dua
- D. Beenish
- E. Ali

**Answer: E. Ali. Explanation:** Step 1: Ehsan and Fiza occupy seats 5 and 6.

Step 2: Ali-Beenish-Chaman-Dua must form a consecutive chain because Beenish is between Ali and Chaman and Dua follows Chaman.

Step 3: That chain fits seats 1 to 4, placing Ali at the extreme left. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight delegates—Omer, Pari, Qasim, Rabia, Salman, Tehmina, Usman, and Warda—sit in a row facing north.

1. Omer and Warda sit at the left and right ends respectively.

2. Pari sits immediately to the right of Omer.
3. Rabia sits immediately to the right of Qasim.
4. Salman sits immediately to the right of Rabia.
5. Tehmina sits immediately to the right of Salman.
6. Usman sits immediately to the left of Warda.

**25. How many delegates sit between Pari and Tehmina?**

- A. One
- B. Four
- C. Three
- D. Two
- E. Five

**Answer: C. Three. Explanation:** Step 1: The order is Omer, Pari, Qasim, Rabia, Salman, Tehmina, Usman, Warda.  
Step 2: Qasim, Rabia, and Salman lie between Pari and Tehmina.  
Step 3: Therefore, the number is three. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

## Practice Set 3 - 25 MCQs

### Shared information for the following question(s):

Eight delegates—Omer, Pari, Qasim, Rabia, Salman, Tehmina, Usman, and Warda—sit in a row facing north.

1. Omer and Warda sit at the left and right ends respectively.
2. Pari sits immediately to the right of Omer.
3. Rabia sits immediately to the right of Qasim.
4. Salman sits immediately to the right of Rabia.
5. Tehmina sits immediately to the right of Salman.
6. Usman sits immediately to the left of Warda.

**1. If Omer leaves and everyone to his right shifts one seat left, who becomes fourth from the left?**

- A. Rabia
- B. Usman
- C. Salman
- D. Tehmina
- E. Qasim

**Answer: C. Salman. Explanation:** Step 1: Remove Omer from the original order.

Step 2: The new order is Pari, Qasim, Rabia, Salman, Tehmina, Usman, Warda.

Step 3: The fourth person is Salman. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

### Shared information for the following question(s):

Use these rules:

1. Exactly one of P and Q is true.
2. If P is true, R is true.
3. If Q is true, S is true.
4. If R is false, T is true.

**2. If S is false, which statement must be true?**

- A. R is true
- B. P is false
- C. R is false
- D. T is false
- E. Q is true

**Answer: A. R is true. Explanation:** Step 1: Rule 3 says Q true implies S true.

Step 2: Since S is false, Q must be false by contrapositive.

Step 3: Exactly one of P and Q is true, so P is true.

Step 4: Rule 2 then makes R true. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

### Shared information for the following question(s):

Use the following rules:

1. If A is true, then B is true.
2. If B is true, then C is true.
3. If C is true, then D is true.
4. If D is false, then E is true.

A conclusion is valid only when it must follow from the rules.

**3. Suppose C is false. What must be true about B?**

- A. Nothing can be known
- B. B is false

- C. B may only be true
- D. B is true
- E. B equals C

**Answer: B. B is false. Explanation:** Step 1: Rule 2 says B true implies C true.

Step 2: Use the contrapositive: if C is false, B cannot be true.

Step 3: Hence, B must be false. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. If a candidate qualifies (Q), the candidate passes Mathematics (M).
2. If a candidate qualifies (Q), the candidate passes the interview (I).
3. If the interview is passed (I), the documents are complete (D).
4. If the documents are complete (D), verification is approved (V).

**4. The documents are not complete. What must be concluded about the interview?**

- A. The interview was repeated
- B. The interview was postponed
- C. The interview was passed
- D. No conclusion is possible
- E. The interview was not passed

**Answer: E. The interview was not passed. Explanation:** Step 1: Rule 3 states: passed interview implies complete documents.

Step 2: Its contrapositive is: incomplete documents imply the interview was not passed.

Step 3: Therefore, the interview was not passed. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six people—Adeel, Bushra, Chetan, Dalia, Ehsan, and Farah—sit around a circular table facing the centre. Adeel's seat is taken as the top reference point.

1. Bushra sits immediately clockwise from Adeel.
2. Dalia sits opposite Adeel.
3. Ehsan sits immediately clockwise from Dalia.
4. Chetan sits immediately clockwise from Bushra.

**5. If Chetan and Farah exchange seats, who will sit immediately anticlockwise from Adeel?**

- A. Chetan
- B. Dalia
- C. Ehsan
- D. Farah
- E. Bushra

**Answer: A. Chetan. Explanation:** Step 1: Originally, Farah sits immediately anticlockwise from Adeel.

Step 2: Chetan and Farah exchange seats, so Chetan moves into Farah's old position.

Step 3: Therefore, Chetan becomes immediately anticlockwise from Adeel. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Ahmed and Sara are married. They have two children: Bilal, a son, and Hina, a daughter.

Bilal is married to Nida, and their son is Owais.

Hina is married to Kamran, and their daughter is Laiba.



**6. How is Laiba related to Bilal?**

- A. Sister
- B. Daughter
- C. Niece
- D. Cousin
- E. Aunt

**Answer: C. Niece. Explanation:** Step 1: Laiba is Hina's daughter.

Step 2: Hina is Bilal's sister.

Step 3: A sister's daughter is a niece.

Step 4: Thus, Laiba is Bilal's niece. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight officers—Gohar, Hina, Imran, Javeria, Kamal, Laila, Musa, and Noreen—sit around a circular table facing the centre. Gohar is fixed at the top.

1. Hina sits immediately clockwise from Gohar.
2. Javeria sits third clockwise from Gohar.
3. Kamal sits immediately clockwise from Javeria.
4. Imran sits between Hina and Javeria.
5. Laila sits opposite Hina.
6. Musa sits immediately clockwise from Laila.

**7. Who is immediately anticlockwise from Noreen?**

- A. Kamal
- B. Musa
- C. Gohar
- D. Hina
- E. Laila

**Answer: B. Musa. Explanation:** Step 1: The completed clockwise order is Gohar, Hina, Imran, Javeria, Kamal, Laila, Musa, Noreen.

Step 2: Musa comes immediately before Noreen in clockwise order.

Step 3: So, Musa is immediately anticlockwise from Noreen. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six friends—Ali, Beenish, Chaman, Dua, Ehsan, and Fiza—stand in a line facing north.

1. Fiza is at the extreme right.
2. Ehsan is immediately to the left of Fiza.
3. Chaman is two places to the right of Ali.
4. Beenish sits immediately between Ali and Chaman.
5. Dua is immediately to the right of Chaman.

**8. Which person is third from the right?**

- A. Ali
- B. Dua
- C. Beenish
- D. Ehsan
- E. Chaman

**Answer: B. Dua. Explanation:** Step 1: The final order is Ali, Beenish, Chaman, Dua, Ehsan, Fiza.

Step 2: Counting from the right gives Fiza first, Ehsan second, and Dua third.

Step 3: Therefore, Dua is third from the right. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

In a particular year, 1 March falls on a Tuesday. Use the ordinary seven-day weekly cycle for all four questions.

**9. On which weekday does 17 March fall?**

- A. Friday
- B. Thursday
- C. Saturday
- D. Tuesday
- E. Wednesday

**Answer: B. Thursday. Explanation:** Step 1: From 1 March to 17 March is a difference of 16 days.

Step 2: Sixteen leaves a remainder of 2 when divided by 7.

Step 3: Two days after Tuesday is Thursday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. Exactly one of P and Q is true.
2. If P is true, R is true.
3. If Q is true, S is true.
4. If R is false, T is true.

**10. If T is false, what follows necessarily?**

- A. S is false
- B. R is true
- C. R is false
- D. Q is true
- E. P is true

**Answer: B. R is true. Explanation:** Step 1: Rule 4 is: R false implies T true.

Step 2: Its contrapositive is: T false implies R true.

Step 3: The truth of P and Q cannot be uniquely determined from R true.

Step 4: Therefore, only R true is necessary. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

In a particular year, 1 March falls on a Tuesday. Use the ordinary seven-day weekly cycle for all four questions.

**11. Which weekday is 31 March?**

- A. Saturday
- B. Sunday
- C. Wednesday
- D. Friday
- E. Thursday

**Answer: E. Thursday. Explanation:** Step 1: From 1 March to 31 March is 30 days.

Step 2: Thirty leaves a remainder of 2 after complete weeks.

Step 3: Two days after Tuesday is Thursday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six students—Amina, Bilal, Camil, Danish, Eman, and Farah—sit in a straight row, all facing north.

1. Amina sits at the extreme left.
2. Farah sits at the extreme right.
3. Camil sits immediately to the right of Bilal.
4. Danish sits second to the right of Bilal.
5. Eman sits immediately to the left of Farah.

**12. If Amina and Farah exchange seats, who will sit immediately to the left of Bilal?**

- A. Amina
- B. Eman
- C. Camil
- D. Farah
- E. Danish

**Answer: D. Farah. Explanation:** Step 1: Originally, the order is Amina, Bilal, Camil, Danish, Eman, Farah.

Step 2: After swapping only Amina and Farah, the order becomes Farah, Bilal, Camil, Danish, Eman, Amina.

Step 3: Farah is then immediately left of Bilal. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six people—Adeel, Bushra, Chetan, Dalia, Ehsan, and Farah—sit around a circular table facing the centre.

Adeel's seat is taken as the top reference point.

1. Bushra sits immediately clockwise from Adeel.
2. Dalia sits opposite Adeel.
3. Ehsan sits immediately clockwise from Dalia.
4. Chetan sits immediately clockwise from Bushra.

**13. Who sits immediately anticlockwise from Dalia?**

- A. Farah
- B. Chetan
- C. Ehsan
- D. Adeel
- E. Bushra

**Answer: B. Chetan. Explanation:** Step 1: Starting from Adeel, place Bushra and then Chetan clockwise.

Step 2: Dalia is opposite Adeel, so she occupies the fourth position.

Step 3: The seat immediately anticlockwise from Dalia is occupied by Chetan. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Rashid and Mariam are married. Their children are Sameer, a son, and Nadia, a daughter.

Sameer is married to Huma; their children are Taimur, a son, and Rida, a daughter.

Nadia is married to Asif; their son is Zain.

**14. How is Mariam related to Rida?**

- A. Paternal grandmother
- B. Great-grandmother

- C. Paternal aunt
- D. Maternal grandmother
- E. Maternal aunt

**Answer: A. Paternal grandmother. Explanation:** Step 1: Rida is Sameer's daughter.

Step 2: Mariam is Sameer's mother.

Step 3: The mother of Rida's father is her paternal grandmother.

Step 4: Therefore, Mariam is Rida's paternal grandmother. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight delegates—Omer, Pari, Qasim, Rabia, Salman, Tehmina, Usman, and Warda—sit in a row facing north.

1. Omer and Warda sit at the left and right ends respectively.
2. Pari sits immediately to the right of Omer.
3. Rabia sits immediately to the right of Qasim.
4. Salman sits immediately to the right of Rabia.
5. Tehmina sits immediately to the right of Salman.
6. Usman sits immediately to the left of Warda.

**15. Who sits immediately to the left of Usman?**

- A. Salman
- B. Tehmina
- C. Warda
- D. Qasim
- E. Rabia

**Answer: B. Tehmina. Explanation:** Step 1: Usman is immediately left of Warda, so he is in seat 7.

Step 2: The Qasim-Rabia-Salman-Tehmina chain ends in seat 6.

Step 3: Thus, Tehmina is immediately left of Usman. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six friends—Ali, Beenish, Chaman, Dua, Ehsan, and Fiza—stand in a line facing north.

1. Fiza is at the extreme right.
2. Ehsan is immediately to the left of Fiza.
3. Chaman is two places to the right of Ali.
4. Beenish sits immediately between Ali and Chaman.
5. Dua is immediately to the right of Chaman.

**16. If the row is viewed from the north side, who appears second from the left to the observer?**

- A. Fiza
- B. Beenish
- C. Dua
- D. Ehsan
- E. Chaman

**Answer: D. Ehsan. Explanation:** Step 1: The north-facing left-to-right order is Ali, Beenish, Chaman, Dua, Ehsan, Fiza. Step 2: An observer on the north side faces south, so the visible order is reversed: Fiza, Ehsan, Dua, Chaman, Beenish, Ali.

Step 3: Ehsan appears second from the observer's left. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**17. Who is positioned between Beenish and Dua?**

- A. Chaman
- B. Ali
- C. Ehsan
- D. No one
- E. Fiza

**Answer: A. Chaman. Explanation:** Step 1: Beenish is in seat 2 and Dua in seat 4.

Step 2: Chaman occupies seat 3.

Step 3: Hence, Chaman is between them. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Ahmed and Sara are married. They have two children: Bilal, a son, and Hina, a daughter.

Bilal is married to Nida, and their son is Owais.

Hina is married to Kamran, and their daughter is Laiba.

**18. How is Sara related to Owais?**

- A. Mother-in-law
- B. Paternal aunt
- C. Maternal aunt
- D. Maternal grandmother
- E. Paternal grandmother

**Answer: E. Paternal grandmother. Explanation:** Step 1: Owais is Bilal's son.

Step 2: Sara is Bilal's mother.

Step 3: A father's mother is the paternal grandmother.

Step 4: Therefore, Sara is Owais's paternal grandmother. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. If a candidate qualifies (Q), the candidate passes Mathematics (M).
2. If a candidate qualifies (Q), the candidate passes the interview (I).
3. If the interview is passed (I), the documents are complete (D).
4. If the documents are complete (D), verification is approved (V).

**19. Verification is not approved. Which status is impossible under the rules?**

- A. The candidate does not qualify
- B. The candidate qualifies
- C. The interview is not passed
- D. The candidate fails Mathematics
- E. The documents are incomplete

**Answer: B. The candidate qualifies. Explanation:** Step 1: If the candidate qualified, the chain  $Q \rightarrow I \rightarrow D \rightarrow V$  would make verification approved.

Step 2: Verification is not approved, so that chain cannot begin with Q.

Step 3: Thus, qualification is impossible. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

A seven-day workshop runs from Monday to Sunday. One session is held each day: Logic, English, Mathematics, Physics, Chemistry, Computer, and Review.

1. Logic is on Monday.
2. Review is on Sunday.
3. English is immediately after Logic.
4. Physics is immediately after Mathematics.
5. Chemistry is on Friday.
6. Computer is immediately before Review.

**20. On which day is Mathematics scheduled?**

- A. Saturday
- B. Friday
- C. Thursday
- D. Tuesday
- E. Wednesday

**Answer: E. Wednesday. Explanation:** Step 1: Logic and English occupy Monday and Tuesday.

Step 2: Chemistry is Friday; Computer and Review are Saturday and Sunday.

Step 3: The only consecutive pair of open days for Mathematics followed by Physics is Wednesday and Thursday.

Step 4: Thus, Mathematics is on Wednesday. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use the following rules:

1. If A is true, then B is true.
2. If B is true, then C is true.
3. If C is true, then D is true.
4. If D is false, then E is true.

A conclusion is valid only when it must follow from the rules.

**21. If D is false, which conclusion follows directly?**

- A. B is true
- B. A is true
- C. C is true
- D. E is false
- E. E is true

**Answer: E. E is true. Explanation:** Step 1: Rule 4 directly links D being false to E being true.

Step 2: No reverse assumption is needed.

Step 3: Therefore, E is true. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Eight officers—Gohar, Hina, Imran, Javeria, Kamal, Laila, Musa, and Noreen—sit around a circular table facing the centre. Gohar is fixed at the top.

1. Hina sits immediately clockwise from Gohar.
2. Javeria sits third clockwise from Gohar.
3. Kamal sits immediately clockwise from Javeria.
4. Imran sits between Hina and Javeria.
5. Laila sits opposite Hina.
6. Musa sits immediately clockwise from Laila.

**22. Which pair sits opposite each other?**

- A. Imran and Musa
- B. Hina and Musa

- C. Javeria and Noreen
- D. Kamal and Laila
- E. Gohar and Javeria

**Answer: A. Imran and Musa. Explanation:** Step 1: Opposite seats in an eight-person circle are four positions apart.  
 Step 2: Imran occupies position 3 and Musa position 7.  
 Step 3: They are therefore opposite each other. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Rashid and Mariam are married. Their children are Sameer, a son, and Nadia, a daughter.  
 Sameer is married to Huma; their children are Taimur, a son, and Rida, a daughter.  
 Nadia is married to Asif; their son is Zain.

**23. What is Zain's relation to Sameer?**

- A. Nephew
- B. Uncle
- C. Son
- D. Brother
- E. Cousin

**Answer: A. Nephew. Explanation:** Step 1: Zain is Nadia's son.  
 Step 2: Nadia is Sameer's sister.  
 Step 3: A sister's son is a nephew.  
 Step 4: Thus, Zain is Sameer's nephew. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Use these rules:

1. Exactly one of P and Q is true.
2. If P is true, R is true.
3. If Q is true, S is true.
4. If R is false, T is true.

**24. Assume R is false. Which result must follow?**

- A. P is true
- B. Q is false
- C. S is false
- D. T is false
- E. S is true

**Answer: E. S is true. Explanation:** Step 1: R false means P cannot be true because P would imply R.  
 Step 2: Since exactly one of P and Q is true, Q must be true.  
 Step 3: Q true implies S true.  
 Step 4: Rule 4 also makes T true, so S must be true. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.

**Shared information for the following question(s):**

Six people—Adeel, Bushra, Chetan, Dalia, Ehsan, and Farah—sit around a circular table facing the centre.  
 Adeel's seat is taken as the top reference point.

1. Bushra sits immediately clockwise from Adeel.
2. Dalia sits opposite Adeel.

3. Ehsan sits immediately clockwise from Dalia.
4. Chetan sits immediately clockwise from Bushra.

**25. Who are Adeel's immediate neighbours?**

- A. Bushra and Chetan
- B. Dalia and Farah
- C. Ehsan and Farah
- D. Chetan and Dalia
- E. Bushra and Farah

**Answer: E. Bushra and Farah. Explanation:** Step 1: The clockwise order is Adeel, Bushra, Chetan, Dalia, Ehsan, Farah.

Step 2: The seats directly next to Adeel are Bushra on one side and Farah on the other.

Step 3: Thus, Bushra and Farah are Adeel's neighbours. **Quick tactic:** Keep the verified base diagram visible and apply temporary changes on a separate line.



**MATHEMATICS-BASED QUANTITATIVE REASONING****Topics and contents**

Quantitative Reasoning tests efficient numerical interpretation. The aim is not long calculation; it is selecting a compact relationship, controlling units and using estimation or answer choices intelligently.

This section covers Number properties and arithmetic; Fractions, decimals and percentages; Ratios, proportions and variation; Averages, weighted averages and mixtures; Rates, time, work and distance; Algebraic equations and inequalities; Geometry and mensuration; Data interpretation and basic statistics; Probability; Counting, permutations and combinations.

**FOUR-LINE ROUGH WORK:** Line 1: what is required. Line 2: formula or relationship. Line 3: substitution. Line 4: answer with unit or interpretation.

**1. Number properties and arithmetic**

Integers are classified by sign, parity, divisibility, factors and primes. Order of operations and place value control calculations.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

**Core ideas in plain language**

- Prime factorization supports HCF/LCM. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- For two positive integers,  $\text{product} = \text{HCF} \times \text{LCM}$  when the pair is considered. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Use divisibility tests for 2,3,5,9,10,11. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find HCF and LCM of 12 and 18.

**STEP-BY-STEP REASONING:**  $12 = 2^2 \times 3$ ,  $18 = 2 \times 3^2$ .  $\text{HCF} = 2 \times 3 = 6$ ;  $\text{LCM} = 2^2 \times 3^2 = 36$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Prime-factorize once and read minimum/maximum powers.

**COMMON ERROR TO AVOID:** Zero is even but neither positive nor negative.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

**2. Fractions, decimals and percentages**

Fractions, decimals and percentages are equivalent representations of part-whole relationships.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

**Core ideas in plain language**

- Percentage change  $= (\text{new-old})/\text{old} \times 100\%$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Successive changes multiply factors; they do not simply add when bases change. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Convert recurring decimals algebraically if needed. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** A price rises 20% then falls 20%. Is it unchanged?

**STEP-BY-STEP REASONING:** Factor =  $1.20 \times 0.80 = 0.96$ , so it is 4% below the original. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use multiplier factors for repeated changes.

**COMMON ERROR TO AVOID:** Equal percentage rise and fall do not cancel.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 3. Ratios, proportions and variation

Ratios compare quantities in the same units; proportions equate ratios. Variation models how quantities change together.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

#### Core ideas in plain language

- Cross-multiply proportions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Direct variation  $y=kx$ ; inverse  $y=k/x$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Divide a total in ratio  $a:b$  using  $a/(a+b)$  and  $b/(a+b)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Divide 300 in ratio 2:3.

**STEP-BY-STEP REASONING:** Total parts = 5; shares = 120 and 180. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Convert units before forming a ratio.

**COMMON ERROR TO AVOID:** A ratio has no meaning if unlike units are left unconverted.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 4. Averages, weighted averages and mixtures

An average compresses a dataset; weighted averages account for unequal importance or group size.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

#### Core ideas in plain language

- Mean total = mean  $\times$  count. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Combined mean = (sum group totals) / (sum counts). Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Mixture average is weighted by amount. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Ten students average 12 and twenty average 15. Find combined mean.

**STEP-BY-STEP REASONING:** Totals 120 and 300; combined= $420/30=14$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Convert means to totals before combining.

**COMMON ERROR TO AVOID:** The average of group means is wrong when group sizes differ.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 5. Rates, time, work and distance

Rate problems connect amount, time and speed.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

### Core ideas in plain language

- Distance=speed  $\times$  time. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Average speed=total distance/total time. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Work rates add: if A takes  $a$  days, rate= $1/a$  job/day. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- For same distance, speed and time vary inversely. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** A completes a job in 6 days, B in 3. Together?

**STEP-BY-STEP REASONING:** Rate= $1/6+1/3=1/2$ , so 2 days. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Work with rates, not times, when agents cooperate.

**COMMON ERROR TO AVOID:** Average speed is not normally the arithmetic mean of speeds.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 6. Algebraic equations and inequalities

Algebra translates unknown relationships into equations and solution ranges.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

### Core ideas in plain language

- Collect like terms. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Use substitution or elimination for simultaneous equations. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Reverse inequality when dividing by negative. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Check restrictions from denominators and roots. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Solve  $2x+5=17$ .

**STEP-BY-STEP REASONING:**  $2x=12$ ,  $x=6$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Estimate the answer before exact solving.

**COMMON ERROR TO AVOID:** An extraneous root may appear after squaring.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 7. Geometry and mensuration

Geometry questions combine angle facts, similarity, perimeter, area and volume.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

### Core ideas in plain language

- Triangle angles sum 180 degrees. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Pythagoras  $a^2+b^2=c^2$  in a right triangle. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Circle area= $\pi r^2$ ; circumference= $2\pi r$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Volume formulas require cubic units. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find area of circle radius 3.

**STEP-BY-STEP REASONING:**  $9\pi$  square units. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw and label the figure, including units.

**COMMON ERROR TO AVOID:** Diameter and radius are commonly confused.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 8. Data interpretation and basic statistics

Data interpretation reads tables, graphs and summaries accurately.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

### Core ideas in plain language

- Check title, axes, scale and units. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Percentage share= $\text{value}/\text{total} \times 100$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- Mean, median and mode answer different questions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Use changes relative to the correct base. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Sales rise from 80 to 100. Percentage increase?

**STEP-BY-STEP REASONING:**  $20/80 \times 100 = 25\%$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Read exact values before comparing trends.

**COMMON ERROR TO AVOID:** A 20-unit rise is not automatically a 20% rise.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 9. Probability

Probability compares favourable outcomes with the sample space and combines events through rules.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

### Core ideas in plain language

- Complement =  $1 - P$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Exclusive union adds. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Independent intersection multiplies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Use trees for successive events. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Two fair coins are tossed.  $P(\text{exactly one head})$ ?

**STEP-BY-STEP REASONING:** Outcomes HH, HT, TH, TT; favourable HT, TH, so  $1/2$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** List outcomes when the sample is small.

**COMMON ERROR TO AVOID:** “At least one” is often easier by complement.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 10. Counting, permutations and combinations

Counting principles determine the number of possible outcomes without listing all.

The central aim is to understand how the main ideas are connected. Translate the wording into a short numerical relationship. Use ratios, multipliers, unit rates, diagrams or option testing to reduce work. Estimate first, calculate second, and check whether the answer fits the original situation.

### Core ideas in plain language

- Product rule multiplies sequential choices. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Permutation counts ordered selections. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Combination counts unordered selections. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Factorials grow rapidly; cancel before multiplying. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Choose 3 students from 8.

**STEP-BY-STEP REASONING:**  ${}^8C_3 = \frac{8 \times 7 \times 6}{(3 \times 2 \times 1)} = 56$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Ask whether order creates a different outcome.

**COMMON ERROR TO AVOID:** Do not count the same committee in different orders.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

**MATHEMATICS-BASED QUANTITATIVE REASONING - PRACTICE EXERCISES**

Three independent sets are provided. Attempt each question before reading the answer, explanation and quick tactic immediately below it. Each set contains 25 MCQs with five options (A–E).

**Practice Set 1 - 25 MCQs**

1. Evaluate  $89 + 9 \times 5 - 7$ .

- A. 127
- B. 71
- C. 483
- D. 136
- E. 122

**Answer: A. 127.** Explanation: Apply multiplication first:  $9 \times 5 = 45$ ; then  $89 + 45 - 7 = 127$ . **Quick tactic:** Use BODMAS/PEMDAS before doing addition or subtraction.

2. Find  $\frac{3}{17} + \frac{5}{18}$  in simplest form.

- A.  $\frac{8}{35}$
- B.  $\frac{139}{306}$
- C.  $-\frac{31}{306}$
- D.  $\frac{4}{153}$
- E.  $\frac{139}{35}$

**Answer: B. 139/306.** Explanation: Use a common denominator:  $(3 \times 18 + 5 \times 17) / (17 \times 18) = 139/306$ . **Quick tactic:** For fractions, combine cross-products and simplify at the end.

3. What is 15% of 1225?

- A.  $\frac{62}{5}$
- B.  $\frac{245}{3}$
- C.  $\frac{735}{4}$
- D.  $\frac{4165}{4}$
- E.  $\frac{3675}{2}$

**Answer: C. 735/4.** Explanation: Convert 15% to  $\frac{15}{100}$  and multiply by 1225:  $(\frac{15}{100}) \times 1225 = 735/4$ . **Quick tactic:** Use 10%, 5% and 1% building blocks when mental calculation is faster.

4. A price of Rs. 2140 is increased by 30%. What is the new price?

- A. Rs. 642
- B. Rs. 2170
- C. Rs. 1498
- D. Rs. 2782
- E. Rs. 64200

**Answer: D. Rs. 2782.** Explanation: New price =  $2140 \times (1 + 30/100) = \text{Rs. } 2782$ . **Quick tactic:** Percentage increase means multiply by a factor greater than 1.

5. Rs. 488 is divided in the ratio 3:5. What is the larger share?

- A. 183
- B. 244
- C. 8
- D. 366
- E. 305

**Answer: E. 305.** Explanation: Total ratio parts = 8; one part =  $488/8 = 61$ ; larger share =  $5 \times 61 = 305$ . **Quick tactic:** Find the value of one ratio part before calculating either share.

6. If 5 identical notebooks cost Rs. 865, what will 8 notebooks cost at the same rate?

- A. 1384
- B. 873
- C. 6920
- D. 1038
- E. 1385

**Answer: A. 1384.** Explanation: Unit cost =  $865/5 = \text{Rs. } 173$ ; therefore 8 notebooks cost  $8 \times 173 = \text{Rs. } 1384$ . **Quick tactic:** Reduce a proportion problem to a one-unit rate.

7. Find the arithmetic mean of 128, 134, 140, 146, 152.

- A. 700
- B. 140
- C. 134
- D. 146
- E. 141

**Answer: B. 140.** Explanation: The numbers are equally spaced, so the middle value is the mean: 140. **Quick tactic:** For an odd number of equally spaced values, the centre value is the mean.



8. A student scores 91 in a 4-credit course and 90 in a 4-credit course. Find the weighted mean.

- A. 362
- B. 45.25
- C. 90.5
- D. 91
- E. 91.5

**Answer: C. 90.5.** Explanation: Weighted mean =  $(4 \times 91 + 4 \times 90) / (4 + 4) = 90.5$ . **Quick tactic:** Multiply each value by its weight, then divide by total weight.

9. A vehicle travels 336 km at a constant speed of 112 km/h. How long does the journey take?

- A. 448 hours
- B. 224 hours
- C. 1/3 hours
- D. 3 hours
- E. 4 hours

**Answer: D. 3 hours.** Explanation: Time = distance/speed =  $336/112 = 3$  hours. **Quick tactic:** Write  $D = ST$  and isolate the required quantity before substituting.

10. Worker A can complete a job in 45 days and Worker B in 89 days. Working together, how many days will they take?

- A. 67 days
- B. 134/4005 days
- C. 4005/44 days
- D. 134 days
- E. 4005/134 days

**Answer: E. 4005/134 days.** Explanation: Combined rate =  $1/45 + 1/89 = (134)/4005$ ; time =  $4005/134 = 4005/134$  days. **Quick tactic:** Add work rates, not completion times.

11. An item costs Rs. 1220 and is sold at a profit of 10%. Find the selling price.

- A. Rs. 1342
- B. Rs. 122
- C. Rs. 1098
- D. Rs. 1230
- E. Rs. 12200

**Answer: A. Rs. 1342.** Explanation: Selling price = cost  $\times$  (1 + profit rate) =  $1220 \times 110/100 = \text{Rs. } 1342$ . **Quick tactic:** Profit increases cost; use a multiplier above 1.

12. Find the simple interest on Rs. 5100 at 10% per year for 3 years.

- A. Rs. 510
- B. Rs. 1530
- C. Rs. 153
- D. Rs. 6630
- E. Rs. 15300

**Answer: B. Rs. 1530.** Explanation: Simple interest =  $PRT/100 = 5100 \times 10 \times 3/100 = \text{Rs. } 1530$ . **Quick tactic:** Use simple interest only when interest is not added back to principal.

13. Solve  $8x + 13 = 365$ .

- A. 352
- B. 352/13
- C. 44
- D. 45
- E. 43

**Answer: C. 44.** Explanation: Subtract 13:  $8x = 352$ ; divide by 8:  $x = 44$ . **Quick tactic:** Undo operations in reverse order and check by substitution.

14. What is the larger root of  $x^2 - 54x + 368 = 0$ ?

- A. 8
- B. 54
- C. 368
- D. 46
- E. -46

**Answer: D. 46.** Explanation: Factor as  $(x - 8)(x - 46) = 0$ ; the roots are 8 and 46, so the larger root is 46. **Quick tactic:** For  $x^2 - sx + p$ , look for two numbers with sum  $s$  and product  $p$ .

15. Find the 9th term of the arithmetic sequence with first term 85 and common difference 3.

- A. 112
- B. 106
- C. 792
- D. 768
- E. 109

**Answer: E. 109.** Explanation:  $a_n = a + (n-1)d = 85 + (9-1) \times 3 = 109$ . **Quick tactic:** The first term is already counted, so multiply  $d$  by  $n - 1$ .



16. If  $43^x = 3418801$ , find  $x$ .

- A. 4
- B. 43
- C. 3418801
- D. 5
- E. 3

**Answer: A. 4.** Explanation:  $3418801 = 43^4$ ; therefore  $x = 4$ . **Quick tactic:** Rewrite both sides with the same base.

17. Using  $\pi = 22/7$ , find the circumference of a circle of radius 294 cm.

- A. 271656 cm
- B. 1848 cm
- C. 924 cm
- D. 588 cm
- E. 1176 cm

**Answer: B. 1848 cm.** Explanation: Circumference =  $2\pi r = 2 \times 22/7 \times 294 = 1848$  cm. **Quick tactic:** Circumference uses  $2\pi r$ ; area uses  $\pi r^2$ .

18. Find the distance between (41, 42) and (44, 46).

- A. 7
- B. 4
- C. 5
- D. 25
- E. 3

**Answer: C. 5.** Explanation: Distance =  $\sqrt{[(3)^2 + (4)^2]} = \sqrt{25} = 5$ . **Quick tactic:** Look for a 3-4-5 right triangle before using a calculator.

19. A bag contains 4 red and 10 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A. 5/7
- B. 2/5
- C. 1/14
- D. 2/7
- E. 7/2

**Answer: D. 2/7.** Explanation:  $P(\text{red}) = \text{favourable}/\text{total} = 4/(4+10) = 2/7$ . **Quick tactic:** Count favourable outcomes and total outcomes from the same sample space.

20. How many different pairs can be selected from 46 people?

- A. 2070
- B. 48
- C. 46
- D. 15180
- E. 1035

**Answer: E. 1035.** Explanation: Order does not matter, so use  $C(46,2) = 46 \times 45/2 = 1035$ . **Quick tactic:** Use combinations for selections and permutations for ordered arrangements.

21. Convert 43 kilometres to metres.

- A. 43000
- B. 4300
- C. 0.04
- D. 430000
- E. 1043

**Answer: A. 43000.** Explanation: 1 km = 1000 m, so 43 km =  $43 \times 1000 = 43000$  m. **Quick tactic:** Write the conversion factor before multiplying or dividing.

22. Solve the inequality  $3x \leq 46$ .

- A.  $x \leq -46/3$
- B.  $x \leq 46/3$
- C.  $x \leq 43$
- D.  $x \leq 3/46$
- E.  $x \leq 138$

**Answer: B.  $x \leq 46/3$ .** Explanation: Divide both sides by positive 3:  $x \leq 46/3$ . **Quick tactic:** Reverse an inequality sign only when multiplying or dividing by a negative number.

23. If  $n(A)=56$ ,  $n(B)=17$ , and  $n(A \cap B)=6$ , find  $n(A \cup B)$ .

- A. 73
- B. 79
- C. 67
- D. 39
- E. 6

**Answer: C. 67.** Explanation:  $n(A \cup B) = n(A) + n(B) - n(A \cap B) = 56 + 17 - 6 = 67$ . **Quick tactic:** Subtract the intersection once because it was counted twice.

24. The monthly outputs are 61, 66, 71, 76 units. What is the range?

- A. 274
- B. 68
- C. 76
- D. 15
- E. 61

**Answer: D. 15.** Explanation: Range = maximum - minimum =  $76 - 61 = 15$ . **Quick tactic:** Range uses only the largest and smallest observations.

25. A student is 51 years old now. How old will the student be after 9 years?

- A. 42
- B. -42
- C. 459
- D. 61
- E. 60

**Answer: E. 60.** Explanation: Future age = present age + elapsed years =  $51 + 9 = 60$ . **Quick tactic:** Create a simple time line: now, change, future.

## Practice Set 2 - 25 MCQs

1. Evaluate  $91 + 3 \times 6 - 8$ .

- A. 101
- B. 85
- C. 556
- D. 104
- E. 95

**Answer: A. 101.** Explanation: Apply multiplication first:  $3 \times 6 = 18$ ; then  $91 + 18 - 8 = 101$ . **Quick tactic:** Use BODMAS/PEMDAS before doing addition or subtraction.

2. Find  $5/11 + 1/19$  in simplest form.

- A.  $1/5$
- B.  $106/209$
- C.  $84/209$
- D.  $6/209$
- E.  $53/15$

**Answer: B. 106/209.** Explanation: Use a common denominator:  $(5 \times 19 + 1 \times 11)/(11 \times 19) = 106/209$ . **Quick tactic:** For fractions, combine cross-products and simplify at the end.

3. What is 20% of 1250?

- A.  $127/10$
- B.  $125/2$
- C. 250
- D. 1000
- E. 2500

**Answer: C. 250.** Explanation: Convert 20% to  $20/100$  and multiply by 1250:  $(20/100) \times 1250 = 250$ . **Quick tactic:** Use 10%, 5% and 1% building blocks when mental calculation is faster.

4. A price of Rs. 2180 is increased by 5%. What is the new price?

- A. Rs. 109
- B. Rs. 2185
- C. Rs. 2071
- D. Rs. 2289
- E. Rs. 10900

**Answer: D. Rs. 2289.** Explanation: New price =  $2180 \times (1 + 5/100) = \text{Rs. } 2289$ . **Quick tactic:** Percentage increase means multiply by a factor greater than 1.

5. Rs. 682 is divided in the ratio 4:7. What is the larger share?

- A. 248
- B. 341
- C. 11
- D. 496
- E. 434

**Answer: E. 434.** Explanation: Total ratio parts = 11; one part =  $682/11 = 62$ ; larger share =  $7 \times 62 = 434$ . **Quick tactic:** Find the value of one ratio part before calculating either share.

6. If 6 identical notebooks cost Rs. 1056, what will 10 notebooks cost at the same rate?

- A. 1760
- B. 1066
- C. 10560
- D. 1232
- E. 1761

**Answer: A. 1760.** Explanation: Unit cost =  $1056/6 = \text{Rs. } 176$ ; therefore 10 notebooks cost  $10 \times 176 = \text{Rs. } 1760$ . **Quick tactic:** Reduce a proportion problem to a one-unit rate.

7. Find the arithmetic mean of 131, 132, 133, 134, 135.

- A. 665
- B. 133
- C. 132
- D. 134
- E. 135

**Answer: B. 133.** Explanation: The numbers are equally spaced, so the middle value is the mean: 133. **Quick tactic:** For an odd number of equally spaced values, the centre value is the mean.

8. A student scores 92 in a 2-credit course and 70 in a 5-credit course. Find the weighted mean.

- A. 81
- B. 267
- C. 76.29
- D. 53.4

E. 85.71

**Answer: C. 76.29.** Explanation: Weighted mean =  $(2 \times 92 + 5 \times 70) / (2 + 5) = 76.29$ . **Quick tactic:** Multiply each value by its weight, then divide by total weight.

9. A vehicle travels 456 km at a constant speed of 114 km/h. How long does the journey take?

- A. 570 hours
- B. 342 hours
- C. 1/4 hours
- D. 4 hours
- E. 5 hours

**Answer: D. 4 hours.** Explanation: Time = distance/speed =  $456/114 = 4$  hours. **Quick tactic:** Write  $D = ST$  and isolate the required quantity before substituting.

10. Worker A can complete a job in 46 days and Worker B in 91 days. Working together, how many days will they take?

- A. 137/2 days
- B. 137/4186 days
- C. 4186/45 days
- D. 137 days
- E. 4186/137 days

**Answer: E. 4186/137 days.** Explanation: Combined rate =  $1/46 + 1/91 = (137)/4186$ ; time =  $4186/137 = 4186/137$  days. **Quick tactic:** Add work rates, not completion times.

11. An item costs Rs. 1240 and is sold at a profit of 15%. Find the selling price.

- A. Rs. 1426
- B. Rs. 186
- C. Rs. 1054
- D. Rs. 1255
- E. Rs. 18600

**Answer: A. Rs. 1426.** Explanation: Selling price = cost  $\times$  (1 + profit rate) =  $1240 \times 115/100 = \text{Rs. } 1426$ . **Quick tactic:** Profit increases cost; use a multiplier above 1.

12. Find the simple interest on Rs. 5200 at 4% per year for 4 years.

- A. Rs. 208
- B. Rs. 832
- C. Rs. 6032
- D. Rs. 8320
- E. Rs. 1665/2

**Answer: B. Rs. 832.** Explanation: Simple interest =  $PRT/100 = 5200 \times 4 \times 4/100 = \text{Rs. } 832$ . **Quick tactic:** Use simple interest only when interest is not added back to principal.

13. Solve  $2x + 14 = 104$ .

- A. 90
- B. 45/7
- C. 45
- D. 46
- E. 44

**Answer: C. 45.** Explanation: Subtract 14:  $2x = 90$ ; divide by 2:  $x = 45$ . **Quick tactic:** Undo operations in reverse order and check by substitution.

14. What is the larger root of  $x^2 - 49x + 94 = 0$ ?

- A. 2
- B. 49
- C. 94
- D. 47
- E. -47

**Answer: D. 47.** Explanation: Factor as  $(x - 2)(x - 47) = 0$ ; the roots are 2 and 47, so the larger root is 47. **Quick tactic:** For  $x^2 - sx + p$ , look for two numbers with sum  $s$  and product  $p$ .

15. Find the 10th term of the arithmetic sequence with first term 87 and common difference 4.

- A. 127
- B. 119
- C. 910
- D. 874
- E. 123

**Answer: E. 123.** Explanation:  $a_n = a + (n-1)d = 87 + (10-1) \times 4 = 123$ . **Quick tactic:** The first term is already counted, so multiply  $d$  by  $n - 1$ .

16. If  $44^x = 1936$ , find  $x$ .

- A. 2
- B. 44
- C. 1936

- D. 3  
E. 1

**Answer: A. 2.** Explanation:  $1936 = 44^2$ ; therefore  $x = 2$ . **Quick tactic:** Rewrite both sides with the same base.

17. Find the area of a rectangle of length 50 cm and width 3 cm.

- A.  $106 \text{ cm}^2$   
B.  $150 \text{ cm}^2$   
C.  $53 \text{ cm}^2$   
D.  $300 \text{ cm}^2$   
E.  $153 \text{ cm}^2$

**Answer: B.  $150 \text{ cm}^2$ .** Explanation: Area = length  $\times$  width =  $50 \times 3 = 150 \text{ cm}^2$ . **Quick tactic:** Do not confuse area with perimeter.

18. Find the slope of the line through (42, 44) and (46, 52).

- A.  $1/2$   
B. 8  
C. 2  
D. 4  
E. -2

**Answer: C. 2.** Explanation:  $m = (y_2 - y_1)/(x_2 - x_1) = (52 - 44)/(46 - 42) = 2$ . **Quick tactic:** Use change in y over change in x in the same point order.

19. A bag contains 5 red and 4 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A.  $4/9$   
B.  $5/4$   
C.  $1/9$   
D.  $5/9$   
E.  $9/5$

**Answer: D.  $5/9$ .** Explanation:  $P(\text{red}) = \text{favourable}/\text{total} = 5/(5+4) = 5/9$ . **Quick tactic:** Count favourable outcomes and total outcomes from the same sample space.

20. How many different pairs can be selected from 47 people?

- A. 2162  
B. 49  
C. 47  
D. 16215  
E. 1081

**Answer: E. 1081.** Explanation: Order does not matter, so use  $C(47, 2) = 47 \times 46 / 2 = 1081$ . **Quick tactic:** Use combinations for selections and permutations for ordered arrangements.

21. Convert 44 kilometres to metres.

- A. 44000  
B. 4400  
C. 0.04  
D. 440000  
E. 1044

**Answer: A. 44000.** Explanation: 1 km = 1000 m, so 44 km =  $44 \times 1000 = 44000$  m. **Quick tactic:** Write the conversion factor before multiplying or dividing.

22. Solve the inequality  $4x \leq 47$ .

- A.  $x \leq -47/4$   
B.  $x \leq 47/4$   
C.  $x \leq 43$   
D.  $x \leq 4/47$   
E.  $x \leq 188$

**Answer: B.  $x \leq 47/4$ .** Explanation: Divide both sides by positive 4:  $x \leq 47/4$ . **Quick tactic:** Reverse an inequality sign only when multiplying or dividing by a negative number.

23. If  $n(A)=57$ ,  $n(B)=18$ , and  $n(A \cap B)=7$ , find  $n(A \cup B)$ .

- A. 75  
B. 82  
C. 68  
D. 39  
E. 7

**Answer: C. 68.** Explanation:  $n(A \cup B) = n(A) + n(B) - n(A \cap B) = 57 + 18 - 7 = 68$ . **Quick tactic:** Subtract the intersection once because it was counted twice.

24. The monthly outputs are 62, 67, 72, 77 units. What is the range?

- A. 278  
B. 69  
C. 77  
D. 15

E. 62

**Answer: D. 15.** Explanation: Range = maximum - minimum =  $77 - 62 = 15$ . **Quick tactic: Range uses only the largest and smallest observations.**

25. A student is 52 years old now. How old will the student be after 3 years?

A. 49

B. -49

C. 156

D. 56

E. 55

**Answer: E. 55.** Explanation: Future age = present age + elapsed years =  $52 + 3 = 55$ . **Quick tactic: Create a simple time line: now, change, future.**

## Practice Set 3 - 25 MCQs

1. Evaluate  $93 + 4 \times 7 - 9$ .

- A. 112
- B. 85
- C. 670
- D. 116
- E. 105

**Answer: A. 112.** Explanation: Apply multiplication first:  $4 \times 7 = 28$ ; then  $93 + 28 - 9 = 112$ . **Quick tactic: Use BODMAS/PEMDAS before doing addition or subtraction.**

2. Find  $10/12 + 16/20$  in simplest form.

- A.  $13/16$
- B.  $49/30$
- C.  $1/30$
- D.  $13/120$
- E.  $49/4$

**Answer: B.  $49/30$ .** Explanation: Use a common denominator:  $(10 \times 20 + 16 \times 12)/(12 \times 20) = 49/30$ . **Quick tactic: For fractions, combine cross-products and simplify at the end.**

3. What is 25% of 1275?

- A. 13
- B. 51
- C.  $1275/4$
- D.  $3825/4$
- E.  $6375/2$

**Answer: C.  $1275/4$ .** Explanation: Convert 25% to  $25/100$  and multiply by 1275:  $(25/100) \times 1275 = 1275/4$ . **Quick tactic: Use 10%, 5% and 1% building blocks when mental calculation is faster.**

4. A price of Rs. 2220 is increased by 10%. What is the new price?

- A. Rs. 222
- B. Rs. 2230
- C. Rs. 1998
- D. Rs. 2442
- E. Rs. 22200

**Answer: D. Rs. 2442.** Explanation: New price =  $2220 \times (1 + 10/100) = \text{Rs. } 2442$ . **Quick tactic: Percentage increase means multiply by a factor greater than 1.**

5. Rs. 882 is divided in the ratio 5:9. What is the larger share?

- A. 315
- B. 441
- C. 14
- D. 630
- E. 567

**Answer: E. 567.** Explanation: Total ratio parts = 14; one part =  $882/14 = 63$ ; larger share =  $9 \times 63 = 567$ . **Quick tactic: Find the value of one ratio part before calculating either share.**

6. If 7 identical notebooks cost Rs. 1253, what will 12 notebooks cost at the same rate?

- A. 2148
- B. 1265
- C. 15036
- D. 1432
- E. 2149

**Answer: A. 2148.** Explanation: Unit cost =  $1253/7 = \text{Rs. } 179$ ; therefore 12 notebooks cost  $12 \times 179 = \text{Rs. } 2148$ . **Quick tactic: Reduce a proportion problem to a one-unit rate.**

7. Find the arithmetic mean of 134, 136, 138, 140, 142.

- A. 690
- B. 138
- C. 136
- D. 140
- E. 139

**Answer: B. 138.** Explanation: The numbers are equally spaced, so the middle value is the mean: 138. **Quick tactic: For an odd number of equally spaced values, the centre value is the mean.**

8. A student scores 93 in a 3-credit course and 71 in a 6-credit course. Find the weighted mean.

- A. 82
- B. 352.5
- C. 78.33
- D. 39.17

E. 85.67

**Answer: C. 78.33.** Explanation: Weighted mean =  $(3 \times 93 + 6 \times 71) / (3 + 6) = 78.33$ . **Quick tactic:** Multiply each value by its weight, then divide by total weight.

9. A vehicle travels 580 km at a constant speed of 116 km/h. How long does the journey take?

- A. 696 hours
- B. 464 hours
- C. 1/5 hours
- D. 5 hours
- E. 6 hours

**Answer: D. 5 hours.** Explanation: Time = distance/speed =  $580/116 = 5$  hours. **Quick tactic:** Write  $D = ST$  and isolate the required quantity before substituting.

10. Worker A can complete a job in 47 days and Worker B in 93 days. Working together, how many days will they take?

- A. 70 days
- B. 140/4371 days
- C. 4371/46 days
- D. 140 days
- E. 4371/140 days

**Answer: E. 4371/140 days.** Explanation: Combined rate =  $1/47 + 1/93 = (140)/4371$ ; time =  $4371/140 = 4371/140$  days. **Quick tactic:** Add work rates, not completion times.

11. An item costs Rs. 1260 and is sold at a profit of 20%. Find the selling price.

- A. Rs. 1512
- B. Rs. 252
- C. Rs. 1008
- D. Rs. 1280
- E. Rs. 25200

**Answer: A. Rs. 1512.** Explanation: Selling price = cost  $\times$  (1 + profit rate) =  $1260 \times 120/100 = \text{Rs. } 1512$ . **Quick tactic:** Profit increases cost; use a multiplier above 1.

12. Find the simple interest on Rs. 5300 at 5% per year for 5 years.

- A. Rs. 265
- B. Rs. 1325
- C. Rs. 6625
- D. Rs. 13250
- E. Rs. 2651/2

**Answer: B. Rs. 1325.** Explanation: Simple interest =  $PRT/100 = 5300 \times 5 \times 5/100 = \text{Rs. } 1325$ . **Quick tactic:** Use simple interest only when interest is not added back to principal.

13. Solve  $3x + 15 = 153$ .

- A. 138
- B. 46/5
- C. 46
- D. 47
- E. 45

**Answer: C. 46.** Explanation: Subtract 15:  $3x = 138$ ; divide by 3:  $x = 46$ . **Quick tactic:** Undo operations in reverse order and check by substitution.

14. What is the larger root of  $x^2 - 51x + 144 = 0$ ?

- A. 3
- B. 51
- C. 144
- D. 48
- E. -48

**Answer: D. 48.** Explanation: Factor as  $(x - 3)(x - 48) = 0$ ; the roots are 3 and 48, so the larger root is 48. **Quick tactic:** For  $x^2 - sx + p$ , look for two numbers with sum  $s$  and product  $p$ .

15. Find the 11th term of the arithmetic sequence with first term 89 and common difference 5.

- A. 144
- B. 134
- C. 1034
- D. 984
- E. 139

**Answer: E. 139.** Explanation:  $a_n = a + (n-1)d = 89 + (11-1) \times 5 = 139$ . **Quick tactic:** The first term is already counted, so multiply  $d$  by  $n - 1$ .

16. If  $45^x = 91125$ , find  $x$ .

- A. 3
- B. 45
- C. 91125



- D. 4  
E. 2

**Answer: A. 3.** Explanation:  $91125 = 45^3$ ; therefore  $x = 3$ . **Quick tactic:** Rewrite both sides with the same base.

17. Find the area of a triangle with base 53 cm and height 11 cm.

- A.  $583 \text{ cm}^2$   
B.  $583/2 \text{ cm}^2$   
C.  $64 \text{ cm}^2$   
D.  $583/4 \text{ cm}^2$   
E.  $128 \text{ cm}^2$

**Answer: B.  $583/2 \text{ cm}^2$ .** Explanation: Area =  $\frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times 53 \times 11 = 583/2 \text{ cm}^2$ . **Quick tactic:** Use the perpendicular height, not a sloping side.

18. Find the midpoint of the segment joining (43, 45) and (49, 53).

- A. (6, 8)  
B. (92, 98)  
C. (46, 49)  
D. (3, 4)  
E. (43, 53)

**Answer: C. (46, 49).** Explanation: Midpoint =  $((43+49)/2, (45+53)/2) = (46, 49)$ . **Quick tactic:** Average the x-coordinates and y-coordinates separately.

19. A bag contains 6 red and 5 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A.  $5/11$   
B.  $6/5$   
C.  $1/11$   
D.  $6/11$   
E.  $11/6$

**Answer: D.  $6/11$ .** Explanation:  $P(\text{red}) = \text{favourable}/\text{total} = 6/(6+5) = 6/11$ . **Quick tactic:** Count favourable outcomes and total outcomes from the same sample space.

20. How many different pairs can be selected from 48 people?

- A. 2256  
B. 50  
C. 48  
D. 17296  
E. 1128

**Answer: E. 1128.** Explanation: Order does not matter, so use  $C(48,2) = 48 \times 47/2 = 1128$ . **Quick tactic:** Use combinations for selections and permutations for ordered arrangements.

21. Convert 45 kilometres to metres.

- A. 45000  
B. 4500  
C. 0.04  
D. 450000  
E. 1045

**Answer: A. 45000.** Explanation:  $1 \text{ km} = 1000 \text{ m}$ , so  $45 \text{ km} = 45 \times 1000 = 45000 \text{ m}$ . **Quick tactic:** Write the conversion factor before multiplying or dividing.

22. Solve the inequality  $5x \leq 48$ .

- A.  $x \leq -48/5$   
B.  $x \leq 48/5$   
C.  $x \leq 43$   
D.  $x \leq 5/48$   
E.  $x \leq 240$

**Answer: B.  $x \leq 48/5$ .** Explanation: Divide both sides by positive 5:  $x \leq 48/5$ . **Quick tactic:** Reverse an inequality sign only when multiplying or dividing by a negative number.

23. If  $n(A)=58$ ,  $n(B)=19$ , and  $n(A \cap B)=8$ , find  $n(A \cup B)$ .

- A. 77  
B. 85  
C. 69  
D. 39  
E. 8

**Answer: C. 69.** Explanation:  $n(A \cup B) = n(A) + n(B) - n(A \cap B) = 58 + 19 - 8 = 69$ . **Quick tactic:** Subtract the intersection once because it was counted twice.

24. The monthly outputs are 63, 68, 73, 78 units. What is the range?

- A. 282  
B. 70

C. 78

D. 15

E. 63

**Answer: D. 15.** Explanation: Range = maximum - minimum =  $78 - 63 = 15$ . **Quick tactic: Range uses only the largest and smallest observations.**

25. A student is 53 years old now. How old will the student be after 4 years?

A. 49

B. -49

C. 212

D. 58

E. 57

**Answer: E. 57.** Explanation: Future age = present age + elapsed years =  $53 + 4 = 57$ . **Quick tactic: Create a simple time line: now, change, future.**

# MATHEMATICS

## Topics and contents

The Mathematics section develops definitions, algebraic structure, graphical interpretation, geometry, trigonometry, counting, calculus and vector methods. Each topic is treated as a problem-solving tool rather than a list of formulas.

This section covers Real Numbers; Logarithms; Sets and Functions; Factorization and Algebraic Manipulation; Linear Equations and Inequalities; Trigonometry; Coordinate Geometry; Logic; Similar Figures; Graphs of Functions; Loci and Construction.

It also develops understanding of Information Handling; Probability; Quadratic Equations; Theory of Quadratic Equations; Variations; Partial Fractions; Basic Statistics; Introduction to Trigonometry; Projection of a Side of a Triangle; Chords of a Circle; Tangent to a Circle.

It also develops understanding of Chords and Arcs; Angle in a Segment of a Circle; Practical Geometry - Circles; Complex Numbers; Functions and Graphs; Theory of Quadratic Functions; Matrices and Determinants; Sequences and Series; Permutations and Combinations; Mathematical Induction and Binomial Theorem; Division of Polynomials.

It also develops understanding of Trigonometric Identities; Trigonometric Functions and Their Graphs; Limit and Continuity; Differentiation; Vectors in Space; Functions and Limits; Integration; Introduction to Analytic Geometry; Linear Inequalities and Linear Programming; Conic Sections; Vectors.

## 1. Real Numbers

Real numbers combine rational and irrational numbers. Rational decimals terminate or repeat; irrational decimals neither terminate nor repeat.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Use closure, commutative, associative and distributive properties correctly. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- For nonzero  $a$ , the reciprocal is  $1/a$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A rational plus a nonzero irrational is irrational. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Classify  $0.272727\dots$  and  $\sqrt{11}$ .

**STEP-BY-STEP REASONING:**  $0.272727\dots$  repeats, so it is rational.  $\sqrt{11}$  is not a perfect square and is irrational. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Convert repeating decimals to fractions when options are close.

**COMMON ERROR TO AVOID:** Do not call every non-terminating decimal irrational; repeating decimals are rational.

**SECOND WORKED EXAMPLE:** Show that  $0.125$  is rational.

**STEP-BY-STEP REASONING:**  $0.125 = 125/1000 = 1/8$ , so it can be written as a ratio of integers and is rational.

**QUICK CHECK:** A terminating decimal is always rational.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 2. Logarithms

A logarithm is an exponent:  $\log_b a = x$  means  $b^x = a$ , where  $b > 0$ ,  $b \neq 1$  and  $a > 0$ .

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Product:  $\log_b(MN) = \log_b M + \log_b N$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Quotient:  $\log_b(M/N) = \log_b M - \log_b N$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Power:  $\log_b(M^k) = k \log_b M$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Change of base:  $\log_b a = \log a / \log b$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Evaluate  $\log_2 32$ .

**STEP-BY-STEP REASONING:** Since  $2^5 = 32$ ,  $\log_2 32 = 5$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Rewrite a logarithm as an exponential statement before calculating.

**COMMON ERROR TO AVOID:**  $\log(M+N)$  is not  $\log M + \log N$ .

**SECOND WORKED EXAMPLE:** Evaluate  $\log_3 81 - \log_3 3$ .

**STEP-BY-STEP REASONING:** Use the quotient rule:  $\log_3(81/3) = \log_3 27 = 3$ .

**QUICK CHECK:** Combine logarithms before evaluating.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 3. Sets and Functions

Sets collect distinct objects. A function assigns exactly one output to each input in its domain.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- $n(A \cup B) = n(A) + n(B) - n(A \cap B)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- A function may be one-one, many-one, onto or into. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Domain contains allowable inputs; range contains actual outputs. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** If  $A = \{1, 2, 3\}$  and  $B = \{3, 4\}$ , find  $A \cup B$  and  $A \cap B$ .

**STEP-BY-STEP REASONING:**  $A \cup B = \{1, 2, 3, 4\}$ ;  $A \cap B = \{3\}$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use a Venn diagram for counting problems.

**COMMON ERROR TO AVOID:** A repeated element is written only once in a set.

**SECOND WORKED EXAMPLE:** If  $n(A)=20$ ,  $n(B)=15$  and  $n(A \cap B)=6$ , find  $n(A \cup B)$ .

**STEP-BY-STEP REASONING:**  $n(A \cup B)=20+15-6=29$ . The intersection is subtracted because it was counted twice.

**QUICK CHECK:** In union-counting questions, write the inclusion-exclusion formula first.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 4. Factorization and Algebraic Manipulation

Factorization rewrites an expression as a product. It supports simplification, equation solving and partial fractions.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Common factor first. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- $a^2-b^2=(a-b)(a+b)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $a^2+2ab+b^2=(a+b)^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- For  $x^2+bx+c$ , find numbers with product  $c$  and sum  $b$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Factor  $x^2+7x+12$ .

**STEP-BY-STEP REASONING:**  $3 \times 4=12$  and  $3+4=7$ , so  $(x+3)(x+4)$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Check by multiplying the factors mentally.

**COMMON ERROR TO AVOID:** Never cancel terms across addition; cancel factors only.

**SECOND WORKED EXAMPLE:** Factor  $2x^2-8$ .

**STEP-BY-STEP REASONING:** Take out the common factor:  $2(x^2-4)=2(x-2)(x+2)$ .

**QUICK CHECK:** Remove the greatest common factor before applying identities.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 5. Linear Equations and Inequalities

A linear equation has first-degree variables. Inequalities describe ranges rather than a single value.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Perform the same operation on both sides. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Reverse the inequality sign when multiplying or dividing by a negative number. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Represent solutions on a number line. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Solve  $-2x+3>7$ .

**STEP-BY-STEP REASONING:**  $-2x>4$ , so  $x<-2$  after division by  $-2$  and reversal of the sign. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Move constants first, then divide once.

**COMMON ERROR TO AVOID:** Forgetting to reverse the sign is the most common error.

**SECOND WORKED EXAMPLE:** Solve  $3-5x \leq 18$ .

**STEP-BY-STEP REASONING:** Subtract 3:  $-5x \leq 15$ . Divide by  $-5$  and reverse the sign:  $x \geq -3$ .

**QUICK CHECK:** Circle the negative divisor so you remember to reverse the inequality.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 6. Trigonometry

Trigonometry relates angles and side ratios. In a right triangle:  $\sin = \text{opposite/hypotenuse}$ ,  $\cos = \text{adjacent/hypotenuse}$ ,  $\tan = \text{opposite/adjacent}$ .

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- $\tan \theta = \sin \theta / \cos \theta$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $\sin^2 \theta + \cos^2 \theta = 1$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Use degrees or radians consistently. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** If  $\sin \theta = 3/5$  for an acute angle, find  $\cos \theta$ .

**STEP-BY-STEP REASONING:** A 3-4-5 triangle gives adjacent 4 and hypotenuse 5, so  $\cos \theta = 4/5$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Sketch the triangle and label opposite, adjacent and hypotenuse.

**COMMON ERROR TO AVOID:** Side names depend on the chosen angle.

**SECOND WORKED EXAMPLE:** If  $\tan \theta = 5/12$  for an acute angle, find  $\sin \theta$ .

**STEP-BY-STEP REASONING:** Use a right triangle with opposite 5 and adjacent 12; the hypotenuse is 13. Therefore  $\sin \theta = 5/13$ .

**QUICK CHECK:** Recognise common Pythagorean triples to save time.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 7. Coordinate Geometry

Coordinate geometry translates geometric relationships into algebra using points, slopes and distances.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Slope  $m = (y_2 - y_1) / (x_2 - x_1)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Distance  $= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Midpoint  $= ((x_1 + x_2) / 2, (y_1 + y_2) / 2)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Parallel lines have equal slopes; perpendicular slopes multiply to  $-1$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find the slope through (1,2) and (5,10).

**STEP-BY-STEP REASONING:**  $m = (10 - 2) / (5 - 1) = 8 / 4 = 2$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use a consistent point order in numerator and denominator.

**COMMON ERROR TO AVOID:** A vertical line has undefined slope, not zero.

**SECOND WORKED EXAMPLE:** Find the midpoint of  $(-2, 4)$  and  $(6, 10)$ .

**STEP-BY-STEP REASONING:** Midpoint  $= ((-2 + 6) / 2, (4 + 10) / 2) = (2, 7)$ .

**QUICK CHECK:** Average x-coordinates and y-coordinates separately.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 8. Logic

Mathematical logic studies statements and valid reasoning. A statement has a definite truth value.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Negation reverses truth value. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- $p$  implies  $q$  is false only when  $p$  is true and  $q$  is false. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Contrapositive of  $p$  implies  $q$  is not  $q$  implies not  $p$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Converse is  $q$  implies  $p$  and need not be equivalent. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.



**WORKED EXAMPLE:** State the contrapositive of: If a number is divisible by 4, it is even.

**STEP-BY-STEP REASONING:** If a number is not even, then it is not divisible by 4. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use a truth table for unfamiliar compound statements.

**COMMON ERROR TO AVOID:** Do not confuse converse with contrapositive.

**SECOND WORKED EXAMPLE:** Negate the statement “All applicants submitted the form.”

**STEP-BY-STEP REASONING:** The correct negation is “At least one applicant did not submit the form.”

**QUICK CHECK:** The negation of “all” is “at least one not,” not “none.”

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 9. Similar Figures

Similar figures have equal corresponding angles and proportional corresponding lengths.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Scale factor  $k$ =corresponding length ratio. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Perimeter ratio= $k$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Area ratio= $k^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Volume ratio= $k^3$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

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**WORKED EXAMPLE:** Two similar triangles have side ratio 2:3. Find area ratio.

**STEP-BY-STEP REASONING:** Area ratio= $(2/3)^2=4/9$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Write the side ratio before squaring or cubing.

**COMMON ERROR TO AVOID:** Equal area is not required for similarity.

**SECOND WORKED EXAMPLE:** Two similar triangles have corresponding sides 4 and 10. If another side of the smaller triangle is 6, find the matching larger side.

**STEP-BY-STEP REASONING:** Scale factor =  $10/4 = 2.5$ , so the matching side is  $6 \times 2.5 = 15$ .

**QUICK CHECK:** Use the same larger-to-smaller order in every ratio.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 10. Graphs of Functions

A graph shows how output changes with input. Key features include intercepts, domain, range, symmetry and transformations.



The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- $y=f(x)+k$  shifts vertically. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $y=f(x-h)$  shifts right by  $h$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $y=af(x)$  stretches vertically. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Zeros are  $x$ -intercepts. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Describe  $y=(x-2)^2+3$  relative to  $y=x^2$ .

**STEP-BY-STEP REASONING:** It is shifted 2 units right and 3 units up. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Read transformations from inside out; horizontal signs appear reversed.

**COMMON ERROR TO AVOID:** Do not confuse  $y=f(x)-2$  with  $y=f(x-2)$ .

**SECOND WORKED EXAMPLE:** Describe  $y=(x-3)^2$  compared with  $y=x^2$ .

**STEP-BY-STEP REASONING:** The graph is shifted 3 units to the right; its shape and opening do not change.

**QUICK CHECK:** Inside-bracket horizontal shifts act in the opposite direction to the sign.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 11. Loci and Construction

A locus is the set of points satisfying a condition. Constructions use compass and straightedge properties.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Points equidistant from two points lie on the perpendicular bisector. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Points equidistant from two intersecting lines lie on angle bisectors. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Points at fixed distance from a point form a circle. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** What is the locus of points 3 cm from point P?

**STEP-BY-STEP REASONING:** A circle centred at P with radius 3 cm. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Translate each phrase into a standard locus before combining conditions.

**COMMON ERROR TO AVOID:** A line segment itself is not the locus of all points equidistant from its endpoints.

**SECOND WORKED EXAMPLE:** What is the locus of points equidistant from two fixed points A and B?

**STEP-BY-STEP REASONING:** It is the perpendicular bisector of segment AB.

**QUICK CHECK:** Translate “equidistant from two points” immediately into perpendicular bisector.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 12. Information Handling

Information handling includes collection, organization, tables, graphs and interpretation of data.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Choose graph type to match data: bar for categories, histogram for continuous grouped data, line for time trends. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Check scale and units before comparing. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Frequency density=frequency/class width for unequal intervals. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** A class has frequency 20 and width 5. Find frequency density.

**STEP-BY-STEP REASONING:**  $20/5=4$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Estimate the overall pattern before reading exact values.

**COMMON ERROR TO AVOID:** Histogram bar height is not always frequency when widths differ.

**SECOND WORKED EXAMPLE:** The frequencies are 3, 5, 7 and 5. Find the total frequency.

**STEP-BY-STEP REASONING:** Add all frequencies:  $3+5+7+5=20$ .

**QUICK CHECK:** Check that the total matches the number of observations represented.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 13. Probability

Probability measures likelihood from 0 to 1.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- $P(\text{A complement})=1-P(\text{A})$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $P(\text{A union B})=P(\text{A})+P(\text{B})-P(\text{A intersection B})$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- For independent events,  $P(A \text{ intersection } B) = P(A)P(B)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Conditional  $P(A|B) = P(A \text{ intersection } B)/P(B)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** A fair die is rolled. Find  $P(\text{even})$ .

**STEP-BY-STEP REASONING:** There are 3 even outcomes among 6, so  $3/6 = 1/2$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** List the sample space for small experiments.

**COMMON ERROR TO AVOID:** Mutually exclusive and independent are different ideas.

**SECOND WORKED EXAMPLE:** A bag contains 4 red and 6 blue balls. Find the probability of selecting a red ball.

**STEP-BY-STEP REASONING:** There are 10 balls and 4 favourable outcomes, so  $P(\text{red}) = 4/10 = 2/5$ .

**QUICK CHECK:** Probability = favourable outcomes divided by total equally likely outcomes.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 14. Quadratic Equations

A quadratic equation has form  $ax^2 + bx + c = 0$ ,  $a \neq 0$ . Solve by factorization, completing the square or the quadratic formula.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Formula  $x = (-b \pm \sqrt{b^2 - 4ac}) / (2a)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Discriminant  $D = b^2 - 4ac$  determines root type. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Check roots by substitution. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Solve  $x^2 - 5x + 6 = 0$ .

**STEP-BY-STEP REASONING:**  $(x-2)(x-3) = 0$ , so  $x = 2$  or  $3$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Try factorization first when coefficients are small integers.

**COMMON ERROR TO AVOID:** Do not lose one root by dividing by a variable factor.

**SECOND WORKED EXAMPLE:** Solve  $x^2 - 9 = 0$ .

**STEP-BY-STEP REASONING:** Use difference of squares:  $(x-3)(x+3) = 0$ , so  $x = 3$  or  $x = -3$ .

**QUICK CHECK:** Look for factorisation before using the quadratic formula.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 15. Theory of Quadratic Equations

The theory of quadratics connects roots with coefficients without solving completely.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- If roots are  $\alpha, \beta$ :  $\alpha + \beta = -b/a$  and  $\alpha\beta = c/a$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $D > 0$  gives two distinct real roots;  $D = 0$  equal real roots;  $D < 0$  non-real conjugates. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Construct equation  $x^2 - (\text{sum})x + \text{product} = 0$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** For  $2x^2 - 7x + 3 = 0$ , find sum and product of roots.

**STEP-BY-STEP REASONING:** Sum =  $7/2$ ; product =  $3/2$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use coefficient relationships to save time.

**COMMON ERROR TO AVOID:** Remember the negative sign in  $-b/a$ .

**SECOND WORKED EXAMPLE:** For  $x^2 - 7x + 10 = 0$ , find the sum and product of roots.

**STEP-BY-STEP REASONING:** For  $ax^2 + bx + c = 0$ , sum =  $-b/a = 7$  and product =  $c/a = 10$ .

**QUICK CHECK:** Use coefficient relations without solving when only sum or product is asked.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 16. Variations

Variation models proportional relationships.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Direct:  $y = kx$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Inverse:  $y = k/x$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Joint:  $y = kxz$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Partial variation combines a constant and varying part. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** If  $y$  varies directly as  $x$  and  $y = 12$  when  $x = 3$ , find  $y$  when  $x = 5$ .

**STEP-BY-STEP REASONING:**  $k=12/3=4$ ;  $y=4(5)=20$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Find  $k$  from the first condition before using the second.

**COMMON ERROR TO AVOID:** Direct variation must pass through the origin.

**SECOND WORKED EXAMPLE:**  $y$  varies directly as  $x$  and  $y=18$  when  $x=6$ . Find  $y$  when  $x=10$ .

**STEP-BY-STEP REASONING:**  $y=kx$ , so  $k=18/6=3$ . Hence  $y=3(10)=30$ .

**QUICK CHECK:** Find the constant of variation first.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 17. Partial Fractions

Partial fractions decompose a rational expression into simpler fractions for algebra and integration.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Proper fraction required; divide first if improper. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Distinct linear factors use  $A/(x-a)+B/(x-b)$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Repeated factors need a term for every power. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Irreducible quadratic uses  $(Ax+B)/(\text{quadratic})$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Decompose  $1/((x+1)(x+2))$ .

**STEP-BY-STEP REASONING:**  $1/(x+1)-1/(x+2)$ , since the combined numerator is 1. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use cover-up for distinct linear factors.

**COMMON ERROR TO AVOID:** Do not omit terms for repeated factors.

**SECOND WORKED EXAMPLE:** Decompose  $5/[(x+1)(x+2)]$ .

**STEP-BY-STEP REASONING:** Let  $5/[...] = A/(x+1)+B/(x+2)$ . Then  $5=A(x+2)+B(x+1)$ . Setting  $x=-1$  gives  $A=5$ ; setting  $x=-2$  gives  $B=-5$ .

**QUICK CHECK:** Substitute values that make one factor zero.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 18. Basic Statistics

Basic statistics summarizes data using location and spread.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign

and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Mean =  $\text{sum}/n$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Median is the middle ordered value. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Mode is most frequent. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Range =  $\text{max} - \text{min}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find the median of 3, 5, 7, 9, 11.

**STEP-BY-STEP REASONING:** The ordered list has five values; the middle is 7. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Sort data before finding median or quartiles.

**COMMON ERROR TO AVOID:** The mean is sensitive to extreme values.

**SECOND WORKED EXAMPLE:** Find the mean of 6, 8, 9 and 13.

**STEP-BY-STEP REASONING:** Mean =  $(6+8+9+13)/4 = 36/4 = 9$ .

**QUICK CHECK:** Count the observations before dividing.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 19. Introduction to Trigonometry

This topic develops angle measurement, right-triangle ratios and standard angles.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- $180 \text{ degrees} = \pi \text{ radians}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Know exact values at 0, 30, 45, 60, 90 degrees. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Use reciprocal ratios sec, cosec, cot when needed. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Convert 60 degrees to radians.

**STEP-BY-STEP REASONING:**  $60(\pi/180) = \pi/3$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Cancel 60/180 before multiplying.

**COMMON ERROR TO AVOID:** Calculator mode must match degree/radian units.



**SECOND WORKED EXAMPLE:** Convert  $150^\circ$  to radians.

**STEP-BY-STEP REASONING:**  $150^\circ \times \pi/180^\circ = 5\pi/6$ .

**QUICK CHECK:** For degrees to radians, multiply by  $\pi/180$ .

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 20. Projection of a Side of a Triangle

Projection expresses one side component along another direction and supports cosine-rule relationships.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Projection of side  $b$  on direction of  $c$  is  $b \cos A$ , with the correct included angle. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Cosine rule:  $a^2 = b^2 + c^2 - 2bc \cos A$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** If  $b=10$  and  $A=60$  degrees, find the projection of  $b$  along the adjacent direction.

**STEP-BY-STEP REASONING:**  $10 \cos 60 = 5$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw the altitude and identify the adjacent component.

**COMMON ERROR TO AVOID:** Use the included angle, not an unrelated triangle angle.

**SECOND WORKED EXAMPLE:** A side of length 10 makes an angle of  $60^\circ$  with a line. Find its projection on the line.

**STEP-BY-STEP REASONING:** Projection =  $10 \cos 60^\circ = 10(1/2) = 5$ .

**QUICK CHECK:** Projection uses cosine of the included angle.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 21. Chords of a Circle

A chord joins two points on a circle. The perpendicular from the centre to a chord bisects it.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Equal chords are equidistant from the centre. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Equal chords subtend equal central angles. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- The longest chord is the diameter. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** A radius is perpendicular to a chord of length 12. What half-length is formed?

**STEP-BY-STEP REASONING:** The perpendicular bisects the chord, so each half is 6. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Look for a right triangle using radius, half-chord and centre distance.

**COMMON ERROR TO AVOID:** A chord need not pass through the centre.

**SECOND WORKED EXAMPLE:** Two equal chords lie in the same circle. Compare their distances from the centre.

**STEP-BY-STEP REASONING:** Equal chords are equidistant from the centre.

**QUICK CHECK:** Equal chord, equal distance and equal arc facts usually travel together.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 22. Tangent to a Circle

A tangent touches a circle at one point and is perpendicular to the radius at that point.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Tangents from the same external point are equal. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Radius-tangent angle is 90 degrees. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Tangent-chord theorem links angle with the alternate segment. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Two tangents PA and PB are drawn from P. If PA=7, find PB.

**STEP-BY-STEP REASONING:** PB=7. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Mark equal tangent lengths immediately.

**COMMON ERROR TO AVOID:** A secant cuts the circle at two points; a tangent does not.

**SECOND WORKED EXAMPLE:** A radius is drawn to the point of contact of a tangent. What angle is formed?

**STEP-BY-STEP REASONING:** The radius is perpendicular to the tangent, so the angle is  $90^\circ$ .

**QUICK CHECK:** Mark the right angle immediately in tangent diagrams.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 23. Chords and Arcs

Chords and arcs correspond through central angles.



The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Equal chords subtend equal arcs. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A larger chord is closer to the centre and subtends a larger minor arc. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A diameter subtends a semicircle. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** If two chords are equal, compare their minor arcs.

**STEP-BY-STEP REASONING:** The minor arcs are equal. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Translate chord equality into arc or central-angle equality.

**COMMON ERROR TO AVOID:** Compare minor arcs consistently, not one minor and one major arc.

**SECOND WORKED EXAMPLE:** If two chords are equal, what can be said about their corresponding minor arcs?

**STEP-BY-STEP REASONING:** Equal chords subtend equal arcs in the same or congruent circles.

**QUICK CHECK:** Match equal chords with equal central angles and arcs.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 24. Angle in a Segment of a Circle

Angles at the circumference are controlled by the arcs they subtend.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Angle at centre is twice angle at circumference on the same arc. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Angles in the same segment are equal. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Angle in a semicircle is 90 degrees. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Opposite angles of a cyclic quadrilateral sum to 180 degrees. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** An arc subtends 100 degrees at the centre. Find the angle at the circumference.

**STEP-BY-STEP REASONING:**  $100/2=50$  degrees. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the same arc before applying the factor of two.

**COMMON ERROR TO AVOID:** Do not halve when the two angles do not stand on the same arc.

**SECOND WORKED EXAMPLE:** An arc subtends  $84^\circ$  at the centre. Find the angle it subtends at the circumference on the same arc.

**STEP-BY-STEP REASONING:** The angle at the circumference is half the central angle:  $84^\circ/2=42^\circ$ .

**QUICK CHECK:** Central angle is twice the inscribed angle on the same arc.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 25. Practical Geometry - Circles

Practical geometry constructs circles, tangents, chords and related figures from given conditions.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Use perpendicular bisectors to locate a circumcentre. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Use angle bisectors to locate an incentre. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Construct tangent by drawing a radius to the contact point then a perpendicular. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** How is the centre of a circle through three non-collinear points found?

**STEP-BY-STEP REASONING:** Intersect perpendicular bisectors of two chords joining the points. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** State construction steps in order and preserve arcs as evidence.

**COMMON ERROR TO AVOID:** Three collinear points cannot determine a circle.

**SECOND WORKED EXAMPLE:** How is the centre of a given circle located geometrically?

**STEP-BY-STEP REASONING:** Draw two chords and construct their perpendicular bisectors; their intersection is the centre.

**QUICK CHECK:** Two independent perpendicular bisectors are enough.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 26. Complex Numbers

A complex number is  $z=a+bi$  with  $i^2=-1$ .  $a$  is real part and  $b$  imaginary coefficient.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Conjugate of  $a+bi$  is  $a-bi$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- $|z| = \sqrt{a^2 + b^2}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Multiply by conjugate to divide complex numbers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Polar form supports products and powers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Simplify  $(3+2i)+(1-5i)$ .

**STEP-BY-STEP REASONING:**  $4-3i$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Combine real and imaginary parts separately.

**COMMON ERROR TO AVOID:**  $i^2 = -1$ , not  $+1$ .

**SECOND WORKED EXAMPLE:** Simplify  $(3+2i)+(5-7i)$ .

**STEP-BY-STEP REASONING:** Combine real and imaginary parts separately:  $8-5i$ .

**QUICK CHECK:** Treat  $i$  terms like like terms; remember  $i^2 = -1$  for products.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 27. Functions and Graphs

Functions and graphs extend mapping, composition, inverse functions and transformations.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- $(f \circ g)(x) = f(g(x))$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- An inverse exists on a domain where the function is one-one. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Reflect  $y=f(x)$  in  $y=x$  to obtain the inverse graph. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** If  $f(x) = 2x+3$ , find  $f^{-1}(x)$ .

**STEP-BY-STEP REASONING:** Let  $y = 2x+3$ ; swap  $x, y$  and solve:  $f^{-1}(x) = (x-3)/2$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For composition, evaluate the inner function first.

**COMMON ERROR TO AVOID:**  $f^{-1}(x)$  does not mean  $1/f(x)$ .

**SECOND WORKED EXAMPLE:** If  $f(x) = 2x-1$ , find  $f(4)$ .

**STEP-BY-STEP REASONING:** Substitute  $x=4$ :  $f(4) = 8-1=7$ .

**QUICK CHECK:** Replace every  $x$  carefully before simplifying.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 28. Theory of Quadratic Functions

Quadratic functions produce parabolas whose vertex, axis and intercepts reveal behaviour.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Axis  $x = -b/(2a)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Vertex value  $= f(-b/(2a))$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $a > 0$  opens upward;  $a < 0$  downward. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Discriminant controls  $x$ -intercepts. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find the axis of  $y = 2x^2 - 8x + 1$ .

**STEP-BY-STEP REASONING:**  $x = -(-8)/(2 \times 2) = 2$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use the axis formula before completing the square.

**COMMON ERROR TO AVOID:** The  $y$ -intercept is  $c$ , not the vertex.

**SECOND WORKED EXAMPLE:** Find the axis of symmetry of  $y = x^2 - 6x + 5$ .

**STEP-BY-STEP REASONING:** For  $y = ax^2 + bx + c$ ,  $x = -b/(2a) = 6/2 = 3$ .

**QUICK CHECK:** The vertex lies on  $x = -b/(2a)$ .

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 29. Matrices and Determinants

Matrices organize numbers and represent transformations and linear systems.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Addition requires same order. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- $AB$  is defined when columns of  $A$  equal rows of  $B$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- For  $2 \times 2$ ,  $\det = \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $A^{-1} = 1/\det \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$  when  $\det \neq 0$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find  $\det \begin{bmatrix} 2 & 3 \\ 1 & 4 \end{bmatrix}$ .

**STEP-BY-STEP REASONING:**  $2 \times 4 - 3 \times 1 = 5$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Check matrix dimensions before multiplying.

**COMMON ERROR TO AVOID:** Matrix multiplication is generally not commutative.

**SECOND WORKED EXAMPLE:** Find the determinant of  $\begin{bmatrix} 2 & 3 \\ 1 & 4 \end{bmatrix}$ .

**STEP-BY-STEP REASONING:**  $\det = (2)(4) - (3)(1) = 8 - 3 = 5$ .

**QUICK CHECK:** For a  $2 \times 2$  determinant, multiply main diagonal minus other diagonal.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 30. Sequences and Series

A sequence is an ordered list; a series is its sum.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Arithmetic:  $a_n = a + (n-1)d$ ;  $S_n = n/2[2a + (n-1)d]$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Geometric:  $a_n = ar^{n-1}$ ;  $S_n = a(1-r^n)/(1-r)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Infinite geometric sum  $= a/(1-r)$  for  $|r| < 1$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find the 10th term of 3, 7, 11, ...

**STEP-BY-STEP REASONING:**  $a=3, d=4$ ;  $a_{10} = 3 + 9 \times 4 = 39$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify constant difference or ratio first.

**COMMON ERROR TO AVOID:** An infinite geometric sum exists only when  $|r| < 1$ .

**SECOND WORKED EXAMPLE:** Find the 10th term of 4, 7, 10, ...

**STEP-BY-STEP REASONING:** This is arithmetic with  $a=4$  and  $d=3$ .  $a_{10} = 4 + 9(3) = 31$ .

**QUICK CHECK:** For the  $n$ th term, use  $a + (n-1)d$ .

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 31. Permutations and Combinations

Permutations count arrangements; combinations count selections.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- $nPr = \frac{n!}{(n-r)!}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $nCr = \frac{n!}{r!(n-r)!}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Use permutations when order matters. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Circular arrangements of  $n$  distinct objects:  $(n-1)!$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** How many ways can 2 students be selected from 6?

**STEP-BY-STEP REASONING:**  $6C2 = 15$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Ask: would swapping the chosen items create a new outcome?

**COMMON ERROR TO AVOID:** Do not use  $nPr$  for an unordered committee.

**SECOND WORKED EXAMPLE:** How many committees of 3 can be selected from 8 people?

**STEP-BY-STEP REASONING:** Order does not matter, so use  $8C3 = 8!/(3!5!) = 56$ .

**QUICK CHECK:** Use combinations for selection and permutations for ordered positions.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 32. Mathematical Induction and Binomial Theorem

Induction proves statements for all positive integers. The binomial theorem expands powers efficiently.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Induction: prove base case, assume  $k$ , prove  $k+1$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- $(a+b)^n = \sum nCr a^{n-r} b^r$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- General term  $T_{r+1} = nCr a^{n-r} b^r$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find the coefficient of  $x^2$  in  $(1+x)^5$ .

**STEP-BY-STEP REASONING:** It is  $5C2 = 10$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For a requested power, match  $r$  to the exponent.

**COMMON ERROR TO AVOID:** The induction hypothesis is assumed only for  $k$ , not for every integer.



**SECOND WORKED EXAMPLE:** Find the coefficient of  $x^2$  in  $(1+x)^5$ .

**STEP-BY-STEP REASONING:** The coefficient is  $5C2=10$ .

**QUICK CHECK:** In  $(a+b)^n$ , the coefficient of the  $r$ th power is a binomial coefficient.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 33. Division of Polynomials

Polynomial division expresses  $P(x)=D(x)Q(x)+R(x)$ .

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

#### Core ideas in plain language

- Remainder theorem: remainder on division by  $x-a$  is  $P(a)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Factor theorem:  $x-a$  is a factor iff  $P(a)=0$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Synthetic division is efficient for linear divisors. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find the remainder when  $x^3-2x+5$  is divided by  $x-2$ .

**STEP-BY-STEP REASONING:**  $P(2)=8-4+5=9$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use the remainder theorem instead of long division for a linear divisor.

**COMMON ERROR TO AVOID:** For divisor  $x+a$ , substitute  $x=-a$ .

**SECOND WORKED EXAMPLE:** Find the remainder when  $f(x)=x^3-2x+5$  is divided by  $x-2$ .

**STEP-BY-STEP REASONING:** By the remainder theorem, remainder= $f(2)=8-4+5=9$ .

**QUICK CHECK:** Substitute the root of the divisor instead of performing long division.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 34. Trigonometric Identities

Identities are equations true for all allowable angles and are used to simplify or prove expressions.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

#### Core ideas in plain language

- Start with one side, usually the more complicated. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Convert to sin and cos when stuck. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Use  $1+\tan^2=\sec^2$  and  $1+\cot^2=\operatorname{cosec}^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Factor before expanding. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Simplify  $(1 - \cos^2 x) / \sin x$ .

**STEP-BY-STEP REASONING:** Using  $1 - \cos^2 x = \sin^2 x$ , result  $= \sin x$  where defined. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Do not manipulate both sides independently in a proof.

**COMMON ERROR TO AVOID:** Division may exclude values where the denominator is zero.

**SECOND WORKED EXAMPLE:** Simplify  $(1 - \cos^2 \theta) / \sin \theta$ .

**STEP-BY-STEP REASONING:** Since  $1 - \cos^2 \theta = \sin^2 \theta$ , the expression becomes  $\sin \theta$ , provided  $\sin \theta \neq 0$ .

**QUICK CHECK:** Convert to one basic identity before cancelling.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 35. Trigonometric Functions and Their Graphs

Sine, cosine and tangent are periodic functions with characteristic amplitude, period and asymptotes.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- $\sin$  and  $\cos$  have period  $2\pi$ ;  $\tan$  has period  $\pi$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- For  $y = A \sin(Bx)$ , amplitude  $= |A|$  and period  $= 2\pi/|B|$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Tangent has vertical asymptotes where  $\cos x = 0$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find the period of  $y = \sin(3x)$ .

**STEP-BY-STEP REASONING:** Period  $= 2\pi/3$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Read amplitude and period before sketching.

**COMMON ERROR TO AVOID:** Tangent has no finite amplitude.

**SECOND WORKED EXAMPLE:** State the period of  $y = \sin(2x)$ .

**STEP-BY-STEP REASONING:** For  $\sin(kx)$ , period  $= 2\pi/|k|$ , so the period is  $\pi$ .

**QUICK CHECK:** A larger frequency coefficient gives a shorter period.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 36. Limit and Continuity

A limit describes behaviour near a point. Continuity requires the limit to exist and equal the function value.



The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Factor or rationalize removable  $0/0$  forms. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A function is continuous at  $a$  if  $\lim_{x \rightarrow a} f(x) = f(a)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Standard limit  $\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Evaluate  $\lim_{x \rightarrow 2} \frac{(x^2-4)}{(x-2)}$ .

**STEP-BY-STEP REASONING:** Factor  $\frac{(x-2)(x+2)}{(x-2)}$ ; limit=4. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Substitute first; only transform if an indeterminate form appears.

**COMMON ERROR TO AVOID:**  $0/0$  is not the answer; it signals further work.

**SECOND WORKED EXAMPLE:** Evaluate  $\lim_{x \rightarrow 2} \frac{(x^2-4)}{(x-2)}$ .

**STEP-BY-STEP REASONING:** Factor:  $\frac{(x-2)(x+2)}{(x-2)} = x+2$ , so the limit is 4.

**QUICK CHECK:** Factor or rationalise before substituting when direct substitution gives  $0/0$ .

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 37. Differentiation

Differentiation measures instantaneous rate of change and slope.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Power rule  $\frac{d}{dx} x^n = nx^{n-1}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Product, quotient and chain rules handle combinations. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Stationary points satisfy  $f'(x) = 0$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Second derivative helps classify extrema. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Differentiate  $3x^4 - 2x + 5$ .

**STEP-BY-STEP REASONING:**  $12x^3 - 2$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Differentiate term by term and check constants vanish.

**COMMON ERROR TO AVOID:** The derivative of a product is not the product of derivatives.

**SECOND WORKED EXAMPLE:** Differentiate  $y=3x^4-5x^2+7$ .

**STEP-BY-STEP REASONING:**  $dy/dx=12x^3-10x$ . The constant differentiates to zero.

**QUICK CHECK:** Apply the power rule term by term.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 38. Vectors in Space

A vector has magnitude and direction and may be represented by components.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- $AB=(x_2-x_1, y_2-y_1, z_2-z_1)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $\text{Magnitude}=\sqrt{x^2+y^2+z^2}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Dot product  $a \cdot b = |a||b|\cos\theta$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Perpendicular vectors have dot product zero. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find vector from A(1,2,3) to B(4,6,3).

**STEP-BY-STEP REASONING:** (3,4,0). After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Always subtract initial coordinates from terminal coordinates.

**COMMON ERROR TO AVOID:** BA is the negative of AB.

**SECOND WORKED EXAMPLE:** Find the magnitude of vector  $2i-3j+6k$ .

**STEP-BY-STEP REASONING:**  $\text{Magnitude}=\sqrt{(2)^2+(-3)^2+(6)^2}=\sqrt{49}=7$ .

**QUICK CHECK:** Square each component; signs disappear after squaring.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 39. Functions and Limits

This topic combines function properties with advanced limit methods and continuity.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Check domain restrictions first. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Use algebraic simplification, standard limits and one-sided limits. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- Composite limits require inner and outer behaviours to be valid. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find  $\lim_{x \rightarrow 0} (\sin 5x)/x$ .

**STEP-BY-STEP REASONING:** Write  $5(\sin 5x)/(5x)$ ; limit=5. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Create the standard  $\sin u/u$  form.

**COMMON ERROR TO AVOID:** Do not substitute degrees into calculus limits; angles are in radians.

**SECOND WORKED EXAMPLE:** If  $f(x)=1/(x-4)$ , state the domain restriction.

**STEP-BY-STEP REASONING:**  $x$  cannot equal 4 because the denominator would be zero.

**QUICK CHECK:** Check denominators, square roots and logarithms before giving a domain.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 40. Integration

Integration reverses differentiation and measures accumulation and area.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Power rule integral  $x^n dx = x^{n+1}/(n+1) + C$ ,  $n! = -1$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Definite integral evaluates antiderivative at limits. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Substitution reverses the chain rule. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Integration by parts:  $\int u dv = uv - \int v du$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Integrate  $6x^2 - 4$ .

**STEP-BY-STEP REASONING:**  $2x^3 - 4x + C$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Differentiate your answer quickly to verify.

**COMMON ERROR TO AVOID:** Do not omit the constant  $C$  in an indefinite integral.

**SECOND WORKED EXAMPLE:** Evaluate  $\int (3x^2 - 4) dx$ .

**STEP-BY-STEP REASONING:** The antiderivative is  $x^3 - 4x + C$ .

**QUICK CHECK:** Increase the power by one, divide by the new power and include  $C$ .

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 41. Introduction to Analytic Geometry

Analytic geometry studies lines and geometric objects through equations.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Line forms:  $y=mx+c$ ;  $y-y_1=m(x-x_1)$ ;  $Ax+By+C=0$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Distance from point to line  $=|Ax_0+By_0+C|/\sqrt{A^2+B^2}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Angle between lines uses slopes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Find the line through (2,3) with slope 4.

**STEP-BY-STEP REASONING:**  $y-3=4(x-2)$ , or  $y=4x-5$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use point-slope form first to reduce errors.

**COMMON ERROR TO AVOID:** A line perpendicular to slope  $m$  has slope  $-1/m$ , unless vertical/horizontal special cases apply.

**SECOND WORKED EXAMPLE:** Find the equation of the line with slope 3 through (2,1).

**STEP-BY-STEP REASONING:** Use  $y-1=3(x-2)$ , giving  $y=3x-5$ .

**QUICK CHECK:** Point-slope form is quickest when a point and slope are given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 42. Linear Inequalities and Linear Programming

Linear programming optimizes a linear objective over a feasible region defined by inequalities.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Graph each boundary line. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Test a point to choose the correct half-plane. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Feasible region is the intersection. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- For a bounded polygon, test objective at vertices. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Maximize  $Z=2x+y$  over vertices (0,0),(0,4),(3,2).

**STEP-BY-STEP REASONING:** Z values are 0,4,8; maximum 8 at (3,2). After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** The optimum occurs at a corner point for standard linear programs.

**COMMON ERROR TO AVOID:** Do not optimize before finding the common feasible region.

**SECOND WORKED EXAMPLE:** Which side of  $x+y \leq 6$  contains the origin?

**STEP-BY-STEP REASONING:** Test (0,0):  $0 \leq 6$  is true, so shade the side containing the origin.

**QUICK CHECK:** Use a test point not on the boundary line.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 43. Conic Sections

Conics include circles, parabolas, ellipses and hyperbolas, defined by geometric loci and standard equations.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

### Core ideas in plain language

- Circle:  $(x-h)^2 + (y-k)^2 = r^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Parabola:  $(y-k)^2 = 4a(x-h)$  or  $(x-h)^2 = 4a(y-k)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Ellipse has sum of focal distances constant. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Hyperbola has absolute difference constant. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** Identify  $x^2 + y^2 - 4x + 6y - 12 = 0$ .

**STEP-BY-STEP REASONING:** Complete squares:  $(x-2)^2 + (y+3)^2 = 25$ , a circle centre (2,-3), radius 5. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Complete squares to reach standard form.

**COMMON ERROR TO AVOID:** Signs and unequal coefficients distinguish conics.

**SECOND WORKED EXAMPLE:** Identify  $x^2/9 + y^2/4 = 1$ .

**STEP-BY-STEP REASONING:** Both squared terms are positive and unequal denominators appear, so the graph is an ellipse.

**QUICK CHECK:** Use the signs and denominators to identify the conic quickly.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 44. Vectors

Vector algebra in two and three dimensions supports geometry, mechanics and lines/planes.

The central aim is to understand how the main ideas are connected. Begin by naming the required quantity, writing the relevant definition or formula, and checking restrictions. Simplify symbolically before inserting numbers. Estimate the sign and approximate size, complete the calculation, and verify the result by substitution, a special case, or comparison with the options.

## Core ideas in plain language

- Unit vector  $\mathbf{a}/|\mathbf{a}|$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Projection of  $\mathbf{a}$  on  $\mathbf{b} = (\mathbf{a} \cdot \mathbf{b}/|\mathbf{b}|^2)\mathbf{b}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Cross product magnitude  $= |\mathbf{a}||\mathbf{b}|\sin \theta$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Scalar triple product gives signed volume. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

A strong solution should show the controlling idea before the arithmetic. When two methods are possible, prefer the method that exposes structure - factorisation before a long formula, symmetry before case-by-case counting, or a graph before repeated substitution. The answer choices can be used for checking, but they should not replace a logically valid method.

**WORKED EXAMPLE:** If  $\mathbf{a} = (3, 4)$ , find its unit vector.

**STEP-BY-STEP REASONING:**  $|\mathbf{a}| = 5$ , so unit vector  $= (3/5, 4/5)$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Compute magnitude before normalizing.

**COMMON ERROR TO AVOID:** A zero vector has no defined direction and cannot be normalized.

**SECOND WORKED EXAMPLE:** Find the dot product of  $(2, -1)$  and  $(3, 4)$ .

**STEP-BY-STEP REASONING:**  $2(3) + (-1)(4) = 6 - 4 = 2$ .

**QUICK CHECK:** Multiply corresponding components and add.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## MATHEMATICS - PRACTICE EXERCISES

Three independent sets are provided. Attempt each question before reading the answer, explanation and quick tactic immediately below it. Each set contains 25 MCQs with five options (A–E).

### Practice Set 1 - 25 MCQs

1. Resolve  $(3x+5)/[(x+1)(x+2)]$ . The coefficient of  $1/(x+1)$  is:

- A. -2
- B. 1
- C. 3
- D. 5
- E. 2

**Answer: D. 5. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 5: Partial Fractions; the calculation or property leads to 5. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

2. For frequencies 2, 3, and 5 corresponding to values 1, 2, and 3, the mean is:

- A. 2.0
- B. 2.3
- C. 2.5
- D. 3.0
- E. 6.0

**Answer: B. 2.3. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 12: Information Handling; the calculation or property leads to 2.3. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

3. A process with an uncertain result, such as tossing a coin, is a:

- A. Certain event
- B. Random experiment
- C. Sample point
- D. Class interval
- E. Frequency polygon

**Answer: B. Random experiment. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 13: Probability; the calculation or property leads to Random experiment. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

4. The maximum value of  $y = -x^2 + 4x - 1$  is:

- A. -3
- B. 3
- C. 4
- D. 1



E. 5

**Answer: C. 4. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 3: Theory of Quadratic Functions; the calculation or property leads to 4. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**5. The set containing all objects under discussion is the:**

- A. Universal set
- B. Empty set
- C. Singleton set
- D. Power set
- E. Disjoint set

**Answer: A. Universal set. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 3: Sets and Functions; the calculation or property leads to Universal set. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**6. Find  $\sin 30^\circ$ .**

- A.  $\sqrt{3}/2$
- B.  $1/\sqrt{2}$
- C.  $1/2$
- D. 1
- E. 0

**Answer: C.  $1/2$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 7: Introduction to Trigonometry; the calculation or property leads to  $1/2$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**7. For the system  $x+y=5$  and  $x-y=1$ , the solution is:**

- A.  $x=2, y=3$
- B.  $x=4, y=1$
- C.  $x=1, y=4$
- D.  $x=5, y=0$
- E.  $x=3, y=2$

**Answer: B.  $x=4, y=1$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Matrices and Determinants; the calculation or property leads to  $x=4, y=1$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**8. Partial-fraction resolution is useful because it converts a rational expression into:**

- A. A single higher-degree polynomial
- B. A product of unrelated radicals
- C. A sum of simpler rational fractions
- D. A matrix of coefficients
- E. A trigonometric series



**Answer: E. A trigonometric series.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 5: Partial Fractions; the calculation or property leads to A trigonometric series. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**9. The cumulative frequency of a class is obtained by:**

- A. Subtracting all earlier frequencies
- B. Multiplying class limits
- C. Averaging class marks
- D. Adding frequencies up to that class
- E. Dividing by class width

**Answer: D. Adding frequencies up to that class.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 6: Basic Statistics; the calculation or property leads to Adding frequencies up to that class. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**10. To construct tangents from an external point P, the first main segment drawn is:**

- A. A random chord through P
- B. OP, joining P to the center
- C. A diameter parallel to P
- D. A radius perpendicular to OP at O only
- E. An arc centered at P with any radius

**Answer: B. OP, joining P to the center.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 13: Practical Geometry - Circles; the calculation or property leads to OP, joining P to the center. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**11. In the fourth quadrant, the positive basic trigonometric ratio is:**

- A.  $\cos \theta$
- B.  $\sin \theta$
- C.  $\tan \theta$
- D.  $\operatorname{cosec} \theta$
- E.  $\cot \theta$

**Answer: A.  $\cos \theta$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 7: Introduction to Trigonometry; the calculation or property leads to  $\cos \theta$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**12. The power law of logarithms gives  $\log(a^n)$  as:**

- A.  $(\log a)^n$
- B.  $n \log a$
- C.  $\log a + n$
- D.  $a \log n$
- E.  $n + \log a$

**Answer: B.  $n \log a$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 2: Logarithms; the calculation or property leads to  $n \log a$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**13. If  $y$  varies inversely as  $x^2$ , its equation is:**

- A.  $y = kx^2$
- B.  $y^2 = k/x$
- C.  $xy = k^2$
- D.  $y = x^2/k$
- E.  $y = k/x^2$

**Answer: E.  $y = k/x^2$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 3: Variations; the calculation or property leads to  $y = k/x^2$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**14. An arc smaller than a semicircle is called a:**

- A. Minor arc
- B. Major arc
- C. Reflex chord
- D. Tangent arc
- E. Diameter arc

**Answer: A. Minor arc.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 11: Chords and Arcs; the calculation or property leads to Minor arc. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**15. In a circle of radius 7 cm, the maximum chord length is:**

- A. 7 cm
- B. 21 cm
- C. 14 cm
- D. 28 cm
- E. 49 cm

**Answer: C. 14 cm.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 9: Chords of a Circle; the calculation or property leads to 14 cm. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**16. A ball rebounds to  $3/4$  of its previous height. If dropped from 16 m, its height after the third rebound is:**

- A. 6.75 m
- B. 9 m
- C. 12 m
- D. 7.5 m
- E. 5.0625 m

**Answer: E. 5.0625 m. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 6: Sequences and Series; the calculation or property leads to 5.0625 m. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**17. The point (4, 3) lies in which quadrant?**

- A. Second quadrant
- B. First quadrant
- C. Third quadrant
- D. Fourth quadrant
- E. On the x-axis

**Answer: B. First quadrant. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 7: Coordinate Geometry; the calculation or property leads to First quadrant. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**18. What is the principal argument of  $1 + i$ ?**

- A.  $\pi/2$
- B.  $\pi/4$
- C.  $3\pi/4$
- D.  $-\pi/4$
- E. 0

**Answer: C.  $3\pi/4$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 1: Complex Numbers; the calculation or property leads to  $3\pi/4$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**19. After finding all coefficients, the best check is to:**

- A. Set every coefficient equal to one
- B. Differentiate each term
- C. Discard the polynomial part
- D. Replace x by infinity
- E. Combine the fractions and recover the original expression

**Answer: E. Combine the fractions and recover the original expression. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Partial Fractions; the calculation or property leads to Combine the fractions and recover the original expression. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**20. The statement  $\log_2 8 = 3$  is equivalent to:**

- A.  $2^3 = 8$
- B.  $3^2 = 8$
- C.  $8^2 = 3$
- D.  $2^8 = 3$
- E.  $8^3 = 2$

**Answer: A.  $2^3 = 8$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 2: Logarithms; the calculation or property leads to  $2^3 = 8$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**21. Two figures are similar when they have the same shape and:**

- A. Exactly the same area
- B. Exactly the same perimeter
- C. Equal corresponding sides only
- D. Different corresponding angles
- E. Corresponding sides in the same ratio

**Answer: E. Corresponding sides in the same ratio.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 9: Similar Figures; the calculation or property leads to Corresponding sides in the same ratio. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**22. A homogeneous system has a non-trivial solution when the rank of its coefficient matrix is:**

- A. Greater than the number of variables
- B. Less than the number of variables
- C. Equal to twice the number of variables
- D. Always zero
- E. Equal to the number of equations only

**Answer: B. Less than the number of variables.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Matrices and Determinants; the calculation or property leads to Less than the number of variables. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**23. A feasible solution of  $x \geq 0$ ,  $y \geq 0$ , and  $x + y \leq 5$  is:**

- A. (-1, 3)
- B. (4, 3)
- C. (2, -2)
- D. (6, 0)
- E. (2, 2)

**Answer: E. (2, 2).** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 5: Linear Equations and Inequalities; the calculation or property leads to (2, 2). **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**24. The gradient of a vertical line is:**

- A. 0
- B. 1
- C. Undefined
- D. -1
- E. Always positive

**Answer: C. Undefined. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 7: Coordinate Geometry; the calculation or property leads to Undefined. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**25. Which is the correct scientific notation for 7,800,000?**

- A.  $78 \times 10^5$
- B.  $7.8 \times 10^6$
- C.  $0.78 \times 10^7$
- D.  $7.8 \times 10^5$
- E.  $78 \times 10^6$

**Answer: B.  $7.8 \times 10^6$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 2: Logarithms; the calculation or property leads to  $7.8 \times 10^6$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

## Practice Set 2 - 25 MCQs

### 1. Which formula is the cosine rule for side a?

- A.  $a^2 = b^2 + c^2 + 2bc \cos A$
- B.  $a = b + c - 2bc \cos A$
- C.  $a^2 = b^2 + c^2 - 2bc \cos A$
- D.  $a^2 = b^2 - c^2 + 2bc \cos A$
- E.  $a^2 = 2b^2 + 2c^2 - bc$

**Answer: C.  $a^2 = b^2 + c^2 - 2bc \cos A$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 8: Projection of a Side of a Triangle; the calculation or property leads to  $a^2 = b^2 + c^2 - 2bc \cos A$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

### 2. The corresponding sides of two similar triangles are in the ratio 2:5. Their areas are in the ratio:

- A. 2:5
- B. 4:25
- C. 4:10
- D. 8:125
- E. 5:2

**Answer: B. 4:25.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 9: Similar Figures; the calculation or property leads to 4:25. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

### 3. A semicircle has an arc measure of:

- A.  $90^\circ$
- B.  $120^\circ$
- C.  $180^\circ$
- D.  $270^\circ$
- E.  $360^\circ$

**Answer: C.  $180^\circ$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 11: Chords and Arcs; the calculation or property leads to  $180^\circ$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

### 4. The cofactor $A_{ij}$ is related to the minor $M_{ij}$ by:

- A.  $A_{ij} = (-1)^{ij} M_{ij}$
- B.  $A_{ij} = (-1)^{i+j} M_{ij}$
- C.  $A_{ij} = i+j+M_{ij}$
- D.  $A_{ij} = M_{ij}^2$
- E.  $A_{ij} = -M_{ij}$  for every  $i, j$

**Answer: A.  $A_{ij} = (-1)^{ij} M_{ij}$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Matrices and Determinants; the calculation or property leads to  $A_{ij} = (-1)^{ij} M_{ij}$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**5. For distinct linear factors  $(x - a)(x - b)$ , the partial-fraction form is:**

- A.  $A/(x - a)^2 + B/(x - b)^2$
- B.  $(Ax + B)/[(x - a)(x - b)]$
- C.  $A/(x - a) + B/(x - a)^2$
- D.  $A/(x - a) + B/(x - b)$
- E.  $(A + Bx)/(x - a)$

**Answer: D.  $A/(x - a) + B/(x - b)$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Partial Fractions; the calculation or property leads to  $A/(x - a) + B/(x - b)$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**6. Which measure equals the largest value minus the smallest value?**

- A. Range
- B. Mean
- C. Median
- D. Mode
- E. Standard deviation

**Answer: A. Range. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 6: Basic Statistics; the calculation or property leads to Range. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**7. Equal chords of the same circle are:**

- A. Always diameters
- B. Equidistant from the center
- C. Perpendicular to each other
- D. Parallel in every case
- E. Unequal in length

**Answer: B. Equidistant from the center. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 9: Chords of a Circle; the calculation or property leads to Equidistant from the center. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**8. Reasoning from a general rule to a specific conclusion is:**

- A. Deductive reasoning
- B. Inductive reasoning
- C. Experimental guessing
- D. Pattern listing
- E. Approximation

**Answer: A. Deductive reasoning. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 8: Logic; the calculation or property leads to Deductive reasoning. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**9. A tangent to a curve is a line that:**

- A. Is always parallel to the x-axis
- B. Cuts the curve at three points
- C. Passes through the origin
- D. Has zero gradient
- E. Touches the curve at the point considered

**Answer: E. Touches the curve at the point considered.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 10: Graphs of Functions; the calculation or property leads to Touches the curve at the point considered. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**10. Which function from  $\mathbb{R}$  to  $\mathbb{R}$  is one-to-one?**

- A.  $f(x) = x^2$
- B.  $f(x) = |x|$
- C.  $f(x) = 5$
- D.  $f(x) = x^4$
- E.  $f(x) = 3x - 1$

**Answer: B.  $f(x) = |x|$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 2: Functions and Graphs; the calculation or property leads to  $f(x) = |x|$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**11. If  $\ln e^4 = k$ , the value of  $k$  is:**

- A.  $e$
- B. 1
- C. 0
- D. 16
- E. 4

**Answer: E. 4.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 2: Logarithms; the calculation or property leads to 4. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**12. If  $b^2 + c^2 = 100$  and  $a = 8$ , then  $ma^2$  is:**

- A. 42
- B. 50
- C. 68
- D. 84
- E. 34

**Answer: E. 34.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 8: Projection of a Side of a Triangle; the calculation or property leads to 34. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**13. The set of all possible outcomes is the:**

- A. Event only



- B. Relative frequency
- C. Sample space
- D. Expected value
- E. Universal frequency

**Answer: C. Sample space. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 13: Probability; the calculation or property leads to Sample space. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**14. What is the HCF of  $6x^2y$  and  $15xy^2$ ?**

- A.  $3xy$
- B.  $3x^2y^2$
- C.  $5xy$
- D.  $6xy$
- E.  $30x^3y^3$

**Answer: A.  $3xy$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Factorization and Algebraic Manipulation; the calculation or property leads to  $3xy$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**15. A perpendicular bisector of a line segment passes through its midpoint and forms an angle of:**

- A.  $90^\circ$
- B.  $30^\circ$
- C.  $45^\circ$
- D.  $60^\circ$
- E.  $180^\circ$

**Answer: A.  $90^\circ$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 11: Loci and Construction; the calculation or property leads to  $90^\circ$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**16. In an SAS construction, the given angle lies:**

- A. Opposite both given sides
- B. Between the two given sides
- C. Outside the triangle
- D. At the midpoint of a side
- E. Between two unknown sides

**Answer: B. Between the two given sides. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 11: Loci and Construction; the calculation or property leads to Between the two given sides. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**17. Which point lies on the graph  $y = \sqrt{x}$ ?**

- A. (3, 9)
- B. (-4, 2)

- C. (4, -2)
- D. (1, -1)
- E. (9, 3)

**Answer: B. (-4, 2).** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 2: Functions and Graphs; the calculation or property leads to (-4, 2). **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**18. For  $f(x) = 2x + 3$ , what is  $f(4)$ ?**

- A. 8
- B. 9
- C. 10
- D. 11
- E. 13

**Answer: E. 13.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 2: Functions and Graphs; the calculation or property leads to 13. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**19. The cover-up method is most directly useful for finding coefficients of:**

- A. Distinct linear factors
- B. Repeated irreducible quadratics only
- C. Polynomial quotients only
- D. Numerators of degree two only
- E. Non-rational expressions

**Answer: B. Repeated irreducible quadratics only.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 5: Partial Fractions; the calculation or property leads to Repeated irreducible quadratics only. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**20. An exterior angle of a cyclic quadrilateral equals the:**

- A. Adjacent interior angle
- B. Interior opposite angle
- C. Central angle
- D. Half the adjacent angle
- E. Sum of both adjacent angles

**Answer: B. Interior opposite angle.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 12: Angle in a Segment of a Circle; the calculation or property leads to Interior opposite angle. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**21. A determinant with two identical rows has value:**

- A. 1
- B. -1
- C. 0

D. 2

E. Undefined

**Answer: D. 2. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Matrices and Determinants; the calculation or property leads to 2. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**22. Which expression is the square of  $2x - 3$ ?**

A.  $4x^2 - 12x + 9$ B.  $4x^2 - 9$ C.  $4x^2 + 12x + 9$ D.  $2x^2 - 6x + 9$ E.  $4x^2 - 6x + 9$ 

**Answer: A.  $4x^2 - 12x + 9$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Factorization and Algebraic Manipulation; the calculation or property leads to  $4x^2 - 12x + 9$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**23. The gradient of the line through (1, 2) and (3, 6) is:**

A.  $1/2$ 

B. 3

C. 2

D. 4

E. -2

**Answer: C. 2. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 7: Coordinate Geometry; the calculation or property leads to 2. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**24. When the two endpoints are opposite ends of a diameter, the two arcs are:**

A. A minor and a major arc

B. Unequal quarters

C. Equal semicircles

D. Zero arcs

E. Tangents

**Answer: C. Equal semicircles. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 11: Chords and Arcs; the calculation or property leads to Equal semicircles. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**25. If  $a = b = c$  in a triangle, each angle is:**

A.  $30^\circ$ B.  $60^\circ$ C.  $45^\circ$ D.  $90^\circ$

E.  $120^\circ$

**Answer: B.  $60^\circ$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 8: Projection of a Side of a Triangle; the calculation or property leads to  $60^\circ$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

## Practice Set 3 - 25 MCQs

### 1. A circle is divided by two points into:

- A. A minor arc and a major arc
- B. Two diameters
- C. Two radii only
- D. A tangent and a chord
- E. Two equal arcs in every case

**Answer: A. A minor arc and a major arc.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 11: Chords and Arcs; the calculation or property leads to A minor arc and a major arc. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

### 2. The set of actual output values of a function is its:

- A. Domain
- B. Universal set
- C. Inverse set
- D. Power set
- E. Range

**Answer: E. Range.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 5: Sets and Functions; the calculation or property leads to Range. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

### 3. The locus of points at a fixed distance from a fixed straight line consists of:

- A. One circle
- B. One perpendicular line
- C. Two intersecting lines
- D. One angle bisector
- E. Two parallel lines

**Answer: E. Two parallel lines.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 11: Loci and Construction; the calculation or property leads to Two parallel lines. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

### 4. Which expression is an improper rational fraction?

- A.  $(x + 1)/(x^2 + 2)$
- B.  $3/(x - 1)$
- C.  $(2x + 5)/(x^2 - 4)$
- D.  $(x^2 + 1)/(x + 2)$
- E.  $1/(x^2 + x + 1)$

**Answer: D.  $(x^2 + 1)/(x + 2)$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Partial Fractions; the calculation or property leads to  $(x^2 + 1)/(x + 2)$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

5. A conditional statement is logically equivalent to its:

- A. Converse
- B. Contrapositive
- C. Inverse only
- D. Negation
- E. Conclusion

**Answer: B. Contrapositive. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 8: Logic; the calculation or property leads to Contrapositive. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

6. Two circles touching externally have how many common tangents?

- A. 1
- B. 2
- C. 3
- D. 4
- E. 0

**Answer: C. 3. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 10: Tangent to a Circle; the calculation or property leads to 3. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

7. Find the mean of 2, 4, 6, and 8.

- A. 4
- B. 5
- C. 6
- D. 8
- E. 20

**Answer: B. 5. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 6: Basic Statistics; the calculation or property leads to 5. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

8. If the roots are  $2 + \sqrt{3}$  and  $2 - \sqrt{3}$ , their sum is:

- A. 4
- B. 2
- C. 3
- D.  $2\sqrt{3}$
- E.  $4\sqrt{3}$

**Answer: A. 4. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 2: Theory of Quadratic Equations; the calculation or property leads to 4. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

9. Which assumed form is correct for  $1/[(x - 2)(x^2 + 4)]$ ?

- A.  $A/(x - 2) + B/(x^2 + 4)$
- B.  $(Ax + B)/(x - 2) + C/(x^2 + 4)$
- C.  $A/(x - 2)^2 + B/(x^2 + 4)$
- D.  $(Ax^2 + B)/(x - 2) + C/(x^2 + 4)$
- E.  $A/(x - 2) + (Bx + C)/(x^2 + 4)$

**Answer: E.  $A/(x - 2) + (Bx + C)/(x^2 + 4)$ .** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Partial Fractions; the calculation or property leads to  $A/(x - 2) + (Bx + C)/(x^2 + 4)$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**10. In triangle ABC, the side opposite angle A is conventionally denoted by:**

- A. a
- B. b
- C. c
- D. A
- E.  $m_a$

**Answer: A. a.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 8: Projection of a Side of a Triangle; the calculation or property leads to a. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**11. If two chords are equally distant from the center, their lengths are:**

- A. The same
- B. In the ratio 1 : 2
- C. In the ratio 2 : 1
- D. Always radii
- E. Always diameters

**Answer: A. The same.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 9: Chords of a Circle; the calculation or property leads to The same. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**12. A function from A to B assigns each element of A:**

- A. At least two elements of B
- B. Exactly one element of B
- C. No element of B
- D. Every element of B
- E. One subset of B

**Answer: B. Exactly one element of B.** **Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 5: Sets and Functions; the calculation or property leads to Exactly one element of B. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**13. If  $y \propto x$  and  $y = 18$  when  $x = 6$ , the constant of variation is:**

- A. 6

- B. 12
- C. 18
- D. 3
- E. 108

**Answer: D. 3. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 3: Variations; the calculation or property leads to 3. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**14. An ordered list of numbers formed according to a rule is called a:**

- A. Determinant
- B. Polynomial
- C. Permutation
- D. Sequence
- E. Function inverse

**Answer: C. Permutation. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 6: Sequences and Series; the calculation or property leads to Permutation. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**15. A rational fraction  $P(x)/Q(x)$  is proper when:**

- A.  $\deg P > \deg Q$
- B.  $\deg P = \deg Q$  in every case
- C.  $P(x)$  has no constant term
- D.  $\deg P < \deg Q$
- E.  $Q(x)$  is linear

**Answer: C.  $P(x)$  has no constant term. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 5: Partial Fractions; the calculation or property leads to  $P(x)$  has no constant term. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**16. Which method can solve every quadratic equation, whether factorable or not?**

- A. Factorization only
- B. Taking square roots only
- C. Quadratic formula
- D. Long division
- E. Ratio method

**Answer: C. Quadratic formula. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 1: Quadratic Equations; the calculation or property leads to Quadratic formula. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**17. The value of  $\log_5 1$  is:**

- A. 1
- B. 5



- C. -1
- D. 0
- E. Undefined

**Answer: D. 0. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 2: Logarithms; the calculation or property leads to 0. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**18. Five less than twice a number is 17. The number is:**

- A. 6
- B. 11
- C. 8
- D. 12
- E. 22

**Answer: B. 11. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 5: Linear Equations and Inequalities; the calculation or property leads to 11. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**19. The ratio of the perimeters of two similar polygons equals the ratio of their:**

- A. Areas
- B. Volumes
- C. Numbers of diagonals
- D. Corresponding side lengths
- E. Interior angle sums

**Answer: D. Corresponding side lengths. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 9: Similar Figures; the calculation or property leads to Corresponding side lengths. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**20. If  $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ , then  $A^T$  is:**

- A.  $\begin{bmatrix} 4 & 3 \\ 2 & 1 \end{bmatrix}$
- B.  $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$
- C.  $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$
- D.  $\begin{bmatrix} 2 & 1 \\ 4 & 3 \end{bmatrix}$
- E.  $\begin{bmatrix} 3 & 4 \\ 1 & 2 \end{bmatrix}$

**Answer: C.  $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Matrices and Determinants; the calculation or property leads to  $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**21. Two matrices are equal when they have the same order and:**

- A. Their determinants are equal
- B. Their traces are equal
- C. Their row sums are equal

D. Corresponding entries are equal

E. Their transposes are equal

**Answer: E. Their transposes are equal. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Matrices and Determinants; the calculation or property leads to Their transposes are equal. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**22. If two chords subtend equal angles at the center, then the chords are:**

A. Perpendicular

B. Diameters

C. Parallel

D. Tangents

E. Equal

**Answer: E. Equal. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 9: Chords of a Circle; the calculation or property leads to Equal. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**23. Which number is irrational?**

A. 0.25

B.  $\frac{7}{9}$

C. -3

D. 0.444...

E.  $\sqrt{11}$

**Answer: E.  $\sqrt{11}$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 1: Real Numbers; the calculation or property leads to  $\sqrt{11}$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**24. Find the length of a chord in a circle of radius 13 cm if its distance from the center is 5 cm.**

A. 24 cm

B. 12 cm

C. 18 cm

D. 26 cm

E. 10 cm

**Answer: A. 24 cm. Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 9: Chords of a Circle; the calculation or property leads to 24 cm. **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

**25. The square root of  $9x^2$ , assuming  $x \geq 0$ , is:**

A.  $9x$

B.  $3x^2$

C.  $\pm 9x$

D.  $\frac{x}{3}$

E.  $3x$

**Answer: E.  $3x$ . Explanation:** Apply the relevant definition, algebraic rule or formula from Chapter 4: Factorization and Algebraic Manipulation; the calculation or property leads to  $3x$ . **Quick tactic:** Write the governing formula or identity before substituting and check the final value in the original condition.

# PHYSICS

## Topics and contents

The Physics section connects physical meaning with units, laws, diagrams and calculations. Every numerical answer should be supported by a principle and checked for dimensions and physical sense.

This section covers Physical Quantities and Measurements; Kinematics; Dynamics; Turning Effects of Force; Work, Energy and Power; Mechanical Properties of Matter; Thermal Properties of Matter; Magnetism; Nature of Science; Simple Harmonic Motion and Waves; Sound.

It also develops understanding of Geometrical Optics; Electrostatics; Current Electricity; Electromagnetism; Basic Electronics; Information and Communication Technology; Atomic and Nuclear Physics; Measurements; Force and Motion; Circular and Rotational Motion; Solids and Fluid Dynamics.

It also develops understanding of Heat and Thermodynamics; Waves and Vibrations; Physical Optics and Gravitational Waves; Electrostatics and Current Electricity; Special Theory of Relativity; Nuclear and Particle Physics; Electromagnetic Induction; Alternating Current; Physics of Solids; Electronics; Dawn of Modern Physics.

It also develops understanding of Atomic Spectra; Nuclear Physics.

## 1. Physical Quantities and Measurements

Physics begins with measurable quantities, SI units, instruments, uncertainty and dimensional consistency.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Base quantities include length, mass, time, current and temperature. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Derived units come from algebraic combinations of base units. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Scientific notation and prefixes express very large or small values. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Precision, accuracy and uncertainty describe measurement quality. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Convert 0.005 m to millimetres.

**STEP-BY-STEP REASONING:**  $0.005 \times 1000 = 5$  mm. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Write the conversion factor as a fraction so units cancel.

**COMMON ERROR TO AVOID:** A result without a unit is incomplete.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 2. Kinematics

Kinematics describes motion without explaining its cause.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Speed is scalar; velocity includes direction. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Acceleration is change of velocity per time. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- For constant acceleration:  $v = u + at$ ,  $s = ut + \frac{1}{2}at^2$ ,  $v^2 = u^2 + 2as$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- Slope and area on motion graphs have physical meanings. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A car changes velocity from 5 to 17 m/s in 4 s. Find acceleration.

**STEP-BY-STEP REASONING:**  $(17-5)/4=3 \text{ m/s}^2$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** List  $u, v, a, s, t$  before selecting an equation.

**COMMON ERROR TO AVOID:** Distance and displacement are not interchangeable.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 3. Dynamics

Dynamics connects forces with changes of motion through Newton laws and momentum.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

#### Core ideas in plain language

- Net force  $F=ma$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Inertia is resistance to change of motion. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Momentum  $p=mv$ ; impulse=change in momentum. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Action-reaction forces act on different bodies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A 2 kg body accelerates at  $3 \text{ m/s}^2$ . Find net force.

**STEP-BY-STEP REASONING:**  $F=ma=6 \text{ N}$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw a free-body diagram and combine forces before applying  $F=ma$ .

**COMMON ERROR TO AVOID:** Balanced forces mean zero acceleration, not necessarily zero velocity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 4. Turning Effects of Force

Rotational physics uses torque, angular quantities and centripetal effects.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

#### Core ideas in plain language

- Torque=force x perpendicular distance. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Equilibrium requires zero net force and zero net torque. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Centripetal acceleration= $v^2/r$  toward the centre. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Angular momentum is conserved when external torque is zero. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A 10 N force acts 0.2 m perpendicularly from a pivot. Find torque.

**STEP-BY-STEP REASONING:**  $10 \times 0.2 = 2 \text{ N m}$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use perpendicular distance, not simply the length of the lever.

**COMMON ERROR TO AVOID:** Centripetal force is the name of the inward resultant, not an extra force.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 5. Work, Energy and Power

Work transfers energy; power measures the rate of transfer.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- $W = Fs \cos \theta$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Kinetic energy  $= \frac{1}{2}mv^2$ ; gravitational potential  $= mgh$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Power  $= W/t = Fv$  for parallel steady motion. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Mechanical energy is conserved when only conservative forces do work. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A force is perpendicular to displacement. What work is done?

**STEP-BY-STEP REASONING:** Zero, because  $\cos 90^\circ = 0$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Check the angle before multiplying force and displacement.

**COMMON ERROR TO AVOID:** A force can act without doing work on a particular displacement.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 6. Mechanical Properties of Matter

Mechanical properties describe deformation, pressure, density, elasticity and fluid behaviour.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Density  $= m/V$ ; pressure  $= F/A$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Stress  $= F/A$ ; strain  $= \text{change}/\text{original}$ ; Young modulus  $= \text{stress}/\text{strain}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Buoyant force equals displaced fluid weight. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Continuity and Bernoulli principles describe ideal flow. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A 100 N force acts on  $0.5 \text{ m}^2$ . Find pressure.

**STEP-BY-STEP REASONING:**  $100/0.5 = 200 \text{ Pa}$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Keep area in square metres before using SI formulas.

**COMMON ERROR TO AVOID:** Mass density and weight density are different quantities.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 7. Thermal Properties of Matter

Thermal physics relates temperature, internal energy, heat transfer and thermodynamic laws.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Heat  $Q = mc\Delta T$  without phase change. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Latent heat  $Q = mL$  during phase change. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Internal energy of an ideal gas is mainly molecular kinetic energy. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- First law: change in internal energy = heat supplied - work done by system. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Why can temperature stay constant while ice melts?

**STEP-BY-STEP REASONING:** Added energy increases potential energy during the phase change rather than average kinetic energy. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Decide first whether temperature changes or phase changes.

**COMMON ERROR TO AVOID:** Heat and temperature are not the same physical quantity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 8. Magnetism

Magnetism describes fields, poles, magnetic materials and forces on moving charges or currents.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Field lines leave north and enter south outside a magnet. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Like poles repel; unlike poles attract. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A current produces a magnetic field. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Magnetic force is perpendicular to motion and field. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What is a magnetic field?

**STEP-BY-STEP REASONING:** A region where a magnetic object or moving charge experiences magnetic force. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use right-hand rules only after identifying current/velocity and field directions.

**COMMON ERROR TO AVOID:** Magnetic field lines never cross.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 9. Nature of Science

The nature of science emphasizes evidence, models, testability, peer review and the limits of measurement.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Scientific models simplify reality and may be revised. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A good hypothesis produces testable predictions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Repeated evidence raises confidence but does not make measurement uncertainty disappear. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why can a scientific model change?

**STEP-BY-STEP REASONING:** New evidence or a more effective explanatory framework may reveal limits of the old model. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Distinguish evidence from inference and theory from guess.

**COMMON ERROR TO AVOID:** Scientific uncertainty is not the same as ignorance.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 10. Simple Harmonic Motion and Waves

Oscillations and waves transfer energy through periodic motion. Sound is a mechanical longitudinal wave in ordinary fluids.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- In SHM, acceleration is proportional to displacement and directed toward equilibrium. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- $v = f \lambda$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Frequency controls pitch; amplitude relates to intensity. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Nodes have zero displacement in stationary waves. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What defines SHM?

**STEP-BY-STEP REASONING:** Restoring acceleration is proportional to displacement and points toward the mean position. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For wave questions, write  $v = f \lambda$  and mark known units.

**COMMON ERROR TO AVOID:** A wave transports energy without permanent bulk transport of matter.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.



## 11. Sound

Oscillations and waves transfer energy through periodic motion. Sound is a mechanical longitudinal wave in ordinary fluids.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- In SHM, acceleration is proportional to displacement and directed toward equilibrium. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- $v = f \lambda$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Frequency controls pitch; amplitude relates to intensity. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Nodes have zero displacement in stationary waves. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

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**QUICK TACTIC:** For wave questions, write  $v = f \lambda$  and mark known units.

**COMMON ERROR TO AVOID:** A wave transports energy without permanent bulk transport of matter.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 12. Geometrical Optics

Optics studies reflection, refraction, lenses, mirrors, interference, diffraction and polarization.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Reflection angle equals incidence angle. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Snell law  $n_1 \sin \theta_1 = n_2 \sin \theta_2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Plane-mirror image is virtual, upright and same size. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Wave effects become prominent when aperture size is comparable to wavelength. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Describe a plane-mirror image.

**STEP-BY-STEP REASONING:** Virtual, upright, laterally inverted and the same size, at equal distance behind the mirror. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw principal rays or wavefronts rather than relying on memory alone.

**COMMON ERROR TO AVOID:** A virtual image cannot be projected directly on a screen.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 13. Electrostatics

Electrostatics studies charge at rest, electric fields, potential and capacitance.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Coulomb force is proportional to  $q_1q_2/r^2$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Electric field  $E=F/q$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Potential  $V=W/q$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Capacitance  $C=Q/V$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** How does rubbing charge a plastic rod?

**STEP-BY-STEP REASONING:** Electrons transfer between materials; charge is conserved. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use a positive test charge to define field direction.

**COMMON ERROR TO AVOID:** Protons do not move between ordinary rubbed solids.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 14. Current Electricity

Current electricity studies moving charge, potential difference, resistance and circuits.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- $I=Q/t$ ;  $V=W/Q$ ;  $V=IR$  for ohmic conductors. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Series current is common; parallel voltage is common. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Electrical power  $P=VI=I^2R=V^2/R$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- EMF is energy supplied per unit charge. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A 12 V source drives 3 A. Find power.

**STEP-BY-STEP REASONING:**  $P=VI=36$  W. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Reduce the circuit first, then calculate branch quantities.

**COMMON ERROR TO AVOID:** Current is not used up as charge passes through a component.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 15. Electromagnetism

Electromagnetism links currents, fields, forces and induced EMF.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- A current-carrying conductor in a field experiences force. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Changing magnetic flux induces EMF. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Lenz law gives a direction opposing the change. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Transformers require alternating flux. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A split-ring commutator reverses coil current each half-turn in a DC motor. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What does a split-ring commutator do?

**STEP-BY-STEP REASONING:** It reverses current in the rotating coil after each half-turn to maintain torque direction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify whether the device is a motor, generator or transformer.

**COMMON ERROR TO AVOID:** Induced current opposes the change in flux, not necessarily the original field itself.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 16. Basic Electronics

Electronics controls electron flow using semiconductor devices and logic circuits.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Diodes conduct mainly in one direction. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transistors act as switches or amplifiers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Rectifiers convert AC to pulsating DC. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Logic gates implement Boolean functions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What is the broad concern of electronics?

**STEP-BY-STEP REASONING:** Controlling the motion and behaviour of electrons in devices and circuits. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For diode questions, mark forward or reverse bias first.

**COMMON ERROR TO AVOID:** A transistor has different roles depending on circuit configuration.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 17. Information and Communication Technology

ICT uses electronic systems to store, process and transmit information.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Signals may be analog or digital. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Bandwidth and noise affect communication quality. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Modulation places information on a carrier. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Digital systems support reliable storage and processing. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** What three actions summarize ICT?

**STEP-BY-STEP REASONING:** Storing, processing and transmitting information. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Separate the information signal from the transmission medium.

**COMMON ERROR TO AVOID:** More bandwidth does not automatically remove all noise.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 18. Atomic and Nuclear Physics

Modern physics explains phenomena beyond classical models: relativity, quantum behaviour, atomic spectra and nuclear processes.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Photon energy  $E = hf$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Atomic spectra arise from quantized energy transitions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Radioactive decay is probabilistic; half-life is constant for a nuclide. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Mass-energy relation  $E = mc^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Fission splits heavy nuclei; fusion joins light nuclei. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are atomic spectra discrete?

**STEP-BY-STEP REASONING:** Electrons can occupy only allowed energy levels, so transitions emit or absorb specific photon energies. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Link every spectral line to an energy difference.

**COMMON ERROR TO AVOID:** Half-life is not the time for every nucleus to decay.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 19. Measurements

Physics begins with measurable quantities, SI units, instruments, uncertainty and dimensional consistency.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Base quantities include length, mass, time, current and temperature. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Derived units come from algebraic combinations of base units. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Scientific notation and prefixes express very large or small values. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Precision, accuracy and uncertainty describe measurement quality. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Convert 0.005 m to millimetres.

**STEP-BY-STEP REASONING:**  $0.005 \times 1000 = 5$  mm. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Write the conversion factor as a fraction so units cancel.

**COMMON ERROR TO AVOID:** A result without a unit is incomplete.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 20. Force and Motion

Dynamics connects forces with changes of motion through Newton laws and momentum.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Net force  $F=ma$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Inertia is resistance to change of motion. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Momentum  $p=mv$ ; impulse=change in momentum. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Action-reaction forces act on different bodies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A 2 kg body accelerates at  $3 \text{ m/s}^2$ . Find net force.

**STEP-BY-STEP REASONING:**  $F=ma=6 \text{ N}$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw a free-body diagram and combine forces before applying  $F=ma$ .

**COMMON ERROR TO AVOID:** Balanced forces mean zero acceleration, not necessarily zero velocity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 21. Circular and Rotational Motion

Rotational physics uses torque, angular quantities and centripetal effects.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Torque = force  $\times$  perpendicular distance. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Equilibrium requires zero net force and zero net torque. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Centripetal acceleration =  $v^2/r$  toward the centre. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Angular momentum is conserved when external torque is zero. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A 10 N force acts 0.2 m perpendicularly from a pivot. Find torque.

**STEP-BY-STEP REASONING:**  $10 \times 0.2 = 2$  N m. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use perpendicular distance, not simply the length of the lever.

**COMMON ERROR TO AVOID:** Centripetal force is the name of the inward resultant, not an extra force.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 22. Solids and Fluid Dynamics

Mechanical properties describe deformation, pressure, density, elasticity and fluid behaviour.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Density =  $m/V$ ; pressure =  $F/A$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Stress =  $F/A$ ; strain = change/original; Young modulus = stress/strain. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Buoyant force equals displaced fluid weight. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Continuity and Bernoulli principles describe ideal flow. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A 100 N force acts on  $0.5 \text{ m}^2$ . Find pressure.

**STEP-BY-STEP REASONING:**  $100/0.5 = 200$  Pa. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Keep area in square metres before using SI formulas.

**COMMON ERROR TO AVOID:** Mass density and weight density are different quantities.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 23. Heat and Thermodynamics

Thermal physics relates temperature, internal energy, heat transfer and thermodynamic laws.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Heat  $Q = mc\Delta T$  without phase change. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.



- Latent heat  $Q = mL$  during phase change. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Internal energy of an ideal gas is mainly molecular kinetic energy. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- First law: change in internal energy = heat supplied - work done by system. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Why can temperature stay constant while ice melts?

**STEP-BY-STEP REASONING:** Added energy increases potential energy during the phase change rather than average kinetic energy. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Decide first whether temperature changes or phase changes.

**COMMON ERROR TO AVOID:** Heat and temperature are not the same physical quantity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 24. Waves and Vibrations

Oscillations and waves transfer energy through periodic motion. Sound is a mechanical longitudinal wave in ordinary fluids.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- In SHM, acceleration is proportional to displacement and directed toward equilibrium. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- $v = f \lambda$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Frequency controls pitch; amplitude relates to intensity. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Nodes have zero displacement in stationary waves. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What defines SHM?

**STEP-BY-STEP REASONING:** Restoring acceleration is proportional to displacement and points toward the mean position. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For wave questions, write  $v = f \lambda$  and mark known units.

**COMMON ERROR TO AVOID:** A wave transports energy without permanent bulk transport of matter.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 25. Physical Optics and Gravitational Waves

Optics studies reflection, refraction, lenses, mirrors, interference, diffraction and polarization.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Reflection angle equals incidence angle. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Snell law  $n_1 \sin \theta_1 = n_2 \sin \theta_2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- Plane-mirror image is virtual, upright and same size. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Wave effects become prominent when aperture size is comparable to wavelength. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Describe a plane-mirror image.

**STEP-BY-STEP REASONING:** Virtual, upright, laterally inverted and the same size, at equal distance behind the mirror. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw principal rays or wavefronts rather than relying on memory alone.

**COMMON ERROR TO AVOID:** A virtual image cannot be projected directly on a screen.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 26. Electrostatics and Current Electricity

Current electricity studies moving charge, potential difference, resistance and circuits.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- $I=Q/t$ ;  $V=W/Q$ ;  $V=IR$  for ohmic conductors. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Series current is common; parallel voltage is common. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Electrical power  $P=VI=I^2R=V^2/R$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- EMF is energy supplied per unit charge. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A 12 V source drives 3 A. Find power.

**STEP-BY-STEP REASONING:**  $P=VI=36$  W. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Reduce the circuit first, then calculate branch quantities.

**COMMON ERROR TO AVOID:** Current is not used up as charge passes through a component.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 27. Special Theory of Relativity

Modern physics explains phenomena beyond classical models: relativity, quantum behaviour, atomic spectra and nuclear processes.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Photon energy  $E=hf$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Atomic spectra arise from quantized energy transitions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Radioactive decay is probabilistic; half-life is constant for a nuclide. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.



- Mass-energy relation  $E=mc^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Fission splits heavy nuclei; fusion joins light nuclei. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are atomic spectra discrete?

**STEP-BY-STEP REASONING:** Electrons can occupy only allowed energy levels, so transitions emit or absorb specific photon energies. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Link every spectral line to an energy difference.

**COMMON ERROR TO AVOID:** Half-life is not the time for every nucleus to decay.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 28. Nuclear and Particle Physics

Modern physics explains phenomena beyond classical models: relativity, quantum behaviour, atomic spectra and nuclear processes.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Photon energy  $E=hf$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Atomic spectra arise from quantized energy transitions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Radioactive decay is probabilistic; half-life is constant for a nuclide. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Mass-energy relation  $E=mc^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Fission splits heavy nuclei; fusion joins light nuclei. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are atomic spectra discrete?

**STEP-BY-STEP REASONING:** Electrons can occupy only allowed energy levels, so transitions emit or absorb specific photon energies. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Link every spectral line to an energy difference.

**COMMON ERROR TO AVOID:** Half-life is not the time for every nucleus to decay.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 29. Electromagnetic Induction

Electromagnetism links currents, fields, forces and induced EMF.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- A current-carrying conductor in a field experiences force. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Changing magnetic flux induces EMF. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Lenz law gives a direction opposing the change. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Transformers require alternating flux. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A split-ring commutator reverses coil current each half-turn in a DC motor. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What does a split-ring commutator do?

**STEP-BY-STEP REASONING:** It reverses current in the rotating coil after each half-turn to maintain torque direction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify whether the device is a motor, generator or transformer.

**COMMON ERROR TO AVOID:** Induced current opposes the change in flux, not necessarily the original field itself.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 30. Alternating Current

Electromagnetism links currents, fields, forces and induced EMF.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- A current-carrying conductor in a field experiences force. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Changing magnetic flux induces EMF. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Lenz law gives a direction opposing the change. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Transformers require alternating flux. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A split-ring commutator reverses coil current each half-turn in a DC motor. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What does a split-ring commutator do?

**STEP-BY-STEP REASONING:** It reverses current in the rotating coil after each half-turn to maintain torque direction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify whether the device is a motor, generator or transformer.

**COMMON ERROR TO AVOID:** Induced current opposes the change in flux, not necessarily the original field itself.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 31. Physics of Solids

Mechanical properties describe deformation, pressure, density, elasticity and fluid behaviour.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Density= $m/V$ ; pressure= $F/A$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- Stress= $F/A$ ; strain=change/original; Young modulus=stress/strain. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Buoyant force equals displaced fluid weight. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Continuity and Bernoulli principles describe ideal flow. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A 100 N force acts on  $0.5 \text{ m}^2$ . Find pressure.

**STEP-BY-STEP REASONING:**  $100/0.5=200 \text{ Pa}$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Keep area in square metres before using SI formulas.

**COMMON ERROR TO AVOID:** Mass density and weight density are different quantities.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 32. Electronics

Electronics controls electron flow using semiconductor devices and logic circuits.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Diodes conduct mainly in one direction. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transistors act as switches or amplifiers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Rectifiers convert AC to pulsating DC. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Logic gates implement Boolean functions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What is the broad concern of electronics?

**STEP-BY-STEP REASONING:** Controlling the motion and behaviour of electrons in devices and circuits. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For diode questions, mark forward or reverse bias first.

**COMMON ERROR TO AVOID:** A transistor has different roles depending on circuit configuration.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 33. Dawn of Modern Physics

Modern physics explains phenomena beyond classical models: relativity, quantum behaviour, atomic spectra and nuclear processes.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Photon energy  $E=hf$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Atomic spectra arise from quantized energy transitions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Radioactive decay is probabilistic; half-life is constant for a nuclide. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Mass-energy relation  $E=mc^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Fission splits heavy nuclei; fusion joins light nuclei. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are atomic spectra discrete?

**STEP-BY-STEP REASONING:** Electrons can occupy only allowed energy levels, so transitions emit or absorb specific photon energies. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Link every spectral line to an energy difference.

**COMMON ERROR TO AVOID:** Half-life is not the time for every nucleus to decay.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 34. Atomic Spectra

Modern physics explains phenomena beyond classical models: relativity, quantum behaviour, atomic spectra and nuclear processes.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Photon energy  $E=hf$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Atomic spectra arise from quantized energy transitions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Radioactive decay is probabilistic; half-life is constant for a nuclide. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Mass-energy relation  $E=mc^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Fission splits heavy nuclei; fusion joins light nuclei. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are atomic spectra discrete?

**STEP-BY-STEP REASONING:** Electrons can occupy only allowed energy levels, so transitions emit or absorb specific photon energies. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Link every spectral line to an energy difference.

**COMMON ERROR TO AVOID:** Half-life is not the time for every nucleus to decay.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 35. Nuclear Physics

Modern physics explains phenomena beyond classical models: relativity, quantum behaviour, atomic spectra and nuclear processes.

The central aim is to understand how the main ideas are connected. Sketch the situation, list known and unknown quantities, convert to consistent units, and choose the governing principle before calculating. Keep vector direction and sign conventions visible. After calculation, check dimensions and ask whether the result is physically reasonable.

### Core ideas in plain language

- Photon energy  $E=hf$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Atomic spectra arise from quantized energy transitions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Radioactive decay is probabilistic; half-life is constant for a nuclide. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Mass-energy relation  $E=mc^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Fission splits heavy nuclei; fusion joins light nuclei. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are atomic spectra discrete?

**STEP-BY-STEP REASONING:** Electrons can occupy only allowed energy levels, so transitions emit or absorb specific photon energies. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Link every spectral line to an energy difference.

**COMMON ERROR TO AVOID:** Half-life is not the time for every nucleus to decay.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## PHYSICS - PRACTICE EXERCISES

Three independent sets are provided. Attempt each question before reading the answer, explanation and quick tactic immediately below it. Each set contains 25 MCQs with five options (A–E).

### Practice Set 1 - 25 MCQs

**1. The uncertainty in a reading taken from an analogue scale is commonly related to:**

- A. the mass of the observer
- B. the room temperature only
- C. the least count of the instrument
- D. the colour of the instrument
- E. the brand name of the instrument

**Answer: C. the least count of the instrument. Explanation:** The governing physical definition or law in CHAPTER 1 gives the least count of the instrument. .

**2. Ampère's law relates the line integral of magnetic field around a closed path to the:**

- A. Current enclosed by the path
- B. Charge enclosed by the path
- C. Electric flux through the path
- D. Resistance of the path
- E. Potential difference along the path

**Answer: A. Current enclosed by the path. Explanation:** The governing physical definition or law in Chapter 14: Electromagnetism gives Current enclosed by the path. .

**3. In domain theory, a ferromagnetic material contains regions called:**

- A. elastic limits
- B. pressure zones
- C. magnetic domains
- D. electric cells
- E. thermal junctions

**Answer: C. magnetic domains. Explanation:** The governing physical definition or law in CHAPTER 8 gives magnetic domains. .

**4. A galvanometer is converted into an ammeter by connecting a low resistance in:**

- A. parallel
- B. series
- C. the battery only
- D. the magnetic field only
- E. an open circuit

**Answer: A. parallel. Explanation:** The governing physical definition or law in Chapter 9: Electrostatics and Current Electricity gives parallel. .

**5. A vibrating source has a time period of 0.20 s. How many vibrations does it make per second?**

- A. 5
- B. 0.20
- C. 20
- D. 2
- E. 0.04

**Answer: A. 5. Explanation:** The governing physical definition or law in Unit 10: Simple Harmonic Motion and Waves gives 5. .

**6. Impulse is equal to the change in:**

- A. mass
- B. distance
- C. power
- D. weight
- E. momentum

**Answer: E. momentum. Explanation:** The governing physical definition or law in CHAPTER 3 gives momentum. .

**7. A wave on a stretched rope is transverse because the rope particles move:**

- A. Along the direction in which the wave travels
- B. Without transferring energy
- C. Only toward the fixed end
- D. Perpendicular to the direction in which the wave travels
- E. With the same speed as the wavefront

**Answer: D. Perpendicular to the direction in which the wave travels. Explanation:** The governing physical definition or law in Unit 10: Simple Harmonic Motion and Waves gives Perpendicular to the direction in which the wave travels. .

**8. Control rods in a nuclear reactor regulate the reaction by:**

- A. Accelerating neutrons
- B. Producing additional fuel
- C. Absorbing neutrons
- D. Increasing uranium mass
- E. Reflecting visible light

**Answer: C. Absorbing neutrons. Explanation:** The governing physical definition or law in Chapter 21: Nuclear Physics gives Absorbing neutrons. .

**9. An op-amp comparator produces an output determined mainly by:**

- A. Which input voltage is greater
- B. The sum of the input currents only
- C. The resistance of the power supply

D. The input frequency alone

E. The transistor  $\beta$  only

**Answer: A. Which input voltage is greater. Explanation:** The governing physical definition or law in Chapter 18: Electronics gives Which input voltage is greater. .

**10. A two-input NOR gate produces an output of 1 only when:**

A. At least one input is 1

B. The inputs are different

C. Both inputs are 0

D. Both inputs are 1

E. Exactly one input is 0

**Answer: C. Both inputs are 0. Explanation:** The governing physical definition or law in Unit 16: Basic Electronics gives Both inputs are 0. .

**11. The closely spaced regions in a longitudinal wave are known as:**

A. Compressions

B. Troughs

C. Wavefronts

D. Crests

E. Rarefactions

**Answer: A. Compressions. Explanation:** The governing physical definition or law in Unit 10: Simple Harmonic Motion and Waves gives Compressions. .

**12. Sound waves in air are best described as:**

A. Transverse electromagnetic waves

B. Circular gravitational waves

C. Longitudinal mechanical waves

D. Transverse matter waves

E. Stationary electric waves

**Answer: C. Longitudinal mechanical waves. Explanation:** The governing physical definition or law in Unit 11: Sound gives Longitudinal mechanical waves. .

**13. The tendency of a body to resist a change in its state of motion is called:**

A. impulse

B. inertia

C. weight

D. friction

E. momentum

**Answer: B. inertia. Explanation:** The governing physical definition or law in CHAPTER 3 gives inertia. .

**14. When the force is perpendicular to the displacement, the work done by that force is:**



- A. maximum negative
- B. equal to force
- C. equal to displacement
- D. zero
- E. maximum positive

**Answer: D. zero. Explanation:** The governing physical definition or law in CHAPTER 5 gives zero. .

**15. In an automobile shock absorber, the energy of unwanted vibrations is mainly converted into:**

- A. Chemical energy in the battery
- B. Heat energy in the oil
- C. Gravitational potential energy
- D. Light energy in the lamps
- E. Nuclear energy in the metal

**Answer: B. Heat energy in the oil. Explanation:** The governing physical definition or law in Unit 10: Simple Harmonic Motion and Waves gives Heat energy in the oil. .

**16. A two-input NAND gate produces an output of 0 only when:**

- A. Both inputs are 0
- B. Exactly one input is 1
- C. The inputs are different
- D. Both inputs are 1
- E. At least one input is 0

**Answer: D. Both inputs are 1. Explanation:** The governing physical definition or law in Unit 16: Basic Electronics gives Both inputs are 1. .

**17. A night switch can use a light-dependent sensor and a comparator to turn a lamp on when:**

- A. Light intensity rises without limit
- B. The supply frequency becomes zero
- C. Both comparator inputs are disconnected
- D. Light intensity falls below a set level
- E. The diode is always reverse broken down

**Answer: D. Light intensity falls below a set level. Explanation:** The governing physical definition or law in Chapter 18: Electronics gives Light intensity falls below a set level. .

**18. For a vacuum parallel-plate capacitor, increasing plate area while keeping separation fixed will:**

- A. Increase the capacitance
- B. Decrease the capacitance
- C. Leave the capacitance unchanged
- D. Reverse the plate charges

E. Make the potential difference zero

**Answer: A. Increase the capacitance. Explanation:** The governing physical definition or law in Chapter 12: Electrostatics gives Increase the capacitance. .

**19. Forward bias causes the depletion-layer width to:**

- A. Increase
- B. Decrease
- C. Remain unchanged
- D. Become infinite
- E. Alternate periodically

**Answer: B. Decrease. Explanation:** The governing physical definition or law in Chapter 18: Electronics gives Decrease. .

**20. A moving object's length along its direction of motion is observed to:**

- A. become zero at low speed
- B. rotate by  $90^\circ$
- C. remain unchanged at all speeds
- D. contract
- E. expand

**Answer: D. contract. Explanation:** The governing physical definition or law in Chapter 11: Special Theory of Relativity gives contract. .

**21. The earth wire in a household appliance provides:**

- A. A low-resistance path for fault current
- B. An increase in appliance resistance
- C. A source of extra voltage
- D. A path for normal current through the user
- E. A method of storing charge

**Answer: A. A low-resistance path for fault current. Explanation:** The governing physical definition or law in Unit 14: Current Electricity gives A low-resistance path for fault current. .

**22. When a hot metal block touches a colder block, thermal energy flows:**

- A. from the hotter block to the colder block
- B. from the colder block to the hotter block
- C. equally in both directions with no net transfer
- D. only if both blocks have equal temperature
- E. from the smaller block to the larger block

**Answer: A. from the hotter block to the colder block. Explanation:** The governing physical definition or law in CHAPTER 7 gives from the hotter block to the colder block. .

**23. The two broad groups used to classify the study of nature are:**

- A. social sciences and language sciences
- B. medical sciences and commercial sciences
- C. biological sciences and physical sciences
- D. engineering sciences and art sciences
- E. computer sciences and historical sciences

**Answer: C. biological sciences and physical sciences.** **Explanation:** The governing physical definition or law in CHAPTER 9 gives biological sciences and physical sciences. .

**24. A car covers 150 m in 10 s. Its average speed is:**

- A.  $1500 \text{ m s}^{-1}$
- B.  $20 \text{ m s}^{-1}$
- C.  $10 \text{ m s}^{-1}$
- D.  $15 \text{ m s}^{-1}$
- E.  $12 \text{ m s}^{-1}$

**Answer: D.  $15 \text{ m s}^{-1}$ .** **Explanation:** The governing physical definition or law in CHAPTER 2 gives  $15 \text{ m s}^{-1}$ . .

**25. The radius of a charged particle moving perpendicular to a magnetic field is:**

- A.  $r=qv/mB$
- B.  $r=mq/vB$
- C.  $r=mv/qB$
- D.  $r=mvB/q$
- E.  $r=qB/mv$

**Answer: C.  $r=mv/qB$ .** **Explanation:** The governing physical definition or law in Chapter 10: Electromagnetism gives  $r=mv/qB$ . .

## Practice Set 2 - 25 MCQs

1. Entropy is commonly associated with the degree of:

- A. angular speed
- B. force
- C. electric potential
- D. disorder
- E. mass

**Answer: D. disorder. Explanation:** The governing physical definition or law in Chapter 6: Heat and Thermodynamics gives disorder. .

2. In a series circuit, the same \_\_\_\_\_ passes through every resistor.

- A. Current
- B. Power
- C. Potential difference
- D. Charge stored
- E. Resistance

**Answer: A. Current. Explanation:** The governing physical definition or law in Unit 14: Current Electricity gives Current. .

3. The magnetic field lines around a long straight current-carrying wire are:

- A. Straight parallel lines
- B. Ellipses with no centre
- C. Random curves
- D. Concentric circles
- E. Radial lines ending on the wire

**Answer: D. Concentric circles. Explanation:** The governing physical definition or law in Unit 15: Electromagnetism gives Concentric circles. .

4. A fluid flows from area  $6 \text{ cm}^2$  at  $3 \text{ m s}^{-1}$  into area  $2 \text{ cm}^2$ . Its new speed is:

- A.  $1 \text{ m s}^{-1}$
- B.  $9 \text{ m s}^{-1}$
- C.  $6 \text{ m s}^{-1}$
- D.  $2 \text{ m s}^{-1}$
- E.  $18 \text{ m s}^{-1}$

**Answer: B.  $9 \text{ m s}^{-1}$ . Explanation:** The governing physical definition or law in Chapter 5: Solids and Fluid Dynamics gives  $9 \text{ m s}^{-1}$ . .

5. A balanced Wheatstone bridge has  $R_1/R_2$  equal to:

- A.  $R_1 + R_2$
- B.  $R_1 R_2$

- C.  $R_4/R_3$
- D.  $R_3/R_4$
- E.  $R_3+R_4$

**Answer: D.  $R_3/R_4$ .** **Explanation:** The governing physical definition or law in Chapter 9: Electrostatics and Current Electricity gives  $R_3/R_4$ . .

**6. In unpolarized light, electric-field vibrations occur in:**

- A. no plane
- B. a single circular path only
- C. many planes
- D. one fixed plane
- E. the direction of travel only

**Answer: C. many planes.** **Explanation:** The governing physical definition or law in Chapter 8: Physical Optics and Gravitational Waves gives many planes. .

**7. Which device is primarily used to enter typed data into a computer?**

- A. Speaker
- B. Printer
- C. Projector
- D. Monitor
- E. Keyboard

**Answer: E. Keyboard.** **Explanation:** The governing physical definition or law in Unit 17: Information and Communication Technology gives Keyboard. .

**8. The induced e.m.f. in a coil becomes larger when the magnetic field changes:**

- A. Not at all
- B. Only after the coil is disconnected
- C. Without passing through the coil
- D. More rapidly
- E. More slowly

**Answer: D. More rapidly.** **Explanation:** The governing physical definition or law in Unit 15: Electromagnetism gives More rapidly. .

**9. The strength of an electromagnet can be increased by:**

- A. Decreasing current to zero
- B. Using no core
- C. Replacing the wire with an insulator
- D. Removing the coil
- E. Increasing the current or the number of coil turns

**Answer: E. Increasing the current or the number of coil turns. Explanation:** The governing physical definition or law in Unit 15: Electromagnetism gives Increasing the current or the number of coil turns. .

**10. A process lasts 4.0 s in its proper frame. Observed at  $0.60c$ , its duration is:**

- A. 5.0 s
- B. 6.4 s
- C. 4.0 s
- D. 2.4 s
- E. 3.2 s

**Answer: A. 5.0 s. Explanation:** The governing physical definition or law in Chapter 11: Special Theory of Relativity gives 5.0 s. .

**11. Removal of an electron from a metal surface requires a minimum energy called the:**

- A. Stopping potential
- B. Kinetic energy
- C. Ionization current
- D. Work function
- E. Power factor

**Answer: D. Work function. Explanation:** The governing physical definition or law in Chapter 19: Dawn of Modern Physics gives Work function. .

**12. One joule of work is done when a force of one newton moves an object:**

- A. one metre with zero force
- B. one metre perpendicular to the force
- C. one kilogram through one metre
- D. one metre in the force direction
- E. one second in the force direction

**Answer: D. one metre in the force direction. Explanation:** The governing physical definition or law in CHAPTER 5 gives one metre in the force direction. .

**13. The point at which the entire weight of a body may be considered to act is its:**

- A. line of action
- B. centre of gravity
- C. moment arm
- D. axis of rotation
- E. neutral point

**Answer: B. centre of gravity. Explanation:** The governing physical definition or law in CHAPTER 4 gives centre of gravity. .

**14. An electric field is a region in which:**

- A. Every object becomes magnetic

- B. A charge experiences an electric force
- C. Gravity is absent
- D. Light cannot travel
- E. Only neutral particles can move

**Answer: B. A charge experiences an electric force. Explanation:** The governing physical definition or law in Unit 13: Electrostatics gives A charge experiences an electric force. .

**15. Wave intensity is proportional to the square of the:**

- A. phase difference
- B. wavelength only
- C. period
- D. amplitude
- E. frequency only

**Answer: D. amplitude. Explanation:** The governing physical definition or law in Chapter 7: Waves and Vibrations gives amplitude. .

**16. For small oscillations, the time period of a simple pendulum depends mainly on its:**

- A. Mass and amplitude
- B. Mass and density
- C. Amplitude and bob size
- D. Length and gravitational acceleration
- E. Shape and colour of the bob

**Answer: D. Length and gravitational acceleration. Explanation:** The governing physical definition or law in Unit 10: Simple Harmonic Motion and Waves gives Length and gravitational acceleration. .

**17. One kilowatt-hour is equal to:**

- A.  $1.0 \times 10^6$  J
- B.  $3.6 \times 10^6$  J
- C.  $3.6 \times 10^3$  J
- D. 360 J
- E. 36 J

**Answer: B.  $3.6 \times 10^6$  J. Explanation:** The governing physical definition or law in Unit 14: Current Electricity gives  $3.6 \times 10^6$  J. .

**18. Which pair of regions travels through air when sound is produced?**

- A. Crests and troughs
- B. Positive and negative charges
- C. Bright and dark fringes
- D. Compressions and rarefactions
- E. Nodes and antinodes only

**Answer: D. Compressions and rarefactions.** **Explanation:** The governing physical definition or law in Unit 11: Sound gives Compressions and rarefactions. .

**19. In a laser interferometer, a passing gravitational wave is detected through a tiny change in:**

- A. laser colour only
- B. relative arm lengths
- C. electric charge of the beam
- D. mirror mass
- E. air pressure only

**Answer: B. relative arm lengths.** **Explanation:** The governing physical definition or law in Chapter 8: Physical Optics and Gravitational Waves gives relative arm lengths. .

**20. Which force acts between masses without physical contact?**

- A. Tension force
- B. Normal reaction
- C. Frictional force
- D. Air resistance
- E. Gravitational force

**Answer: E. Gravitational force.** **Explanation:** The governing physical definition or law in CHAPTER 3 gives Gravitational force. .

**21. Which device works directly on Pascal's law?**

- A. Simple pendulum
- B. Beam balance
- C. Hydraulic press
- D. Mercury thermometer
- E. Micrometre screw gauge

**Answer: C. Hydraulic press.** **Explanation:** The governing physical definition or law in CHAPTER 6 gives Hydraulic press. .

**22. For normal transistor action, the collector-base junction is:**

- A. Reverse biased
- B. Forward biased
- C. Unbiased
- D. Short-circuited
- E. At zero potential difference always

**Answer: A. Reverse biased.** **Explanation:** The governing physical definition or law in Chapter 18: Electronics gives Reverse biased. .

**23. Two point charges remain unchanged while their separation is doubled. Their electrostatic force becomes:**



- A. One-half of its original value
- B. Twice its original value
- C. Four times its original value
- D. One-fourth of its original value
- E. Unchanged

**Answer: D. One-fourth of its original value. Explanation:** The governing physical definition or law in Chapter 12: Electrostatics gives One-fourth of its original value. .

**24. A transformer has 200 primary turns and 1000 secondary turns. If the primary voltage is 12 V, the ideal secondary voltage is:**

- A. 120 V
- B. 12 V
- C. 2.4 V
- D. 24 V
- E. 60 V

**Answer: E. 60 V. Explanation:** The governing physical definition or law in Unit 15: Electromagnetism gives 60 V. .

**25. The magnetic force on a current-carrying wire is zero when the wire is:**

- A. Made longer
- B. Perpendicular to the magnetic field
- C. Placed near a stronger magnet
- D. Parallel to the magnetic field
- E. Carrying a larger current

**Answer: D. Parallel to the magnetic field. Explanation:** The governing physical definition or law in Unit 15: Electromagnetism gives Parallel to the magnetic field. .

## Practice Set 3 - 25 MCQs

**1. In beta-minus decay, a neutron changes into a proton, so the atomic number:**

- A. decreases by two
- B. doubles
- C. remains unchanged
- D. decreases by one
- E. increases by one

**Answer: E. increases by one. Explanation:** The governing physical definition or law in Chapter 12: Nuclear and Particle Physics gives increases by one. .

**2. Maximum transmitted intensity through an analyzer occurs when its axis is:**

- A. at  $45^\circ$  only
- B. at  $60^\circ$  only
- C. perpendicular to the polarization direction
- D. parallel to the polarization direction
- E. randomly oriented

**Answer: D. parallel to the polarization direction. Explanation:** The governing physical definition or law in Chapter 8: Physical Optics and Gravitational Waves gives parallel to the polarization direction. .

**3. Ohm's law applies to a conductor when its temperature and physical state:**

- A. Increase continuously
- B. Remain constant
- C. Decrease continuously
- D. Become irrelevant
- E. Change randomly

**Answer: B. Remain constant. Explanation:** The governing physical definition or law in Unit 14: Current Electricity gives Remain constant. .

**4. The upward lift on an aeroplane wing is explained mainly by a difference in:**

- A. gravitational constant
- B. wing mass
- C. electric potential
- D. air pressure
- E. air temperature only

**Answer: D. air pressure. Explanation:** The governing physical definition or law in Chapter 5: Solids and Fluid Dynamics gives air pressure. .

**5. The magnetic field around a straight wire becomes stronger when:**

- A. The current increases or the observation point moves closer
- B. The wire carries no current

- C. The wire is replaced by an insulator
- D. The current decreases and distance increases
- E. The observation point moves farther away only

**Answer: A. The current increases or the observation point moves closer. Explanation:** The governing physical definition or law in Unit 15: Electromagnetism gives The current increases or the observation point moves closer. .

**6. Faraday's law gives the induced emf as the negative rate of change of:**

- A. Electric charge
- B. Resistance
- C. Mechanical power
- D. Magnetic flux linkage
- E. Capacitance

**Answer: D. Magnetic flux linkage. Explanation:** The governing physical definition or law in Chapter 15: Electromagnetic Induction gives Magnetic flux linkage. .

**7. Momentum is equal to:**

- A. velocity ÷ mass
- B. weight ÷ time
- C. mass × acceleration
- D. mass × velocity
- E. force × distance

**Answer: D. mass × velocity. Explanation:** The governing physical definition or law in CHAPTER 3 gives mass × velocity. .

**8. Which safety practice reduces radiation exposure?**

- A. Increase time near the source
- B. Minimize time, maximize distance and use suitable shielding
- C. Remove all shielding
- D. Hold the source close to the body
- E. Store sources in open containers

**Answer: B. Minimize time, maximize distance and use suitable shielding. Explanation:** The governing physical definition or law in Unit 18: Atomic and Nuclear Physics gives Minimize time, maximize distance and use suitable shielding. .

**9. Heat is energy transferred because of a difference in:**

- A. pressure only
- B. density only
- C. temperature
- D. volume
- E. mass

**Answer: C. temperature. Explanation:** The governing physical definition or law in Chapter 6: Heat and Thermodynamics gives temperature. .

**10. Counterclockwise angular displacement is conventionally taken as:**

- A. positive
- B. dimensionless
- C. zero
- D. undefined
- E. negative

**Answer: A. positive. Explanation:** The governing physical definition or law in Chapter 3: Circular and Rotational Motion gives positive. .

**11. Which change most directly promotes turbulent rather than streamline flow?**

- A. Increasing the fluid speed greatly
- B. Increasing viscosity
- C. Reducing the fluid speed
- D. Using a smoother tube
- E. Reducing the tube diameter while keeping Reynolds effects small

**Answer: A. Increasing the fluid speed greatly. Explanation:** The governing physical definition or law in Chapter 5: Solids and Fluid Dynamics gives Increasing the fluid speed greatly. .

**12. Magnetic flux linkage for a coil of N turns is:**

- A.  $N\Phi^2$
- B.  $N+\Phi$
- C.  $N/\Phi$
- D.  $N\Phi$
- E.  $\Phi/N$

**Answer: D.  $N\Phi$ . Explanation:** The governing physical definition or law in Chapter 10: Electromagnetism gives  $N\Phi$ . .

**13. For a straight rod of length l moving with speed v perpendicular to magnetic field B, the motional emf is:**

- A.  $B/lv$
- B.  $Bv/l$
- C.  $lv/B$
- D.  $B + l + v$
- E.  $Blv$

**Answer: E.  $Blv$ . Explanation:** The governing physical definition or law in Chapter 15: Electromagnetic Induction gives  $Blv$ . .

**14. Two bodies have equal momentum. Which one has greater kinetic energy?**

- A. The body with larger mass

- B. Both always have equal kinetic energy
- C. The body with smaller speed
- D. The body with smaller mass
- E. The body at greater height

**Answer: D. The body with smaller mass. Explanation:** The governing physical definition or law in Chapter 4: Work, Energy and Power gives The body with smaller mass. .

**15. A transformer works on the principle of:**

- A. Nuclear fission
- B. Thermionic emission
- C. Mutual induction
- D. Total internal reflection
- E. Electrostatic induction only

**Answer: C. Mutual induction. Explanation:** The governing physical definition or law in Unit 15: Electromagnetism gives Mutual induction. .

**16. A thermometric property must change:**

- A. only with mass
- B. only with pressure
- C. predictably with temperature
- D. randomly with time
- E. independently of temperature

**Answer: C. predictably with temperature. Explanation:** The governing physical definition or law in CHAPTER 7 gives predictably with temperature. .

**17. Over one complete revolution in uniform circular motion, the average acceleration is:**

- A. equal to  $2\pi v/T$
- B. zero
- C. directed radially outward
- D. directed radially inward
- E. equal to  $v^2/r$

**Answer: B. zero. Explanation:** The governing physical definition or law in Chapter 3: Circular and Rotational Motion gives zero. .

**18. What happens when two positively charged bodies are brought near each other?**

- A. They exchange all protons.
- B. They become neutral immediately.
- C. They produce no force.
- D. They repel each other.
- E. They attract each other.

**Answer: D. They repel each other.. Explanation:** The governing physical definition or law in Unit 13: Electrostatics gives They repel each other.. .

**19. The energy of a photon is:**

- A.  $E = h/f$
- B.  $E = hf$
- C.  $E = f/h$
- D.  $E = hc f$
- E.  $E = \frac{1}{2}hf$

**Answer: B.  $E = hf$ . Explanation:** The governing physical definition or law in Chapter 19: Dawn of Modern Physics gives  $E = hf$ . .

**20. The magnitude of centripetal force is:**

- A.  $F=mr^2v$
- B.  $F=mv/r^2$
- C.  $F=mv^2/r$
- D.  $F=mr/v^2$
- E.  $F=mvr$

**Answer: C.  $F=mv^2/r$ . Explanation:** The governing physical definition or law in Chapter 3: Circular and Rotational Motion gives  $F=mv^2/r$ . .

**21. Thermal equilibrium is reached when two objects in contact have:**

- A. the same temperature
- B. equal densities
- C. zero internal energy
- D. the same volume
- E. the same mass

**Answer: A. the same temperature. Explanation:** The governing physical definition or law in CHAPTER 7 gives the same temperature. .

**22. A refracting telescope uses:**

- A. A plane mirror and a prism
- B. Two diverging lenses
- C. Two converging lenses
- D. A concave mirror only
- E. One convex and one plane mirror only

**Answer: C. Two converging lenses. Explanation:** The governing physical definition or law in Unit 12: Geometrical Optics gives Two converging lenses. .

**23. Potential difference between two points is the energy transferred per:**

- A. Unit length

- B. Unit time
- C. Unit resistance
- D. Unit mass
- E. Unit charge

**Answer: E. Unit charge. Explanation:** The governing physical definition or law in Unit 14: Current Electricity gives Unit charge. .

**24. Near Earth's surface, a freely falling body has an acceleration directed:**

- A. horizontally east
- B. vertically upward
- C. vertically downward
- D. away from Earth's centre
- E. along its velocity only

**Answer: C. vertically downward. Explanation:** The governing physical definition or law in CHAPTER 2 gives vertically downward. .

**25. A polarizer and analyzer are parallel. Rotating the analyzer by  $90^\circ$  changes transmitted intensity from maximum to:**

- A. one-half maximum
- B. unchanged maximum
- C. double maximum
- D. zero
- E. one-quarter maximum

**Answer: D. zero. Explanation:** The governing physical definition or law in Chapter 8: Physical Optics and Gravitational Waves gives zero. .

# CHEMISTRY

## Topics and contents

The Chemistry section explains matter, particles, bonding, quantitative relationships, energy, equilibrium, reaction behaviour, periodic trends, organic compounds and practical reasoning as connected ideas.

This section covers States of Matter and Phase Changes; Atomic Structure; Chemical Bonding; Stoichiometry; Energetics; Equilibria; Acid-Base Chemistry; Periodic Table and Periodicity; Group Properties and Elements; Environmental Chemistry; Hydrocarbons.

It also develops understanding of Empirical Data Collection and Analysis; Laboratory and Practical Skills; History of Chemistry; Matter; Electrochemistry; Reaction Kinetics; Salts; Nitrogen, Sulphur and Metals; Organic Chemistry; Hydroxy Compounds; Carboxylic Compounds.

It also develops understanding of Polymers; Biochemistry; Periodic Table and Periodic Properties; States and Phases of Matter; Chemical Energetics; Chemical Equilibrium; Nitrogen and Sulfur; Halogens; Atmosphere; Basic Separation Techniques; Lab Safety and Practical Skills.

It also develops understanding of Periodic Classification of Elements and Periodicity; s-Block Elements; Group IIIA and Group IVA Elements; Group VA and Group VIA Elements; The Halogens and the Noble Gases; Transition Elements; Fundamental Principles of Organic Chemistry; Aliphatic Hydrocarbons; Aromatic Hydrocarbons; Alkyl Halides; Alcohols, Phenols and Ethers.

It also develops understanding of Aldehydes and Ketones; Carboxylic Acids; Macromolecules; Common Chemical Industries in Pakistan.

## 1. States of Matter and Phase Changes

Matter has mass and occupies space. Particle arrangement, forces and kinetic energy explain solids, liquids, gases, plasma and phase changes.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Solids have fixed shape and volume; liquids fixed volume; gases neither. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Heating raises particle energy and may overcome attractions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Solutions are homogeneous; suspensions settle; colloids have intermediate particles. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Gas laws use absolute temperature. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are gases compressible?

**STEP-BY-STEP REASONING:** Their particles are far apart, leaving large empty spaces. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use the particle model to explain every macroscopic property.

**COMMON ERROR TO AVOID:** Temperature in gas-law calculations must be kelvin.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 2. Atomic Structure

Atoms contain protons and neutrons in the nucleus and electrons in quantized regions around it.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.



### Core ideas in plain language

- Atomic number=protons; mass number=protons+neutrons. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Isotopes have same protons but different neutrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Ions form by electron loss or gain. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Electronic configuration explains chemical behaviour. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Sodium has 11 protons and loses one electron. How many electrons in  $\text{Na}^+$ ?

**STEP-BY-STEP REASONING:** 10 electrons. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Calculate charge from protons minus electrons.

**COMMON ERROR TO AVOID:** Isotopes differ in neutrons, not atomic number.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 3. Chemical Bonding

Chemical bonds arise from electrostatic attractions and electron sharing or transfer.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Ionic bonding forms oppositely charged ions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Covalent bonding shares electron pairs. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Metallic bonding involves positive ions and delocalized electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Intermolecular forces control many physical properties. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does solid  $\text{NaCl}$  not conduct electricity?

**STEP-BY-STEP REASONING:** Its ions are fixed in the lattice and cannot carry charge through the solid. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Separate intramolecular bonds from intermolecular forces.

**COMMON ERROR TO AVOID:** Low boiling point of a molecular substance does not mean weak covalent bonds.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 4. Stoichiometry

Stoichiometry uses balanced equations to relate particles, moles, masses, gas volumes and concentrations.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Moles=mass/molar mass. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- Use coefficients as mole ratios. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Identify limiting reagent before theoretical yield. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Percentage yield =  $\text{actual/theoretical} \times 100$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** How many moles are in 18 g of water,  $M = 18 \text{ g mol}^{-1}$ ?

**STEP-BY-STEP REASONING:**  $18/18 = 1 \text{ mol}$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Balanced equation  $\rightarrow$  moles  $\rightarrow$  ratio  $\rightarrow$  requested unit.

**COMMON ERROR TO AVOID:** Never use mass ratios directly unless derived from molar masses.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 5. Energetics

Energetics tracks heat changes in reactions. Bond breaking absorbs energy and bond formation releases it.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Exothermic  $\Delta H < 0$ ; endothermic  $\Delta H > 0$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Activation energy controls rate, not total enthalpy change. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Hess law adds equations and enthalpy changes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Standard formation enthalpy refers to one mole from elements in standard states. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** A reaction releases 100 kJ. What is the sign of  $\Delta H$ ?

**STEP-BY-STEP REASONING:** Negative,  $\Delta H = -100 \text{ kJ}$  for the stated amount. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Sketch reactant and product energy levels.

**COMMON ERROR TO AVOID:** Catalysts lower activation energy but do not change  $\Delta H$ .

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 6. Equilibria

Dynamic equilibrium occurs in a closed system when forward and reverse rates are equal.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Concentrations are constant, not necessarily equal. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Le Chatelier: the system opposes concentration, pressure or temperature changes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Only temperature changes the equilibrium constant. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- Catalysts speed attainment but do not shift position. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** For an exothermic forward reaction, what does higher temperature do?

**STEP-BY-STEP REASONING:** It favours the endothermic reverse direction and reduces product yield. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Treat heat as a reactant or product.

**COMMON ERROR TO AVOID:** A catalyst does not increase equilibrium yield.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 7. Acid-Base Chemistry

Acids and bases are described by proton transfer and aqueous ion behaviour.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Acid donates  $H^+$ ; base accepts  $H^+$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- $pH = -\log[H^+]$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Strong means highly ionized; concentrated means much solute. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- At strong acid-strong base equivalence, pH is about 7 at 25 C. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** If  $[H^+] = 1 \times 10^{-3} \text{ M}$ , find pH.

**STEP-BY-STEP REASONING:**  $pH = 3$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Translate powers of ten directly for simple pH questions.

**COMMON ERROR TO AVOID:** Strong and concentrated are not synonyms.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 8. Periodic Table and Periodicity

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 9. Group Properties and Elements

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 10. Environmental Chemistry

Environmental chemistry explains pollutants, atmospheric reactions, water quality and sustainable control.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Photochemical smog needs nitrogen oxides, hydrocarbons and sunlight. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Greenhouse gases absorb outgoing infrared radiation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Acid rain involves sulfur and nitrogen oxides. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Treatment combines physical, chemical and biological steps. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Which three conditions favour photochemical smog?

**STEP-BY-STEP REASONING:** Nitrogen oxides, hydrocarbons and sunlight. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Match pollutant to source, chemistry and effect.

**COMMON ERROR TO AVOID:** Ozone is protective in the stratosphere but harmful near the ground.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 11. Hydrocarbons

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 12. Empirical Data Collection and Analysis

Practical chemistry depends on safe measurement, separation and evaluation of uncertainty.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Filtration separates insoluble solid from liquid; distillation separates by boiling point; chromatography by differential attraction. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Read scales at eye level and record units/significant figures. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Wear protection and add acid to water when dilution is required. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which method separates an insoluble solid from a liquid?

**STEP-BY-STEP REASONING:** Filtration. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Choose the property difference first: solubility, boiling point, particle size or adsorption.

**COMMON ERROR TO AVOID:** A precise reading is not automatically accurate.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 13. Laboratory and Practical Skills

Practical chemistry depends on safe measurement, separation and evaluation of uncertainty.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

#### Core ideas in plain language

- Filtration separates insoluble solid from liquid; distillation separates by boiling point; chromatography by differential attraction. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Read scales at eye level and record units/significant figures. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Wear protection and add acid to water when dilution is required. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which method separates an insoluble solid from a liquid?

**STEP-BY-STEP REASONING:** Filtration. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Choose the property difference first: solubility, boiling point, particle size or adsorption.

**COMMON ERROR TO AVOID:** A precise reading is not automatically accurate.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 14. History of Chemistry

Chemistry developed from practical arts and alchemy into a quantitative science based on measurement, conservation and atomic theory.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

#### Core ideas in plain language

- Know contributions of major models rather than memorizing names alone. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Modern chemistry links composition, structure, properties and changes of matter. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why was the balance important to early modern chemistry?

**STEP-BY-STEP REASONING:** It enabled quantitative mass measurements and evidence for conservation. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Connect each scientist or period with one distinctive idea.

**COMMON ERROR TO AVOID:** Do not treat alchemy and modern experimental chemistry as equivalent methods.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*



## 15. Matter

Matter has mass and occupies space. Particle arrangement, forces and kinetic energy explain solids, liquids, gases, plasma and phase changes.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Solids have fixed shape and volume; liquids fixed volume; gases neither. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Heating raises particle energy and may overcome attractions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Solutions are homogeneous; suspensions settle; colloids have intermediate particles. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Gas laws use absolute temperature. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are gases compressible?

**STEP-BY-STEP REASONING:** Their particles are far apart, leaving large empty spaces. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use the particle model to explain every macroscopic property.

**COMMON ERROR TO AVOID:** Temperature in gas-law calculations must be kelvin.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 16. Electrochemistry

Electrochemistry links redox reactions and electrical energy.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Oxidation at anode; reduction at cathode. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Galvanic cells are spontaneous and produce electricity. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Electrolytic cells use electricity to drive non-spontaneous change. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Electrons move through the external circuit; ions move in electrolyte. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What energy conversion occurs in a galvanic cell?

**STEP-BY-STEP REASONING:** Chemical energy becomes electrical energy. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Remember AN OX and RED CAT.

**COMMON ERROR TO AVOID:** Anode sign differs between galvanic and electrolytic cells; the reaction names do not.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 17. Reaction Kinetics

Reaction kinetics studies rate and factors affecting successful collisions.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Rate increases with concentration, pressure for gases, temperature and surface area. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A catalyst provides a lower-energy pathway. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Only collisions with enough energy and suitable orientation react. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does stirring often increase rate?

**STEP-BY-STEP REASONING:** It brings reactant particles into contact more frequently. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Explain a factor using collision frequency or energy.

**COMMON ERROR TO AVOID:** A catalyst is not consumed overall and does not raise product yield at equilibrium.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 18. Salts

Salts are ionic compounds formed when acidic hydrogen is replaced by a metal or ammonium ion.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Soluble salts may be prepared by titration or reacting excess solid with acid. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Precipitation makes an insoluble salt. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Solubility rules predict precipitates. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Hydrolysis can make salt solutions acidic or basic. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What ion can replace  $H^+$  in an acid besides a metal ion?

**STEP-BY-STEP REASONING:** The ammonium ion,  $NH_4^+$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Choose preparation method from solubility of reactants and product.

**COMMON ERROR TO AVOID:** Do not evaporate to dryness if the salt decomposes on strong heating.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 19. Nitrogen, Sulphur and Metals

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.



### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 20. Organic Chemistry

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 21. Hydroxy Compounds

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 22. Carboxylic Compounds

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 23. Polymers

Macromolecules include synthetic polymers and biological molecules made from repeating or linked small units.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Addition polymers form from unsaturated monomers without small by-products. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Condensation polymers form links while eliminating small molecules. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Proteins are amino-acid polymers; carbohydrates and nucleic acids have characteristic monomers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What monomer feature is required for addition polymerization?

**STEP-BY-STEP REASONING:** A carbon-carbon double bond or equivalent unsaturation. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Find the repeating unit and work backward to the monomer.

**COMMON ERROR TO AVOID:** Polymer properties depend on structure, branching and intermolecular forces.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 24. Biochemistry

Macromolecules include synthetic polymers and biological molecules made from repeating or linked small units.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Addition polymers form from unsaturated monomers without small by-products. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Condensation polymers form links while eliminating small molecules. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Proteins are amino-acid polymers; carbohydrates and nucleic acids have characteristic monomers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What monomer feature is required for addition polymerization?

**STEP-BY-STEP REASONING:** A carbon-carbon double bond or equivalent unsaturation. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Find the repeating unit and work backward to the monomer.

**COMMON ERROR TO AVOID:** Polymer properties depend on structure, branching and intermolecular forces.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 25. Periodic Table and Periodic Properties

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 26. States and Phases of Matter

Matter has mass and occupies space. Particle arrangement, forces and kinetic energy explain solids, liquids, gases, plasma and phase changes.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Solids have fixed shape and volume; liquids fixed volume; gases neither. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Heating raises particle energy and may overcome attractions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Solutions are homogeneous; suspensions settle; colloids have intermediate particles. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Gas laws use absolute temperature. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are gases compressible?

**STEP-BY-STEP REASONING:** Their particles are far apart, leaving large empty spaces. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use the particle model to explain every macroscopic property.

**COMMON ERROR TO AVOID:** Temperature in gas-law calculations must be kelvin.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 27. Chemical Energetics

Energetics tracks heat changes in reactions. Bond breaking absorbs energy and bond formation releases it.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Exothermic  $\Delta H < 0$ ; endothermic  $\Delta H > 0$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Activation energy controls rate, not total enthalpy change. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Hess law adds equations and enthalpy changes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Standard formation enthalpy refers to one mole from elements in standard states. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** A reaction releases 100 kJ. What is the sign of  $\Delta H$ ?

**STEP-BY-STEP REASONING:** Negative,  $\Delta H = -100$  kJ for the stated amount. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Sketch reactant and product energy levels.

**COMMON ERROR TO AVOID:** Catalysts lower activation energy but do not change  $\Delta H$ .

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 28. Chemical Equilibrium

Dynamic equilibrium occurs in a closed system when forward and reverse rates are equal.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Concentrations are constant, not necessarily equal. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Le Chatelier: the system opposes concentration, pressure or temperature changes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Only temperature changes the equilibrium constant. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Catalysts speed attainment but do not shift position. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** For an exothermic forward reaction, what does higher temperature do?

**STEP-BY-STEP REASONING:** It favours the endothermic reverse direction and reduces product yield. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Treat heat as a reactant or product.

**COMMON ERROR TO AVOID:** A catalyst does not increase equilibrium yield.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 29. Nitrogen and Sulfur

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 30. Halogens

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 31. Atmosphere

Environmental chemistry explains pollutants, atmospheric reactions, water quality and sustainable control.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Photochemical smog needs nitrogen oxides, hydrocarbons and sunlight. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Greenhouse gases absorb outgoing infrared radiation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Acid rain involves sulfur and nitrogen oxides. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Treatment combines physical, chemical and biological steps. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.



**WORKED EXAMPLE:** Which three conditions favour photochemical smog?

**STEP-BY-STEP REASONING:** Nitrogen oxides, hydrocarbons and sunlight. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Match pollutant to source, chemistry and effect.

**COMMON ERROR TO AVOID:** Ozone is protective in the stratosphere but harmful near the ground.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 32. Basic Separation Techniques

Practical chemistry depends on safe measurement, separation and evaluation of uncertainty.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Filtration separates insoluble solid from liquid; distillation separates by boiling point; chromatography by differential attraction. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Read scales at eye level and record units/significant figures. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Wear protection and add acid to water when dilution is required. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which method separates an insoluble solid from a liquid?

**STEP-BY-STEP REASONING:** Filtration. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Choose the property difference first: solubility, boiling point, particle size or adsorption.

**COMMON ERROR TO AVOID:** A precise reading is not automatically accurate.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 33. Lab Safety and Practical Skills

Practical chemistry depends on safe measurement, separation and evaluation of uncertainty.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Filtration separates insoluble solid from liquid; distillation separates by boiling point; chromatography by differential attraction. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Read scales at eye level and record units/significant figures. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Wear protection and add acid to water when dilution is required. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which method separates an insoluble solid from a liquid?

**STEP-BY-STEP REASONING:** Filtration. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Choose the property difference first: solubility, boiling point, particle size or adsorption.

**COMMON ERROR TO AVOID:** A precise reading is not automatically accurate.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 34. Periodic Classification of Elements and Periodicity

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 35. s-Block Elements

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.



**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 36. Group IIIA and Group IVA Elements

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

#### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 37. Group VA and Group VIA Elements

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

#### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 38. The Halogens and the Noble Gases

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 39. Transition Elements

Periodic patterns arise from electronic configuration, nuclear charge and shielding.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Across a period, atomic radius generally decreases and ionization energy rises. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Down a group, radius and shielding increase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Group properties reflect valence electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Transition metals commonly show variable oxidation states, coloured ions and catalysis. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why does atomic radius generally decrease across a period?

**STEP-BY-STEP REASONING:** Nuclear charge increases while electrons enter the same main shell, strengthening attraction. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use electron configuration to explain a trend, not only state it.

**COMMON ERROR TO AVOID:** Periodic trends have exceptions; choose the general rule unless a specific species is given.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 40. Fundamental Principles of Organic Chemistry

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 41. Aliphatic Hydrocarbons

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 42. Aromatic Hydrocarbons

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 43. Alkyl Halides

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 44. Alcohols, Phenols and Ethers

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 45. Aldehydes and Ketones

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 46. Carboxylic Acids

Organic chemistry organizes carbon compounds by functional groups and reaction patterns.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Alkanes undergo substitution; alkenes addition; aromatic rings often substitution. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Alcohols may oxidize; aldehydes oxidize to acids; ketones resist mild oxidation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Carboxylic acids form salts and esters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Homologous series share a functional group and general formula. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Ethene reacts with steam under suitable conditions. Product?

**STEP-BY-STEP REASONING:** Ethanol, by hydration across the C=C bond. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the functional group before selecting the reaction.

**COMMON ERROR TO AVOID:** Structural isomers share molecular formula but differ in connectivity.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 47. Macromolecules

Macromolecules include synthetic polymers and biological molecules made from repeating or linked small units.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Addition polymers form from unsaturated monomers without small by-products. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Condensation polymers form links while eliminating small molecules. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Proteins are amino-acid polymers; carbohydrates and nucleic acids have characteristic monomers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What monomer feature is required for addition polymerization?

**STEP-BY-STEP REASONING:** A carbon-carbon double bond or equivalent unsaturation. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Find the repeating unit and work backward to the monomer.

**COMMON ERROR TO AVOID:** Polymer properties depend on structure, branching and intermolecular forces.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 48. Common Chemical Industries in Pakistan

Chemical industries convert raw materials into products through optimized reactions, separations, recycling and quality control.

The central aim is to understand how the main ideas are connected. Identify whether the question tests definition, structure, trend, equation, equilibrium, calculation, or laboratory reasoning. Write a balanced equation where a reaction is involved, track moles and charge, and use periodic or bonding principles to explain trends rather than memorising isolated facts.

### Core ideas in plain language

- Industrial choices balance yield, rate, energy, cost, safety and environment. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.



- Continuous processes suit large steady production. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Catalysts and heat recovery improve efficiency. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why are moderate conditions often chosen for equilibrium processes?

**STEP-BY-STEP REASONING:** They compromise between equilibrium yield, reaction rate, equipment cost and safety. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For an industrial process, discuss both chemistry and economics.

**COMMON ERROR TO AVOID:** Maximum theoretical yield may not be the most economical operating point.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## CHEMISTRY - PRACTICE EXERCISES

Three independent sets are provided. Attempt each question before reading the answer, explanation and quick tactic immediately below it. Each set contains 25 MCQs with five options (A–E).

### Practice Set 1 - 25 MCQs

1. A volume of 500 cm<sup>3</sup> is equal to:

- A. 5.00 dm<sup>3</sup>
- B. 0.500 dm<sup>3</sup>
- C. 50.0 dm<sup>3</sup>
- D. 0.050 dm<sup>3</sup>
- E. 500 dm<sup>3</sup>

**Answer: B. 0.500 dm<sup>3</sup>.** **Explanation:** The chemical principle in Chapter 3: Stoichiometry identifies 0.500 dm<sup>3</sup>. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

2. A carbon-carbon triple bond is characteristic of an:

- A. Alkyne
- B. Alkane
- C. Alkene
- D. Alcohol
- E. Carboxylic acid

**Answer: D. Alcohol.** **Explanation:** The chemical principle in Chapter 8: Organic Chemistry identifies Alcohol. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

3. Food is kept in a refrigerator mainly because low temperature:

- A. Increases all reaction rates
- B. Raises activation energy of products
- C. Slows chemical and biological reactions
- D. Removes water completely
- E. Converts food into polymers

**Answer: A. Increases all reaction rates.** **Explanation:** The chemical principle in Chapter 5: Reaction Kinetics identifies Increases all reaction rates. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

4. Ethyl ethanoate is formed from ethanol and:

- A. Methanoic acid
- B. Propanoic acid
- C. Ethanoic acid
- D. Ethene



E. Methane

**Answer: B. Propanoic acid. Explanation:** The chemical principle in Chapter 11: Carboxylic Compounds identifies Propanoic acid. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**5. Ozonolysis is useful for locating the position of a carbon-carbon:**

- A. hydrogen bond
- B. single bond only
- C. ionic bond
- D. metallic bond
- E. double bond

**Answer: E. double bond. Explanation:** The chemical principle in Chapter 11: Hydrocarbons identifies double bond. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**6. The molecular formula of ethyne is:**

- A. C<sub>2</sub>H<sub>4</sub>
- B. C<sub>2</sub>H<sub>2</sub>
- C. C<sub>2</sub>H<sub>6</sub>
- D. CH<sub>4</sub>
- E. C<sub>3</sub>H<sub>8</sub>

**Answer: C. C<sub>2</sub>H<sub>6</sub>. Explanation:** The chemical principle in Chapter 9: Hydrocarbons identifies C<sub>2</sub>H<sub>6</sub>. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**7. Gases are highly compressible because their particles are:**

- A. fixed in place
- B. joined by strong ionic bonds
- C. tightly packed
- D. without kinetic energy
- E. far apart

**Answer: E. far apart. Explanation:** The chemical principle in Chapter 5: States and Phases of Matter identifies far apart. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**8. Accuracy describes how close a measurement is to the:**

- A. Largest value
- B. Smallest value
- C. Average colour
- D. Number of trials

E. True or accepted value

**Answer: B. Smallest value. Explanation:** The chemical principle in Chapter 1: History of Chemistry identifies Smallest value. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option.

**Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**9. The key equilibrium step in the Contact process converts SO<sub>2</sub> and O<sub>2</sub> into:**

- A. S<sub>8</sub>
- B. NO<sub>2</sub>
- C. H<sub>2</sub>SO<sub>4</sub> directly
- D. SO<sub>3</sub>
- E. H<sub>2</sub>S

**Answer: D. SO<sub>3</sub>. Explanation:** The chemical principle in Chapter 12: Nitrogen and Sulfur identifies SO<sub>3</sub>. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**10. Evaporation occurs:**

- A. At the surface of a liquid at many temperatures
- B. Only at the boiling point
- C. Only inside a solid
- D. Only under high pressure
- E. Throughout the liquid at one fixed temperature

**Answer: E. Throughout the liquid at one fixed temperature. Explanation:** The chemical principle in Chapter 2: Matter identifies Throughout the liquid at one fixed temperature. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**11. For copper electroplating, the electrolyte should contain:**

- A. Copper ions
- B. Only chloride ions
- C. Only hydrogen ions
- D. No ions
- E. Solid copper only

**Answer: E. Solid copper only. Explanation:** The chemical principle in Chapter 4: Electrochemistry identifies Solid copper only. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**12. Condensation polymerization usually releases a small molecule such as:**

- A. Water
- B. A polymer chain
- C. A metal ion
- D. A neutron

E. A catalyst

**Answer: D. A neutron. Explanation:** The chemical principle in Chapter 12: Polymers identifies A neutron. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**13. Evaporation causes cooling because the molecules that escape have relatively:**

- A. no intermolecular forces
- B. low kinetic energy
- C. high kinetic energy
- D. high mass number
- E. zero kinetic energy

**Answer: C. high kinetic energy. Explanation:** The chemical principle in Chapter 5: States and Phases of Matter identifies high kinetic energy. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**14. Nylon is commonly formed by:**

- A. Addition polymerization of ethene
- B. Condensation polymerization
- C. Electrolysis
- D. Cracking
- E. Neutralization

**Answer: A. Addition polymerization of ethene. Explanation:** The chemical principle in Chapter 12: Polymers identifies Addition polymerization of ethene. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**15. Cooling in a refrigerator mainly involves the:**

- A. Freezing of air
- B. Combustion of gas
- C. Sublimation of metal
- D. Deposition of water only
- E. Evaporation of a refrigerant

**Answer: C. Sublimation of metal. Explanation:** The chemical principle in Chapter 2: Matter identifies Sublimation of metal. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**16. A common use of liquid crystals is in:**

- A. nuclear reactors only
- B. display screens
- C. water softening
- D. blast furnaces

E. electroplating tanks

**Answer: B. display screens. Explanation:** The chemical principle in Chapter 5: States and Phases of Matter identifies display screens. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**17. Bromine water is decolourized by an alkene because bromine:**

- A. removes all hydrogen atoms
- B. adds across the double bond
- C. forms a precipitate only
- D. acts as a catalyst
- E. polymerizes itself

**Answer: B. adds across the double bond. Explanation:** The chemical principle in Chapter 11: Hydrocarbons identifies adds across the double bond. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**18. The number of moles is calculated by:**

- A. mass multiplied by molar mass
- B. particles multiplied by Avogadro constant
- C. molar mass divided by mass
- D. volume divided by density only
- E. mass divided by molar mass

**Answer: E. mass divided by molar mass. Explanation:** The chemical principle in Chapter 4: Stoichiometry identifies mass divided by molar mass. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**19. Vitamin A is especially important for:**

- A. Blood clotting only
- B. Bone calcium absorption only
- C. Protein digestion only
- D. Vision
- E. Salt balance only

**Answer: B. Bone calcium absorption only. Explanation:** The chemical principle in Chapter 13: Biochemistry identifies Bone calcium absorption only. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**20. Lowering temperature favours the:**

- A. forward direction always
- B. side with more gases only
- C. endothermic direction

- D. exothermic direction
- E. side with a catalyst

**Answer: D. exothermic direction. Explanation:** The chemical principle in Chapter 8: Chemical Equilibrium identifies exothermic direction. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**21. Which principle states that matter and energy are not created or destroyed in a chemical reaction?**

- A. Law of conservation of mass and energy
- B. Law of multiple proportions
- C. Boyle's law
- D. Avogadro's law
- E. Law of definite volumes

**Answer: B. Law of multiple proportions. Explanation:** The chemical principle in Chapter 1: History of Chemistry identifies Law of multiple proportions. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**22. Hess's law states that the total enthalpy change is independent of the:**

- A. initial and final states
- B. temperature in every situation
- C. identity of reactants
- D. route taken
- E. balanced equation

**Answer: D. route taken. Explanation:** The chemical principle in Chapter 6: Chemical Energetics identifies route taken. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**23. Fluorides are added in controlled amounts to toothpaste mainly to reduce:**

- A. blood pressure
- B. tooth decay
- C. rusting
- D. air pollution
- E. water hardness

**Answer: B. tooth decay. Explanation:** The chemical principle in Chapter 13: Halogens identifies tooth decay. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**24. The Air Quality Index provides information about:**

- A. the level of air pollution and health concern
- B. atomic masses
- C. water hardness

D. soil fertility only

E. boiling points

**Answer: A. the level of air pollution and health concern. Explanation:** The chemical principle in Chapter 14: Atmosphere identifies the level of air pollution and health concern. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**25. An enzyme is a:**

A. Metal electrode

B. Strong acid

C. Polymer monomer

D. Biological catalyst

E. Salt bridge

**Answer: C. Polymer monomer. Explanation:** The chemical principle in Chapter 5: Reaction Kinetics identifies Polymer monomer. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option.

**Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

## Practice Set 2 - 25 MCQs

### 1. Thermochemistry deals with heat changes during:

- A. physical and chemical processes
- B. only phase diagrams
- C. only mechanical motion
- D. only nuclear decay
- E. only electrical conduction

**Answer: A. physical and chemical processes. Explanation:** The chemical principle in Chapter 6: Chemical Energetics identifies physical and chemical processes. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

### 2. Rutherford's experiment provided evidence for a small, dense, positively charged:

- A. Electron cloud
- B. Shell
- C. Molecule
- D. Ion
- E. Nucleus

**Answer: D. Ion. Explanation:** The chemical principle in Chapter 1: History of Chemistry identifies Ion. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

### 3. If actual yield is 8 g and theoretical yield is 10 g, the percentage yield is:

- A. 125%
- B. 80%
- C. 100%
- D. 20%
- E. 50%

**Answer: B. 80%. Explanation:** The chemical principle in Chapter 4: Stoichiometry identifies 80%. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

### 4. The halogen molecules exist naturally as:

- A. triatomic ions
- B. diatomic molecules
- C. metallic lattices
- D. giant covalent solids
- E. single atoms only

**Answer: B. diatomic molecules. Explanation:** The chemical principle in Chapter 13: Halogens identifies diatomic molecules. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option.

**Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**5. Particulate matter with diameter 2.5 micrometres or less is called:**

- A. VOC
- B. PM<sub>2.5</sub>
- C. CFC
- D. PM<sub>10</sub>
- E. POPs

**Answer: B. PM<sub>2.5</sub>. Explanation:** The chemical principle in Chapter 14: Atmosphere identifies PM<sub>2.5</sub>. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**6. Aluminium is extracted by electrolysis because it is:**

- A. Less reactive than copper
- B. A noble metal
- C. Found free in nature
- D. More reactive than carbon
- E. A non-metal

**Answer: A. Less reactive than copper. Explanation:** The chemical principle in Chapter 7: Nitrogen, Sulphur and Metals identifies Less reactive than copper. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**7. Alcohols generally have higher boiling points than similar alkanes because alcohols form:**

- A. Metallic bonds
- B. Ionic crystals
- C. Fewer intermolecular forces
- D. No dipoles
- E. Hydrogen bonds

**Answer: B. Ionic crystals. Explanation:** The chemical principle in Chapter 10: Hydroxy Compounds identifies Ionic crystals. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**8. In the blast furnace, iron(III) oxide is mainly reduced by:**

- A. Oxygen
- B. Nitrogen
- C. Carbon monoxide
- D. Steam
- E. Chlorine



**Answer: E. Chlorine. Explanation:** The chemical principle in Chapter 7: Nitrogen, Sulphur and Metals identifies Chlorine. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option.

**Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**9. Which molecule has zero net dipole moment because of its symmetry?**

- A. SO<sub>2</sub>
- B. NH<sub>3</sub>
- C. BF<sub>3</sub>
- D. HCl
- E. H<sub>2</sub>O

**Answer: C. BF<sub>3</sub>. Explanation:** The chemical principle in Chapter 3: Chemical Bonding identifies BF<sub>3</sub>. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**10. Balancing a chemical equation demonstrates the law of conservation of:**

- A. Mass
- B. Temperature
- C. Pressure
- D. Volume
- E. Charge only

**Answer: E. Charge only. Explanation:** The chemical principle in Chapter 3: Stoichiometry identifies Charge only. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**11. Starch is a natural polymer of:**

- A. Glucose
- B. Ethene
- C. Amino acids
- D. Glycerol
- E. Chloroethene

**Answer: B. Ethene. Explanation:** The chemical principle in Chapter 12: Polymers identifies Ethene. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**12. Increasing temperature usually increases reaction rate because particles move:**

- A. More slowly
- B. In fixed positions
- C. Faster
- D. Without collisions
- E. With lower energy

**Answer: D. Without collisions. Explanation:** The chemical principle in Chapter 5: Reaction Kinetics identifies Without collisions. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option.

**Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**13. During a phase change, absorbed energy mainly increases the particles':**

- A. Atomic number
- B. Mass
- C. Potential energy
- D. Charge
- E. Number

**Answer: B. Mass. Explanation:** The chemical principle in Chapter 2: Matter identifies Mass. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**14. The heat content of a system is called its:**

- A. viscosity
- B. enthalpy
- C. entropy
- D. molarity
- E. density

**Answer: B. enthalpy. Explanation:** The chemical principle in Chapter 6: Chemical Energetics identifies enthalpy. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**15. In both galvanic and electrolytic cells, where does reduction occur?**

- A. The cathode is always negative
- B. The anode gains electrons
- C. Reduction occurs at the cathode
- D. Ions cannot move
- E. The cell contains no electrolyte

**Answer: E. The cell contains no electrolyte. Explanation:** The chemical principle in Chapter 4: Electrochemistry identifies The cell contains no electrolyte. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**16. The low reactivity of N<sub>2</sub> is best explained by its high bond energy and:**

- A. strong ionic charge
- B. lack of polarity
- C. metallic bonding
- D. hydrogen bonding
- E. large atomic radius only

**Answer: B. lack of polarity. Explanation:** The chemical principle in Chapter 12: Nitrogen and Sulfur identifies lack of polarity. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option.

**Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**17. Salts of sodium, potassium and ammonium are generally:**

- A. Insoluble
- B. Neutral gases
- C. Non-electrolytes
- D. Soluble
- E. Always coloured

**Answer: D. Soluble. Explanation:** The chemical principle in Chapter 6: Salts identifies Soluble. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**18. A covalent bond is formed by:**

- A. mutual sharing of electron pairs
- B. loss of neutrons
- C. sharing of nuclei
- D. complete transfer of protons
- E. attraction between ions only

**Answer: A. mutual sharing of electron pairs. Explanation:** The chemical principle in Chapter 3: Chemical Bonding identifies mutual sharing of electron pairs. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**19. A measurement written as 25.0 +/- 0.2 cm shows its:**

- A. Uncertainty
- B. Atomic mass
- C. Reaction order
- D. Oxidation state
- E. Mole ratio

**Answer: A. Uncertainty. Explanation:** The chemical principle in Chapter 1: History of Chemistry identifies Uncertainty. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**20. When a transition-metal atom forms a positive ion, electrons are generally removed first from:**

- A. the outer s subshell
- B. the p subshell only
- C. the inner 1s subshell
- D. the d subshell in every case
- E. the nucleus

**Answer: A. the outer s subshell. Explanation:** The chemical principle in Chapter 2: Atomic Structure identifies the outer s subshell. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**21. The rate of diffusion generally increases when temperature:**

- A. Decreases
- B. Increases
- C. Becomes 0 K
- D. Remains constant
- E. Equals pressure

**Answer: B. Increases. Explanation:** The chemical principle in Chapter 2: Matter identifies Increases. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**22. Concordant titres are repeated readings that are:**

- A. measured in grams
- B. taken without indicator
- C. all zero
- D. widely different
- E. very close to one another

**Answer: E. very close to one another. Explanation:** The chemical principle in Chapter 16: Lab Safety and Practical Skills identifies very close to one another. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**23. According to collision theory, reacting particles must:**

- A. remain far apart
- B. always be ions
- C. have zero kinetic energy
- D. collide with sufficient energy and proper orientation
- E. collide at any angle with no energy

**Answer: D. collide with sufficient energy and proper orientation. Explanation:** The chemical principle in Chapter 7: Reaction Kinetics identifies collide with sufficient energy and proper orientation. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**24. Sucrose is a:**

- A. Disaccharide
- B. Monosaccharide
- C. Polysaccharide
- D. Amino acid
- E. Fatty acid

**Answer: B. Monosaccharide. Explanation:** The chemical principle in Chapter 13: Biochemistry identifies Monosaccharide. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**25. Compounds with the same molecular formula but different structures are:**

- A. Isotopes
- B. Allotropes
- C. Ions
- D. Catalysts
- E. Isomers

**Answer: A. Isotopes. Explanation:** The chemical principle in Chapter 8: Organic Chemistry identifies Isotopes. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

## Practice Set 3 - 25 MCQs

### 1. Most sulphates are soluble, but which one is insoluble?

- A. Sodium sulphate
- B. Potassium sulphate
- C. Barium sulphate
- D. Ammonium sulphate
- E. Zinc sulphate

**Answer: C. Barium sulphate. Explanation:** The chemical principle in Chapter 6: Salts identifies Barium sulphate. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

### 2. Molar mass is expressed in:

- A. g dm<sup>-3</sup> only
- B. dm<sup>3</sup> mol<sup>-1</sup>
- C. mol dm<sup>-3</sup>
- D. g mol<sup>-1</sup>
- E. kJ mol<sup>-1</sup>

**Answer: D. g mol<sup>-1</sup>. Explanation:** The chemical principle in Chapter 4: Stoichiometry identifies g mol<sup>-1</sup>. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

### 3. As carbon chain length increases, the water solubility of carboxylic acids generally:

- A. Increases indefinitely
- B. Remains exactly constant
- C. Becomes zero for methanoic acid
- D. Depends only on colour
- E. Decreases

**Answer: E. Decreases. Explanation:** The chemical principle in Chapter 11: Carboxylic Compounds identifies Decreases. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

### 4. Purity of a liquid can be checked using its:

- A. mass number
- B. boiling point
- C. crystal habit only
- D. pH in every case
- E. electron affinity

**Answer: B. boiling point. Explanation:** The chemical principle in Chapter 15: Basic Separation Techniques identifies boiling point. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the

option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**5. Which step must be performed before using mole ratios in stoichiometric calculations?**

- A. measure colour only
- B. remove the limiting reactant
- C. convert all products to gases
- D. balance the chemical equation
- E. add a catalyst

**Answer: D. balance the chemical equation. Explanation:** The chemical principle in Chapter 4: Stoichiometry identifies balance the chemical equation. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**6. A basic salt may form by incomplete neutralization of a:**

- A. Noble gas
- B. Base
- C. Hydrocarbon
- D. Metal alloy
- E. Non-electrolyte

**Answer: E. Non-electrolyte. Explanation:** The chemical principle in Chapter 6: Salts identifies Non-electrolyte. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**7. Standard enthalpy of combustion refers to complete burning of:**

- A. one mole of a substance in oxygen
- B. one gram of a substance in nitrogen
- C. any amount without oxygen
- D. one mole of water
- E. one atom in vacuum

**Answer: A. one mole of a substance in oxygen. Explanation:** The chemical principle in Chapter 6: Chemical Energetics identifies one mole of a substance in oxygen. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**8. The oxidizing power of halogens generally:**

- A. depends only on state
- B. is zero
- C. remains constant
- D. increases down the group
- E. decreases down the group

**Answer: E. decreases down the group. Explanation:** The chemical principle in Chapter 13: Halogens identifies decreases down the group. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**9. An ester is formed by reacting a carboxylic acid with an:**

- A. Alkane
- B. Metal
- C. Salt
- D. Alcohol
- E. Ammonium ion

**Answer: B. Metal. Explanation:** The chemical principle in Chapter 11: Carboxylic Compounds identifies Metal. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**10. Overall reaction order is the:**

- A. activation energy
- B. largest coefficient
- C. product of the orders
- D. sum of the individual orders
- E. number of products

**Answer: D. sum of the individual orders. Explanation:** The chemical principle in Chapter 7: Reaction Kinetics identifies sum of the individual orders. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**11. A proposed mechanism must agree with the experimentally determined:**

- A. rate law
- B. crystal habit
- C. molar masses only
- D. colour of catalyst
- E. period numbers

**Answer: A. rate law. Explanation:** The chemical principle in Chapter 7: Reaction Kinetics identifies rate law. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**12. Lead and mercury are examples of atmospheric:**

- A. noble gases
- B. natural nutrients
- C. halogens only
- D. greenhouse-free gases
- E. heavy-metal pollutants



**Answer: E. heavy-metal pollutants. Explanation:** The chemical principle in Chapter 14: Atmosphere identifies heavy-metal pollutants. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**13. The amount of product formed in a reaction must be calculated from the:**

- A. Excess reactant only
- B. Limiting reactant
- C. Catalyst mass
- D. Solvent colour
- E. Container volume only

**Answer: D. Solvent colour. Explanation:** The chemical principle in Chapter 3: Stoichiometry identifies Solvent colour. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**14. Photochemical smog forms from NO<sub>x</sub> and VOCs in the presence of:**

- A. pure nitrogen
- B. snow only
- C. darkness
- D. sunlight
- E. high vacuum

**Answer: D. sunlight. Explanation:** The chemical principle in Chapter 14: Atmosphere identifies sunlight. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**15. The direct change of a solid into a gas is called:**

- A. Deposition
- B. Condensation
- C. Freezing
- D. Fusion
- E. Sublimation

**Answer: A. Deposition. Explanation:** The chemical principle in Chapter 2: Matter identifies Deposition. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**16. A homogeneous equilibrium has all species in the:**

- A. different phases
- B. gas phase only
- C. liquid phase only
- D. solid phase only
- E. same phase

**Answer: E. same phase. Explanation:** The chemical principle in Chapter 8: Chemical Equilibrium identifies same phase. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option.

**Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**17. A primary alcohol can first be oxidized to an aldehyde and then to a:**

- A. Alkane
- B. Metal
- C. Carboxylic acid
- D. Salt only
- E. Polymer

**Answer: A. Alkane. Explanation:** The chemical principle in Chapter 10: Hydroxy Compounds identifies Alkane.

Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick**

**tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**18. Complete combustion of an organic compound containing carbon and hydrogen produces carbon dioxide and:**

- A. Ammonia
- B. Water
- C. Chlorine
- D. Sulphur dioxide
- E. Nitrogen

**Answer: D. Sulphur dioxide. Explanation:** The chemical principle in Chapter 8: Organic Chemistry identifies Sulphur dioxide. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option.

**Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**19. Removal of water from ethanol produces:**

- A. Ethene
- B. Ethane
- C. Ethanoic acid
- D. Methane
- E. Ethyne

**Answer: C. Ethanoic acid. Explanation:** The chemical principle in Chapter 10: Hydroxy Compounds identifies Ethanoic acid. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick**

**tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**20. Polypropene is made from:**

- A. Propene
- B. Propane
- C. Ethyne
- D. Methanol

E. Ethanoic acid

**Answer: E. Ethanoic acid. Explanation:** The chemical principle in Chapter 12: Polymers identifies Ethanoic acid. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**21. An empirical formula shows the:**

- A. Actual number of every atom in a molecule
- B. Number of moles in a gas
- C. Simplest whole-number ratio of atoms
- D. Charge on an ion
- E. Shape of a crystal

**Answer: C. Simplest whole-number ratio of atoms. Explanation:** The chemical principle in Chapter 3: Stoichiometry identifies Simplest whole-number ratio of atoms. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**22. Bromine water is decolourized by:**

- A. An alkane in the dark
- B. A saturated salt
- C. An alkene
- D. Water
- E. Carbon dioxide

**Answer: B. A saturated salt. Explanation:** The chemical principle in Chapter 9: Hydrocarbons identifies A saturated salt. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**23. In a Daniell cell, zinc acts as the:**

- A. anode
- B. salt bridge
- C. oxidizing agent only
- D. indicator
- E. cathode

**Answer: A. anode. Explanation:** The chemical principle in Chapter 10: Electrochemistry identifies anode. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**24. Magnesium burns in oxygen with an intense:**

- A. green flame
- B. red flame
- C. white flame
- D. yellow flame

E. blue flame

**Answer: C. white flame. Explanation:** The chemical principle in Chapter 1: Periodic Table and Periodic Properties identifies white flame. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

**25. Dehydration of ethanol can be carried out using concentrated sulphuric acid or heated:**

- A. Sodium chloride
- B. Aluminium oxide
- C. Calcium carbonate
- D. Copper metal
- E. Silver nitrate

**Answer: D. Copper metal. Explanation:** The chemical principle in Chapter 10: Hydroxy Compounds identifies Copper metal. Compare particle behaviour, bonding, reaction conditions or the defining property before selecting the option. **Quick tactic:** Identify whether the question tests particles, bonding, equilibrium, calculation or reaction conditions before comparing choices.

# COMPUTER SCIENCE

## Topics and contents

The Computer Science section develops systems thinking, digital logic, networking, programming, data handling, databases, software development, emerging technologies and responsible computing.

This section covers Introduction to Systems; Number Systems; Digital Systems and Logic Design; System Troubleshooting; Software System; Introduction to Computer Networks; Computational Thinking; Web Development with HTML, CSS and JavaScript; Data Science and Data Gathering; Emerging Technologies in Computer Science; Ethical, Social, and Legal Concerns in Computer Usage.

It also develops understanding of Entrepreneurship in Digital Age; Introduction to Programming; User Interaction; Conditional Logic; Data and Repetition; Functions; Introduction to Software Development; Python Programming; Algorithms and Problem Solving; Computational Structures; Data Analytics.

It also develops understanding of Emerging Technologies; Legal and Ethical Aspects of Computing System; Online Research and Digital Literacy; Data Basics; Basic Concepts and Terminology of Databases; Database Design Process; Data Integrity and Normalization; Introduction to Microsoft Access; Table and Query; Microsoft Access - Forms and Reports; Getting Started with C.

It also develops understanding of Elements of C; Input / Output; Decision Constructs; Loop Constructs; Functions in C; File Handling in C.

## 1. Introduction to Systems

A computer system combines hardware, software, data, people and procedures to achieve an objective.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Systems have input, process, output, storage and feedback. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- System software manages resources; application software serves user tasks. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Troubleshooting follows identify, hypothesize, test, repair and verify. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Backups provide recoverable copies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** After a repair, a technician tests normal and related operations. What step?

**STEP-BY-STEP REASONING:** Verification of full system functionality. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Follow the troubleshooting sequence instead of jumping to replacement.

**COMMON ERROR TO AVOID:** A symptom is not always the root cause.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 2. Number Systems

Computers represent data using positional number systems, especially binary, octal and hexadecimal.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Value = sum digit  $\times$  base<sup>position</sup>. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- Binary groups of 3 map to octal; groups of 4 map to hexadecimal. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Repeated division converts decimal integers to another base. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Two complement represents signed integers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Convert decimal 75 to octal.

**STEP-BY-STEP REASONING:** 75/8 gives remainders 3,1,1 read upward: 113<sub>8</sub>. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Verify by expanding the result back to decimal.

**COMMON ERROR TO AVOID:** Do not read remainders in the order they are produced.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 3. Digital Systems and Logic Design

Digital logic uses Boolean values and gates to build decision circuits.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

#### Core ideas in plain language

- AND is 1 only when all required inputs are 1. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- OR is 1 when at least one input is 1. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- NOT reverses; NAND and NOR are universal gates. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Truth tables list every input combination. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Find NAND output for inputs 1 and 1.

**STEP-BY-STEP REASONING:** AND gives 1, then NOT gives 0. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Evaluate inner gate first and negate last.

**COMMON ERROR TO AVOID:** NAND is not the same as OR.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 4. System Troubleshooting

A computer system combines hardware, software, data, people and procedures to achieve an objective.

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**STEP-BY-STEP REASONING:** Verification of full system functionality. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Follow the troubleshooting sequence instead of jumping to replacement.

**COMMON ERROR TO AVOID:** A symptom is not always the root cause.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 5. Software System

A computer system combines hardware, software, data, people and procedures to achieve an objective.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Systems have input, process, output, storage and feedback. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
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**COMMON ERROR TO AVOID:** A symptom is not always the root cause.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 6. Introduction to Computer Networks

Networks connect devices to share data and resources under agreed protocols.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- LAN covers a limited area; WAN spans larger areas. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Switches connect devices within a LAN; routers forward between networks. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Protocols define message format, addressing and timing. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Topology describes physical/logical arrangement. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Why are protocols necessary?

**STEP-BY-STEP REASONING:** They provide common rules so different devices can exchange data correctly. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the layer or device role asked.

**COMMON ERROR TO AVOID:** The internet and the World Wide Web are related but not identical.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 7. Computational Thinking

Computational thinking uses decomposition, pattern recognition, abstraction and algorithm design.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- An algorithm must be finite, clear and effective. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Pseudocode and flowcharts communicate logic independently of language syntax. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Testing includes normal, boundary and invalid cases. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Efficiency compares time and memory use. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why define a clear objective before solution design?

**STEP-BY-STEP REASONING:** It states what successful output must achieve and prevents irrelevant work. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Write inputs, outputs and constraints before steps.

**COMMON ERROR TO AVOID:** A program that runs is not necessarily correct for all cases.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 8. Web Development with HTML, CSS and JavaScript

Web pages combine HTML structure, CSS presentation and JavaScript behaviour.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- HTML elements form a document tree. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- CSS selectors apply style rules. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- JavaScript responds to events and manipulates page content. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Accessibility uses semantic markup, labels and meaningful alternatives. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which HTML tag creates a table row?



**STEP-BY-STEP REASONING:** <tr>. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Separate structure, style and behaviour when reading code.

**COMMON ERROR TO AVOID:** A visual effect does not replace semantic HTML.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 9. Data Science and Data Gathering

Data work moves from a question to collection, cleaning, analysis, visualization and interpretation.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Data may be structured or unstructured, qualitative or quantitative. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Cleaning handles missing, inconsistent and duplicate values. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Correlation describes association, not causation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Visualizations must match variable types and scales. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why clean data before analysis?

**STEP-BY-STEP REASONING:** Errors and inconsistencies can distort summaries and models. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Ask what each row and column represents before calculating.

**COMMON ERROR TO AVOID:** A large dataset is not automatically a representative dataset.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 10. Emerging Technologies in Computer Science

Emerging technologies include AI, cloud, IoT, robotics and distributed systems; entrepreneurship turns a problem and solution into sustainable value.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Evaluate usefulness, feasibility, risk, privacy and cost. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Cloud models share configurable resources. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A prototype tests assumptions early. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A value proposition identifies user problem and benefit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Using AWS, Azure and Google Cloud together illustrates what?

**STEP-BY-STEP REASONING:** A multi-cloud strategy. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the defining feature, not the brand name.

**COMMON ERROR TO AVOID:** New technology is not automatically the best solution.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 11. Ethical, Social, and Legal Concerns in Computer Usage

Responsible computing protects privacy, security, intellectual property and trustworthy information.

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### Core ideas in plain language

- Terms of Use define permitted service use. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Phishing uses deceptive messages to steal information. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Evaluate source authority, evidence, date and bias. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Copyright and licenses govern reuse. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A suspicious link requests account verification. Safest action?

**STEP-BY-STEP REASONING:** Verify through the organization's official channel without using the supplied link. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Pause, verify independently, then act.

**COMMON ERROR TO AVOID:** A professional-looking message may still be fraudulent.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 12. Entrepreneurship in Digital Age

Emerging technologies include AI, cloud, IoT, robotics and distributed systems; entrepreneurship turns a problem and solution into sustainable value.

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### Core ideas in plain language

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- A value proposition identifies user problem and benefit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Using AWS, Azure and Google Cloud together illustrates what?

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**COMMON ERROR TO AVOID:** New technology is not automatically the best solution.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 13. Introduction to Programming

Programming translates algorithms into precise instructions using variables, data types, operators and expressions.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Choose a data type that matches the values. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Variables should be initialized before use. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Syntax rules differ between languages, but sequence and expressions are universal. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Comments explain intent and maintenance decisions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What is the purpose of comments in C?

**STEP-BY-STEP REASONING:** To document and explain code for readers; comments are not executed. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Trace expressions using operator precedence and current variable values.

**COMMON ERROR TO AVOID:** Assignment = and equality comparison == have different meanings in C-like languages.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 14. User Interaction

Input/output connects a program with users, files or devices.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Validate input type and range. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Formatted I/O uses matching format specifiers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Prompts should state expected units or form. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Output should be clear and testable. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which C call reads two integers and one float?

**STEP-BY-STEP REASONING:** `scanf("%d%d%f", &a, &b, &c);` After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Match each conversion code and include addresses for scanf variables.

**COMMON ERROR TO AVOID:** Using the wrong format specifier can cause incorrect behaviour.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 15. Conditional Logic

Selection chooses among paths according to Boolean conditions.

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### Core ideas in plain language

- if handles one condition; if-else two alternatives; else-if multiple ordered cases. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Nested decisions solve hierarchical choices. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Compound conditions use AND, OR and NOT. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What controls which statements execute in a selection?

**STEP-BY-STEP REASONING:** The truth value of conditions. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Test boundary values and overlapping conditions.

**COMMON ERROR TO AVOID:** Ordering matters in an else-if chain.

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## 16. Data and Repetition

Repetition executes a block while a condition or count requires it.

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### Core ideas in plain language

- for suits known counts; while checks before; do-while checks after. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A loop needs initialization, condition and update. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Arrays store indexed collections. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Off-by-one errors arise at boundaries. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** When does a while loop continue?

**STEP-BY-STEP REASONING:** While its condition remains true. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Trace iteration number, condition and changed variables in a table.

**COMMON ERROR TO AVOID:** A missing update can create an infinite loop.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 17. Functions

Functions divide programs into reusable, testable modules.

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### Core ideas in plain language

- A function has a name, parameters, return type/value and body. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Arguments supply actual values. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Local variables have limited scope. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Good functions perform one clear task. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why use a function for repeated calculation?

**STEP-BY-STEP REASONING:** It avoids duplication and allows one tested implementation to be reused. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Write the contract: inputs, output and side effects.

**COMMON ERROR TO AVOID:** A declared return type must match returned values.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 18. Introduction to Software Development

Software development follows a life cycle from requirements through design, implementation, testing, deployment and maintenance.

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### Core ideas in plain language

- Requirements state what is needed. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Design creates architecture and models. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Testing compares actual with expected behaviour. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Maintenance corrects, adapts and improves after release. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which SDLC phase creates architecture and implementation plans?

**STEP-BY-STEP REASONING:** Design. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Match the activity to the life-cycle deliverable.

**COMMON ERROR TO AVOID:** Testing is not a single final event; it occurs at several levels.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 19. Python Programming

Programming translates algorithms into precise instructions using variables, data types, operators and expressions.

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### Core ideas in plain language

- Choose a data type that matches the values. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Variables should be initialized before use. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
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**WORKED EXAMPLE:** What is the purpose of comments in C?

**STEP-BY-STEP REASONING:** To document and explain code for readers; comments are not executed. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Trace expressions using operator precedence and current variable values.

**COMMON ERROR TO AVOID:** Assignment = and equality comparison == have different meanings in C-like languages.

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## 20. Algorithms and Problem Solving

Computational thinking uses decomposition, pattern recognition, abstraction and algorithm design.

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### Core ideas in plain language

- An algorithm must be finite, clear and effective. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Pseudocode and flowcharts communicate logic independently of language syntax. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Testing includes normal, boundary and invalid cases. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Efficiency compares time and memory use. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why define a clear objective before solution design?

**STEP-BY-STEP REASONING:** It states what successful output must achieve and prevents irrelevant work. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Write inputs, outputs and constraints before steps.

**COMMON ERROR TO AVOID:** A program that runs is not necessarily correct for all cases.

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## 21. Computational Structures

Computational structures organize data and operations.

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### Core ideas in plain language

- Stack is LIFO; queue is FIFO. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Arrays provide indexed access. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Linked structures connect nodes through references. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Choice depends on access and update requirements. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What operation removes the front item of a queue?

**STEP-BY-STEP REASONING:** Dequeue. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Write LIFO/FIFO beside the structure before answering.

**COMMON ERROR TO AVOID:** Push/pop belong to stacks; enqueue/dequeue to queues.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 22. Data Analytics

Data work moves from a question to collection, cleaning, analysis, visualization and interpretation.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

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- Data may be structured or unstructured, qualitative or quantitative. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
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**COMMON ERROR TO AVOID:** A large dataset is not automatically a representative dataset.

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## 23. Emerging Technologies

Emerging technologies include AI, cloud, IoT, robotics and distributed systems; entrepreneurship turns a problem and solution into sustainable value.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Evaluate usefulness, feasibility, risk, privacy and cost. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Cloud models share configurable resources. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A prototype tests assumptions early. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A value proposition identifies user problem and benefit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Using AWS, Azure and Google Cloud together illustrates what?

**STEP-BY-STEP REASONING:** A multi-cloud strategy. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the defining feature, not the brand name.

**COMMON ERROR TO AVOID:** New technology is not automatically the best solution.

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## 24. Legal and Ethical Aspects of Computing System

Responsible computing protects privacy, security, intellectual property and trustworthy information.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Terms of Use define permitted service use. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Phishing uses deceptive messages to steal information. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Evaluate source authority, evidence, date and bias. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Copyright and licenses govern reuse. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A suspicious link requests account verification. Safest action?

**STEP-BY-STEP REASONING:** Verify through the organization's official channel without using the supplied link. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Pause, verify independently, then act.

**COMMON ERROR TO AVOID:** A professional-looking message may still be fraudulent.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 25. Online Research and Digital Literacy

Responsible computing protects privacy, security, intellectual property and trustworthy information.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.



### Core ideas in plain language

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## 26. Data Basics

Databases store related data with controlled structure, integrity and retrieval.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- A table contains records and fields. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A primary key uniquely identifies a record; foreign keys connect tables. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Normalization reduces redundancy and update anomalies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Queries select or transform data; forms support entry; reports present output. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why must a primary key be unique?

**STEP-BY-STEP REASONING:** It provides an unambiguous identity for each record and supports relationships. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify entities, attributes and keys before designing tables.

**COMMON ERROR TO AVOID:** Storing the same fact in many places creates inconsistency risk.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 27. Basic Concepts and Terminology of Databases

Databases store related data with controlled structure, integrity and retrieval.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- A table contains records and fields. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
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- Queries select or transform data; forms support entry; reports present output. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why must a primary key be unique?

**STEP-BY-STEP REASONING:** It provides an unambiguous identity for each record and supports relationships. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify entities, attributes and keys before designing tables.

**COMMON ERROR TO AVOID:** Storing the same fact in many places creates inconsistency risk.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 28. Database Design Process

Databases store related data with controlled structure, integrity and retrieval.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- A table contains records and fields. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A primary key uniquely identifies a record; foreign keys connect tables. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Normalization reduces redundancy and update anomalies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Queries select or transform data; forms support entry; reports present output. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why must a primary key be unique?

**STEP-BY-STEP REASONING:** It provides an unambiguous identity for each record and supports relationships. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify entities, attributes and keys before designing tables.

**COMMON ERROR TO AVOID:** Storing the same fact in many places creates inconsistency risk.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 29. Data Integrity and Normalization

Databases store related data with controlled structure, integrity and retrieval.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- A table contains records and fields. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A primary key uniquely identifies a record; foreign keys connect tables. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Normalization reduces redundancy and update anomalies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Queries select or transform data; forms support entry; reports present output. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why must a primary key be unique?

**STEP-BY-STEP REASONING:** It provides an unambiguous identity for each record and supports relationships. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify entities, attributes and keys before designing tables.

**COMMON ERROR TO AVOID:** Storing the same fact in many places creates inconsistency risk.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 30. Introduction to Microsoft Access

Databases store related data with controlled structure, integrity and retrieval.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- A table contains records and fields. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A primary key uniquely identifies a record; foreign keys connect tables. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Normalization reduces redundancy and update anomalies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
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**STEP-BY-STEP REASONING:** It provides an unambiguous identity for each record and supports relationships. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify entities, attributes and keys before designing tables.

**COMMON ERROR TO AVOID:** Storing the same fact in many places creates inconsistency risk.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 31. Table and Query

Databases store related data with controlled structure, integrity and retrieval.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- A table contains records and fields. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A primary key uniquely identifies a record; foreign keys connect tables. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Normalization reduces redundancy and update anomalies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Queries select or transform data; forms support entry; reports present output. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why must a primary key be unique?

**STEP-BY-STEP REASONING:** It provides an unambiguous identity for each record and supports relationships. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify entities, attributes and keys before designing tables.

**COMMON ERROR TO AVOID:** Storing the same fact in many places creates inconsistency risk.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 32. Microsoft Access - Forms and Reports

Databases store related data with controlled structure, integrity and retrieval.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- A table contains records and fields. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A primary key uniquely identifies a record; foreign keys connect tables. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Normalization reduces redundancy and update anomalies. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
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**COMMON ERROR TO AVOID:** Storing the same fact in many places creates inconsistency risk.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 33. Getting Started with C

Programming translates algorithms into precise instructions using variables, data types, operators and expressions.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Choose a data type that matches the values. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Variables should be initialized before use. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Syntax rules differ between languages, but sequence and expressions are universal. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Comments explain intent and maintenance decisions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What is the purpose of comments in C?

**STEP-BY-STEP REASONING:** To document and explain code for readers; comments are not executed. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Trace expressions using operator precedence and current variable values.

**COMMON ERROR TO AVOID:** Assignment = and equality comparison == have different meanings in C-like languages.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 34. Elements of C

Programming translates algorithms into precise instructions using variables, data types, operators and expressions.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Choose a data type that matches the values. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.
- Variables should be initialized before use. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Syntax rules differ between languages, but sequence and expressions are universal. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Comments explain intent and maintenance decisions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What is the purpose of comments in C?

**STEP-BY-STEP REASONING:** To document and explain code for readers; comments are not executed. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Trace expressions using operator precedence and current variable values.

**COMMON ERROR TO AVOID:** Assignment = and equality comparison == have different meanings in C-like languages.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 35. Input / Output

Input/output connects a program with users, files or devices.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Validate input type and range. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Formatted I/O uses matching format specifiers. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Prompts should state expected units or form. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Output should be clear and testable. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which C call reads two integers and one float?

**STEP-BY-STEP REASONING:** `scanf("%d%d%f", &a, &b, &c);` After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Match each conversion code and include addresses for scanf variables.

**COMMON ERROR TO AVOID:** Using the wrong format specifier can cause incorrect behaviour.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 36. Decision Constructs

Selection chooses among paths according to Boolean conditions.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- if handles one condition; if-else two alternatives; else-if multiple ordered cases. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Nested decisions solve hierarchical choices. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Compound conditions use AND, OR and NOT. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What controls which statements execute in a selection?

**STEP-BY-STEP REASONING:** The truth value of conditions. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Test boundary values and overlapping conditions.

**COMMON ERROR TO AVOID:** Ordering matters in an else-if chain.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 37. Loop Constructs

Repetition executes a block while a condition or count requires it.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- for suits known counts; while checks before; do-while checks after. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A loop needs initialization, condition and update. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.



- Arrays store indexed collections. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Off-by-one errors arise at boundaries. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** When does a while loop continue?

**STEP-BY-STEP REASONING:** While its condition remains true. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Trace iteration number, condition and changed variables in a table.

**COMMON ERROR TO AVOID:** A missing update can create an infinite loop.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 38. Functions in C

Functions divide programs into reusable, testable modules.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- A function has a name, parameters, return type/value and body. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Arguments supply actual values. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Local variables have limited scope. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Good functions perform one clear task. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why use a function for repeated calculation?

**STEP-BY-STEP REASONING:** It avoids duplication and allows one tested implementation to be reused. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Write the contract: inputs, output and side effects.

**COMMON ERROR TO AVOID:** A declared return type must match returned values.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 39. File Handling in C

File handling provides persistent storage beyond program execution.

The central aim is to understand how the main ideas are connected. First identify the system, data structure, programming construct, database object, or ethical principle being tested. Trace inputs, states and outputs in order. For code, execute one statement at a time and record variable values; for conceptual questions, distinguish purpose from implementation.

### Core ideas in plain language

- Open with an appropriate mode, check success, read/write, then close. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Text and binary files have different representations. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Sequential and random access suit different tasks. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Errors must be handled. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why close a file after use?

**STEP-BY-STEP REASONING:** To flush buffered data and release the resource safely. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Track file pointer position and mode.

**COMMON ERROR TO AVOID:** Writing in an overwrite mode can destroy existing content.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*



## COMPUTER SCIENCE - PRACTICE EXERCISES

Three independent sets are provided. Attempt each question before reading the answer, explanation and quick tactic immediately below it. Each set contains 25 MCQs with five options (A–E).

### Practice Set 1 - 25 MCQs

#### 1. Which set lists the primary ERD components identified in the chapter?

- A. Files, folders, programs, printers, users
- B. Inputs, outputs, loops, functions, arrays
- C. Objects, attributes, relationships, cardinality, modality
- D. Tables, forms, reports, macros, modules
- E. Bits, bytes, words, records, disks

**Answer: D. Tables, forms, reports, macros, modules.** **Explanation:** The exact role, definition or operation described in Chapter 3: Database Design Process is Tables, forms, reports, macros, modules. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

#### 2. Which OSI layer provides end-to-end delivery and reliability services?

- A. Physical layer
- B. Data Link layer
- C. Application layer
- D. Transport layer
- E. Presentation layer

**Answer: D. Transport layer.** **Explanation:** The exact role, definition or operation described in Unit 6: Introduction to Computer Networks is Transport layer. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

#### 3. A request to retrieve selected information from a database is a:

- A. Macro
- B. Query
- C. Table
- D. Form
- E. Module

**Answer: E. Module.** **Explanation:** The exact role, definition or operation described in Chapter 5: Introduction to Microsoft Access is Module. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

#### 4. The value true is an example of which JavaScript data type?

- A. String
- B. Number
- C. Boolean
- D. Function name

E. Array

**Answer: C. Boolean. Explanation:** The exact role, definition or operation described in Unit 8: Web Development with HTML, CSS and JavaScript is Boolean. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**5. Coordinates  $x > 0$  and  $y > 0$  place a point in the:**

- A. Second quadrant
- B. Third quadrant
- C. On the origin
- D. Fourth quadrant
- E. First quadrant

**Answer: A. Second quadrant. Explanation:** The exact role, definition or operation described in Chapter 11: Decision Constructs is Second quadrant. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**6. A loop whose condition never becomes false is an:**

- A. Function call
- B. Empty loop
- C. Nested loop
- D. Infinite loop
- E. Selection block

**Answer: B. Empty loop. Explanation:** The exact role, definition or operation described in Chapter 12: Loop Constructs is Empty loop. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**7. Why can blackbox models create concern in high-stakes decisions?**

- A. They contain no mathematical operations
- B. Users may not understand how the result was reached
- C. They cannot process any data
- D. They always require paper records
- E. They cannot produce predictions

**Answer: B. Users may not understand how the result was reached. Explanation:** The exact role, definition or operation described in Unit 10: Emerging Technologies in Computer Science is Users may not understand how the result was reached. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**8. Dividing a program into clearly named functions mainly improves its:**

- A. Memory address
- B. Readability
- C. Character size
- D. Operator count
- E. Format specifier

**Answer: B. Readability. Explanation:** The exact role, definition or operation described in Chapter 5: Functions is Readability. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**9. To record a choice such as True/False, which data type should be used?**

- A. AutoNumber
- B. Date/Time
- C. Memo
- D. Yes/No
- E. Currency

**Answer: A. AutoNumber. Explanation:** The exact role, definition or operation described in Chapter 6: Table and Query is AutoNumber. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**10. Opening a file performs which action on its stream?**

- A. Compile operation
- B. Return operation
- C. Sort operation
- D. Close operation
- E. Open operation

**Answer: A. Compile operation. Explanation:** The exact role, definition or operation described in Chapter 14: File Handling in C is Compile operation. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**11. What does fopen() return when it fails to open a file?**

- A. NULL pointer
- B. Zero character
- C. Newline character
- D. The file name
- E. A valid FILE pointer

**Answer: A. NULL pointer. Explanation:** The exact role, definition or operation described in Chapter 14: File Handling in C is NULL pointer. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**12. Why must a proper relation avoid duplicate rows?**

- A. Views cannot display repeated data
- B. Each occurrence must be uniquely identifiable
- C. Every column must have two values
- D. Indexes require duplicate records
- E. Rows must be stored alphabetically

**Answer: B. Each occurrence must be uniquely identifiable. Explanation:** The exact role, definition or operation described in Chapter 2: Basic Concepts and Terminology of Databases is Each occurrence must be uniquely identifiable.

Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**13. In a traditional file system, every file and its fields should have names that are:**

- A. Unique and meaningful
- B. Identical and fixed
- C. Hidden and coded
- D. Short and numeric
- E. Temporary and random

**Answer: E. Temporary and random. Explanation:** The exact role, definition or operation described in Chapter 2: Basic Concepts and Terminology of Databases is Temporary and random. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**14. In a flowchart, arrows are used to show:**

- A. The direction of control or sequence
- B. The colour of each symbol
- C. The value of every variable
- D. The name of the programmer
- E. The amount of memory used

**Answer: A. The direction of control or sequence. Explanation:** The exact role, definition or operation described in Unit 7: Computational Thinking is The direction of control or sequence. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**15. The type FILE used for file pointers is defined in:**

- A. math.h
- B. string.h
- C. conio.h
- D. stdio.h
- E. ctype.h

**Answer: E. ctype.h. Explanation:** The exact role, definition or operation described in Chapter 14: File Handling in C is ctype.h. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**16. The abbreviation IDE stands for:**

- A. Internal Data Entry
- B. Interactive Design Element
- C. Indexed Database Engine
- D. Integrated Development Environment
- E. Integrated Digital Equipment

**Answer: C. Indexed Database Engine. Explanation:** The exact role, definition or operation described in Chapter 5: Introduction to Microsoft Access is Indexed Database Engine. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**17. Reducing a large set of sales figures to monthly totals is an example of:**

- A. Classifying
- B. Communicating
- C. Capturing
- D. Summarizing
- E. Reproducing

**Answer: E. Reproducing. Explanation:** The exact role, definition or operation described in Chapter 1: Data Basics is Reproducing. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**18. Computing supports global trade by enabling:**

- A. The elimination of customer information
- B. Online communication, transactions, and access to wider markets
- C. A ban on electronic payments
- D. The removal of all international communication
- E. Only face-to-face local sales

**Answer: B. Online communication, transactions, and access to wider markets. Explanation:** The exact role, definition or operation described in Unit 11: Ethical, Social, and Legal Concerns in Computer Usage is Online communication, transactions, and access to wider markets. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**19. Records entered through a form are generally:**

- A. Saved only after printing
- B. Lost when the form closes
- C. Saved automatically
- D. Converted into macros
- E. Stored only in the report

**Answer: A. Saved only after printing. Explanation:** The exact role, definition or operation described in Chapter 7: Microsoft Access - Forms and Reports is Saved only after printing. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**20. Reading and writing an already existing text file requires mode:**

- A. "w"
- B. "w+"
- C. "r+"
- D. "r"

E. "a"

**Answer: B. "w+". Explanation:** The exact role, definition or operation described in Chapter 14: File Handling in C is "w+". Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**21. The output produced and sent back by a function is called its:**

- A. Parameter list
- B. Return value
- C. Function body
- D. Header file
- E. Array index

**Answer: B. Return value. Explanation:** The exact role, definition or operation described in Chapter 5: Functions is Return value. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**22. Assigning values to an array for the first time is called:**

- A. Array initialization
- B. Array compilation
- C. Array termination
- D. Array comparison
- E. Array documentation

**Answer: A. Array initialization. Explanation:** The exact role, definition or operation described in Chapter 4: Data and Repetition is Array initialization. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**23. Data analysis in an IoT system is used to:**

- A. Remove all sensor readings
- B. Disconnect every device
- C. Extract insights and support decisions from sensor data
- D. Convert actuators into sensors
- E. Prevent any automated response

**Answer: C. Extract insights and support decisions from sensor data. Explanation:** The exact role, definition or operation described in Unit 10: Emerging Technologies in Computer Science is Extract insights and support decisions from sensor data. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**24. Table relationships operate within a query through links called:**

- A. Modules
- B. Captions
- C. Masks
- D. Macros
- E. Joins

**Answer: B. Captions. Explanation:** The exact role, definition or operation described in Chapter 6: Table and Query is Captions. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**25. A user must add and update customer records without opening the table directly. Which object is most suitable?**

- A. Form
- B. Module
- C. Macro
- D. Report
- E. Data page

**Answer: C. Macro. Explanation:** The exact role, definition or operation described in Chapter 5: Introduction to Microsoft Access is Macro. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

## Practice Set 2 - 25 MCQs

### 1. The complement of Boolean variable A is commonly written as:

- A.  $A + 0$
- B.  $A \cdot 1$
- C.  $A'$
- D.  $A \cdot A$
- E.  $A + A$

**Answer: C.  $A'$ .** **Explanation:** The exact role, definition or operation described in Unit 3: Digital Systems and Logic Design is  $A'$ . Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

### 2. Before sharing a cloud document, the owner should check:

- A. The access permissions granted to other users
- B. The colour of the file icon
- C. The keyboard layout
- D. The monitor brightness
- E. The computer's decimal conversion

**Answer: A. The access permissions granted to other users.** **Explanation:** The exact role, definition or operation described in Unit 11: Ethical, Social, and Legal Concerns in Computer Usage is The access permissions granted to other users. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

### 3. The default control structure in C executes statements:

- A. Only when a condition is false
- B. From the last statement to the first
- C. In the sequence in which they are written
- D. In random order selected by the compiler
- E. Only inside nested loops

**Answer: C. In the sequence in which they are written.** **Explanation:** The exact role, definition or operation described in Chapter 3: Conditional Logic is In the sequence in which they are written. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

### 4. Copyright protects:

- A. Original creative works such as books, music, software, and films
- B. Every general idea without expression
- C. Only new mechanical inventions
- D. Public facts that have no creator
- E. Only company names and logos

**Answer: A. Original creative works such as books, music, software, and films.** **Explanation:** The exact role, definition or operation described in Unit 11: Ethical, Social, and Legal Concerns in Computer Usage is Original creative



works such as books, music, software, and films. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**5. Which database model has an inverted-tree structure with a root at the top?**

- A. Network model
- B. Relational model
- C. Sequential model
- D. Object model
- E. Hierarchical model

**Answer: C. Sequential model. Explanation:** The exact role, definition or operation described in Chapter 1: Data Basics is Sequential model. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**6. A function prime(n) is designed to return 1 for a prime number. What should it return for a non-prime number?**

- A. 0
- B. -1
- C. 2
- D. n
- E. 10

**Answer: A. 0. Explanation:** The exact role, definition or operation described in Chapter 5: Functions is 0. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**7. Dividing binary 1100 by binary 10 gives:**

- A. 101
- B. 110
- C. 1000
- D. 1001
- E. 111

**Answer: B. 110. Explanation:** The exact role, definition or operation described in Unit 2: Number Systems is 110. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**8. A variable name may contain letters, digits, and the:**

- A. Hash character
- B. Underscore character
- C. Percent character
- D. Hyphen character
- E. Space character

**Answer: D. Hyphen character. Explanation:** The exact role, definition or operation described in Chapter 9: Elements of C is Hyphen character. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**9. Changing one fact requires updating several rows. This situation is a:**

- A. Modification anomaly
- B. Cardinality problem
- C. Deletion anomaly
- D. Insertion anomaly
- E. Entity constraint

**Answer: A. Modification anomaly. Explanation:** The exact role, definition or operation described in Chapter 4: Data Integrity and Normalization is Modification anomaly. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**10. Which set gives the three main parts of a function header?**

- A. Input, output, and loop count
- B. File name, mode, and pointer
- C. Case, break, and default
- D. Type, record, and field
- E. Return type, function name, parameter list

**Answer: C. Case, break, and default. Explanation:** The exact role, definition or operation described in Chapter 13: Functions in C is Case, break, and default. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**11. Words with predefined meanings that cannot be redefined are called:**

- A. Expressions
- B. Variables
- C. Constants
- D. Keywords
- E. Comments

**Answer: B. Variables. Explanation:** The exact role, definition or operation described in Chapter 9: Elements of C is Variables. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**12. Field names or descriptive text on a form are normally displayed by a:**

- A. Subform
- B. Record selector
- C. Label
- D. Text box
- E. Combo box

**Answer: D. Text box. Explanation:** The exact role, definition or operation described in Chapter 7: Microsoft Access - Forms and Reports is Text box. Computing questions are best solved by matching the term with its precise function.

**Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**13. What is another name for a group of statements enclosed in braces?**

- A. Compound statement
- B. Reserved statement
- C. Machine statement
- D. Header statement
- E. Escape statement

**Answer: A. Compound statement. Explanation:** The exact role, definition or operation described in Chapter 3: Conditional Logic is Compound statement. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**14. Given  $x = 10$  and  $y = 15$ , the condition  $x \neq y$  evaluates to:**

- A. False (zero)
- B. The value -5
- C. True (non-zero)
- D. The value 25
- E. A syntax error

**Answer: D. The value 25. Explanation:** The exact role, definition or operation described in Chapter 11: Decision Constructs is The value 25. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**15. Which for header counts downward from 5 to 1?**

- A. `for(i = 5; i <= 1; i++)`
- B. `for(i = 1; i <= 5; i--)`
- C. `for(i = 0; i < 5; i++)`
- D. `for(i = 5; i >= 1; i--)`
- E. `for(i = 5; i >= 1; i++)`

**Answer: E. `for(i = 5; i >= 1; i++)`. Explanation:** The exact role, definition or operation described in Chapter 12: Loop Constructs is `for(i = 5; i >= 1; i++)`. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**16. Which component carries data between IoT devices and internet services?**

- A. File archive
- B. Flowchart symbol
- C. Arithmetic Logic Unit
- D. Network connection
- E. Word processor

**Answer: D. Network connection. Explanation:** The exact role, definition or operation described in Unit 10: Emerging Technologies in Computer Science is Network connection. Computing questions are best solved by matching the term

with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**17. Which is an environmental concern linked to computing?**

- A. Electronic waste and energy consumption
- B. Faster communication between countries
- C. Improved access to education
- D. Growth of online business
- E. Creation of digital art

**Answer: A. Electronic waste and energy consumption. Explanation:** The exact role, definition or operation described in Unit 11: Ethical, Social, and Legal Concerns in Computer Usage is Electronic waste and energy consumption. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**18. Which SQL command adds a new row to an existing table?**

- A. SELECT
- B. ALTER
- C. DROP
- D. INSERT
- E. CREATE

**Answer: C. DROP. Explanation:** The exact role, definition or operation described in Chapter 2: Basic Concepts and Terminology of Databases is DROP. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**19. The scanf() function is primarily used for:**

- A. Printing reports
- B. Linking object code
- C. Compiling source code
- D. Formatted input
- E. Formatted output

**Answer: C. Compiling source code. Explanation:** The exact role, definition or operation described in Chapter 10: Input / Output is Compiling source code. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**20. The double right-arrow button in the Form Wizard moves:**

- A. One selected field
- B. All available fields
- C. One control
- D. The current record
- E. The form title

**Answer: E. The form title.** **Explanation:** The exact role, definition or operation described in Chapter 7: Microsoft Access - Forms and Reports is The form title. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**21. For a small table of marks and simple calculations, the most suitable storage tool is a:**

- A. Web browser cache
- B. Router
- C. Presentation file
- D. Data warehouse
- E. Spreadsheet

**Answer: E. Spreadsheet.** **Explanation:** The exact role, definition or operation described in Unit 9: Data Science and Data Gathering is Spreadsheet. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**22. Software is best described as:**

- A. A set of programs and instructions used by a computer
- B. A collection of printed documents
- C. A permanent electrical circuit on a motherboard
- D. The physical parts inside a computer case
- E. A cable that connects network devices

**Answer: A. A set of programs and instructions used by a computer.** **Explanation:** The exact role, definition or operation described in Unit 5: Software System is A set of programs and instructions used by a computer. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**23. Which Unicode format uses a variable length of one to four bytes?**

- A. BCD
- B. UTF-16
- C. UTF-8
- D. UTF-32
- E. ASCII-7

**Answer: C. UTF-8.** **Explanation:** The exact role, definition or operation described in Unit 2: Number Systems is UTF-8. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**24. Respectful online interaction requires users to:**

- A. Spread rumours without checking
- B. Treat online actions as consequence-free
- C. Consider how their words may affect other people
- D. Post hurtful comments when they disagree
- E. Share embarrassing images without consent

**Answer: C. Consider how their words may affect other people.** **Explanation:** The exact role, definition or operation described in Unit 11: Ethical, Social, and Legal Concerns in Computer Usage is Consider how their words may affect other people. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**25. Which is an IoT application in healthcare?**

- A. A flowchart showing an algorithm
- B. A word processor formatting a report
- C. A wearable device monitoring a patient's vital signs
- D. A printer producing a paper form
- E. A calculator adding two values

**Answer: C. A wearable device monitoring a patient's vital signs.** **Explanation:** The exact role, definition or operation described in Unit 10: Emerging Technologies in Computer Science is A wearable device monitoring a patient's vital signs. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

## Practice Set 3 - 25 MCQs

### 1. Which tag creates the largest standard HTML heading?

- A. <title>
- B. <h6>
- C. <h1>
- D. <p>
- E. <head>

**Answer: C. <h1>.** **Explanation:** The exact role, definition or operation described in Unit 8: Web Development with HTML, CSS and JavaScript is <h1>. Computing questions are best solved by matching the term with its precise function.

**Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

### 2. Which input combination makes a two-input NOR gate produce 1?

- A. A = 0, B = 1
- B. A = 0, B = 0
- C. A = 1, B = 1
- D. Every input combination
- E. A = 1, B = 0

**Answer: B. A = 0, B = 0.** **Explanation:** The exact role, definition or operation described in Unit 3: Digital Systems and Logic Design is A = 0, B = 0. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

### 3. A number with a fractional part is commonly stored using:

- A. float
- B. unsigned
- C. int
- D. char
- E. void

**Answer: C. int.** **Explanation:** The exact role, definition or operation described in Chapter 9: Elements of C is int. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

### 4. Why are int and Int treated differently in C?

- A. C ignores keywords
- B. C uses only uppercase letters
- C. C automatically corrects spelling
- D. C is case-sensitive
- E. C stores both as character constants

**Answer: D. C is case-sensitive.** **Explanation:** The exact role, definition or operation described in Chapter 1: Introduction to Programming is C is case-sensitive. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**5. A graphical user interface helps users interact with a computer through:**

- A. Network cables and routers
- B. Binary machine instructions only
- C. Compression archives only
- D. Electrical control signals only
- E. Windows, icons, menus, and pointers

**Answer: E. Windows, icons, menus, and pointers. Explanation:** The exact role, definition or operation described in Unit 5: Software System is Windows, icons, menus, and pointers. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**6. A rule that restricts acceptable entries in a field is a:**

- A. Primary caption
- B. Validation Rule
- C. Sort order
- D. Report footer
- E. Record selector

**Answer: D. Report footer. Explanation:** The exact role, definition or operation described in Chapter 6: Table and Query is Report footer. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**7. Requiring two-factor authentication may make login slower but increases protection. This illustrates a trade-off between:**

- A. Data and information
- B. Security and usability
- C. HTML and CSS
- D. Copyright and patents
- E. Hardware and software

**Answer: B. Security and usability. Explanation:** The exact role, definition or operation described in Unit 11: Ethical, Social, and Legal Concerns in Computer Usage is Security and usability. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**8. Character strings are displayed with which format specifier?**

- A. %d
- B. %s
- C. %c
- D. %u
- E. %x

**Answer: C. %c. Explanation:** The exact role, definition or operation described in Chapter 10: Input / Output is %c. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.



**9. Before using data from an online source, a researcher should first check its:**

- A. Screen colour and font
- B. File icon and folder name
- C. Download speed only
- D. Number of advertisements
- E. Credibility and relevance

**Answer: E. Credibility and relevance. Explanation:** The exact role, definition or operation described in Unit 9: Data Science and Data Gathering is Credibility and relevance. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**10. A file must support both sequential and random processing. Which organization is most suitable?**

- A. Transaction file
- B. Master file
- C. Pure sequential
- D. Indexed sequential
- E. Direct only

**Answer: B. Master file. Explanation:** The exact role, definition or operation described in Chapter 1: Data Basics is Master file. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**11. Which algorithm is given as an example of a whitebox approach?**

- A. Decision tree
- B. Deep learning model
- C. Convolutional neural network
- D. Deep neural network
- E. Recurrent neural network

**Answer: A. Decision tree. Explanation:** The exact role, definition or operation described in Unit 10: Emerging Technologies in Computer Science is Decision tree. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**12. Through one return statement, a function directly returns at most:**

- A. Four values
- B. One value
- C. Three values
- D. Unlimited values
- E. Two values

**Answer: C. Three values. Explanation:** The exact role, definition or operation described in Chapter 13: Functions in C is Three values. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**13. What is the main purpose of communication among system components?**

- A. To separate the system from its environment
- B. To make every component operate independently
- C. To coordinate their work in achieving the system objective
- D. To replace all components with one device
- E. To prevent the system from receiving inputs

**Answer: C. To coordinate their work in achieving the system objective.** **Explanation:** The exact role, definition or operation described in Unit 1: Introduction to Systems is To coordinate their work in achieving the system objective. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**14. Which programming language is used for examples in this textbook?**

- A. Java
- B. Python
- C. C#
- D. C
- E. Visual Basic

**Answer: D. C.** **Explanation:** The exact role, definition or operation described in Chapter 1: Introduction to Programming is C. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**15. SQL commands such as SELECT, INSERT, UPDATE, and DELETE are provided through:**

- A. SQL
- B. A device driver
- C. A spreadsheet
- D. A compiler
- E. A report generator

**Answer: C. A spreadsheet.** **Explanation:** The exact role, definition or operation described in Chapter 1: Data Basics is A spreadsheet. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**16. A relationship in which each row in both tables matches at most one row in the other is:**

- A. One-to-many
- B. Unrelated
- C. One-to-one
- D. Recursive-only
- E. Many-to-many

**Answer: C. One-to-one.** **Explanation:** The exact role, definition or operation described in Chapter 6: Table and Query is One-to-one. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**17. Unauthorized access to another person's private data may result in:**

- A. Automatic ownership of the data

- B. Improved system performance
- C. A stronger password for the victim
- D. Permission to distribute the information
- E. Legal and ethical consequences

**Answer: E. Legal and ethical consequences. Explanation:** The exact role, definition or operation described in Unit 11: Ethical, Social, and Legal Concerns in Computer Usage is Legal and ethical consequences. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**18. What happens to function execution when a return statement is executed?**

- A. It restarts from the header
- B. It repeats the body
- C. It declares all variables global
- D. It opens a file
- E. It stops and control returns to the caller

**Answer: E. It stops and control returns to the caller. Explanation:** The exact role, definition or operation described in Chapter 13: Functions in C is It stops and control returns to the caller. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**19. If  $\text{int total} = 12 + 8$ ; is executed, what value is stored in total?**

- A. 4
- B. 20
- C. 96
- D. 1
- E. 128

**Answer: B. 20. Explanation:** The exact role, definition or operation described in Chapter 2: User Interaction is 20. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**20. In C, what does the semicolon at the end of a statement indicate?**

- A. The end of the statement
- B. The beginning of a function
- C. A comment line
- D. A format specifier
- E. A loop condition

**Answer: A. The end of the statement. Explanation:** The exact role, definition or operation described in Chapter 2: User Interaction is The end of the statement. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**21. What is a flowchart?**

- A. A list of network addresses

- B. A visual representation of process steps connected by arrows
- C. A table used only for storing numbers
- D. An executable programming language
- E. A document containing only definitions

**Answer: B. A visual representation of process steps connected by arrows.** **Explanation:** The exact role, definition or operation described in Unit 7: Computational Thinking is A visual representation of process steps connected by arrows. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**22. The two main arguments of fopen() are the file name and the:**

- A. Array index
- B. Return value
- C. Loop count
- D. Field width
- E. Opening mode

**Answer: D. Field width.** **Explanation:** The exact role, definition or operation described in Chapter 14: File Handling in C is Field width. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**23. Which tool can be used to test computer memory for errors?**

- A. Disk Cleanup
- B. Presentation Software
- C. Windows Memory Diagnostic
- D. File Compression Utility
- E. Web Browser

**Answer: C. Windows Memory Diagnostic.** **Explanation:** The exact role, definition or operation described in Unit 4: System Troubleshooting is Windows Memory Diagnostic. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**24. In hexadecimal notation, which symbols represent decimal values ten through fifteen?**

- A. a through f only
- B. P through U
- C. G through L
- D. 0 through 5
- E. A through F

**Answer: E. A through F.** **Explanation:** The exact role, definition or operation described in Unit 2: Number Systems is A through F. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

**25. All statements enclosed within the braces of main() make up the:**

- A. Body of the main function
- B. Header section

C. Reserved-word list

D. Compiler code

E. Character set

**Answer: A. Body of the main function. Explanation:** The exact role, definition or operation described in Chapter 1: Introduction to Programming is Body of the main function. Computing questions are best solved by matching the term with its precise function. **Quick tactic:** Match each option to the exact input-process-output or program behaviour described.

# BIOLOGY

## Topics and contents

The Biology section develops life processes from molecules and cells to organisms, inheritance, evolution and ecosystems. Structure-function relationships and process sequences receive special attention.

This section covers The Science of Biology; Biodiversity; The Cell; Cell Cycle; Tissues, Organs, and Organ Systems; Biomolecules; Enzymes; Bioenergetics; Plant Physiology; Reproduction in Plants; Biostatistics.

It also develops understanding of Human Digestive System; Human Respiratory System; Human Blood Circulatory System; Human Urinary System; Coordination; Reproduction; Inheritance; Biotechnology; Diseases and Immunity; Evolution; Introduction.

It also develops understanding of Biological Molecules; Variety of Life; Kingdom Prokaryotae (Monera); The Kingdom Protista (or Protoctista); Fungi; Kingdom Plantae; Kingdom Animalia; Nutrition; Gaseous Exchange; Transport; Homeostasis.

It also develops understanding of Support and Movements; Coordination and Control; Growth and Development; Chromosomes and DNA; Variation and Genetics; Ecosystem; Some Major Ecosystems; Man and His Environment.

## 1. The Science of Biology

Biology is the scientific study of life. It connects observation, hypothesis, controlled testing, evidence and explanation across levels from molecules to the biosphere.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Distinguish observation, hypothesis, prediction, experiment and conclusion. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Know major branches such as botany, zoology, microbiology, molecular biology, ecology and taxonomy. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Use SI units and distinguish qualitative from quantitative observations. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.

**WORKED EXAMPLE:** A scientist changes light intensity while keeping water and temperature constant. What is the independent variable?

**STEP-BY-STEP REASONING:** Light intensity is deliberately changed, so it is the independent variable. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** In experiment questions, identify changed, measured and controlled variables in that order.

**COMMON ERROR TO AVOID:** A hypothesis is testable; it is not simply a final proven fact.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 2. Biodiversity

Biological diversity is organized through classification. Modern classification uses cellular organization, nutrition, reproduction, evolutionary relationships and molecular evidence.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Species is the basic taxonomic unit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A scientific name has genus followed by species. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Prokaryotes lack a membrane-bound nucleus; fungi absorb nutrients; plants are mainly photosynthetic; animals ingest food. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Viruses are acellular and depend on host cells. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A bacterium has no membrane-bound nucleus. Which broad cell type is it?

**STEP-BY-STEP REASONING:** It is prokaryotic. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use cell type first, then nutrition and cell-wall features to identify a kingdom.

**COMMON ERROR TO AVOID:** Protists are diverse; do not assume every protist is unicellular or photosynthetic.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 3. The Cell

Cells are the structural and functional units of life. Organelles divide cellular work, and specialized cells combine into tissues, organs and systems.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

#### Core ideas in plain language

- Cell membrane regulates exchange; nucleus stores genetic information; ribosomes make protein; mitochondria release ATP. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Plant cells commonly have a cellulose wall, chloroplasts and a large vacuole. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Organization rises from organelle to cell, tissue, organ, organ system and organism. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Put these in increasing order: tissue, organelle, organ, cell.

**STEP-BY-STEP REASONING:** Organelle → cell → tissue → organ. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Match each structure to one defining function before comparing options.

**COMMON ERROR TO AVOID:** A cell wall and cell membrane are not interchangeable.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 4. Cell Cycle

The cell cycle includes interphase and cell division. Interphase comprises G1 growth, S-phase DNA replication and G2 preparation; mitosis preserves chromosome number.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

#### Core ideas in plain language

- Chromosomes duplicate in S phase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Mitosis proceeds through prophase, metaphase, anaphase and telophase. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Cytokinesis divides cytoplasm. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Meiosis produces haploid variation through crossing over and independent assortment. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** A cell checks replicated DNA and prepares spindle proteins. Which phase?

**STEP-BY-STEP REASONING:** G2 phase. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use the sequence G1-S-G2-M and attach one job to each stage.

**COMMON ERROR TO AVOID:** Chromosome number and DNA amount are not the same thing.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 5. Tissues, Organs, and Organ Systems

Cells are the structural and functional units of life. Organelles divide cellular work, and specialized cells combine into tissues, organs and systems.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Cell membrane regulates exchange; nucleus stores genetic information; ribosomes make protein; mitochondria release ATP. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Plant cells commonly have a cellulose wall, chloroplasts and a large vacuole. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Organization rises from organelle to cell, tissue, organ, organ system and organism. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Put these in increasing order: tissue, organelle, organ, cell.

**STEP-BY-STEP REASONING:** Organelle → cell → tissue → organ. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Match each structure to one defining function before comparing options.

**COMMON ERROR TO AVOID:** A cell wall and cell membrane are not interchangeable.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 6. Biomolecules

Living systems are built mainly from water, carbohydrates, lipids, proteins and nucleic acids. Their structures determine their roles.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Monosaccharides build carbohydrates; amino acids build proteins; nucleotides build nucleic acids. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Lipids store concentrated energy and form membranes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Hydrogen bonding gives water cohesion, high heat capacity and solvent power. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why is water polar?



**STEP-BY-STEP REASONING:** Oxygen attracts shared electrons more strongly, creating partial charges. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the monomer and bond type for each macromolecule.

**COMMON ERROR TO AVOID:** Energy value and immediate biological role are different questions.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 7. Enzymes

Enzymes are biological catalysts that lower activation energy without being consumed. Their active sites bind specific substrates.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Temperature and pH affect shape and activity. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- At low substrate concentration, rate rises with concentration; saturation creates a maximum rate. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Inhibitors may compete for the active site or alter enzyme shape. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What happens to an enzyme after a normal catalysed reaction?

**STEP-BY-STEP REASONING:** It is released unchanged and can be reused. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For graph questions, locate optimum, denaturation region and saturation plateau.

**COMMON ERROR TO AVOID:** High temperature may denature an enzyme; low temperature usually slows it reversibly.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 8. Bioenergetics

Bioenergetics explains how cells capture, transfer and use energy. ATP is the immediate energy currency.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Photosynthesis stores light energy in glucose. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Aerobic respiration oxidizes fuel using oxygen and yields much more ATP than anaerobic pathways. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Oxidation loses electrons; reduction gains electrons. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A molecule gains electrons. Is it oxidized or reduced?

**STEP-BY-STEP REASONING:** It is reduced. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use OIL RIG: Oxidation Is Loss, Reduction Is Gain of electrons.

**COMMON ERROR TO AVOID:** Photosynthesis and respiration are linked but not exact reverse pathways in every step.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 9. Plant Physiology

Plant physiology covers transport, gas exchange, mineral nutrition, growth responses and reproduction.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Xylem carries water/minerals mainly upward; phloem translocates sugars between sources and sinks. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Stomata regulate gas exchange and water loss. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Pollination transfers pollen; fertilization fuses gametes; seeds contain embryo and food reserve. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which tissues define vascular plants?

**STEP-BY-STEP REASONING:** Xylem and phloem. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Trace water: soil → root hair → xylem → leaf → atmosphere.

**COMMON ERROR TO AVOID:** Pollination is not fertilization.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 10. Reproduction in Plants

Plant physiology covers transport, gas exchange, mineral nutrition, growth responses and reproduction.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Xylem carries water/minerals mainly upward; phloem translocates sugars between sources and sinks. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Stomata regulate gas exchange and water loss. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Pollination transfers pollen; fertilization fuses gametes; seeds contain embryo and food reserve. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which tissues define vascular plants?

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**QUICK TACTIC:** Trace water: soil → root hair → xylem → leaf → atmosphere.

**COMMON ERROR TO AVOID:** Pollination is not fertilization.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 11. Biostatistics

Biostatistics applies numerical summaries and probability to biological data.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Mean uses all values; median is resistant to extreme values; mode is most frequent. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Range and standard deviation describe spread. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Graphs must match the data type and show units. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** The values are 2, 3, 3, 4, 8. Find the mode and median.

**STEP-BY-STEP REASONING:** Mode=3 and median=3 after ordering. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For a small list, sort it before any location calculation.

**COMMON ERROR TO AVOID:** Do not confuse a high mean with low variability.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 12. Human Digestive System

Nutrition supplies molecules for energy, growth and repair. Digestion converts large insoluble food molecules into small absorbable forms.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Mechanical digestion increases surface area; enzymes perform chemical digestion. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Absorption moves products into blood or lymph; assimilation uses them in cells. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Villi increase intestinal surface area. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What is the use of absorbed nutrients in tissues called?

**STEP-BY-STEP REASONING:** Assimilation. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Separate ingestion, digestion, absorption, assimilation and egestion.

**COMMON ERROR TO AVOID:** Absorption does not mean digestion.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 13. Human Respiratory System

Gas exchange moves oxygen and carbon dioxide across thin moist surfaces; breathing ventilates those surfaces.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Alveoli have large area, thin walls and rich blood supply. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Diffusion follows partial-pressure gradients. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Haemoglobin transports most oxygen. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Define breathing rather than respiration.

**STEP-BY-STEP REASONING:** Breathing is movement of air into and out of the body; respiration is cellular energy release. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Watch whether the question asks ventilation, gas exchange or cellular respiration.

**COMMON ERROR TO AVOID:** The three terms are related but not synonymous.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 14. Human Blood Circulatory System

Transport systems distribute gases, nutrients, hormones and wastes. The mammalian system is closed and double-circulatory.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Arteries carry blood away from the heart; veins return it; capillaries exchange materials. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Red blood cells transport oxygen; platelets support clotting; white cells defend. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Xylem and phloem provide plant transport. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which blood cells carry most oxygen?

**STEP-BY-STEP REASONING:** Red blood cells through haemoglobin. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use direction relative to the heart, not oxygen content, to name an artery or vein.

**COMMON ERROR TO AVOID:** The pulmonary artery carries deoxygenated blood.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 15. Human Urinary System

Homeostasis keeps internal conditions within workable limits. The kidneys regulate water, ions and nitrogenous wastes.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Nephrons filter blood, selectively reabsorb useful substances and secrete some wastes. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

- ADH increases water reabsorption. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Urine passes kidney → ureter → bladder → urethra. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Where is urine stored temporarily?

**STEP-BY-STEP REASONING:** In the urinary bladder. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Trace the pathway and distinguish formation from storage.

**COMMON ERROR TO AVOID:** The ureter and urethra have different directions and roles.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 16. Coordination

Coordination links stimuli to responses through nervous and endocrine systems; support and movement involve skeleton, joints and muscles.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Receptors detect; coordinators process; effectors respond. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Neurons transmit electrical signals; synapses use neurotransmitters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Hormones travel in blood and often act more slowly. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Antagonistic muscles work in pairs. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What are muscles and glands in a response pathway?

**STEP-BY-STEP REASONING:** Effectors. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw stimulus → receptor → coordinator → effector → response.

**COMMON ERROR TO AVOID:** A hormone is a signal, not an effector.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 17. Reproduction

Reproduction creates new individuals, while growth and development depend on regulated cell division, differentiation and gene expression.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Asexual reproduction produces genetically similar offspring; sexual reproduction generates variation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Gametes are haploid and fertilization restores diploidy. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Development proceeds through organized changes, not size increase alone. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** How many chromosomes are in a normal human gamete?

**STEP-BY-STEP REASONING:** 23 chromosomes. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify whether the cell is somatic or gametic before using chromosome numbers.

**COMMON ERROR TO AVOID:** Gametes have 23 chromosomes, not 23 pairs.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 18. Inheritance

Inheritance transfers genetic information through DNA, genes and chromosomes. Alleles produce variation in traits.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Genotype is allele combination; phenotype is observable expression. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Dominant alleles can mask recessive alleles in heterozygotes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Meiosis and fertilization reshuffle alleles. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Mutations create new genetic variation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Cross Aa x Aa. What fraction is aa?

**STEP-BY-STEP REASONING:** Genotypes 1 AA : 2 Aa : 1 aa, so 1/4. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use a Punnett square and label gametes first.

**COMMON ERROR TO AVOID:** A dominant trait is not necessarily common or beneficial.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 19. Biotechnology

Biotechnology uses organisms, cells or biomolecules to make products or solve problems, from fermentation to recombinant DNA.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Traditional biotechnology includes yoghurt and bread. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Genetic engineering inserts or edits DNA. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- PCR amplifies DNA; gel electrophoresis separates fragments. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Benefits must be weighed against biosafety and ethical concerns. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which is an ancient biotechnology product: yoghurt or steel?



**STEP-BY-STEP REASONING:** Yoghurt, produced by microbial fermentation. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the biological agent and desired product.

**COMMON ERROR TO AVOID:** Biotechnology is broader than genetic engineering.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 20. Diseases and Immunity

Disease may be infectious or non-infectious. Immunity recognizes and removes harmful agents while preserving self.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Pathogens include bacteria, viruses, fungi and parasites. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Innate defence is rapid and non-specific; adaptive immunity is specific and forms memory. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Vaccination exposes antigens safely to build memory. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why can a vaccine protect later?

**STEP-BY-STEP REASONING:** It produces memory cells that respond rapidly on re-exposure. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Distinguish pathogen, antigen, antibody and antibiotic.

**COMMON ERROR TO AVOID:** Antibiotics do not treat viral infections directly.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 21. Evolution

Evolution is change in inherited characteristics of populations over generations.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Variation, heritability, differential survival/reproduction and time drive natural selection. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Fossils, anatomy, embryology and molecular data support common descent. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Selection acts on phenotypes; populations evolve. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why can antibiotic resistance spread?

**STEP-BY-STEP REASONING:** Resistant bacteria survive treatment and reproduce more, increasing resistance alleles. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** State variation first, then selection and reproduction.

**COMMON ERROR TO AVOID:** Individuals do not evolve because they need to.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 22. Introduction

Biology is the scientific study of life. It connects observation, hypothesis, controlled testing, evidence and explanation across levels from molecules to the biosphere.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Distinguish observation, hypothesis, prediction, experiment and conclusion. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Know major branches such as botany, zoology, microbiology, molecular biology, ecology and taxonomy. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Use SI units and distinguish qualitative from quantitative observations. This is a working step, not merely a fact; apply it explicitly on rough paper so that the reasoning remains visible and easy to verify.

**WORKED EXAMPLE:** A scientist changes light intensity while keeping water and temperature constant. What is the independent variable?

**STEP-BY-STEP REASONING:** Light intensity is deliberately changed, so it is the independent variable. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** In experiment questions, identify changed, measured and controlled variables in that order.

**COMMON ERROR TO AVOID:** A hypothesis is testable; it is not simply a final proven fact.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 23. Biological Molecules

Living systems are built mainly from water, carbohydrates, lipids, proteins and nucleic acids. Their structures determine their roles.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Monosaccharides build carbohydrates; amino acids build proteins; nucleotides build nucleic acids. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Lipids store concentrated energy and form membranes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Hydrogen bonding gives water cohesion, high heat capacity and solvent power. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why is water polar?

**STEP-BY-STEP REASONING:** Oxygen attracts shared electrons more strongly, creating partial charges. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the monomer and bond type for each macromolecule.

**COMMON ERROR TO AVOID:** Energy value and immediate biological role are different questions.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.



## 24. Variety of Life

Biological diversity is organized through classification. Modern classification uses cellular organization, nutrition, reproduction, evolutionary relationships and molecular evidence.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Species is the basic taxonomic unit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A scientific name has genus followed by species. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Prokaryotes lack a membrane-bound nucleus; fungi absorb nutrients; plants are mainly photosynthetic; animals ingest food. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Viruses are acellular and depend on host cells. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A bacterium has no membrane-bound nucleus. Which broad cell type is it?

**STEP-BY-STEP REASONING:** It is prokaryotic. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use cell type first, then nutrition and cell-wall features to identify a kingdom.

**COMMON ERROR TO AVOID:** Protists are diverse; do not assume every protist is unicellular or photosynthetic.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 25. Kingdom Prokaryotae (Monera)

Biological diversity is organized through classification. Modern classification uses cellular organization, nutrition, reproduction, evolutionary relationships and molecular evidence.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Species is the basic taxonomic unit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A scientific name has genus followed by species. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Prokaryotes lack a membrane-bound nucleus; fungi absorb nutrients; plants are mainly photosynthetic; animals ingest food. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Viruses are acellular and depend on host cells. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A bacterium has no membrane-bound nucleus. Which broad cell type is it?

**STEP-BY-STEP REASONING:** It is prokaryotic. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use cell type first, then nutrition and cell-wall features to identify a kingdom.

**COMMON ERROR TO AVOID:** Protists are diverse; do not assume every protist is unicellular or photosynthetic.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 26. The Kingdom Protista (or Protoctista)

Biological diversity is organized through classification. Modern classification uses cellular organization, nutrition, reproduction, evolutionary relationships and molecular evidence.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Species is the basic taxonomic unit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A scientific name has genus followed by species. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Prokaryotes lack a membrane-bound nucleus; fungi absorb nutrients; plants are mainly photosynthetic; animals ingest food. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Viruses are acellular and depend on host cells. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A bacterium has no membrane-bound nucleus. Which broad cell type is it?

**STEP-BY-STEP REASONING:** It is prokaryotic. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use cell type first, then nutrition and cell-wall features to identify a kingdom.

**COMMON ERROR TO AVOID:** Protists are diverse; do not assume every protist is unicellular or photosynthetic.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 27. Fungi

Biological diversity is organized through classification. Modern classification uses cellular organization, nutrition, reproduction, evolutionary relationships and molecular evidence.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Species is the basic taxonomic unit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A scientific name has genus followed by species. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Prokaryotes lack a membrane-bound nucleus; fungi absorb nutrients; plants are mainly photosynthetic; animals ingest food. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Viruses are acellular and depend on host cells. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A bacterium has no membrane-bound nucleus. Which broad cell type is it?

**STEP-BY-STEP REASONING:** It is prokaryotic. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use cell type first, then nutrition and cell-wall features to identify a kingdom.

**COMMON ERROR TO AVOID:** Protists are diverse; do not assume every protist is unicellular or photosynthetic.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 28. Kingdom Plantae

Biological diversity is organized through classification. Modern classification uses cellular organization, nutrition, reproduction, evolutionary relationships and molecular evidence.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Species is the basic taxonomic unit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A scientific name has genus followed by species. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Prokaryotes lack a membrane-bound nucleus; fungi absorb nutrients; plants are mainly photosynthetic; animals ingest food. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Viruses are acellular and depend on host cells. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A bacterium has no membrane-bound nucleus. Which broad cell type is it?

**STEP-BY-STEP REASONING:** It is prokaryotic. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use cell type first, then nutrition and cell-wall features to identify a kingdom.

**COMMON ERROR TO AVOID:** Protists are diverse; do not assume every protist is unicellular or photosynthetic.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 29. Kingdom Animalia

Biological diversity is organized through classification. Modern classification uses cellular organization, nutrition, reproduction, evolutionary relationships and molecular evidence.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Species is the basic taxonomic unit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A scientific name has genus followed by species. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Prokaryotes lack a membrane-bound nucleus; fungi absorb nutrients; plants are mainly photosynthetic; animals ingest food. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Viruses are acellular and depend on host cells. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A bacterium has no membrane-bound nucleus. Which broad cell type is it?

**STEP-BY-STEP REASONING:** It is prokaryotic. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use cell type first, then nutrition and cell-wall features to identify a kingdom.

**COMMON ERROR TO AVOID:** Protists are diverse; do not assume every protist is unicellular or photosynthetic.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 30. Nutrition

Nutrition supplies molecules for energy, growth and repair. Digestion converts large insoluble food molecules into small absorbable forms.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Mechanical digestion increases surface area; enzymes perform chemical digestion. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Absorption moves products into blood or lymph; assimilation uses them in cells. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Villi increase intestinal surface area. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What is the use of absorbed nutrients in tissues called?

**STEP-BY-STEP REASONING:** Assimilation. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Separate ingestion, digestion, absorption, assimilation and egestion.

**COMMON ERROR TO AVOID:** Absorption does not mean digestion.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 31. Gaseous Exchange

Gas exchange moves oxygen and carbon dioxide across thin moist surfaces; breathing ventilates those surfaces.

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### Core ideas in plain language

- Alveoli have large area, thin walls and rich blood supply. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Diffusion follows partial-pressure gradients. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Haemoglobin transports most oxygen. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Define breathing rather than respiration.

**STEP-BY-STEP REASONING:** Breathing is movement of air into and out of the body; respiration is cellular energy release. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Watch whether the question asks ventilation, gas exchange or cellular respiration.

**COMMON ERROR TO AVOID:** The three terms are related but not synonymous.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 32. Transport

Transport systems distribute gases, nutrients, hormones and wastes. The mammalian system is closed and double-circulatory.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Arteries carry blood away from the heart; veins return it; capillaries exchange materials. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Red blood cells transport oxygen; platelets support clotting; white cells defend. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Xylem and phloem provide plant transport. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Which blood cells carry most oxygen?

**STEP-BY-STEP REASONING:** Red blood cells through haemoglobin. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use direction relative to the heart, not oxygen content, to name an artery or vein.

**COMMON ERROR TO AVOID:** The pulmonary artery carries deoxygenated blood.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 33. Homeostasis

Homeostasis keeps internal conditions within workable limits. The kidneys regulate water, ions and nitrogenous wastes.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Nephrons filter blood, selectively reabsorb useful substances and secrete some wastes. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- ADH increases water reabsorption. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Urine passes kidney → ureter → bladder → urethra. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Where is urine stored temporarily?

**STEP-BY-STEP REASONING:** In the urinary bladder. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Trace the pathway and distinguish formation from storage.

**COMMON ERROR TO AVOID:** The ureter and urethra have different directions and roles.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 34. Support and Movements

Coordination links stimuli to responses through nervous and endocrine systems; support and movement involve skeleton, joints and muscles.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Receptors detect; coordinators process; effectors respond. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Neurons transmit electrical signals; synapses use neurotransmitters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Hormones travel in blood and often act more slowly. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Antagonistic muscles work in pairs. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What are muscles and glands in a response pathway?

**STEP-BY-STEP REASONING:** Effectors. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw stimulus → receptor → coordinator → effector → response.

**COMMON ERROR TO AVOID:** A hormone is a signal, not an effector.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 35. Coordination and Control

Coordination links stimuli to responses through nervous and endocrine systems; support and movement involve skeleton, joints and muscles.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Receptors detect; coordinators process; effectors respond. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Neurons transmit electrical signals; synapses use neurotransmitters. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Hormones travel in blood and often act more slowly. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
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**WORKED EXAMPLE:** What are muscles and glands in a response pathway?

**STEP-BY-STEP REASONING:** Effectors. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw stimulus → receptor → coordinator → effector → response.

**COMMON ERROR TO AVOID:** A hormone is a signal, not an effector.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 36. Growth and Development

Reproduction creates new individuals, while growth and development depend on regulated cell division, differentiation and gene expression.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.



### Core ideas in plain language

- Asexual reproduction produces genetically similar offspring; sexual reproduction generates variation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Gametes are haploid and fertilization restores diploidy. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Development proceeds through organized changes, not size increase alone. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** How many chromosomes are in a normal human gamete?

**STEP-BY-STEP REASONING:** 23 chromosomes. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify whether the cell is somatic or gametic before using chromosome numbers.

**COMMON ERROR TO AVOID:** Gametes have 23 chromosomes, not 23 pairs.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 37. Chromosomes and DNA

Inheritance transfers genetic information through DNA, genes and chromosomes. Alleles produce variation in traits.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Genotype is allele combination; phenotype is observable expression. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Dominant alleles can mask recessive alleles in heterozygotes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Meiosis and fertilization reshuffle alleles. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Mutations create new genetic variation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Cross Aa x Aa. What fraction is aa?

**STEP-BY-STEP REASONING:** Genotypes 1 AA : 2 Aa : 1 aa, so 1/4. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use a Punnett square and label gametes first.

**COMMON ERROR TO AVOID:** A dominant trait is not necessarily common or beneficial.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 38. Variation and Genetics

Inheritance transfers genetic information through DNA, genes and chromosomes. Alleles produce variation in traits.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Genotype is allele combination; phenotype is observable expression. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Dominant alleles can mask recessive alleles in heterozygotes. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Meiosis and fertilization reshuffle alleles. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Mutations create new genetic variation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Cross Aa x Aa. What fraction is aa?

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**QUICK TACTIC:** Use a Punnett square and label gametes first.

**COMMON ERROR TO AVOID:** A dominant trait is not necessarily common or beneficial.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 39. Ecosystem

Ecology studies organisms and their environment. Energy flows through trophic levels while matter cycles.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Producers capture energy; consumers transfer it; decomposers recycle nutrients. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Food webs are more realistic than single chains. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Population size depends on resources, competition, predation and disturbance. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Biodiversity often improves resilience. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why can a diverse ecosystem remain more stable after change?

**STEP-BY-STEP REASONING:** Multiple species and feeding pathways provide functional alternatives. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Follow arrows as energy transfer from food to consumer.

**COMMON ERROR TO AVOID:** Energy is not recycled; matter is.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 40. Some Major Ecosystems

Ecology studies organisms and their environment. Energy flows through trophic levels while matter cycles.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

### Core ideas in plain language

- Producers capture energy; consumers transfer it; decomposers recycle nutrients. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Food webs are more realistic than single chains. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Population size depends on resources, competition, predation and disturbance. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Biodiversity often improves resilience. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.



**WORKED EXAMPLE:** Why can a diverse ecosystem remain more stable after change?

**STEP-BY-STEP REASONING:** Multiple species and feeding pathways provide functional alternatives. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Follow arrows as energy transfer from food to consumer.

**COMMON ERROR TO AVOID:** Energy is not recycled; matter is.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 41. Man and His Environment

Ecology studies organisms and their environment. Energy flows through trophic levels while matter cycles.

The central aim is to understand how the main ideas are connected. Relate structure to function, place processes in the correct sequence, and distinguish levels of organisation. For comparison questions, identify the feature that truly separates the alternatives. For pathways and cycles, track where the process starts, what changes, and what product or response follows.

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## BIOLOGY - PRACTICE EXERCISES

Three independent sets are provided. Attempt each question before reading the answer, explanation and quick tactic immediately below it. Each set contains 25 MCQs with five options (A–E).

### Practice Set 1 - 25 MCQs

**1. The dark, non-conducting central wood of an old stem is called:**

- A. Heartwood
- B. Cork
- C. Cambium
- D. Springwood
- E. Sapwood

**Answer: A. Heartwood. Explanation:** The biological structure-function relationship or process described in Chapter 16: Support and Movements points to Heartwood. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**2. Rough endoplasmic reticulum appears rough because it bears:**

- A. Lysosomes
- B. Chromosomes
- C. Ribosomes
- D. Vacuoles
- E. Centrioles

**Answer: C. Ribosomes. Explanation:** The biological structure-function relationship or process described in Chapter 4: The Cell points to Ribosomes. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**3. The chromosomal theory of inheritance links Mendel's factors with:**

- A. Lysosomes
- B. Ribosomes
- C. Mitochondrial cristae
- D. Cell walls
- E. Chromosomes

**Answer: E. Chromosomes. Explanation:** The biological structure-function relationship or process described in Chapter 20: Chromosomes and DNA points to Chromosomes. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**4. In a scientific name, the first word identifies the organism's:**

- A. Species
- B. Family
- C. Order
- D. Kingdom

E. Genus

**Answer: E. Genus. Explanation:** The biological structure-function relationship or process described in Chapter 2: Biodiversity points to Genus. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**5. In a withdrawal reflex, the spinal cord can coordinate the response before the:**

- A. Receptor is stimulated
- B. Motor neuron fires
- C. Muscle contracts
- D. Skin is touched
- E. Brain becomes consciously aware

**Answer: E. Brain becomes consciously aware. Explanation:** The biological structure-function relationship or process described in Chapter 5: Coordination points to Brain becomes consciously aware. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**6. The primary wall of a plant cell is mainly composed of:**

- A. Lignin and chitin
- B. Peptidoglycan and protein
- C. Cellulose and hemicellulose
- D. DNA and ribosomal RNA
- E. Actin and tubulin

**Answer: C. Cellulose and hemicellulose. Explanation:** The biological structure-function relationship or process described in Chapter 3: The Cell points to Cellulose and hemicellulose. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**7. An endospore helps a bacterium mainly to:**

- A. Exchange genes
- B. Reproduce rapidly
- C. Survive unfavourable conditions
- D. Carry out photosynthesis
- E. Move through water

**Answer: C. Survive unfavourable conditions. Explanation:** The biological structure-function relationship or process described in Chapter 6: Kingdom Prokaryotae (Monera) points to Survive unfavourable conditions. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**8. Glyoxysomes are especially important in germinating oil-rich seeds because they help convert:**

- A. Minerals into lipids
- B. Starch into cellulose
- C. RNA into proteins
- D. Proteins into DNA

E. Stored fats into carbohydrates

**Answer: E. Stored fats into carbohydrates. Explanation:** The biological structure-function relationship or process described in Chapter 4: The Cell points to Stored fats into carbohydrates. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**9. Palisade mesophyll is efficient in photosynthesis because its cells are:**

- A. Filled with haemoglobin
- B. Rich in chloroplasts
- C. Covered by lignin
- D. Lacking cytoplasm
- E. Specialized for nerve impulses

**Answer: B. Rich in chloroplasts. Explanation:** The biological structure-function relationship or process described in Chapter 5: Tissues, Organs, and Organ Systems points to Rich in chloroplasts. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**10. Rusts and smuts are agriculturally important because they:**

- A. Cause plant diseases
- B. Produce antibiotics
- C. Improve seed germination
- D. Form coral reefs
- E. Fix atmospheric nitrogen

**Answer: A. Cause plant diseases. Explanation:** The biological structure-function relationship or process described in Chapter 8: Fungi points to Cause plant diseases. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**11. Artificial selection differs from natural selection because choices are made by:**

- A. The environment
- B. Mutations alone
- C. Humans
- D. Fossils
- E. Predators only

**Answer: C. Humans. Explanation:** The biological structure-function relationship or process described in Chapter 10: Evolution points to Humans. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**12. A loosely attached organic cofactor is a:**

- A. Coenzyme
- B. Substrate
- C. Activator ion
- D. Apoenzyme

E. Prosthetic group

**Answer: A. Coenzyme. Explanation:** The biological structure-function relationship or process described in Chapter 3: Enzymes points to Coenzyme. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**13. When a substrate binds to an enzyme before products form, the temporary association is the:**

- A. Lipid bilayer
- B. Chromosome pair
- C. Metabolic waste
- D. Nuclear pore
- E. Enzyme-substrate complex

**Answer: E. Enzyme-substrate complex. Explanation:** The biological structure-function relationship or process described in Chapter 7: Enzymes points to Enzyme-substrate complex. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**14. A chromosome with the centromere close to one end is:**

- A. Telocentric only
- B. Acrocentric
- C. Metacentric
- D. Submetacentric
- E. Dicentric

**Answer: B. Acrocentric. Explanation:** The biological structure-function relationship or process described in Chapter 20: Chromosomes and DNA points to Acrocentric. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**15. The lymphatic system helps return excess tissue fluid to the:**

- A. Skin surface
- B. Urinary bladder
- C. Blood circulation
- D. Lungs
- E. Digestive tract

**Answer: C. Blood circulation. Explanation:** The biological structure-function relationship or process described in Chapter 14: Transport points to Blood circulation. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**16. Which measure is generally less affected by one extremely large value?**

- A. Mean
- B. Range
- C. Total
- D. Median
- E. Frequency

**Answer: D. Median. Explanation:** The biological structure-function relationship or process described in Chapter 11: Biostatistics points to Median. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**17. As temperature rises toward an enzyme's optimum, reaction rate generally increases because:**

- A. The enzyme becomes a carbohydrate
- B. Every substrate changes into an inhibitor
- C. The active site is permanently destroyed
- D. Molecules move and collide more frequently
- E. The solution loses all hydrogen ions

**Answer: D. Molecules move and collide more frequently. Explanation:** The biological structure-function relationship or process described in Chapter 7: Enzymes points to Molecules move and collide more frequently. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**18. Bioreactors provide controlled conditions for large-scale growth of:**

- A. Rocks
- B. Microorganisms
- C. Metals
- D. Bones
- E. Air molecules

**Answer: B. Microorganisms. Explanation:** The biological structure-function relationship or process described in Chapter 8: Biotechnology points to Microorganisms. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**19. Each enzyme has an optimum pH at which it:**

- A. Stops binding substrate
- B. Changes into a coenzyme
- C. Is always denatured
- D. Works most efficiently
- E. Produces no product

**Answer: D. Works most efficiently. Explanation:** The biological structure-function relationship or process described in Chapter 3: Enzymes points to Works most efficiently. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**20. Nondisjunction can produce gametes with:**

- A. Abnormal chromosome numbers
- B. No genetic material in all cases
- C. Extra cell walls
- D. Only normal chromosome numbers
- E. Identical protein sequences only

**Answer: A. Abnormal chromosome numbers. Explanation:** The biological structure-function relationship or process described in Chapter 21: Cell Cycle points to Abnormal chromosome numbers. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**21. Which major field studies plant structure, growth, reproduction, and environmental interactions?**

- A. Zoology
- B. Botany
- C. Microbiology
- D. Pathology
- E. Ecology

**Answer: B. Botany. Explanation:** The biological structure-function relationship or process described in Chapter 1: The Science of Biology points to Botany. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**22. Sulfur dioxide contributes strongly to:**

- A. Eutrophication only
- B. Soil salinization only
- C. Acid rain
- D. Nitrogen fixation
- E. Ozone formation in the stratosphere

**Answer: C. Acid rain. Explanation:** The biological structure-function relationship or process described in Chapter 27: Man and His Environment points to Acid rain. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**23. Shivering helps a cold mammal because it:**

- A. Reduces blood flow to internal organs
- B. Lowers the metabolic rate
- C. Increases evaporative cooling
- D. Stops cellular respiration
- E. Raises heat production by muscle contractions

**Answer: E. Raises heat production by muscle contractions. Explanation:** The biological structure-function relationship or process described in Chapter 15: Homeostasis points to Raises heat production by muscle contractions. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**24. The four nitrogenous bases in DNA are adenine, thymine, cytosine, and:**

- A. Uracil
- B. Ribose
- C. Glycerol
- D. Phosphate
- E. Guanine

**Answer: E. Guanine. Explanation:** The biological structure-function relationship or process described in Chapter 6: Biomolecules points to Guanine. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**25. Which example best demonstrates an emergent property at the organ level?**

- A. A ribosome synthesizes a protein
- B. Heart tissues coordinate to pump blood
- C. A mitochondrion releases energy
- D. A carbon atom combines with oxygen
- E. A neuron transmits an impulse alone

**Answer: B. Heart tissues coordinate to pump blood. Explanation:** The biological structure-function relationship or process described in Chapter 5: Tissues, Organs, and Organ Systems points to Heart tissues coordinate to pump blood. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.



## Practice Set 2 - 25 MCQs

### 1. Traditional two-kingdom classification divided organisms into:

- A. Fungi and Plantae
- B. Monera and Protista
- C. Archaea and Bacteria
- D. Plantae and Animalia
- E. Protista and Animalia

**Answer: D. Plantae and Animalia. Explanation:** The biological structure-function relationship or process described in Chapter 5: Variety of Life points to Plantae and Animalia. Place the term in the correct biological sequence or system.

**Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

### 2. Mendel's law of segregation states that allele pairs separate during:

- A. Fertilization only
- B. Protein synthesis
- C. Gamete formation
- D. Respiration
- E. Growth by mitosis

**Answer: C. Gamete formation. Explanation:** The biological structure-function relationship or process described in Chapter 7: Inheritance points to Gamete formation. Place the term in the correct biological sequence or system. **Quick**

**tactic:** Connect structure with function and keep the sequence of the biological process clear.

### 3. Parathyroid hormone is important in regulating blood:

- A. Oxygen concentration
- B. Urea concentration
- C. Calcium concentration
- D. Antibody level
- E. Haemoglobin type

**Answer: C. Calcium concentration. Explanation:** The biological structure-function relationship or process described in Chapter 17: Coordination and Control points to Calcium concentration. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

### 4. An organ is composed of:

- A. One type of atom only
- B. Identical organ systems
- C. Independent organisms
- D. Only one specialized cell
- E. Different related tissues working together

**Answer: E. Different related tissues working together. Explanation:** The biological structure-function relationship or process described in Chapter 5: Tissues, Organs, and Organ Systems points to Different related tissues working together. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**5. Comma-shaped bacteria are described as:**

- A. Cocci
- B. Filaments
- C. Spirilla
- D. Bacilli
- E. Vibrios

**Answer: E. Vibrios. Explanation:** The biological structure-function relationship or process described in Chapter 6: Kingdom Prokaryotae (Monera) points to Vibrios. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**6. Hydrochloric acid activates pepsinogen to form:**

- A. Trypsin
- B. Pepsin
- C. Lipase
- D. Amylase
- E. Peptidase

**Answer: B. Pepsin. Explanation:** The biological structure-function relationship or process described in Chapter 1: Human Digestive System points to Pepsin. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**7. Adenine and guanine are classified as:**

- A. Purines
- B. Phosphates
- C. Pyrimidines
- D. Peptides
- E. Pentoses

**Answer: A. Purines. Explanation:** The biological structure-function relationship or process described in Chapter 20: Chromosomes and DNA points to Purines. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**8. DNA sequencing determines the order of:**

- A. Amino acids in every protein directly
- B. Chromosomes in a karyotype only
- C. Nucleotides
- D. Organisms in a food chain
- E. Cells in a tissue

**Answer: C. Nucleotides. Explanation:** The biological structure-function relationship or process described in Chapter 23: Biotechnology points to Nucleotides. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**9. Biotechnology uses living organisms, systems, or processes mainly in:**

- A. Manufacturing and service industries
- B. Describing fossil lineages
- C. Dating sedimentary rocks
- D. Mapping global biomes
- E. Naming and classifying species

**Answer: A. Manufacturing and service industries. Explanation:** The biological structure-function relationship or process described in Chapter 1: Introduction points to Manufacturing and service industries. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**10. AIDS is the advanced condition caused by infection with:**

- A. HBV
- B. Influenza virus
- C. HIV
- D. Plasmodium
- E. Salmonella

**Answer: C. HIV. Explanation:** The biological structure-function relationship or process described in Chapter 9: Diseases and Immunity points to HIV. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**11. Bacterial cells are prokaryotic because they lack a:**

- A. Membrane-bound nucleus
- B. Cell wall
- C. Plasma membrane
- D. Ribosome
- E. Cytoplasm

**Answer: A. Membrane-bound nucleus. Explanation:** The biological structure-function relationship or process described in Chapter 6: Kingdom Prokaryotae (Monera) points to Membrane-bound nucleus. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**12. The part of Earth inhabited by living organisms is the:**

- A. Lithosphere
- B. Biosphere
- C. Community
- D. Biome
- E. Ecosystem

**Answer: B. Biosphere. Explanation:** The biological structure-function relationship or process described in Chapter 1: Introduction points to Biosphere. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**13. The main nitrogenous waste in human urine is:**

- A. Urea
- B. Glucose
- C. Glycogen
- D. Oxygen
- E. Starch

**Answer: A. Urea. Explanation:** The biological structure-function relationship or process described in Chapter 4: Human Urinary System points to Urea. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**14. A tube carrying urine from a kidney to the bladder is a:**

- A. Urethra
- B. Ureter
- C. Artery
- D. Nephron
- E. Collecting duct

**Answer: B. Ureter. Explanation:** The biological structure-function relationship or process described in Chapter 4: Human Urinary System points to Ureter. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**15. A defining feature of chordates present at least during development is the:**

- A. Water vascular system
- B. Radula
- C. Exoskeleton
- D. Notochord
- E. Mantle

**Answer: D. Notochord. Explanation:** The biological structure-function relationship or process described in Chapter 10: Kingdom Animalia points to Notochord. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**16. A ligament connects:**

- A. Muscle to muscle
- B. Nerve to muscle
- C. Muscle to bone
- D. Bone to bone
- E. Cartilage to tendon

**Answer: D. Bone to bone. Explanation:** The biological structure-function relationship or process described in Chapter 16: Support and Movements points to Bone to bone. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**17. Sound is produced mainly by vibration of the:**

- A. C-shaped rings

- B. Pleural membranes
- C. Vocal cords
- D. Ribs
- E. Alveolar walls

**Answer: C. Vocal cords. Explanation:** The biological structure-function relationship or process described in Chapter 2: Human Respiratory System points to Vocal cords. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**18. The visible point where homologous chromatids have exchanged segments is a:**

- A. Nucleolus
- B. Chiasma
- C. Spindle pole
- D. Centromere
- E. Kinetochore

**Answer: B. Chiasma. Explanation:** The biological structure-function relationship or process described in Chapter 21: Cell Cycle points to Chiasma. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**19. Which adaptation most directly reduces water loss in a xerophyte?**

- A. A thick waxy cuticle and few stomata
- B. Broad floating leaves with upper stomata
- C. Thin cuticle and shallow roots
- D. Large air spaces in every tissue
- E. Continuous opening of all stomata

**Answer: A. A thick waxy cuticle and few stomata. Explanation:** The biological structure-function relationship or process described in Chapter 9: Plant Physiology points to A thick waxy cuticle and few stomata. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**20. Among external factors, plant growth is directly influenced by:**

- A. Blood pressure
- B. Light, temperature and water
- C. Nerve impulses
- D. Chromosome number only
- E. Antibody level

**Answer: B. Light, temperature and water. Explanation:** The biological structure-function relationship or process described in Chapter 19: Growth and Development points to Light, temperature and water. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**21. Nitrogen-fixing bacteria are important because they convert atmospheric nitrogen into:**

- A. Water

- B. Glucose
- C. Carbon dioxide
- D. Usable nitrogen compounds
- E. Oxygen gas

**Answer: D. Usable nitrogen compounds. Explanation:** The biological structure-function relationship or process described in Chapter 6: Kingdom Prokaryotae (Monera) points to Usable nitrogen compounds. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**22. A biological rhythm of approximately 24 hours is called:**

- A. Reflex action
- B. Circadian rhythm
- C. Tropic movement
- D. Learned response
- E. Homeostatic drift

**Answer: B. Circadian rhythm. Explanation:** The biological structure-function relationship or process described in Chapter 17: Coordination and Control points to Circadian rhythm. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**23. Untreated sewage in water commonly increases:**

- A. Photosynthesis in deep water only
- B. Safe drinking quality
- C. Water transparency
- D. Biological oxygen demand
- E. Dissolved oxygen permanently

**Answer: D. Biological oxygen demand. Explanation:** The biological structure-function relationship or process described in Chapter 27: Man and His Environment points to Biological oxygen demand. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**24. Gametes are produced by the type of cell division called:**

- A. Mitosis
- B. Binary fission
- C. Budding
- D. Meiosis
- E. Fragmentation

**Answer: D. Meiosis. Explanation:** The biological structure-function relationship or process described in Chapter 6: Reproduction points to Meiosis. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**25. Using sterile needles helps prevent transmission of:**

- A. Genetic traits

- B. Hormonal changes
- C. Menstrual cycles
- D. Blood-borne infections
- E. Puberty

**Answer: D. Blood-borne infections. Explanation:** The biological structure-function relationship or process described in Chapter 6: Reproduction points to Blood-borne infections. Place the term in the correct biological sequence or system.

**Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

## Practice Set 3 - 25 MCQs

### 1. Anaerobic respiration releases less energy because glucose is:

- A. Glucose is completely converted to carbon dioxide and water
- B. Glucose is not involved in the respiratory pathway at all
- C. Glucose is only partly oxidized and retains chemical energy
- D. Glucose is synthesized directly from oxygen molecules
- E. Glucose is stored permanently as cellulose without breakdown

**Answer: C. Glucose is only partly oxidized and retains chemical energy. Explanation:** The biological structure-function relationship or process described in Chapter 8: Bioenergetics points to Glucose is only partly oxidized and retains chemical energy. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

### 2. The ability to replace a lost body part is:

- A. Abscission
- B. Dormancy
- C. Induction
- D. Differentiation
- E. Regeneration

**Answer: E. Regeneration. Explanation:** The biological structure-function relationship or process described in Chapter 19: Growth and Development points to Regeneration. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

### 3. Climate describes the long-term pattern of:

- A. Daily temperature only
- B. Weather conditions
- C. One season only
- D. Atmospheric pressure at one moment
- E. One storm

**Answer: B. Weather conditions. Explanation:** The biological structure-function relationship or process described in Chapter 26: Some Major Ecosystems points to Weather conditions. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

### 4. In carbohydrates, the usual ratio of hydrogen atoms to oxygen atoms is:

- A. 1:1
- B. 2:1
- C. 1:2
- D. 3:1
- E. 4:1

**Answer: B. 2:1. Explanation:** The biological structure-function relationship or process described in Chapter 6: Biomolecules points to 2:1. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.



**5. The numerous pores in a sponge body allow the passage of:**

- A. Nerve impulses
- B. Water
- C. Food through a complete gut
- D. Air only
- E. Blood

**Answer: B. Water. Explanation:** The biological structure-function relationship or process described in Chapter 10: Kingdom Animalia points to Water. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**6. Bacterial diseases may sometimes be treated with:**

- A. Antibiotics
- B. Antibodies as food
- C. Insulin only
- D. Bile salts
- E. Pain alone

**Answer: A. Antibiotics. Explanation:** The biological structure-function relationship or process described in Chapter 9: Diseases and Immunity points to Antibiotics. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**7. Asexual reproduction in fungi often occurs through:**

- A. Binary fission only
- B. Pollen grains
- C. Seeds
- D. Embryos
- E. Spores

**Answer: E. Spores. Explanation:** The biological structure-function relationship or process described in Chapter 8: Fungi points to Spores. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**8. A muscle cell using ATP to move ions against a concentration gradient is carrying out:**

- A. Passive diffusion
- B. Photosynthesis
- C. Binomial nomenclature
- D. Active transport
- E. Crossing over

**Answer: D. Active transport. Explanation:** The biological structure-function relationship or process described in Chapter 8: Bioenergetics points to Active transport. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**9. Compared with mammals, regeneration is generally greater in:**

- A. Adult humans
- B. Primates only
- C. Placental mammals
- D. Birds only
- E. Simpler animals

**Answer: E. Simpler animals. Explanation:** The biological structure-function relationship or process described in Chapter 19: Growth and Development points to Simpler animals. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**10. Droplets released by coughing can spread some:**

- A. Genetic traits
- B. Kidney stones
- C. Nutrient deficiencies
- D. Bone fractures
- E. Respiratory infections

**Answer: E. Respiratory infections. Explanation:** The biological structure-function relationship or process described in Chapter 9: Diseases and Immunity points to Respiratory infections. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**11. The pulmonary artery carries blood from the heart to the:**

- A. Lungs
- B. Kidneys
- C. Liver
- D. Brain
- E. Small intestine

**Answer: A. Lungs. Explanation:** The biological structure-function relationship or process described in Chapter 3: Human Blood Circulatory System points to Lungs. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**12. Faeces are stored temporarily in the:**

- A. Caecum
- B. Colon
- C. Rectum
- D. Ileum
- E. Anus

**Answer: C. Rectum. Explanation:** The biological structure-function relationship or process described in Chapter 1: Human Digestive System points to Rectum. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**13. The characteristic accessory pigment of many red algae is:**

- A. Phycoerythrin

- B. Xanthophyll only
- C. Fucoxanthin
- D. Chlorophyll b only
- E. Carotene only

**Answer: A. Phycoerythrin. Explanation:** The biological structure-function relationship or process described in Chapter 7: The Kingdom Protista (or Protoctista) points to Phycoerythrin. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**14. An enzyme protein without its required cofactor is called an:**

- A. Ribozyme
- B. Isoenzyme
- C. Apoenzyme
- D. Holoenzyme
- E. Activator

**Answer: C. Apoenzyme. Explanation:** The biological structure-function relationship or process described in Chapter 3: Enzymes points to Apoenzyme. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**15. Insects possess:**

- A. One pair of legs
- B. Four pairs of legs
- C. Five pairs of legs
- D. No jointed legs
- E. Three pairs of legs

**Answer: E. Three pairs of legs. Explanation:** The biological structure-function relationship or process described in Chapter 10: Kingdom Animalia points to Three pairs of legs. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**16. Enzyme specificity depends largely on the shape and chemical properties of the:**

- A. Cell membrane
- B. Nuclear envelope
- C. Phosphate group
- D. Active site
- E. Golgi vesicle

**Answer: D. Active site. Explanation:** The biological structure-function relationship or process described in Chapter 7: Enzymes points to Active site. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**17. An increase in antidiuretic hormone causes the kidneys to:**

- A. Reabsorb more water
- B. Produce more urea

- C. Excrete more water
- D. Filter less blood at the glomerulus
- E. Secrete more glucose

**Answer: A. Reabsorb more water. Explanation:** The biological structure-function relationship or process described in Chapter 15: Homeostasis points to Reabsorb more water. Place the term in the correct biological sequence or system.

**Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**18. Intracellular digestion occurs:**

- A. Only in the small intestine
- B. Inside food vacuoles within cells
- C. Outside the organism
- D. In blood plasma
- E. Only in the stomach

**Answer: B. Inside food vacuoles within cells. Explanation:** The biological structure-function relationship or process described in Chapter 12: Nutrition points to Inside food vacuoles within cells. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**19. Mushrooms, rusts, and smuts belong mainly to:**

- A. Basidiomycota
- B. Oomycota
- C. Ascomycota
- D. Deuteromycota
- E. Zygomycota

**Answer: A. Basidiomycota. Explanation:** The biological structure-function relationship or process described in Chapter 8: Fungi points to Basidiomycota. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**20. The enzyme that catalyses the fixation of carbon dioxide to RuBP is:**

- A. Catalase
- B. Amylase
- C. ATP synthase only
- D. Rubisco
- E. Pepsin

**Answer: D. Rubisco. Explanation:** The biological structure-function relationship or process described in Chapter 11: Bioenergetics points to Rubisco. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**21. The green pigment in chloroplasts is:**

- A. Haemoglobin
- B. Keratin
- C. Chlorophyll

- D. Melanin
- E. Carotene only

**Answer: C. Chlorophyll. Explanation:** The biological structure-function relationship or process described in Chapter 4: The Cell points to Chlorophyll. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**22. Coniferous forests of cold northern regions form the:**

- A. Taiga
- B. Chaparral
- C. Savanna
- D. Tundra
- E. Desert

**Answer: A. Taiga. Explanation:** The biological structure-function relationship or process described in Chapter 26: Some Major Ecosystems points to Taiga. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**23. Sponges belong to phylum:**

- A. Platyhelminthes
- B. Annelida
- C. Mollusca
- D. Porifera
- E. Cnidaria

**Answer: D. Porifera. Explanation:** The biological structure-function relationship or process described in Chapter 10: Kingdom Animalia points to Porifera. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**24. Antibiotics can be produced industrially using selected:**

- A. Minerals
- B. Metals
- C. Viruses only
- D. Microorganisms
- E. Human bones

**Answer: D. Microorganisms. Explanation:** The biological structure-function relationship or process described in Chapter 8: Biotechnology points to Microorganisms. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

**25. Grafting allows growers to:**

- A. Produce haploid spores without meiosis
- B. Convert roots into flowers
- C. Create seeds without an ovary
- D. Combine useful characteristics of two plants

E. Prevent all plant diseases

**Answer: D. Combine useful characteristics of two plants.** **Explanation:** The biological structure-function relationship or process described in Chapter 10: Reproduction in Plants points to Combine useful characteristics of two plants. Place the term in the correct biological sequence or system. **Quick tactic:** Connect structure with function and keep the sequence of the biological process clear.

# STATISTICS

## Topics and contents

The Statistics section develops data description, probability, distributions, sampling, estimation, testing, association, regression and time-based analysis with emphasis on interpretation.

This section covers Introduction to Statistics; Representation of Data; Measure of Location; Measure of Dispersion; Index Numbers; Probability; Random Variables; Probability Distributions; Binomial and Hypergeometric Probability Distribution; Normal Distribution; Sampling Techniques and Sampling Distributions.

It also develops understanding of Estimation; Hypothesis Testing; Simple Linear Regression and Correlation; Association; Analysis of Time Series; Orientation of Computers.

## 1. Introduction to Statistics

Statistics turns data into evidence for description and decision-making.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Population is the complete group; sample is a subset. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A parameter describes a population; a statistic describes a sample. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Variables may be qualitative/quantitative and discrete/continuous. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A census studies every unit. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Eighty households chosen from all city households form what?

**STEP-BY-STEP REASONING:** A sample. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Identify the target group before naming population or sample.

**COMMON ERROR TO AVOID:** A large sample is not automatically unbiased.

**SECOND WORKED EXAMPLE:** A survey selects 120 households from all households in a city.

**STEP-BY-STEP REASONING:** The city households form the population; the 120 selected households form the sample.

**QUICK CHECK:** Identify whether the number describes the whole population or a sample.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 2. Representation of Data

Data representation organizes raw values in tables and graphs to reveal distribution and patterns.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Frequency tables group observations. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Bar charts suit categories; histograms suit continuous grouped data. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Cumulative frequency supports medians and percentiles. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

- Pie-chart angle =  $\frac{\text{category}}{\text{total}} \times 360$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** A category is 25% of a pie chart. Find its angle.

**STEP-BY-STEP REASONING:**  $0.25 \times 360 = 90$  degrees. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Check whether intervals are equal before reading histogram heights.

**COMMON ERROR TO AVOID:** Bars touch in a histogram but normally not in a bar chart.

**SECOND WORKED EXAMPLE:** The intervals 10–19, 20–29 and 30–39 have frequencies 4, 7 and 9.

**STEP-BY-STEP REASONING:** A frequency polygon uses class midpoints 14.5, 24.5 and 34.5 plotted against 4, 7 and 9.

**QUICK CHECK:** For grouped data, calculate class midpoints consistently.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 3. Measure of Location

Measures of location describe a typical or positional value.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

#### Core ideas in plain language

- Mean =  $\frac{\text{sum}}{n}$ ; weighted mean =  $\frac{\text{sum}(wx)}{\text{sum}(w)}$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Median divides ordered data in half. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Mode is most frequent. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Quartiles and percentiles locate relative positions. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Find mean of 4, 6, 8, 10.

**STEP-BY-STEP REASONING:** Sum = 28;  $28/4 = 7$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** For combined means, convert each mean back to a group total.

**COMMON ERROR TO AVOID:** Median requires ordered data.

**SECOND WORKED EXAMPLE:** Find the median of 3, 7, 8, 12 and 15.

**STEP-BY-STEP REASONING:** The observations are already ordered; the middle value is 8.

**QUICK CHECK:** Order the data before finding the median.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 4. Measure of Dispersion

Dispersion measures spread around a centre.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.



### Core ideas in plain language

- Range=max-min. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Variance averages squared deviations. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Standard deviation=square root of variance. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Coefficient of variation=SD/mean x100%. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Mean=50 and SD=5. Find CV.

**STEP-BY-STEP REASONING:**  $5/50 \times 100 = 10\%$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Use CV to compare variability across different scales.

**COMMON ERROR TO AVOID:** A larger mean can make the same SD relatively smaller.

**SECOND WORKED EXAMPLE:** Find the range of 18, 9, 21, 14 and 12.

**STEP-BY-STEP REASONING:** Range = maximum – minimum =  $21 - 9 = 12$ .

**QUICK CHECK:** Range uses only the two extreme values.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 5. Index Numbers

Index numbers compare a variable or basket across time relative to a base period.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Simple price relative=current/base x100. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Weighted indices reflect item importance. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Laspeyres uses base quantities; Paasche uses current quantities. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Changing the base rescales the series. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** A price rises from 80 to 100. Find price relative.

**STEP-BY-STEP REASONING:**  $100/80 \times 100 = 125$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Interpret 125 as 25% above the base, not 125% increase.

**COMMON ERROR TO AVOID:** Index points and percentage change are not identical wording.

**SECOND WORKED EXAMPLE:** A price rises from 80 to 100. Find the price relative.

**STEP-BY-STEP REASONING:** Price relative =  $(100/80) \times 100 = 125$ .

**QUICK CHECK:** An index above 100 indicates an increase from the base period.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 6. Probability

Probability quantifies uncertainty using sample spaces, events and rules.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- $P(A^c) = 1 - P(A)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Independent intersection  $= P(A)P(B)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Conditional  $P(A|B) = P(A \cap B) / P(B)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Exclusive events have probabilities 0.3 and 0.4. Find union.

**STEP-BY-STEP REASONING:**  $0.3 + 0.4 = 0.7$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Draw a Venn diagram or tree when events combine.

**COMMON ERROR TO AVOID:** Independent events may overlap; mutually exclusive nonzero events are not independent.

**SECOND WORKED EXAMPLE:** Two fair coins are tossed. Find  $P(\text{exactly one head})$ .

**STEP-BY-STEP REASONING:** Sample space: HH, HT, TH, TT. Favourable outcomes are HT and TH, so probability  $= 2/4 = 1/2$ .

**QUICK CHECK:** List the complete sample space when it is small.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### SPECIAL TOPIC - PERMUTATIONS AND COMBINATIONS

Counting methods support probability questions. A permutation is an arrangement in which order matters; a combination is a selection in which order does not matter.

**FORMULAS:**  $nPr = n! / (n-r)!$  and  $nCr = n! / [r!(n-r)!]$ . Also remember  $0! = 1$ .

**WORKED EXAMPLE 1:** Three office positions are assigned from 8 candidates. Because the positions are different, order matters:  $8P3 = 8 \times 7 \times 6 = 336$ .

**WORKED EXAMPLE 2:** A committee of 3 is selected from 8 students. Order does not matter:  $8C3 = 56$ .

**WORKED EXAMPLE 3:** The letters of DATA can be arranged in  $4!/2! = 12$  distinct ways because A is repeated twice.

**PROBABILITY APPLICATION:** Selecting 2 red balls from 5 red and 3 blue balls without replacement can be handled by combinations: favourable selections  $= 5C2$  and total selections  $= 8C2$ .

**QUICK TACTIC:** Ask one question first: Does changing the order create a different outcome? If yes, use a permutation; if no, use a combination.

## 7. Random Variables

A random variable assigns numerical values to outcomes.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Discrete variables have countable values; continuous variables lie on intervals. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Expected value  $E(X) = \sum x p(x)$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Variance  $= E(X^2) - [E(X)]^2$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- A valid probability mass function is nonnegative and sums to 1. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Find expected value of a fair die.

**STEP-BY-STEP REASONING:**  $(1+2+3+4+5+6)/6=3.5$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Build a value-probability table.

**COMMON ERROR TO AVOID:** Expected value need not be a possible observed value.

**SECOND WORKED EXAMPLE:** Let  $X$  be the number of heads in two coin tosses. State possible values.

**STEP-BY-STEP REASONING:**  $X$  may be 0, 1 or 2. It is a discrete random variable because its values are countable.

**QUICK CHECK:** Define what the random variable measures before listing values.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 8. Probability Distributions

A probability distribution describes how probability is allocated over a random variable.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Discrete distributions use probabilities at points; continuous distributions use density area. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Total probability/area is 1. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Mean and variance summarize centre and spread. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Can a continuous variable have positive probability at exactly one point?

**STEP-BY-STEP REASONING:** For a continuous distribution, probability at a single point is zero; intervals have probability. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Check whether the variable is discrete or continuous first.

**COMMON ERROR TO AVOID:** A density value itself is not a probability unless integrated over an interval.

**SECOND WORKED EXAMPLE:** A distribution gives  $P(X=0)=0.2$ ,  $P(X=1)=0.5$  and  $P(X=2)=0.3$ . Verify it.

**STEP-BY-STEP REASONING:** All probabilities are non-negative and sum to 1, so it is valid.

**QUICK CHECK:** Check both conditions: each probability lies from 0 to 1 and the total is 1.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 9. Binomial and Hypergeometric Probability Distribution

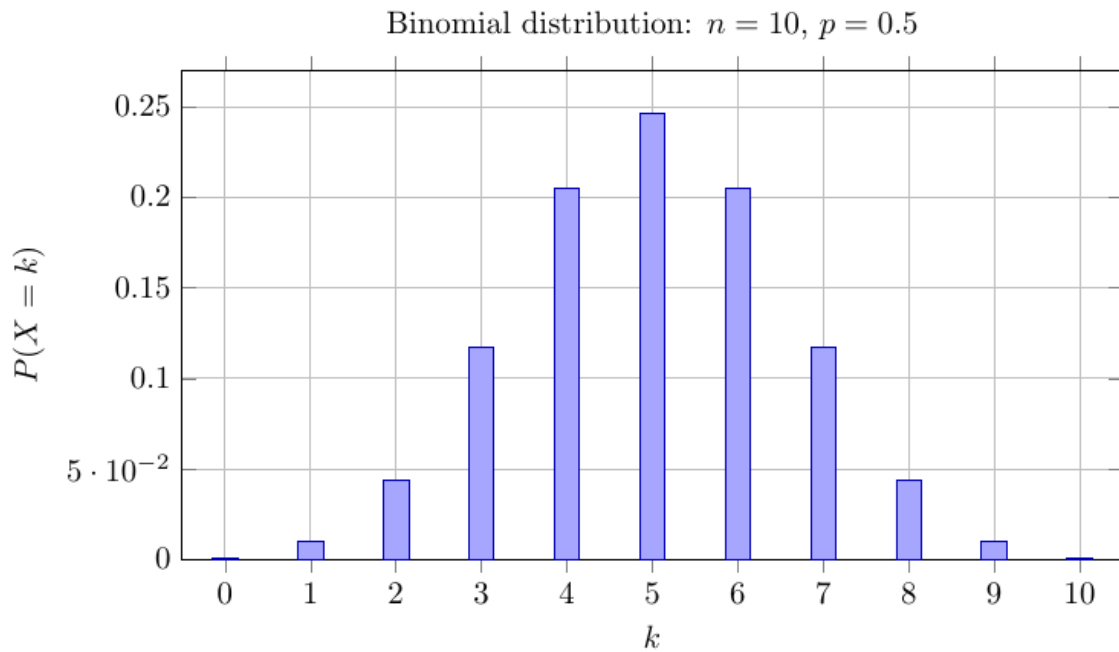


Figure: Binomial distribution for  $n = 10$  and  $p = 0.5$ .

The bars show probabilities for separate integer outcomes. With  $p = 0.5$ , the distribution is symmetric around the mean  $np = 5$ .

**SECOND WORKED EXAMPLE:** A fair coin is tossed 5 times. Find the probability of exactly 3 heads.

**SOLUTION:**  $P(X=3) = {}^5C_3(1/2)^3(1/2)^2 = 10/32 = 5/16$ .

**MODEL CHECK:** Use the binomial model only when the number of trials is fixed, outcomes are binary, trials are independent and the success probability remains constant.

Binomial models independent Bernoulli trials with constant  $p$ ; hypergeometric models sampling without replacement.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Binomial  $P(X=x) = {}^nC_x p^x q^{(n-x)}$ , mean= $np$ , variance= $npq$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Hypergeometric dependence arises because probabilities change after each draw. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Use binomial only with fixed  $n$ , two outcomes, independence and constant  $p$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** For  $X \sim \text{Binomial}(4, 0.5)$ , find  $P(X=2)$ .

**STEP-BY-STEP REASONING:**  ${}^4C_2(0.5)^2(0.5)^2 = 6/16 = 0.375$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Run the BINS checklist: Binary, Independent, Number fixed, Same  $p$ .

**COMMON ERROR TO AVOID:** Without replacement from a small population is not binomial.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 10. Normal Distribution

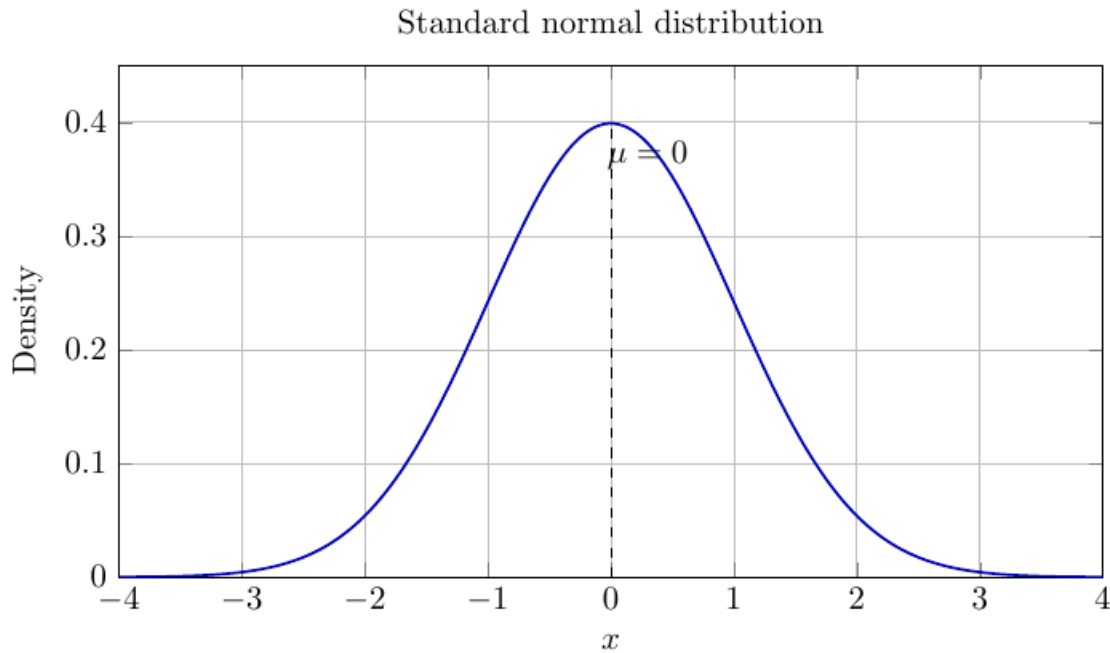


Figure: Standard normal distribution centred at mean 0.

The curve is symmetric; mean, median and mode coincide at the centre. The total area under the curve equals 1, and the tails approach the axis without touching it.

**SECOND WORKED EXAMPLE:** A variable has mean 50 and standard deviation 10. Find the z-score of  $x = 70$ .

**SOLUTION:**  $z = (x - \mu) / \sigma = (70 - 50) / 10 = 2$ . The observation lies two standard deviations above the mean.

**QUICK TACTIC:** A positive z-score lies above the mean; a negative z-score lies below the mean. The larger  $|z|$  is, the farther the value is from the centre.

The normal distribution is symmetric and bell-shaped, defined by mean and standard deviation.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Mean=median=mode. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- $z = (x - \mu) / \sigma$  standardizes values. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Areas represent probabilities. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- About 68%, 95%, 99.7% lie within 1, 2, 3 SD in an ideal normal model. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:**  $x=70$ ,  $\mu=60$ ,  $\sigma=5$ . Find  $z$ .

**STEP-BY-STEP REASONING:**  $(70-60)/5=2$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Keep the sign: above mean positive, below mean negative.

**COMMON ERROR TO AVOID:** A z-score is unit-free.

Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.

## 11. Sampling Techniques and Sampling Distributions

Sampling selects observations to infer about a population; sampling distributions describe statistics over repeated samples.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Probability sampling supports defensible inference. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Stratified sampling ensures subgroup representation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Standard error measures sampling variability. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Larger samples usually reduce standard error. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Why stratify a population?

**STEP-BY-STEP REASONING:** To ensure important subgroups are represented and potentially improve precision. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Separate sampling method from sampling statistic.

**COMMON ERROR TO AVOID:** A sampling distribution is not the raw population distribution.

**SECOND WORKED EXAMPLE:** Every 20th name is selected from an ordered list after a random start.

**STEP-BY-STEP REASONING:** This is systematic sampling.

**QUICK CHECK:** Look for equal selection intervals.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 12. Estimation

Estimation uses sample statistics to approximate unknown parameters.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- A point estimate gives one value. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A confidence interval gives a range with a confidence procedure. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Margin of error depends on critical value, standard error and sample size. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Unbiasedness and consistency are desirable properties. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What happens to margin of error when sample size increases, all else equal?

**STEP-BY-STEP REASONING:** It generally decreases because standard error falls. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Write estimate  $\pm$  margin of error.

**COMMON ERROR TO AVOID:** 95% confidence does not mean 95% of parameter values are inside one fixed interval.

**SECOND WORKED EXAMPLE:** A sample mean is 40 with known standard error 2. Form an approximate 95% interval using 1.96.

**STEP-BY-STEP REASONING:**  $40 \pm 1.96(2) = 40 \pm 3.92$ , giving approximately (36.08, 43.92).

**QUICK CHECK:** Write estimate  $\pm$  margin of error before substituting.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 13. Hypothesis Testing

Hypothesis testing evaluates whether sample evidence is inconsistent with a null claim.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

#### Core ideas in plain language

- State  $H_0$  and  $H_1$  before calculation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- A p-value is the probability, under  $H_0$ , of results at least as extreme. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Reject  $H_0$  when  $p \leq \alpha$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Type I rejects a true  $H_0$ ; Type II fails to reject a false  $H_0$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:**  $p=0.03$  and  $\alpha=0.05$ . Decision?

**STEP-BY-STEP REASONING:** Reject  $H_0$  because  $0.03 < 0.05$ . After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Compare p directly with alpha after checking test direction.

**COMMON ERROR TO AVOID:** Failure to reject  $H_0$  is not proof that  $H_0$  is true.

**SECOND WORKED EXAMPLE:** A p-value is 0.03 and  $\alpha=0.05$ .

**STEP-BY-STEP REASONING:** Because  $0.03 < 0.05$ , reject the null hypothesis.

**QUICK CHECK:** Compare p-value directly with  $\alpha$ .

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

### 14. Simple Linear Regression and Correlation

Correlation measures direction and strength of linear association; regression models a response from predictors.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

#### Core ideas in plain language

- $-1 \leq r \leq 1$ . Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.
- Sign gives direction; magnitude gives linear strength. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Regression line passes through  $(\bar{x}, \bar{y})$ . In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Residual = observed - predicted. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** Interpret  $r = -0.80$ .



**STEP-BY-STEP REASONING:** Strong negative linear association. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Check a scatterplot before trusting  $r$ .

**COMMON ERROR TO AVOID:** Correlation does not establish causation.

**SECOND WORKED EXAMPLE:** The correlation coefficient is  $r = -0.82$ .

**STEP-BY-STEP REASONING:** This indicates a strong negative linear relationship: as one variable increases, the other tends to decrease.

**QUICK CHECK:** The sign gives direction;  $|r|$  gives strength.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 15. Association

Association for categorical variables is examined with contingency tables and expected frequencies.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Compare observed and expected counts. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Independence means category proportions are similar across groups. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Chi-square summarizes squared standardized discrepancies. Treat the expression as a relationship: identify what each symbol represents, check the required units or restrictions, and substitute only after the relationship is clear.

**WORKED EXAMPLE:** What does independence imply in a two-way table?

**STEP-BY-STEP REASONING:** The distribution of one variable is the same across categories of the other, apart from sampling variation. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Work with counts for chi-square, not percentages alone.

**COMMON ERROR TO AVOID:** Association does not identify a causal mechanism.

**SECOND WORKED EXAMPLE:** In a contingency table, observed frequencies differ greatly from expected frequencies.

**STEP-BY-STEP REASONING:** This suggests possible association between the categorical variables.

**QUICK CHECK:** Association is judged by comparing observed and expected patterns.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 16. Analysis of Time Series

A time series records values in time order and may contain trend, seasonal, cyclical and irregular components.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Moving averages smooth short-term variation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Seasonal indices describe recurring within-cycle patterns. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.



- Extrapolation is less reliable far beyond observed data. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Time order creates dependence. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** What component repeats at the same period each year?

**STEP-BY-STEP REASONING:** Seasonal variation. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Plot the series before selecting a model.

**COMMON ERROR TO AVOID:** A trend alone does not explain seasonal peaks.

**SECOND WORKED EXAMPLE:** Monthly sales rise every December and fall every January.

**STEP-BY-STEP REASONING:** This recurring within-year pattern is seasonal variation.

**QUICK CHECK:** Seasonal effects repeat at fixed calendar intervals.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## 17. Orientation of Computers

Computing supports statistical storage, cleaning, calculation, visualization and reproducible analysis.

The central aim is to understand how the main ideas are connected. Identify the type of data, the population or sample, the required measure, and the assumptions behind the method. Write the formula with symbols before substituting. Interpret the numerical answer in words, because statistical questions often test meaning as well as calculation.

### Core ideas in plain language

- Spreadsheets suit modest tabular work; statistical packages support formal modelling. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Variable coding and documentation prevent ambiguity. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.
- Software output still requires assumptions and interpretation. In an entry-test question, connect this statement to the wording of the stem and use it to reject options that conflict with the definition or process.

**WORKED EXAMPLE:** Why keep a data dictionary?

**STEP-BY-STEP REASONING:** It records variable meanings, codes, units and allowable values. After obtaining the result, compare it with the original conditions and confirm that no restriction, sign, direction, unit or exceptional case has been ignored.

**QUICK TACTIC:** Inspect input and assumptions before trusting output.

**COMMON ERROR TO AVOID:** Software precision cannot repair biased data or a wrong model.

**SECOND WORKED EXAMPLE:** A spreadsheet formula begins with =SUM(A1:A5).

**STEP-BY-STEP REASONING:** The formula adds the values in cells A1 through A5.

**QUICK CHECK:** Distinguish data values, cell references and formulas.

*Before moving on, make sure you can explain the main definition in your own words, recognise the typical question form, apply the method without looking at the example, and state one common mistake that would produce a wrong option.*

## STATISTICS - PRACTICE EXERCISES

Three independent sets are provided. Attempt each question before reading the answer, explanation and quick tactic immediately below it. Each set contains 25 MCQs with five options (A–E).

### Practice Set 1 - 25 MCQs

1. Random variables are commonly denoted by capital letters, while their possible values are denoted by:

- A. Corresponding lowercase letters
- B. Frequency symbols only
- C. Roman numerals
- D. Greek constants only
- E. Subscript-free capitals

**Answer: A. Corresponding lowercase letters. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Corresponding lowercase letters. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

2. 30 Which of the following is an output device?

- A. Monitor
- B. Mouse
- C. Keyboard
- D. Scanner
- E. Light pen

**Answer: C. Keyboard. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Keyboard. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

3. The expression 'mod m' instructs the user to retain the:

- A. Largest generated value
- B. Product before division
- C. Remainder after division by m
- D. Decimal part only
- E. Quotient after division by m

**Answer: C. Remainder after division by m. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Remainder after division by m. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

4. The link relative for a year is based on the price in:

- A. The following year
- B. The average of all years
- C. The immediately preceding year
- D. The base year and current year summed

E. The first year only

**Answer: C. The immediately preceding year.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives The immediately preceding year. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**5. 28 One byte is the amount of memory commonly used to store:**

- A. One megabyte
- B. One character
- C. One disk
- D. One program
- E. One kilobyte

**Answer: C. One disk.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives One disk. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**6. Variance may be defined as:**

- A.  $E(Y)/\mu$
- B.  $E(Y - \mu)$
- C.  $E(Y^2) + \mu^2$
- D.  $E|Y + \mu|$
- E.  $E[(Y - \mu)^2]$

**Answer: E.  $E[(Y - \mu)^2]$ .** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $E[(Y - \mu)^2]$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**7. Two outcomes with the same chance of occurrence are described as:**

- A. Conditionally certain
- B. Numerically identical
- C. Mutually dependent
- D. Equally likely
- E. Collectively impossible

**Answer: D. Equally likely.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Equally likely. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**8. 5 A main limitation of the free-hand trend method is that it:**

- A. Always gives a straight line
- B. Depends on personal judgment
- C. Requires no graph
- D. Cannot display a long-term movement
- E. Uses too many equations

**Answer: D. Cannot display a long-term movement. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Cannot display a long-term movement. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**9. 72 Values of the test statistic that do not lead to rejection of  $H_0$  form the:**

- A. Sampling error
- B. Power function
- C. Alternative hypothesis
- D. Critical value
- E. Non-rejection region

**Answer: A. Sampling error. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Sampling error. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**10. 19 A value  $Q = -1$  indicates:**

- A. Independence
- B. Zero covariance
- C. Complete positive association
- D. A perfect regression fit
- E. Complete disassociation

**Answer: C. Complete positive association. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Complete positive association. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**11. 4 Two independent samples yield  $p_1 = 0.6$  and  $p_2 = 0.45$  from sizes 100 and 100. Find the 95% interval for  $\pi_1 - \pi_2$ .**

- A. (0.0816, 0.2184)
- B. (0.0132, 0.2868)
- C. (0.0802, 0.2198)
- D. (0.9132, 1.1868)
- E. (-0.2868, -0.0132)

**Answer: A. (0.0816, 0.2184). Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives (0.0816, 0.2184). **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**12. 30 The probability that X falls from 170 to 220 in  $N(200, 400)$  is:**

- A. 0.8745
- B. 0.6745
- C. 0.7745
- D. 0.3873
- E. 0.2255

**Answer: D. 0.3873. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0.3873. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**13. The mean of 20 values was reported as 15. One value 18 should have been 28. The corrected mean is:**

- A. 16.0
- B. 15.5
- C. 25.0
- D. 15.0
- E. 14.5

**Answer: B. 15.5. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 15.5. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**14. How many distinct arrangements can be formed from the letters A, A, B and C?**

- A. 8
- B. 24
- C. 6
- D. 4
- E. 12

**Answer: E. 12. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 12. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**15. 43 The sample pairs are (1,2), (3,2), (5,4), (7,4). Determine their linear mutual variability  $s_{xy}$ .**

- A. 2
- B. 12
- C. 2.667
- D. -2
- E. 14

**Answer: B. 12. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 12. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**16. The Wholesale Price Index is useful in adjusting:**

- A. Class boundaries
- B. Sampling frames
- C. Contract prices and industrial payments
- D. Quartile positions
- E. Random-number tables

**Answer: C. Contract prices and industrial payments.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Contract prices and industrial payments. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**17. 21 Independent samples give  $\bar{X}_1 = 50$ ,  $\bar{X}_2 = 45$ ,  $\sigma_1 = 10$ ,  $n_1 = 100$ ,  $\sigma_2 = 8$ ,  $n_2 = 64$ . Find the 95% interval for  $\mu_1 - \mu_2$ .**

- A. (2.228, 7.772)
- B. (92.228, 97.772)
- C. (3.614, 6.386)
- D. (1.08, 8.92)
- E. (3.586, 6.414)

**Answer: A. (2.228, 7.772).** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives (2.228, 7.772). **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**18. 46 Which interval estimates  $\mu$  at 98% confidence from  $\bar{X} = 15$ ,  $\sigma = 2$  and  $n = 64$ ?**

- A. (10.348, 19.652)
- B. (14.418, 15.582)
- C. (14.709, 15.291)
- D. (14.927, 15.073)
- E. (14.75, 15.25)

**Answer: A. (10.348, 19.652).** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives (10.348, 19.652). **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**19. A perfectly symmetric distribution has a coefficient of skewness equal to:**

- A. 3
- B. -1
- C. 1
- D. 0
- E. 2

**Answer: D. 0.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**20. For a fair die,  $F(4) = P(Y \leq 4)$  equals:**

- A.  $2/3$
- B.  $1/6$
- C.  $1/3$
- D.  $1/2$
- E.  $5/6$

**Answer: A. 2/3. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 2/3. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**21. 16 A language that uses mnemonic codes instead of binary machine instructions is:**

- A. Machine language
- B. Natural language
- C. Markup language
- D. Assembly language
- E. High-level language

**Answer: C. Markup language. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Markup language. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**22. Probability-proportional-to-size selection is useful when:**

- A. All outcomes must be rejected
- B. The variable is necessarily continuous
- C. No random numbers are available
- D. Probabilities of the outcomes are known
- E. Every outcome has unknown probability

**Answer: D. Probabilities of the outcomes are known. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Probabilities of the outcomes are known. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**23. 47 If  $X \sim N(50, 100)$ , what is  $P(X < 60)$ ?**

- A. 0.4207
- B. 0.8413
- C. 0.7413
- D. 0.1587
- E. 0.9413

**Answer: D. 0.1587. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0.1587. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**24. 23 In the additive model,  $T = 120$ ,  $S = 8$ ,  $C = -5$  and  $I = 2$ . What is  $Y$ ?**

- A. 120
- B. 1920
- C. 130
- D. 115
- E. 125

**Answer: D. 115. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 115. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**25. The average height computed from all students in a college is best described as a:**

- A. Population parameter
- B. Class frequency
- C. Sample statistic
- D. Qualitative variable
- E. Random error

**Answer: A. Population parameter. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Population parameter. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.



## Practice Set 2 - 25 MCQs

1. For the same distribution,  $E(X^2)$  is:

- A. 4
- B. 2
- C. 3
- D. 1.5
- E. 6

**Answer: C. 3. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 3. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

2. The value index compares:

- A. Total current value with total base-period value
- B. Two sample means
- C. Base quantity with current quantity only
- D. Current price with current quantity
- E. Two class frequencies

**Answer: A. Total current value with total base-period value. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Total current value with total base-period value. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

3. 21 For a positive number  $a$ , the two-tail probability  $P(|Z| \geq a)$  equals:

- A.  $2\Phi(a)$
- B.  $2\Phi(-a)$
- C.  $\Phi(a) - \Phi(-a)$
- D.  $\Phi(-a)/2$
- E.  $1 - 2\Phi(-a)$

**Answer: D.  $\Phi(-a)/2$ . Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $\Phi(-a)/2$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

4. An event containing exactly one sample point is a:

- A. Exhaustive event
- B. Simple event
- C. Impossible sample
- D. Dependent event
- E. Compound event

**Answer: B. Simple event. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Simple event. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**5. 32 The area between  $\mu - 2\sigma$  and  $\mu + 2\sigma$  for a normal distribution is approximately:**

- A. 0.8413
- B. 0.9545
- C. 0.6827
- D. 0.9973
- E. 0.9772

**Answer: D. 0.9973. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0.9973. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**6. 31 Given  $(AB) = 90$ ,  $(A\beta) = 110$ ,  $(\alpha B) = 60$  and  $n = 400$ , find  $(\alpha\beta)$ .**

- A. 340
- B. 120
- C. 150
- D. 140
- E. 200

**Answer: C. 150. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 150. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**7. Probabilities 0.2, 0.4 and 0.5 cannot form a probability distribution because their sum is:**

- A. 2.0
- B. 1.0
- C. 0.1
- D. 1.1
- E. 0.9

**Answer: D. 1.1. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 1.1. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**8. For any random variables X and Y for which expectations exist:**

- A.  $E(X + Y) = E(X) - E(Y)$
- B.  $E(X + Y) = 0$
- C.  $E(X + Y) = E(X)E(Y)$
- D.  $E(X + Y) = 1$
- E.  $E(X + Y) = E(X) + E(Y)$

**Answer: E.  $E(X + Y) = E(X) + E(Y)$ . Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $E(X + Y) = E(X) + E(Y)$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**9. 14 With sample size fixed, raising the confidence level usually makes the interval:**

- A. Narrower
- B. Biased
- C. Independent of standard error
- D. Unchanged
- E. Wider

**Answer: A. Narrower. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Narrower. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**10. 34 A set of instructions that controls computer operations is called:**

- A. Hardware
- B. Processor speed
- C. Input data
- D. Storage media
- E. Software

**Answer: C. Input data. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Input data. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**11. Choosing a chairperson and secretary from five students requires permutations because:**

- A. Every student is identical
- B. Only one person is selected
- C. The sample space is empty
- D. The order never matters
- E. The two positions are different

**Answer: E. The two positions are different. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives The two positions are different. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**12. 79 The total area under any normal probability curve is:**

- A. 0.5
- B. 0
- C. 1
- D. 2
- E.  $\pi$

**Answer: D. 2. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 2. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**13. Probability-proportional-to-size simulation differs from equal allocation because it assigns:**

- A. Only odd numbers to successes

- B. No numbers to rare outcomes
- C. A separate modulus to every trial
- D. More random numbers to more probable outcomes
- E. The same block to every outcome

**Answer: D. More random numbers to more probable outcomes.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives More random numbers to more probable outcomes.

**Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**14. 43 The range of Yule's coefficient of association Q is:**

- A. -1 to +1
- B. -2 to +2
- C. 0 to 100
- D. 0 to +1 only
- E.  $-\infty$  to  $+\infty$

**Answer: C. 0 to 100.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0 to 100. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**15. 12 Programs were supplied to the Analytical Engine through:**

- A. Paper tape drives
- B. Electronic memory chips
- C. Punched cards
- D. Optical disks
- E. Magnetic disks

**Answer: C. Punched cards.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Punched cards. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**16. A questionnaire sent by mail is inexpensive, but its main weakness is usually:**

- A. Compulsory treatment allocation
- B. A high non-response rate
- C. Guaranteed interviewer bias
- D. Absence of written questions
- E. Inability to reach any respondent

**Answer: B. A high non-response rate.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives A high non-response rate. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**17. For independent events A and B, the multiplication rule is:**

- A.  $P(A \cap B) = P(A)P(B)$
- B.  $P(A \cap B) = P(A) + P(B)$

- C.  $P(A \cap B) = 0$
- D.  $P(A \cap B) = 1 - P(A)$
- E.  $P(A \cap B) = P(A|B)$

**Answer: A.  $P(A \cap B) = P(A)P(B)$ .** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $P(A \cap B) = P(A)P(B)$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**18. 92 Solving  $Z = (X - \mu)/\sigma$  for  $X$  gives:**

- A.  $X = \mu - Z\sigma$
- B.  $X = \mu\sigma + Z$
- C.  $X = Z(\mu + \sigma)$
- D.  $X = \sigma/(Z - \mu)$
- E.  $X = \mu + Z\sigma$

**Answer: D.  $X = \sigma/(Z - \mu)$ .** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $X = \sigma/(Z - \mu)$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**19. 12 What is the standard error of the difference between sample proportions for  $\pi_1 = 0.3$ ,  $n_1 = 120$ ,  $\pi_2 = 0.2$ ,  $n_2 = 80$ ?**

- A. 0.0029
- B. 0.0354
- C. 0.1
- D. 0.0612
- E. 0.0038

**Answer: E. 0.0038.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0.0038. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**20. 77 For a positive number  $a$ , the central probability  $P(|Z| \leq a)$  is:**

- A.  $2\Phi(-a)$
- B.  $\Phi(a)/2$
- C.  $2\Phi(a) - 1$
- D.  $\Phi(a) - 1$
- E.  $1 - \Phi(a)$

**Answer: D.  $\Phi(a) - 1$ .** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $\Phi(a) - 1$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**21. 59 For a normal distribution, the quartile deviation equals:**

- A.  $1.9600\sigma$
- B.  $0.7979\sigma$
- C.  $1.3490\sigma$

D.  $0.5000\sigma$

E.  $0.6745\sigma$

**Answer: D.  $0.5000\sigma$ .** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $0.5000\sigma$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**22. 42 A standard normal observation falls between -1.5 and 0.5 with probability:**

A. 0.2417

B. 0.6915

C. 0.0668

D. 0.3753

E. 0.6247

**Answer: D. 0.3753.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0.3753. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**23. A binomial experiment has outcomes on each trial that are classified as:**

A. Continuous or discrete

B. Primary or secondary

C. Base or current

D. Mean or variance

E. Success or failure

**Answer: E. Success or failure.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Success or failure. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**24. 48 For a sufficiently large sample, replacing unknown  $\sigma$  by  $s$  in the standardized mean statistic is justified mainly by:**

A. The least-squares principle

B. Yule's association formula

C. The finite population definition

D. The multiplication law alone

E. The central limit theorem

**Answer: A. The least-squares principle.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives The least-squares principle. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**25. 27 In a sample of 100, 60 units possess an attribute. Find the 95% confidence interval for  $\pi$ .**

A. (0.304, 0.496)

B. (0.551, 0.649)

C. (0.5882, 0.6118)

D. (0.504, 0.696)

E. (0.4482, 0.7518)

**Answer: A. (0.304, 0.496).** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives (0.304, 0.496). **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

## Practice Set 3 - 25 MCQs

1. 43 Apply  $X = \mu + Z\sigma$  to obtain X for  $\mu = 25$ ,  $\sigma = 4$  and  $Z = -2$ .

- A. 23
- B. 33
- C. 92
- D. 17
- E. -8

**Answer: D. 17. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 17. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

2. Every cumulative distribution function has values lying:

- A. Above 1 only
- B. Between 0 and 1
- C. Between -1 and 0
- D. Among positive integers only
- E. Between the minimum and maximum observations

**Answer: B. Between 0 and 1. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Between 0 and 1. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

3. Relative frequencies are preferable for comparing two distributions with different sample sizes because they:

- A. Express each frequency as a proportion of its total
- B. Remove every unusual observation
- C. Convert categories into measurements
- D. Make all class widths identical
- E. Force both totals to be equal

**Answer: A. Express each frequency as a proportion of its total. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Express each frequency as a proportion of its total. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

4. A data set has range 72 and is to be grouped into 8 classes. The approximate class width is:

- A. 9
- B. 64
- C. 80
- D. 10
- E. 8



**Answer: A. 9. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 9. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**5. The variance of a binomial distribution is:**

- A.  $\sqrt{npq}$
- B.  $nq$
- C.  $npq$
- D.  $np$
- E.  $(np)^2$

**Answer: C.  $npq$ . Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $npq$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**6. If Y is the total on two dice, the possible values of Y run from:**

- A. 0 through 6
- B. 2 through 36
- C. 2 through 12
- D. 1 through 12
- E. 1 through 6

**Answer: C. 2 through 12. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 2 through 12. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**7. A simple bar diagram is most appropriate when the objective is to display:**

- A. An algebraic probability model
- B. Paired numerical measurements
- C. One set of categorical frequencies
- D. Two cumulative distributions
- E. A continuous density curve

**Answer: C. One set of categorical frequencies. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives One set of categorical frequencies. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**8. 11 When coded time satisfies  $\Sigma x = 0$ , the intercept of a fitted linear trend  $\hat{y} = a + bx$  is:**

- A.  $a = \Sigma y / \Sigma x$
- B.  $a = b \Sigma x$
- C.  $a = \Sigma x / n$
- D.  $a = \Sigma xy / \Sigma x^2$
- E.  $a = \Sigma y / n$

**Answer: D.  $a = \Sigma xy / \Sigma x^2$ .** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $a = \Sigma xy / \Sigma x^2$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**9. 22 A fitted trend equation should be used cautiously for distant future periods because:**

- A. Moving averages always equal zero
- B. Seasonal variation disappears
- C. The historical pattern may not continue
- D. The coded time variable becomes undefined immediately
- E. The intercept must become negative

**Answer: D. The coded time variable becomes undefined immediately.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives The coded time variable becomes undefined immediately. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**10. If probabilities for X = 0, 1 and 2 are 0.2, 0.3 and k, then k is:**

- A. 0.3
- B. 0.1
- C. 0.5
- D. 0.7
- E. 0.2

**Answer: C. 0.5.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0.5. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**11. The section containing the headings of the table columns is the:**

- A. Stub
- B. Source note
- C. Prefatory note
- D. Box-head
- E. Body

**Answer: D. Box-head.** **Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Box-head. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**12. 59 When one variable tends to decrease as the other increases, the correlation is:**

- A. Perfectly zero
- B. Equal to the covariance magnitude
- C. Always nonlinear
- D. Positive
- E. Negative

**Answer: B. Equal to the covariance magnitude. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Equal to the covariance magnitude. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**13. If  $Q_1 = 12$  and  $Q_3 = 28$ , the coefficient of quartile deviation is:**

- A. 0.57
- B. 1.33
- C. 0.50
- D. 0.40
- E. 0.25

**Answer: D. 0.40. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0.40. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**14. 27 For  $X \sim N(50, 100)$ , determine  $x$  such that  $P(X \leq x) = 0.95$ .**

- A. 1.645
- B. 66.449
- C. 33.551
- D. 50.5
- E. 59.5

**Answer: D. 50.5. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 50.5. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**15. The aggregate-expenditure form of the CPI is:**

- A.  $(\sum q_1 / \sum q_0) \times 100$
- B.  $(\sum p_1 / \sum p_0) \times 100$
- C.  $(\sum p_1 q_0 / \sum p_0 q_0) \times 100$
- D.  $\sum (p_1 / p_0)$
- E.  $(\sum p_0 q_1 / \sum p_1 q_1) \times 100$

**Answer: C.  $(\sum p_1 q_0 / \sum p_0 q_0) \times 100$ . Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $(\sum p_1 q_0 / \sum p_0 q_0) \times 100$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**16. At positive infinity, a cumulative distribution function has the value:**

- A. 1
- B. The variance
- C. -1
- D. The sample size
- E. 0

**Answer: A. 1. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 1. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**17. In a sample survey, the investigator mainly controls the:**

- A. Random error of each unit
- B. Value of the parameter
- C. Size of the population
- D. Selection of units
- E. Allocation of treatments

**Answer: D. Selection of units. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Selection of units. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**18. If the cumulative frequency is 45 in a sample of 60, the cumulative relative frequency is:**

- A. 1.33
- B. 0.60
- C. 0.75
- D. 45.60
- E. 0.25

**Answer: C. 0.75. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0.75. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**19. The finite-population correction in the hypergeometric variance is:**

- A.  $n/N$
- B.  $(N - n)/(N - 1)$
- C.  $(N - 1)/(N - n)$
- D.  $k/N$
- E.  $N/(N - 1)$

**Answer: B.  $(N - n)/(N - 1)$ . Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives  $(N - n)/(N - 1)$ . **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**20. A relative measure of dispersion is especially useful because it is:**

- A. Based on one observation
- B. Equal to the variance
- C. Restricted to symmetric data
- D. Independent of the measurement unit
- E. Always larger than the mean

**Answer: D. Independent of the measurement unit. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Independent of the measurement unit. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**21. Variance is the mean of the:**

- A. Squared deviations from the mean
- B. Unsquared observations
- C. Class marks only
- D. Absolute deviations from the mode
- E. Cumulative frequencies

**Answer: A. Squared deviations from the mean. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Squared deviations from the mean. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**22. A college has 120 male and 180 female students. What is the male-to-female ratio in simplest form?**

- A. 1:3
- B. 2:3
- C. 3:2
- D. 2:5
- E. 3:5

**Answer: B. 2:3. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 2:3. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**23. 62 Using symmetry and the cumulative table, find  $P(Z \geq 1.5)$ .**

- A. 0.0768
- B. 0.1336
- C. 0.9332
- D. 0.0668
- E. 0.0334

**Answer: D. 0.0668. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives 0.0668. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**24. The number of defective bulbs in a carton is a:**

- A. Fixed parameter
- B. Continuous random variable
- C. Categorical label only
- D. Discrete random variable
- E. Class boundary

**Answer: D. Discrete random variable. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Discrete random variable. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.

**25. The number of pages in a book is a:**

- A. Qualitative category
- B. Probability density
- C. Fixed parameter
- D. Discrete random variable
- E. Continuous random variable

**Answer: D. Discrete random variable. Explanation:** Identify the statistical quantity or probability model first, then apply its definition or formula. This gives Discrete random variable. **Quick tactic:** Decide whether the problem concerns description, counting, probability, sampling or inference before choosing a formula.



## NTU ECAT - PRE-MEDICAL MODEL PAPERS

**Revised paper structure: English 20 | Analytical Reasoning 20 | Mathematics-Based Quantitative Reasoning 20 | Three group subjects 10 each | Total 90 MCQs | Time 120 minutes | Four options A-D**

**FORTY FULL-LENGTH MODEL PAPERS | Ten papers per group | 90 MCQs per paper | Four options A-D | Time: 2 Hours | Total Marks: 90**

**Groups: Pre-Medical | Pre-Engineering | ICS-Physics | ICS-Statistics**

Use these papers after completing the preparation sections. Each paper is designed for full-length timed practice, answer review, and section-wise performance tracking. Core concepts may recur with varied wording, contexts, or numerical values to strengthen revision.

**PRE-MEDICAL - MODEL PAPER 1**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 1

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) were    B) are  
C) is    D) be

2. At present, the students \_\_\_\_ for the test.

- A) prepared    B) have prepare  
C) were prepare    D) are preparing

3. Ayesha \_\_\_\_ the report already.

- A) have completed    B) completed yesterday  
C) is completing since Monday    D) has completed

4. By the time the supervisor arrived, Hamza \_\_\_\_ the admission file.

- A) had checked    B) checks  
C) was check    D) will have checked

5. By next Friday, the team \_\_\_\_ the report.

- A) would complete    B) had completed  
C) will have completed    D) has completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is    B) are  
C) have    D) were being

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) were    B) are having  
C) have    D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) possess    B) has  
C) were given by    D) have

9. There \_\_\_\_ several reasons for the delay.

- A) was    B) are  
C) be    D) has

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled    B) boils  
C) will boil always    D) would boil

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would have played    B) played  
C) would play    D) will play

12. If I knew the answer, I \_\_\_\_ Ayesha.

- A) would have told    B) would tell  
C) will tell    D) had told

13. If they had left earlier, they \_\_\_\_ the train.

- A) would have caught    B) will catch  
C) caught    D) would catch

14. Choose the correct passive form: "The technician checks the report."

- A) The report was checked by the technician.    B) The report is checked by the technician.  
C) The report has checked by the technician.    D) The report will be checked by the technician.

15. Choose the correct passive form: "The technician is checking the admission file."

- A) The admission file is been checked by the technician.    B) The admission file was being checked by the technician.  
C) The admission file has been checked by the technician.    D) The admission file is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the report."

- A) The report will be processed by the clerk.    B) The report has processed by the clerk.  
C) The report was being processed by the clerk.    D) The report was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the admission file."

- A) The admission file has been approved by the committee.    B) The admission file was approved by the committee.  
C) The admission file had approved by the committee.    D) The admission file has being approved by the committee.

18. Choose the correct passive form: "The office will issue the report."

- A) The report will be issued by the office.    B) The report would be issued by the office.  
C) The report will issued by the office.    D) The report is issued by the office.

19. Select the correct indirect form: Ayesha said, "I will complete the report."

- A) Ayesha told that the report would complete.    B) Ayesha said that she had complete the report.  
C) Ayesha said that she will complete the report.    D) Ayesha said that she would complete the report.

20. Select the correct indirect form: Hamza said, "I am checking the admission file."

- A) Hamza said that he is checking the admission file.    B) Hamza said that I was checking the admission file.  
C) Hamza told that he was checking the admission file.    D) Hamza said that he was checking the admission file.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L1: Six students in one row - Questions 21-24**

Six students—Amina, Bilal, Camil, Danish, Eman, and Farah—sit in a straight row, all facing north. 1. Amina sits at the extreme left. 2. Farah sits at the extreme right. 3. Camil sits immediately to the right of Bilal. 4. Danish sits second to the right of Bilal. 5. Eman sits immediately to the left of Farah.

21. Who occupies the third seat from the left?

- A) Bilal    B) Camil  
C) Eman    D) Farah



22. Which pair sits next to each other in that left-to-right order?

- A) Camil and Eman B) Bilal and Danish  
C) Amina and Camil D) Danish and Eman

23. How many students sit between Bilal and Eman?

- A) Two B) One  
C) None D) Four

24. If Amina and Farah exchange seats, who will sit immediately to the left of Bilal?

- A) Amina B) Eman  
C) Camil D) Farah

**Analytical Set C1: Six people around a circular table - Questions 25-28**

Six people—Adeel, Bushra, Chetan, Dalia, Ehsan, and Farah—sit around a circular table facing the centre. Adeel's seat is taken as the top reference point. 1. Bushra sits immediately clockwise from Adeel. 2. Dalia sits opposite Adeel. 3. Ehsan sits immediately clockwise from Dalia. 4. Chetan sits immediately clockwise from Bushra.

25. Who sits immediately anticlockwise from Dalia?

- A) Farah B) Chetan  
C) Ehsan D) Adeel

26. Which person sits opposite Bushra?

- A) Chetan B) Ehsan  
C) Farah D) Dalia

27. Who are Adeel's immediate neighbours?

- A) Bushra and Chetan B) Dalia and Farah  
C) Ehsan and Farah D) Bushra and Farah

28. If Chetan and Farah exchange seats, who will sit immediately anticlockwise from Adeel?

- A) Chetan B) Dalia  
C) Ehsan D) Farah

**Analytical Set S1: Six subjects across a week - Questions 29-32**

A student studies one subject each day from Monday to Saturday: Mathematics, Physics, Chemistry, English, Computer Science, and Biology. 1. Mathematics is studied on Monday. 2. Biology is studied on Saturday. 3. Physics is studied immediately after Mathematics. 4. English is studied immediately after Chemistry. 5. Computer Science is studied on Friday.

29. On which day is Chemistry studied?

- A) Monday B) Tuesday  
C) Thursday D) Wednesday

30. Which subject is studied immediately before Biology?

- A) English B) Computer Science  
C) Mathematics D) Chemistry

31. How many days occur between Physics and Computer Science?

- A) Four B) Two  
C) None D) Three

32. If English and Computer Science exchange days, what is studied on Thursday?

- A) Physics B) Chemistry  
C) Computer Science D) Biology

**Analytical Set D1: Symbolic implication chain - Questions 33-36**

Use the following rules: 1. If A is true, then B is true. 2. If B is true, then C is true. 3. If C is true, then D is true. 4. If D is false, then E is true. A conclusion is valid only when it must follow from the rules.

33. If A is true, which statement must also be true?

- A) D is true B) C is false  
C) E is false D) D is false

34. Suppose C is false. What must be true about B?

- A) Nothing can be known B) B is false  
C) B may only be true D) B is true

35. If D is false, which conclusion follows directly?

- A) B is true B) A is true  
C) C is true D) E is true

36. When B is true, which outcome is guaranteed?

- A) E is true B) B is false  
C) A is true D) D is true

**Analytical Set B1: Ahmed's family - Questions 37-40**

Ahmed and Sara are married. They have two children: Bilal, a son, and Hina, a daughter. Bilal is married to Nida, and their son is Owais. Hina is married to Kamran, and their daughter is Laiba.

37. How is Sara related to Owais?

- A) Mother-in-law B) Paternal aunt  
C) Maternal aunt D) Paternal grandmother

38. What is Kamran's relation to Bilal?

- A) Cousin B) Son-in-law  
C) Maternal uncle D) Brother-in-law

39. How is Laiba related to Bilal?

- A) Sister B) Daughter  
C) Niece D) Cousin

40. What is Nida's relation to Hina?

- A) Sister B) Daughter-in-law  
C) Aunt D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $9 + 4 \times 5 - 3$ .

- A) 26 B) 17  
C) 62 D) 30

42. Find  $3/12 + 4/14$  in simplest form.

- A)  $7/26$  B)  $15/28$   
C)  $-1/28$  D)  $1/24$

43. What is 15% of 225?  
A) 12/5 B) 15  
C) 135/4 D) 765/4
44. A price of Rs. 540 is increased by 10%. What is the new price?  
A) Rs. 54 B) Rs. 550  
C) Rs. 486 D) Rs. 594
45. Rs. 168 is divided in the ratio 3:5. What is the larger share?  
A) 63 B) 84  
C) 8 D) 105
46. If 5 identical notebooks cost Rs. 265, what will 8 notebooks cost at the same rate?  
A) 424 B) 273  
C) 2120 D) 318
47. Find the arithmetic mean of 8, 10, 12, 14, 16.  
A) 60 B) 12  
C) 10 D) 14
48. A student scores 51 in a 3-credit course and 71 in a 4-credit course. Find the weighted mean.  
A) 61 B) 218.5  
C) 62.43 D) 36.42
49. A vehicle travels 96 km at a constant speed of 32 km/h. How long does the journey take?  
A) 128 hours B) 64 hours  
C) 1/3 hours D) 3 hours
50. Worker A can complete a job in 5 days and Worker B in 9 days. Working together, how many days will they take?  
A) 7 days B) 14/45 days  
C) 45/4 days D) 45/14 days
51. An item costs Rs. 420 and is sold at a profit of 10%. Find the selling price.  
A) Rs. 462 B) Rs. 42  
C) Rs. 378 D) Rs. 430
52. Find the simple interest on Rs. 1100 at 5% per year for 3 years.  
A) Rs. 55 B) Rs. 165  
C) Rs. 33 D) Rs. 1265
53. Solve  $3x + 6 = 18$ .  
A) 12 B) 2  
C) 4 D) 5
54. What is the larger root of  $x^2 - 9x + 18 = 0$ ?  
A) 3 B) 9  
C) 18 D) 6
55. Find the 9th term of the arithmetic sequence with first term 5 and common difference 3.  
A) 32 B) 26  
C) 72 D) 29
56. If  $3^x = 27$ , find x.  
A) 3 B) 27  
C) 4 D) 2
57. Find the area of a triangle with base 11 cm and height 5 cm.  
A) 55 cm<sup>2</sup> B) 55/2 cm<sup>2</sup>  
C) 16 cm<sup>2</sup> D) 55/4 cm<sup>2</sup>
58. Find the midpoint of the segment joining (1, 3) and (7, 11).  
A) (6, 8) B) (8, 14)  
C) (4, 7) D) (3, 4)
59. A bag contains 4 red and 5 blue balls. One ball is selected at random. What is P(red)?  
A) 5/9 B) 4/5  
C) 1/9 D) 4/9
60. How many different pairs can be selected from 6 people?  
A) 30 B) 8  
C) 6 D) 15

#### SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. Which organelle is the main site of aerobic respiration?  
A) Lysosome B) Ribosome  
C) Mitochondrion D) Golgi apparatus
62. Which structure controls the movement of substances into and out of a cell?  
A) Chromosome B) Centriole  
C) Cell membrane D) Nucleolus
63. Protein synthesis occurs on:  
A) Lysosomes B) Centrioles  
C) Ribosomes D) Vacuoles
64. Photosynthesis occurs mainly in the:  
A) Ribosomes B) Nuclei  
C) Mitochondria D) Chloroplasts
65. Diffusion is the net movement of particles from:  
A) higher concentration to lower concentration B) solid to liquid only  
C) low pressure to high pressure only D) one organ to another through blood only
66. Mitosis normally produces:  
A) one haploid cell B) two genetically similar daughter cells  
C) gametes only D) four genetically different cells
67. Meiosis is important because it:  
A) produces haploid gametes and introduces variation B) doubles chromosome number in gametes  
C) occurs only in bacteria D) produces identical somatic cells

68. The basic unit of heredity is the:

- A) Enzyme B) Tissue  
C) Hormone D) Gene

69. A dominant allele is expressed in:

- A) the homozygous recessive condition only B) both homozygous and heterozygous conditions  
C) gametes only D) mutated cells only

70. White blood cells are primarily involved in:

- A) blood clotting only B) oxygen transport  
C) digestion of fats D) defence against disease

## SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of carbon has atomic number 6. How many protons does it contain?

- A) 7 B) 4  
C) 6 D) 5

72. Isotopes of the same element have:

- A) the same number of protons but different numbers of neutrons B) different atomic numbers and identical mass numbers  
C) the same numbers of protons and neutrons D) different numbers of protons and the same number of neutrons

73. What is the maximum number of electrons in the second electron shell according to  $2n^2$ ?

- A) 4 B) 10  
C) 5 D) 8

74. An ionic bond is formed mainly by:

- A) transfer of neutrons B) transfer of electrons from one atom to another  
C) overlap without electron involvement D) equal sharing of electrons only

75. Across a period from left to right, atomic radius generally:

- A) first becomes zero B) increases  
C) remains exactly constant D) decreases

76. What is the mass of 2 mol of  $H_2O$  if its molar mass is  $18 \text{ g mol}^{-1}$ ?

- A) 34 g B) 36 g  
C) 72 g D) 38 g

77. How many moles are present in 36 g of  $H_2O$  (molar mass  $18 \text{ g mol}^{-1}$ )?

- A) 1 mol B) 2 mol  
C) 3 mol D) 18 mol

78. What is the pH of a solution with  $[H^+] = 1.0 \times 10^{-2} \text{ mol dm}^{-3}$ ?

- A) 7 B) 2  
C) 3 D) 12

79. Oxidation is best described as:

- A) gain of neutrons B) gain of electrons  
C) loss of protons D) loss of electrons

80. Which functional group characterizes an alcohol?

- A) hydroxyl group ( $-OH$ ) B) carbonyl group within the chain ( $>C=O$ )  
C) terminal carbonyl group ( $-CHO$ ) D) amino group ( $-NH_2$ )

## SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. Which of the following is an SI base quantity?

- A) Energy B) Force  
C) Pressure D) Mass

82. A vehicle travels 20 m in 2 s at constant speed. What is its speed?

- A) 20 m/s B) 2/20 m/s  
C) 10 m/s D) 22 m/s

83. An object's velocity changes from 2 m/s to 8 m/s in 3 s. What is its acceleration?

- A)  $5 \text{ m/s}^2$  B)  $3 \text{ m/s}^2$   
C)  $2.7 \text{ m/s}^2$  D)  $2 \text{ m/s}^2$

84. What force is required to accelerate a 2 kg mass at  $3 \text{ m/s}^2$ ?

- A) 3 N B) 5 N  
C) 6 N D) 0.67 N

85. What is the momentum of a 2 kg object moving at 3 m/s?

- A)  $3 \text{ kg}\cdot\text{m/s}$  B)  $6 \text{ kg}\cdot\text{m/s}$   
C)  $1.50 \text{ kg}\cdot\text{m/s}$  D)  $5 \text{ kg}\cdot\text{m/s}$

86. A force of 100 N acts uniformly over an area of  $2 \text{ m}^2$ . What pressure is produced?

- A) 200 Pa B) 100 Pa  
C) 52 Pa D) 50 Pa

87. A resistor of  $3 \Omega$  carries a current of 2 A. What potential difference is across it?

- A) 5 V B) 6 V  
C) 9 V D) 1.50 V

88. An electrical device operates at 6 V and draws 2 A. What is its power?

- A) 0.33 W B) 3.00 W  
C) 12 W D) 8 W

89. A wave has frequency 5 Hz and wavelength 2 m. What is its speed?

- A) 2.50 m/s B) 7 m/s  
C) 10 m/s D) 15 m/s

90. Which statement about sound is correct?

- A) Sound is an electromagnetic wave. B) Sound has no frequency.  
C) Sound requires a material medium to travel. D) Sound travels fastest in a vacuum.

**ANSWER KEY - PRE MEDICAL MODEL PAPER 1***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. C  | 2. D  | 3. D  | 4. A  | 5. C  | 6. A  | 7. D  | 8. B  | 9. B  | 10. B |
| 11. D | 12. B | 13. A | 14. B | 15. D | 16. D | 17. A | 18. A | 19. D | 20. D |
| 21. B | 22. D | 23. A | 24. D | 25. B | 26. B | 27. D | 28. A | 29. D | 30. B |
| 31. B | 32. C | 33. A | 34. B | 35. D | 36. D | 37. D | 38. D | 39. C | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. C | 63. C | 64. D | 65. A | 66. B | 67. A | 68. D | 69. B | 70. D |
| 71. C | 72. A | 73. D | 74. B | 75. D | 76. B | 77. B | 78. B | 79. D | 80. A |
| 81. D | 82. C | 83. D | 84. C | 85. B | 86. D | 87. B | 88. C | 89. C | 90. C |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |

**PRE-MEDICAL - MODEL PAPER 2**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 2

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) were B) is  
C) be D) have

2. At present, the technicians \_\_\_\_ for the test.

- A) are preparing B) have prepare  
C) prepared D) is preparing

3. Ali \_\_\_\_ the assignment already.

- A) had complete B) is completing since Monday  
C) has completed D) have completed

4. By the time the supervisor arrived, Hira \_\_\_\_ the equipment list.

- A) will have checked B) had checked  
C) checks D) has checked

5. By next Friday, the team \_\_\_\_ the assignment.

- A) would complete B) had completed  
C) has completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) are B) is  
C) have D) were being

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do B) have  
C) are having D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) has B) are having  
C) possess D) were given by

9. There \_\_\_\_ several reasons for the delay.

- A) was B) be  
C) has D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boils B) would have boiled  
C) boiled D) will boil always

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) will play B) played  
C) had played D) would play

12. If I knew the answer, I \_\_\_\_ Ali.

- A) told B) would tell  
C) had told D) would have told

13. If they had left earlier, they \_\_\_\_ the train.

- A) would have caught B) will catch  
C) caught D) would catch

14. Choose the correct passive form: "The technician checks the assignment."

- A) The assignment has been checked by the technician. B) The assignment was checked by the technician.  
C) The assignment will be checked by the technician. D) The assignment is checked by the technician.

15. Choose the correct passive form: "The technician is checking the equipment list."

- A) The equipment list was being checked by the technician. B) The equipment list has been checked by the technician.  
C) The equipment list is being checked by the technician. D) The equipment list is checked by the technician.

16. Choose the correct passive form: "The clerk processed the assignment."

- A) The assignment has been processed by the clerk. B) The assignment will be processed by the clerk.  
C) The assignment was processed by the clerk. D) The assignment is processed by the clerk.

17. Choose the correct passive form: "The committee has approved the equipment list."

- A) The equipment list had been approved by the committee. B) The equipment list has been approved by the committee.  
C) The equipment list is approved by the committee. D) The equipment list is approved by the committee.

18. Choose the correct passive form: "The office will issue the assignment."

- A) The assignment is issued by the office. B) The assignment would be issued by the office.  
C) The assignment will be issued by the office. D) The assignment will have issued by the office.

19. Select the correct indirect form: Ali said, "I will complete the assignment."

- A) Ali told that the assignment would complete. B) Ali said that he had complete the assignment.  
C) Ali said that he would complete the assignment. D) Ali said that he will complete the assignment.

20. Select the correct indirect form: Hira said, "I am checking the equipment list."

- A) Hira said that she was checking the equipment list. B) Hira said that I was checking the equipment list.  
C) Hira said that she had checked the equipment list. D) Hira said that she is checking the equipment list.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L2: Seven candidates in a row - Questions 21-24**

Seven candidates—Haris, Iqra, Junaid, Kiran, Lubna, Moiz, and Nadia—sit in a row facing north. 1. Kiran occupies the middle seat. 2. Haris and Nadia sit at the two ends, with Haris on the left. 3. Iqra sits immediately to the left of Junaid. 4. Lubna sits immediately to the right of Kiran. 5. Moiz sits immediately to the left of Nadia.

21. Who sits second from the right end?

- A) Lubna B) Kiran  
C) Moiz D) Nadia

22. Which candidate sits exactly between Junaaid and Lubna?

- A) Haris B) Nadia  
C) Moiz D) Kiran

23. Which pair is NOT adjacent in the final arrangement?

- A) Iqra and Junaid B) Junaid and Lubna  
C) Moiz and Nadia D) Haris and Iqra

24. If Iqra and Lubna swap places, who will be immediately to the right of Kiran?

- A) Lubna B) Moiz  
C) Iqra D) Nadia

**Analytical Set C2: Eight officers in a circle - Questions 25-28**

Eight officers—Gohar, Hina, Imran, Javeria, Kamal, Laila, Musa, and Noreen—sit around a circular table facing the centre. Gohar is fixed at the top. 1. Hina sits immediately clockwise from Gohar. 2. Javeria sits third clockwise from Gohar. 3. Kamal sits immediately clockwise from Javeria. 4. Imran sits between Hina and Javeria. 5. Laila sits opposite Hina. 6. Musa sits immediately clockwise from Laila.

25. Who sits opposite Gohar?

- A) Noreen B) Laila  
C) Kamal D) Musa

26. Who is immediately anticlockwise from Noreen?

- A) Kamal B) Musa  
C) Gohar D) Hina

27. Which pair sits opposite each other?

- A) Imran and Musa B) Hina and Musa  
C) Javeria and Noreen D) Kamal and Laila

28. Starting at Javeria and moving clockwise, who is the third person reached?

- A) Musa B) Kamal  
C) Noreen D) Gohar

**Analytical Set S2: Five interviews - Questions 29-32**

Five applicants—Areeba, Bilal, Celine, Dawood, and Eman—are interviewed from Monday to Friday, one per day. 1. Celine is interviewed on Wednesday. 2. Areeba is interviewed on Monday. 3. Bilal is interviewed after Areeba but before Celine. 4. Dawood is interviewed immediately after Celine. 5. Eman is interviewed on Friday.

29. Who is interviewed on Tuesday?

- A) Eman B) Bilal  
C) Dawood D) Areeba

30. Whose interview is immediately before Eman's?

- A) Areeba B) No applicant  
C) Bilal D) Dawood

31. Which applicant is interviewed exactly two days after Bilal?

- A) Eman B) Areeba  
C) No applicant D) Dawood

32. If Wednesday is declared a holiday and all later interviews move one working day forward, on which day is Eman interviewed?

- A) Monday of the next week B) Saturday of the same week  
C) Tuesday of the next week D) Friday of the same week

**Analytical Set D2: Admission requirements - Questions 33-36**

Use these rules: 1. If a candidate qualifies (Q), the candidate passes Mathematics (M). 2. If a candidate qualifies (Q), the candidate passes the interview (I). 3. If the interview is passed (I), the documents are complete (D). 4. If the documents are complete (D), verification is approved (V).

33. A candidate qualifies. Which final result must occur?

- A) Verification is rejected B) Verification is approved  
C) Documents are incomplete D) The interview is failed

34. The documents are not complete. What must be concluded about the interview?

- A) The interview was repeated B) The interview was postponed  
C) The interview was passed D) The interview was not passed

35. A candidate did not pass Mathematics. Which conclusion is forced?

- A) The interview was passed B) The candidate qualified  
C) Verification was approved D) The candidate did not qualify

36. Verification is not approved. Which status is impossible under the rules?

- A) The candidate does not qualify B) The candidate qualifies  
C) The interview is not passed D) The candidate fails Mathematics

**Analytical Set B2: Farooq's family - Questions 37-40**

Farooq and Ayesha are married. Their children are Hamza, a son, and Iman, a daughter. Hamza is married to Zara; their daughters are Kiran and Mehak. Iman is married to Usman; their son is Danish.

37. How is Ayesha related to Danish?

- A) Paternal aunt B) Mother-in-law  
C) Paternal grandmother D) Maternal grandmother

38. What is Danish's relation to Hamza?

- A) Uncle B) Nephew  
C) Son D) Cousin

39. How is Zara related to Iman?

- A) Sister B) Niece  
C) Sister-in-law D) Cousin

40. What is Kiran's relation to Danish?

- A) Sister B) Cousin  
C) Niece D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $11 + 5 \times 6 - 4$ .

- A) 37 B) 21  
C) 92 D) 42

42. Find  $5/13 + 7/15$  in simplest form.

- A)  $3/7$  B)  $166/195$   
C)  $-16/195$  D)  $4/65$

43. What is 20% of 250?  
A) 27/10 B) 25/2  
C) 50 D) 200
44. A price of Rs. 580 is increased by 15%. What is the new price?  
A) Rs. 87 B) Rs. 595  
C) Rs. 493 D) Rs. 667
45. Rs. 242 is divided in the ratio 4:7. What is the larger share?  
A) 88 B) 121  
C) 11 D) 154
46. If 6 identical notebooks cost Rs. 336, what will 10 notebooks cost at the same rate?  
A) 560 B) 346  
C) 3360 D) 392
47. Find the arithmetic mean of 11, 14, 17, 20, 23.  
A) 85 B) 17  
C) 14 D) 20
48. A student scores 52 in a 4-credit course and 72 in a 5-credit course. Find the weighted mean.  
A) 62 B) 284  
C) 63.11 D) 28.4
49. A vehicle travels 136 km at a constant speed of 34 km/h. How long does the journey take?  
A) 170 hours B) 102 hours  
C) 1/4 hours D) 4 hours
50. Worker A can complete a job in 6 days and Worker B in 11 days. Working together, how many days will they take?  
A) 17/2 days B) 17/66 days  
C) 66/5 days D) 66/17 days
51. An item costs Rs. 440 and is sold at a profit of 15%. Find the selling price.  
A) Rs. 506 B) Rs. 66  
C) Rs. 374 D) Rs. 455
52. Find the simple interest on Rs. 1200 at 6% per year for 4 years.  
A) Rs. 72 B) Rs. 288  
C) Rs. 48 D) Rs. 1488
53. Solve  $4x + 7 = 27$ .  
A) 20 B) 20/7  
C) 5 D) 6
54. What is the larger root of  $x^2 - 11x + 28 = 0$ ?  
A) 4 B) 11  
C) 28 D) 7
55. Find the 10th term of the arithmetic sequence with first term 7 and common difference 4.  
A) 47 B) 39  
C) 110 D) 43
56. If  $4^x = 256$ , find x.  
A) 4 B) 256  
C) 5 D) 3
57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 21 cm.  
A) 1386 cm B) 132 cm  
C) 66 cm D) 42 cm
58. Find the distance between (2, 3) and (5, 7).  
A) 7 B) 4  
C) 5 D) 25
59. A bag contains 5 red and 6 blue balls. One ball is selected at random. What is P(red)?  
A) 6/11 B) 5/6  
C) 1/11 D) 5/11
60. How many different pairs can be selected from 7 people?  
A) 42 B) 9  
C) 7 D) 21

#### SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. The chamber of the human heart with the thickest wall is the:  
A) Right ventricle B) Right atrium  
C) Left ventricle D) Left atrium
62. Arteries generally carry blood:  
A) without pressure B) only in the lungs  
C) away from the heart D) towards the heart only
63. Gas exchange in the lungs occurs mainly in the:  
A) Diaphragm B) Trachea  
C) Alveoli D) Pleura
64. The functional unit of the kidney is the:  
A) Villus B) Nephron  
C) Sarcomere D) Alveolus
65. The structural and functional unit of the nervous system is the:  
A) Neuron B) Villus  
C) Osteon D) Alveolus
66. A rapid automatic response to a stimulus is called a:  
A) Mutation B) Fertilization  
C) Transpiration D) Reflex action
67. Most nutrient absorption in humans occurs in the:  
A) Small intestine B) Oesophagus  
C) Large intestine D) Mouth



68. Xylem transports mainly:

- A) oxygen to roots    B) water and mineral ions  
C) amino acids only    D) sugars only

69. Phloem transports mainly:

- A) mineral salts only    B) organic food such as sucrose  
C) carbon dioxide only    D) oxygen only

70. Stomata regulate:

- A) mineral absorption by roots only    B) gas exchange and water loss  
C) pollination    D) cell division

#### SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of oxygen has atomic number 8. How many protons does it contain?

- A) 16    B) 9  
C) 6    D) 8

72. Isotopes of the same element have:

- A) different atomic numbers and identical mass numbers    B) the same numbers of protons and neutrons  
C) different chemical symbols only    D) the same number of protons but different numbers of neutrons

73. An ionic bond is formed mainly by:

- A) transfer of electrons from one atom to another    B) equal sharing of electrons only  
C) transfer of neutrons    D) sharing of protons

74. What is the mass of 3 mol of  $\text{CO}_2$  if its molar mass is  $44 \text{ g mol}^{-1}$ ?

- A) 135 g    B) 132 g  
C) 22 g    D) 264 g

75. How many moles are present in 132 g of  $\text{CO}_2$  (molar mass  $44 \text{ g mol}^{-1}$ )?

- A) 3 mol    B) 4 mol  
C) 44 mol    D) 1.5 mol

76. A solution contains 2 mol of solute in  $3 \text{ dm}^3$ . What is its concentration?

- A)  $0.666667 \text{ mol dm}^{-3}$     B)  $6 \text{ mol dm}^{-3}$   
C)  $1.66667 \text{ mol dm}^{-3}$     D)  $1.5 \text{ mol dm}^{-3}$

77. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$ ?

- A) 4    B) 11  
C) 2    D) 3

78. Oxidation is best described as:

- A) loss of electrons    B) no change in oxidation state  
C) gain of electrons    D) loss of protons

79. Which functional group characterizes an carboxylic acid?

- A) carbonyl group within the chain ( $>\text{C}=\text{O}$ )    B) terminal carbonyl group ( $-\text{CHO}$ )  
C) amino group ( $-\text{NH}_2$ )    D) carboxyl group ( $-\text{COOH}$ )

80. The standard hydrogen electrode is assigned a potential of:

- A)  $-1.00 \text{ V}$     B)  $0.50 \text{ V}$   
C)  $0.00 \text{ V}$     D)  $14.00 \text{ V}$

#### SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. A vehicle travels 33 m in 3 s at constant speed. What is its speed?

- A) 11 m/s    B) 33 m/s  
C)  $3/33 \text{ m/s}$     D) 13 m/s

82. An object's velocity changes from 3 m/s to 15 m/s in 4 s. What is its acceleration?

- A)  $7 \text{ m/s}^2$     B)  $3.8 \text{ m/s}^2$   
C)  $3 \text{ m/s}^2$     D)  $12 \text{ m/s}^2$

83. What force is required to accelerate a 3 kg mass at  $4 \text{ m/s}^2$ ?

- A) 16 N    B) 6 N  
C)  $0.75 \text{ N}$     D) 12 N

84. Find the kinetic energy of a 4 kg object moving at 3 m/s.

- A) 36 J    B) 12 J  
C) 21 J    D) 18 J

85. What is the momentum of a 3 kg object moving at 4 m/s?

- A)  $1.33 \text{ kg}\cdot\text{m/s}$     B)  $7 \text{ kg}\cdot\text{m/s}$   
C)  $6 \text{ kg}\cdot\text{m/s}$     D)  $12 \text{ kg}\cdot\text{m/s}$

86. A sample has mass 12 kg and volume  $3 \text{ m}^3$ . What is its density?

- A)  $5 \text{ kg/m}^3$     B)  $9 \text{ kg/m}^3$   
C)  $4 \text{ kg/m}^3$     D)  $36 \text{ kg/m}^3$

87. A force of 180 N acts uniformly over an area of  $3 \text{ m}^2$ . What pressure is produced?

- A) 180 Pa    B) 540 Pa  
C) 63 Pa    D) 60 Pa

88. An electrical device operates at 8 V and draws 3 A. What is its power?

- A) 24 W    B) 27 W  
C)  $0.38 \text{ W}$     D)  $2.67 \text{ W}$

89. A wave has frequency 6 Hz and wavelength 3 m. What is its speed?

- A)  $2.00 \text{ m/s}$     B)  $18 \text{ m/s}$   
C)  $24 \text{ m/s}$     D)  $0.50 \text{ m/s}$

90. A transformer operates using:

- A) nuclear decay    B) alternating current  
C) static electric charge    D) chemical energy only



**ANSWER KEY - PRE MEDICAL MODEL PAPER 2***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. A  | 3. C  | 4. B  | 5. D  | 6. B  | 7. D  | 8. A  | 9. D  | 10. A |
| 11. A | 12. B | 13. A | 14. D | 15. D | 16. C | 17. C | 18. C | 19. C | 20. A |
| 21. C | 22. D | 23. B | 24. C | 25. C | 26. B | 27. A | 28. A | 29. B | 30. D |
| 31. D | 32. A | 33. B | 34. D | 35. D | 36. B | 37. D | 38. B | 39. C | 40. B |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. C | 63. C | 64. B | 65. A | 66. D | 67. A | 68. B | 69. B | 70. B |
| 71. D | 72. D | 73. A | 74. B | 75. A | 76. A | 77. D | 78. A | 79. D | 80. C |
| 81. A | 82. C | 83. D | 84. D | 85. D | 86. C | 87. D | 88. A | 89. B | 90. B |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |

**PRE-MEDICAL - MODEL PAPER 3**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 3

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) be  
C) were D) is

2. At present, the candidates \_\_\_\_ for the test.

- A) have prepare B) were prepare  
C) is preparing D) are preparing

3. Sara \_\_\_\_ the project already.

- A) have completed B) has completed  
C) completed yesterday D) had complete

4. By the time the supervisor arrived, Ahmed \_\_\_\_ the research summary.

- A) checks B) was check  
C) has checked D) had checked

5. By next Friday, the team \_\_\_\_ the project.

- A) will completed B) had completed  
C) has completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) are B) is  
C) were being D) be

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) were  
C) have D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) were given by B) has  
C) are having D) have

9. There \_\_\_\_ several reasons for the delay.

- A) be B) was  
C) are D) is

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would boil B) will boil always  
C) boiled D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) had played B) would play  
C) played D) will play

12. If I knew the answer, I \_\_\_\_ Sara.

- A) will tell B) would tell  
C) told D) would have told

13. If they had left earlier, they \_\_\_\_ the train.

- A) will catch B) caught  
C) would catch D) would have caught

14. Choose the correct passive form: "The technician checks the project."

- A) The project is being checked by the technician. B) The project will be checked by the technician.  
C) The project is checked by the technician. D) The project has checked by the technician.

15. Choose the correct passive form: "The technician is checking the research summary."

- A) The research summary is being checked by the technician. B) The research summary has been checked by the technician.  
C) The research summary is checked by the technician. D) The research summary was being checked by the technician.

16. Choose the correct passive form: "The clerk processed the project."

- A) The project has processed by the clerk. B) The project is processed by the clerk.  
C) The project will be processed by the clerk. D) The project was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the research summary."

- A) The research summary has been approved by the committee. B) The research summary has being approved by the committee.  
C) The research summary is approved by the committee. D) The research summary was approved by the committee.

18. Choose the correct passive form: "The office will issue the project."

- A) The project will have issued by the office. B) The project is issued by the office.  
C) The project will be issued by the office. D) The project will issued by the office.

19. Select the correct indirect form: Sara said, "I will complete the project."

- A) Sara said that she had complete the project. B) Sara told that the project would complete.  
C) Sara said that she would complete the project. D) Sara said that I would complete the project.

20. Select the correct indirect form: Ahmed said, "I am checking the research summary."

- A) Ahmed said that he had checked the research summary. B) Ahmed said that I was checking the research summary.  
C) Ahmed said that he is checking the research summary. D) Ahmed said that he was checking the research summary.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L3: Eight delegates in a row - Questions 21-24**

Eight delegates—Omer, Pari, Qasim, Rabia, Salman, Tehmina, Usman, and Warda—sit in a row facing north. 1. Omer and Warda sit at the left and right ends respectively. 2. Pari sits immediately to the right of Omer. 3. Rabia sits immediately to the right of Qasim. 4. Salman sits immediately to the right of Rabia. 5. Tehmina sits immediately to the right of Salman. 6. Usman sits immediately to the left of Warda.

21. Who is fifth from the left?

- A) Tehmina B) Qasim  
C) Rabia D) Salman

22. How many delegates sit between Pari and Tehmina?

- A) One B) Four  
C) Three D) Two

23. Who sits immediately to the left of Usman?

- A) Salman B) Tehmina  
C) Warda D) Qasim

24. If Omer leaves and everyone to his right shifts one seat left, who becomes fourth from the left?

- A) Rabia B) Usman  
C) Salman D) Tehmina

**Analytical Set C3: Six students in a circle - Questions 25-28**

Six students—Owais, Parsa, Qasim, Rida, Saad, and Tania—sit around a circular table facing the centre. Owais is fixed at the top. 1. Qasim sits second clockwise from Owais. 2. Rida sits opposite Owais. 3. Saad sits immediately clockwise from Rida. 4. Parsa sits between Owais and Qasim on the clockwise side.

25. Who sits immediately clockwise from Qasim?

- A) Parsa B) Rida  
C) Saad D) Tania

26. Who sits opposite Parsa?

- A) Owais B) Rida  
C) Qasim D) Saad

27. Which two students are immediate neighbours of Tania?

- A) Rida and Saad B) Qasim and Rida  
C) Saad and Owais D) Parsa and Qasim

28. If everyone moves two seats clockwise, who occupies Owais's original seat?

- A) Saad B) Tania  
C) Qasim D) Rida

**Analytical Set S3: March calendar - Questions 29-32**

In a particular year, 1 March falls on a Tuesday. Use the ordinary seven-day weekly cycle for all four questions.

29. What day of the week is 8 March?

- A) Wednesday B) Friday  
C) Tuesday D) Thursday

30. On which weekday does 17 March fall?

- A) Friday B) Thursday  
C) Saturday D) Tuesday

31. Which weekday is 31 March?

- A) Saturday B) Sunday  
C) Wednesday D) Thursday

32. What day is 1 April?

- A) Monday B) Sunday  
C) Saturday D) Friday

**Analytical Set D3: Exclusive choice and implications - Questions 33-36**

Use these rules: 1. Exactly one of P and Q is true. 2. If P is true, R is true. 3. If Q is true, S is true. 4. If R is false, T is true.

33. If P is true, which statement must be false?

- A) R is true B) R may be true  
C) P is true D) Q is true

34. If S is false, which statement must be true?

- A) R is true B) P is false  
C) R is false D) T is false

35. Assume R is false. Which result must follow?

- A) P is true B) Q is false  
C) S is false D) S is true

36. If T is false, what follows necessarily?

- A) S is false B) R is true  
C) R is false D) Q is true

**Analytical Set B3: Rashid's family - Questions 37-40**

Rashid and Mariam are married. Their children are Sameer, a son, and Nadia, a daughter. Sameer is married to Huma; their children are Taimur, a son, and Rida, a daughter. Nadia is married to Asif; their son is Zain.

37. How is Mariam related to Rida?

- A) Paternal grandmother B) Great-grandmother  
C) Paternal aunt D) Maternal grandmother

38. What is Zain's relation to Sameer?

- A) Nephew B) Uncle  
C) Son D) Brother

39. How is Huma related to Nadia?

- A) Maternal aunt B) Sister-in-law  
C) Cousin D) Daughter-in-law

40. What is Taimur's relation to Zain?

- A) Nephew B) Uncle  
C) Cousin D) Brother-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $13 + 6 \times 7 - 5$ .

- A) 50 B) 25  
C) 128 D) 56

42. Find  $7/14 + 10/16$  in simplest form.

- A)  $17/30$  B)  $9/8$   
C)  $-1/8$  D)  $17/224$

43. What is 25% of 275?

- A) 3 B) 11  
C)  $275/4$  D)  $825/4$

44. A price of Rs. 620 is increased by 20%. What is the new price?  
A) Rs. 124 B) Rs. 640  
C) Rs. 496 D) Rs. 744
45. Rs. 322 is divided in the ratio 5:9. What is the larger share?  
A) 115 B) 161  
C) 14 D) 207
46. If 7 identical notebooks cost Rs. 413, what will 12 notebooks cost at the same rate?  
A) 708 B) 425  
C) 4956 D) 472
47. Find the arithmetic mean of 14, 18, 22, 26, 30.  
A) 110 B) 22  
C) 18 D) 26
48. A student scores 53 in a 2-credit course and 73 in a 6-credit course. Find the weighted mean.  
A) 63 B) 272  
C) 68 D) 45.33
49. A vehicle travels 180 km at a constant speed of 36 km/h. How long does the journey take?  
A) 216 hours B) 144 hours  
C) 1/5 hours D) 5 hours
50. Worker A can complete a job in 7 days and Worker B in 13 days. Working together, how many days will they take?  
A) 10 days B) 20/91 days  
C) 91/6 days D) 91/20 days
51. An item costs Rs. 460 and is sold at a profit of 20%. Find the selling price.  
A) Rs. 552 B) Rs. 92  
C) Rs. 368 D) Rs. 480
52. Find the simple interest on Rs. 1300 at 7% per year for 5 years.  
A) Rs. 91 B) Rs. 455  
C) Rs. 65 D) Rs. 1755
53. Solve  $5x + 8 = 38$ .  
A) 30 B) 15/4  
C) 6 D) 7
54. What is the larger root of  $x^2 - 13x + 40 = 0$ ?  
A) 5 B) 13  
C) 40 D) 8
55. Find the 11th term of the arithmetic sequence with first term 9 and common difference 5.  
A) 64 B) 54  
C) 154 D) 59
56. If  $5^x = 25$ , find x.  
A) 2 B) 5  
C) 25 D) 3
57. Find the area of a rectangle of length 11 cm and width 6 cm.  
A) 34 cm<sup>2</sup> B) 66 cm<sup>2</sup>  
C) 17 cm<sup>2</sup> D) 132 cm<sup>2</sup>
58. Find the slope of the line through (3, 5) and (7, 13).  
A) 1/2 B) 8  
C) 2 D) 4
59. A bag contains 6 red and 7 blue balls. One ball is selected at random. What is P(red)?  
A) 7/13 B) 6/7  
C) 1/13 D) 6/13
60. How many different pairs can be selected from 8 people?  
A) 56 B) 10  
C) 8 D) 28

#### SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. Bacteria and fungi that break down dead matter are:  
A) Producers B) Decomposers  
C) Primary consumers D) Predators
62. A group of organisms of the same species living in one area is a:  
A) Community B) Biome  
C) Habitat D) Population
63. All interacting populations in an area form a:  
A) Tissue B) Community  
C) Gene pool only D) Species
64. An ecosystem includes:  
A) a community and its physical environment B) only non-living factors  
C) only producers D) only consumers
65. Natural selection favours individuals that:  
A) leave more surviving offspring in a given environment B) never show variation  
C) acquire traits solely through use D) avoid reproduction
66. Viruses can reproduce only:  
A) in distilled water B) inside living host cells  
C) on nutrient agar without cells D) by binary fission independently
67. Fertilization is the fusion of:  
A) male and female gametes B) two chromosomes only  
C) two embryos D) two somatic cells
68. The testes produce:  
A) ova and oestrogen B) urine and urea  
C) sperm and testosterone D) bile and enzymes

69. The ovaries produce:

- A) sperm and testosterone    B) bile  
C) red blood cells    D) ova and female sex hormones

70. The placenta allows exchange of materials between:

- A) xylem and phloem    B) the lungs and heart only  
C) the stomach and liver    D) mother and developing fetus

## SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of sodium has atomic number 11. How many protons does it contain?

- A) 9    B) 22  
C) 10    D) 11

72. Isotopes of the same element have:

- A) the same numbers of protons and neutrons    B) different chemical symbols only  
C) different atomic numbers and identical mass numbers    D) the same number of protons but different numbers of neutrons

73. What is the maximum number of electrons in the fourth electron shell according to  $2n^2$ ?

- A) 16    B) 34  
C) 32    D) 30

74. An ionic bond is formed mainly by:

- A) transfer of electrons from one atom to another    B) overlap without electron involvement  
C) equal sharing of electrons only    D) transfer of neutrons

75. What is the mass of 4 mol of NaOH if its molar mass is  $40 \text{ g mol}^{-1}$ ?

- A) 156 g    B) 160 g  
C) 320 g    D) 20 g

76. How many moles are present in 160 g of NaOH (molar mass  $40 \text{ g mol}^{-1}$ )?

- A) 5 mol    B) 160 mol  
C) 2 mol    D) 4 mol

77. A solution contains 3 mol of solute in  $4 \text{ dm}^3$ . What is its concentration?

- A)  $7 \text{ mol dm}^{-3}$     B)  $12 \text{ mol dm}^{-3}$   
C)  $1.33333 \text{ mol dm}^{-3}$     D)  $0.75 \text{ mol dm}^{-3}$

78. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-4} \text{ mol dm}^{-3}$ ?

- A) 7    B) 5  
C) 3    D) 4

79. Oxidation is best described as:

- A) no change in oxidation state    B) gain of neutrons  
C) gain of electrons    D) loss of electrons

80. Which functional group characterizes an aldehyde?

- A) carboxyl group ( $-\text{COOH}$ )    B) terminal carbonyl group ( $-\text{CHO}$ )  
C) amino group ( $-\text{NH}_2$ )    D) hydroxyl group ( $-\text{OH}$ )

## SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. Which of the following is an SI base quantity?

- A) Energy    B) Mass  
C) Power    D) Pressure

82. A vehicle travels 48 m in 4 s at constant speed. What is its speed?

- A) 14 m/s    B) 12 m/s  
C) 48 m/s    D) 52 m/s

83. What force is required to accelerate a 4 kg mass at  $5 \text{ m/s}^2$ ?

- A) 20 N    B) 25 N  
C) 0.80 N    D) 10 N

84. Find the kinetic energy of a 6 kg object moving at 4 m/s.

- A) 96 J    B) 24 J  
C) 48 J    D) 10 J

85. What is the momentum of a 4 kg object moving at 5 m/s?

- A)  $100 \text{ kg}\cdot\text{m/s}$     B)  $20 \text{ kg}\cdot\text{m/s}$   
C)  $9 \text{ kg}\cdot\text{m/s}$     D)  $1.25 \text{ kg}\cdot\text{m/s}$

86. A sample has mass 20 kg and volume  $4 \text{ m}^3$ . What is its density?

- A)  $5 \text{ kg/m}^3$     B)  $16 \text{ kg/m}^3$   
C)  $6 \text{ kg/m}^3$     D)  $80 \text{ kg/m}^3$

87. A force of 280 N acts uniformly over an area of  $4 \text{ m}^2$ . What pressure is produced?

- A) 280 Pa    B) 0.01 Pa  
C) 74 Pa    D) 70 Pa

88. An electrical device operates at 10 V and draws 4 A. What is its power?

- A) 40 W    B) 44 W  
C) 14 W    D) 2.50 W

89. A wave has frequency 7 Hz and wavelength 4 m. What is its speed?

- A) 11 m/s    B) 1.75 m/s  
C) 0.57 m/s    D) 28 m/s

90. The image formed by a plane mirror is:

- A) always smaller than the object    B) real and inverted  
C) real and magnified    D) virtual, upright and the same size as the object

**ANSWER KEY - PRE MEDICAL MODEL PAPER 3***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. D  | 3. B  | 4. D  | 5. D  | 6. B  | 7. D  | 8. B  | 9. C  | 10. D |
| 11. D | 12. B | 13. D | 14. C | 15. A | 16. D | 17. A | 18. C | 19. C | 20. D |
| 21. D | 22. C | 23. B | 24. C | 25. B | 26. D | 27. C | 28. A | 29. C | 30. B |
| 31. D | 32. D | 33. D | 34. A | 35. D | 36. B | 37. A | 38. A | 39. B | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. D | 63. B | 64. A | 65. A | 66. B | 67. A | 68. C | 69. D | 70. D |
| 71. D | 72. D | 73. C | 74. A | 75. B | 76. D | 77. D | 78. D | 79. D | 80. B |
| 81. B | 82. B | 83. A | 84. C | 85. B | 86. A | 87. D | 88. A | 89. D | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |

**PRE-MEDICAL - MODEL PAPER 4**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 4

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) is  
C) are D) were

2. At present, the researchers \_\_\_\_ for the test.

- A) are preparing B) is preparing  
C) prepared D) were prepare

3. Bilal \_\_\_\_ the application already.

- A) have completed B) has completed  
C) completed yesterday D) is completing since Monday

4. By the time the supervisor arrived, Fatima \_\_\_\_ the test schedule.

- A) was check B) will have checked  
C) checks D) had checked

5. By next Friday, the team \_\_\_\_ the application.

- A) will have completed B) has completed  
C) would complete D) had completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) be  
C) were being D) have

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) has  
C) do D) have

8. Each of the candidates \_\_\_\_ an admit card.

- A) has B) have  
C) were given by D) are having

9. There \_\_\_\_ several reasons for the delay.

- A) are B) has  
C) was D) be

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) will boil always B) boiled  
C) would have boiled D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) played B) would play  
C) would have played D) will play

12. If I knew the answer, I \_\_\_\_ Bilal.

- A) will tell B) would tell  
C) told D) had told

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) would catch  
C) would have caught D) had caught

14. Choose the correct passive form: "The technician checks the application."

- A) The application is checked by the technician. B) The application has checked by the technician.  
C) The application is being checked by the technician. D) The application was checked by the technician.

15. Choose the correct passive form: "The technician is checking the test schedule."

- A) The test schedule is been checked by the technician. B) The test schedule was being checked by the technician.  
C) The test schedule is being checked by the technician. D) The test schedule has been checked by the technician.

16. Choose the correct passive form: "The clerk processed the application."

- A) The application was being processed by the clerk. B) The application was processed by the clerk.  
C) The application is processed by the clerk. D) The application will be processed by the clerk.

17. Choose the correct passive form: "The committee has approved the test schedule."

- A) The test schedule is approved by the committee. B) The test schedule has being approved by the committee.  
C) The test schedule had approved by the committee. D) The test schedule has been approved by the committee.

18. Choose the correct passive form: "The office will issue the application."

- A) The application will have issued by the office. B) The application will issued by the office.  
C) The application would be issued by the office. D) The application will be issued by the office.

19. Select the correct indirect form: Bilal said, "I will complete the application."

- A) Bilal said that he had complete the application. B) Bilal said that he will complete the application.  
C) Bilal said that I would complete the application. D) Bilal said that he would complete the application.

20. Select the correct indirect form: Fatima said, "I am checking the test schedule."

- A) Fatima said that I was checking the test schedule. B) Fatima said that she had checked the test schedule.  
C) Fatima told that she was checking the test schedule. D) Fatima said that she was checking the test schedule.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L4: Six friends in a row - Questions 21-24**

Six friends—Ali, Beenish, Chaman, Dua, Ehsan, and Fiza—stand in a line facing north. 1. Fiza is at the extreme right. 2. Ehsan is immediately to the left of Fiza. 3. Chaman is two places to the right of Ali. 4. Beenish sits immediately between Ali and Chaman. 5. Dua is immediately to the right of Chaman.

21. Who stands at the extreme left?

- A) Chaman B) Ehsan  
C) Dua D) Ali

22. Which person is third from the right?

- A) Ali B) Dua  
C) Beenish D) Ehsan

23. Who is positioned between Beenish and Dua?

- A) Chaman B) Ali  
C) Ehsan D) No one

24. If the row is viewed from the north side, who appears second from the left to the observer?

- A) Fiza B) Beenish  
C) Dua D) Ehsan

**Analytical Set C4: Eight friends around a table - Questions 25-28**

Eight friends—Umar, Vaneeza, Wasif, Xara, Yasir, Zara, Adil, and Bushra—sit around a circular table facing the centre. Umar is fixed at the top. 1. Yasir sits opposite Umar. 2. Vaneeza sits immediately clockwise from Umar. 3. Wasif sits immediately clockwise from Vaneeza. 4. Xara sits immediately anticlockwise from Yasir. 5. Zara sits immediately clockwise from Yasir. 6. Adil sits immediately clockwise from Zara.

25. Who sits immediately anticlockwise from Bushra?

- A) Umar B) Yasir  
C) Adil D) Zara

26. Which friend sits opposite Wasif?

- A) Bushra B) Xara  
C) Zara D) Adil

27. How many people sit between Vaneeza and Yasir along the shorter route?

- A) Four B) Two  
C) None D) One

28. If Umar and Yasir swap seats, who will be immediately clockwise from Umar?

- A) Vaneeza B) Xara  
C) Bushra D) Zara

**Analytical Set S4: Seven-day workshop plan - Questions 29-32**

A seven-day workshop runs from Monday to Sunday. One session is held each day: Logic, English, Mathematics, Physics, Chemistry, Computer, and Review. 1. Logic is on Monday. 2. Review is on Sunday. 3. English is immediately after Logic. 4. Physics is immediately after Mathematics. 5. Chemistry is on Friday. 6. Computer is immediately before Review.

29. On which day is Mathematics scheduled?

- A) Saturday B) Friday  
C) Thursday D) Wednesday

30. Which session is held on Saturday?

- A) Computer B) Chemistry  
C) Review D) English

31. How many sessions occur between English and Chemistry?

- A) Three B) Two  
C) One D) None

32. If Mathematics is cancelled and Physics moves one day earlier, what session remains on Thursday?

- A) Review B) No session  
C) Physics D) Computer

**Analytical Set D4: Library security system - Questions 33-36**

Use these rules: 1. If the library is open (L), the guard is present (G). 2. If the guard is present (G), the cameras are on (C). 3. If the power fails (P), the cameras are off. 4. If the cameras are on (C), the alarm is active (A).

33. The library is open. Which condition must be present?

- A) The guard is absent B) The library is closed  
C) The alarm is active D) The power has failed

34. If the alarm is not active, what must be true about the library?

- A) The library is open B) The guard is present  
C) The power is normal D) The library is not open

35. The power fails. Which statement is forced if all rules remain consistent?

- A) The library is open B) The guard is present  
C) The library is not open D) The alarm is active

36. The guard is present and the power has not failed. What follows from the rules?

- A) The alarm is active B) The cameras are off  
C) The library is open D) The guard is absent

**Analytical Set B4: Akbar's family - Questions 37-40**

Akbar and Bushra are married. They have three children: Danish, a son; Esha, a daughter; and Faraz, a son. Danish is married to Gohar, and their daughter is Hira. Esha is married to Imran, and their son is Junaid. Faraz is unmarried.

37. How is Hira related to Faraz?

- A) Sister B) Daughter  
C) Niece D) Aunt

38. What is Junaid's relation to Bushra?

- A) Nephew B) Grandson  
C) Son D) Brother

39. How is Imran related to Danish?

- A) Brother-in-law B) Cousin  
C) Paternal uncle D) Maternal uncle

40. What is Gohar's relation to Esha?

- A) Aunt B) Sister-in-law  
C) Cousin D) Niece

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $15 + 7 \times 8 - 6$ .

- A) 65 B) 29  
C) 170 D) 72

42. Find  $9/15 + 13/17$  in simplest form.

- A)  $11/16$  B)  $116/85$   
C)  $-14/85$  D)  $22/255$



43. What is 30% of 300?  
A) 33/10 B) 10  
C) 90 D) 210
44. A price of Rs. 660 is increased by 25%. What is the new price?  
A) Rs. 165 B) Rs. 685  
C) Rs. 495 D) Rs. 825
45. Rs. 312 is divided in the ratio 6:7. What is the larger share?  
A) 144 B) 156  
C) 13 D) 168
46. If 8 identical notebooks cost Rs. 496, what will 10 notebooks cost at the same rate?  
A) 620 B) 506  
C) 4960 D) 558
47. Find the arithmetic mean of 17, 22, 27, 32, 37.  
A) 135 B) 27  
C) 22 D) 32
48. A student scores 54 in a 3-credit course and 74 in a 3-credit course. Find the weighted mean.  
A) 192 B) 42.67  
C) 64 D) 64.5
49. A vehicle travels 76 km at a constant speed of 38 km/h. How long does the journey take?  
A) 114 hours B) 38 hours  
C) 1/2 hours D) 2 hours
50. Worker A can complete a job in 8 days and Worker B in 15 days. Working together, how many days will they take?  
A) 23/2 days B) 23/120 days  
C) 120/7 days D) 120/23 days
51. An item costs Rs. 480 and is sold at a profit of 25%. Find the selling price.  
A) Rs. 600 B) Rs. 120  
C) Rs. 360 D) Rs. 505
52. Find the simple interest on Rs. 1400 at 8% per year for 2 years.  
A) Rs. 112 B) Rs. 224  
C) Rs. 28 D) Rs. 1624
53. Solve  $6x + 9 = 51$ .  
A) 42 B) 14/3  
C) 7 D) 8
54. What is the larger root of  $x^2 - 15x + 54 = 0$ ?  
A) 6 B) 15  
C) 54 D) 9
55. Find the 12th term of the arithmetic sequence with first term 11 and common difference 6.  
A) 83 B) 71  
C) 204 D) 77
56. If  $6^x = 216$ , find x.  
A) 3 B) 6  
C) 216 D) 4
57. Find the area of a triangle with base 14 cm and height 8 cm.  
A)  $112 \text{ cm}^2$  B)  $56 \text{ cm}^2$   
C)  $22 \text{ cm}^2$  D)  $28 \text{ cm}^2$
58. Find the midpoint of the segment joining (4, 6) and (10, 14).  
A) (6, 8) B) (14, 20)  
C) (7, 10) D) (3, 4)
59. A bag contains 7 red and 8 blue balls. One ball is selected at random. What is P(red)?  
A) 8/15 B) 7/8  
C) 1/15 D) 7/15
60. How many different pairs can be selected from 9 people?  
A) 72 B) 11  
C) 9 D) 36

#### SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. Which organelle is the main site of aerobic respiration?  
A) Nucleus B) Lysosome  
C) Ribosome D) Mitochondrion
62. Which structure controls the movement of substances into and out of a cell?  
A) Cell wall B) Nucleolus  
C) Cell membrane D) Chromosome
63. Protein synthesis occurs on:  
A) Ribosomes B) Chloroplasts  
C) Centrioles D) Lysosomes
64. Photosynthesis occurs mainly in the:  
A) Mitochondria B) Chloroplasts  
C) Nuclei D) Lysosomes
65. Diffusion is the net movement of particles from:  
A) lower concentration to higher concentration without energy B) low pressure to high pressure only  
C) solid to liquid only D) higher concentration to lower concentration
66. Mitosis normally produces:  
A) four genetically different cells B) one haploid cell  
C) gametes only D) two genetically similar daughter cells
67. Meiosis is important because it:  
A) occurs only in bacteria B) repairs body tissues only  
C) doubles chromosome number in gametes D) produces haploid gametes and introduces variation

68. The basic unit of heredity is the:

- A) Enzyme B) Tissue  
C) Hormone D) Gene

69. A dominant allele is expressed in:

- A) males only B) both homozygous and heterozygous conditions  
C) gametes only D) the homozygous recessive condition only

70. White blood cells are primarily involved in:

- A) oxygen transport B) defence against disease  
C) production of urine D) blood clotting only

## SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of magnesium has atomic number 12. How many protons does it contain?

- A) 13 B) 12  
C) 24 D) 11

72. Isotopes of the same element have:

- A) the same number of protons but different numbers of neutrons B) different numbers of protons and the same number of neutrons  
C) different atomic numbers and identical mass numbers D) the same numbers of protons and neutrons

73. What is the maximum number of electrons in the second electron shell according to  $2n^2$ ?

- A) 5 B) 8  
C) 6 D) 4

74. An ionic bond is formed mainly by:

- A) sharing of protons B) transfer of electrons from one atom to another  
C) overlap without electron involvement D) equal sharing of electrons only

75. What is the mass of 2 mol of NaCl if its molar mass is  $58.5 \text{ g mol}^{-1}$ ?

- A) 119 g B) 115 g  
C) 117 g D) 29.25 g

76. How many moles are present in 117 g of NaCl (molar mass  $58.5 \text{ g mol}^{-1}$ )?

- A) 58.5 mol B) 2 mol  
C) 3 mol D) 117 mol

77. A solution contains 4 mol of solute in  $5 \text{ dm}^3$ . What is its concentration?

- A)  $1.25 \text{ mol dm}^{-3}$  B)  $20 \text{ mol dm}^{-3}$   
C)  $9 \text{ mol dm}^{-3}$  D)  $0.8 \text{ mol dm}^{-3}$

78. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-5} \text{ mol dm}^{-3}$ ?

- A) 7 B) 5  
C) 6 D) 4

79. Oxidation is best described as:

- A) gain of neutrons B) gain of electrons  
C) loss of electrons D) loss of protons

80. Which functional group characterizes a ketone?

- A) carbonyl group within the chain ( $>\text{C}=\text{O}$ ) B) amino group ( $-\text{NH}_2$ )  
C) hydroxyl group ( $-\text{OH}$ ) D) carboxyl group ( $-\text{COOH}$ )

## SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. A vehicle travels 65 m in 5 s at constant speed. What is its speed?

- A) 13 m/s B) 15 m/s  
C) 70 m/s D) 65 m/s

82. An object's velocity changes from 5 m/s to 35 m/s in 6 s. What is its acceleration?

- A)  $6 \text{ m/s}^2$  B)  $30 \text{ m/s}^2$   
C)  $5 \text{ m/s}^2$  D)  $11 \text{ m/s}^2$

83. What force is required to accelerate a 5 kg mass at  $6 \text{ m/s}^2$ ?

- A) 30 N B) 15 N  
C) 0.83 N D) 36 N

84. Find the kinetic energy of a 8 kg object moving at 5 m/s.

- A) 200 J B) 105 J  
C) 100 J D) 13 J

85. What is the momentum of a 5 kg object moving at 6 m/s?

- A)  $15 \text{ kg}\cdot\text{m/s}$  B)  $180 \text{ kg}\cdot\text{m/s}$   
C)  $1.20 \text{ kg}\cdot\text{m/s}$  D)  $30 \text{ kg}\cdot\text{m/s}$

86. A sample has mass 30 kg and volume  $5 \text{ m}^3$ . What is its density?

- A)  $0.17 \text{ kg/m}^3$  B)  $150 \text{ kg/m}^3$   
C)  $7 \text{ kg/m}^3$  D)  $6 \text{ kg/m}^3$

87. A force of 400 N acts uniformly over an area of  $5 \text{ m}^2$ . What pressure is produced?

- A) 400 Pa B) 0.01 Pa  
C) 85 Pa D) 80 Pa

88. A resistor of  $6 \Omega$  carries a current of 5 A. What potential difference is across it?

- A) 0.83 V B) 11 V  
C) 30 V D) 1.20 V

89. An electrical device operates at 12 V and draws 5 A. What is its power?

- A) 60 W B) 65 W  
C) 2.40 W D) 0.42 W

90. A wave has frequency 8 Hz and wavelength 5 m. What is its speed?

- A) 13 m/s B) 40 m/s  
C) 48 m/s D) 1.60 m/s

**ANSWER KEY - PRE MEDICAL MODEL PAPER 4***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. A  | 3. B  | 4. D  | 5. A  | 6. A  | 7. B  | 8. A  | 9. A  | 10. D |
| 11. D | 12. B | 13. C | 14. A | 15. C | 16. B | 17. D | 18. D | 19. D | 20. D |
| 21. D | 22. B | 23. A | 24. D | 25. C | 26. D | 27. B | 28. D | 29. D | 30. A |
| 31. B | 32. B | 33. C | 34. D | 35. C | 36. A | 37. C | 38. B | 39. A | 40. B |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. C | 63. A | 64. B | 65. D | 66. D | 67. D | 68. D | 69. B | 70. B |
| 71. B | 72. A | 73. B | 74. B | 75. C | 76. B | 77. D | 78. B | 79. C | 80. A |
| 81. A | 82. C | 83. A | 84. C | 85. D | 86. D | 87. D | 88. C | 89. A | 90. B |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |

**PRE-MEDICAL - MODEL PAPER 5**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 5

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) are  
C) is D) be

2. At present, the workers \_\_\_\_ for the test.

- A) were prepare B) prepared  
C) is preparing D) are preparing

3. Iqra \_\_\_\_ the laboratory record already.

- A) had complete B) completed yesterday  
C) have completed D) has completed

4. By the time the supervisor arrived, Junaid \_\_\_\_ the design brief.

- A) will have checked B) was check  
C) had checked D) checks

5. By next Friday, the team \_\_\_\_ the laboratory record.

- A) will completed B) has completed  
C) had completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) be B) have  
C) were being D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) has B) are having  
C) have D) do

8. Each of the candidates \_\_\_\_ an admit card.

- A) possess B) have  
C) were given by D) has

9. There \_\_\_\_ several reasons for the delay.

- A) is B) are  
C) be D) has

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would boil B) will boil always  
C) boils D) boiled

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would have played B) had played  
C) will play D) played

12. If I knew the answer, I \_\_\_\_ Iqra.

- A) would have told B) told  
C) had told D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) will catch B) caught  
C) had caught D) would have caught

14. Choose the correct passive form: "The technician checks the laboratory record."

- A) The laboratory record is being checked by the technician. B) The laboratory record will be checked by the technician.  
C) The laboratory record is checked by the technician. D) The laboratory record was checked by the technician.

15. Choose the correct passive form: "The technician is checking the design brief."

- A) The design brief is checked by the technician. B) The design brief is being checked by the technician.  
C) The design brief is been checked by the technician. D) The design brief was being checked by the technician.

16. Choose the correct passive form: "The clerk processed the laboratory record."

- A) The laboratory record will be processed by the clerk. B) The laboratory record was processed by the clerk.  
C) The laboratory record has processed by the clerk. D) The laboratory record is processed by the clerk.

17. Choose the correct passive form: "The committee has approved the design brief."

- A) The design brief has being approved by the committee. B) The design brief had approved by the committee.  
C) The design brief was approved by the committee. D) The design brief has been approved by the committee.

18. Choose the correct passive form: "The office will issue the laboratory record."

- A) The laboratory record would be issued by the office. B) The laboratory record will issued by the office.  
C) The laboratory record is issued by the office. D) The laboratory record will be issued by the office.

19. Select the correct indirect form: Iqra said, "I will complete the laboratory record."

- A) Iqra told that the laboratory record would complete. B) Iqra said that I would complete the laboratory record.  
C) Iqra said that she would complete the laboratory record. D) Iqra said that she had complete the laboratory record.

20. Select the correct indirect form: Junaid said, "I am checking the design brief."

- A) Junaid told that he was checking the design brief. B) Junaid said that I was checking the design brief.  
C) Junaid said that he was checking the design brief. D) Junaid said that he is checking the design brief.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L5: Seven students in a row - Questions 21-24**

Seven students—Gul, Hamza, Inaya, Jawad, Komal, Laiba, and Mustafa—sit in a row facing north. 1. Jawad sits in the middle. 2. Gul sits third to the left of Jawad. 3. Mustafa sits third to the right of Jawad. 4. Hamza sits immediately to the left of Inaya. 5. Komal sits immediately to the right of Jawad. 6. Laiba sits immediately to the right of Komal.

21. Which student is seated in position three when counted from the left?

- A) Hamza B) Jawad  
C) Komal D) Inaya

22. Which student sits two places to the right of Inaya?

- A) Hamza B) Komal  
C) Jawad D) Laiba

23. How many people are seated between Gul and Jawad?

- A) Two B) One  
C) None D) Three

24. If Jawad moves to Mustafa's seat and everyone between them shifts one place left, who will sit in the middle?

- A) Komal B) Mustafa  
C) Jawad D) Inaya

**Analytical Set C5: Six participants around a round table - Questions 25-28**

Six participants—Cyrus, Daniyal, Esha, Faizan, Ghazal, and Hammad—sit around a round table facing the centre. Cyrus is fixed at the top. 1. Faizan sits opposite Cyrus. 2. Daniyal sits immediately clockwise from Cyrus. 3. Esha sits between Daniyal and Faizan on the clockwise side. 4. Ghazal sits immediately clockwise from Faizan.

25. Who sits immediately anticlockwise from Cyrus?

- A) Esha B) Daniyal  
C) Ghazal D) Hammad

26. Who is opposite Esha?

- A) Daniyal B) Hammad  
C) Faizan D) Cyrus

27. Which pair forms Faizan's immediate neighbours?

- A) Ghazal and Hammad B) Esha and Ghazal  
C) Daniyal and Esha D) Cyrus and Ghazal

28. After a one-seat anticlockwise rotation by everyone, who takes Daniyal's original position?

- A) Ghazal B) Hammad  
C) Esha D) Faizan

**Analytical Set S5: Six class periods - Questions 29-32**

Six lessons—Accounting, Biology, Chemistry, Drawing, English, and French—are placed in periods 1 to 6. 1. Accounting is in period 1. 2. French is in period 6. 3. Biology is immediately before Chemistry. 4. English is immediately after Drawing. 5. Chemistry is earlier than Drawing.

29. Which lesson is in period 3?

- A) Chemistry B) French  
C) Drawing D) English

30. What lesson immediately follows Drawing?

- A) Accounting B) French  
C) Chemistry D) English

31. How many periods separate Biology and English?

- A) Three B) None  
C) One D) Two

32. If the Biology-Chemistry pair swaps places with the Drawing-English pair, which lesson will be in period 2?

- A) Accounting B) Chemistry  
C) English D) Drawing

**Analytical Set D5: Train and meeting chain - Questions 33-36**

Use these rules: 1. If the train is late (T), the meeting is delayed (M). 2. If the meeting is delayed (M), the manager calls (C). 3. If the manager calls (C), the staff wait (W). 4. If the staff do not wait, the report is sent (R).

33. The train is late. Which result must eventually occur?

- A) The report is not sent B) The staff leave immediately  
C) The staff wait D) The manager does not call

34. The manager does not call. What must be true about the train?

- A) The train is late B) The meeting is delayed  
C) The report is not sent D) The train is not late

35. If the staff do not wait, which conclusion follows directly?

- A) The train is late B) The meeting is delayed  
C) The report is withheld D) The report is sent

36. The report is not sent. What must be true?

- A) The staff do not wait B) The train is late  
C) The meeting is delayed D) The staff wait

**Analytical Set B5: Khalid's family - Questions 37-40**

Khalid and Salma are married. Their daughter Lubna is married to Noman and has two children, Omer and Pari. Their son Majid is married to Qurat and has one son, Raza.

37. What is Omer's relation to Majid?

- A) Brother B) Uncle  
C) Cousin D) Nephew

38. How is Salma related to Pari?

- A) Mother-in-law B) Maternal aunt  
C) Paternal grandmother D) Maternal grandmother

39. What is Raza's relation to Pari?

- A) Uncle B) Brother  
C) Nephew D) Cousin

40. How is Qurat related to Lubna?

- A) Sister-in-law B) Maternal aunt  
C) Daughter-in-law D) Sister

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $17 + 8 \times 4 - 7$ .

- A) 42 B) -7  
C) 93 D) 50

42. Find  $11/16 + 16/18$  in simplest form.

- A) 27/34 B) 227/144  
C) -29/144 D) 3/32

43. What is 35% of 325?  
A) 18/5 B) 65/7  
C) 455/4 D) 845/4
44. A price of Rs. 700 is increased by 30%. What is the new price?  
A) Rs. 210 B) Rs. 730  
C) Rs. 490 D) Rs. 910
45. Rs. 150 is divided in the ratio 2:4. What is the larger share?  
A) 50 B) 75  
C) 6 D) 100
46. If 4 identical notebooks cost Rs. 260, what will 7 notebooks cost at the same rate?  
A) 455 B) 267  
C) 1820 D) 325
47. Find the arithmetic mean of 20, 26, 32, 38, 44.  
A) 160 B) 32  
C) 26 D) 38
48. A student scores 55 in a 4-credit course and 75 in a 4-credit course. Find the weighted mean.  
A) 260 B) 32.5  
C) 65 D) 65.5
49. A vehicle travels 120 km at a constant speed of 40 km/h. How long does the journey take?  
A) 160 hours B) 80 hours  
C) 1/3 hours D) 3 hours
50. Worker A can complete a job in 9 days and Worker B in 17 days. Working together, how many days will they take?  
A) 13 days B) 26/153 days  
C) 153/8 days D) 153/26 days
51. An item costs Rs. 500 and is sold at a profit of 30%. Find the selling price.  
A) Rs. 650 B) Rs. 150  
C) Rs. 350 D) Rs. 530
52. Find the simple interest on Rs. 1500 at 9% per year for 3 years.  
A) Rs. 135 B) Rs. 405  
C) Rs. 45 D) Rs. 1905
53. Solve  $7x + 10 = 66$ .  
A) 56 B) 28/5  
C) 8 D) 9
54. What is the larger root of  $x^2 - 17x + 70 = 0$ ?  
A) 7 B) 17  
C) 70 D) 10
55. Find the 13th term of the arithmetic sequence with first term 13 and common difference 2.  
A) 39 B) 35  
C) 195 D) 37
56. If  $7^x = 2401$ , find x.  
A) 4 B) 7  
C) 2401 D) 5
57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 42 cm.  
A) 5544 cm B) 264 cm  
C) 132 cm D) 84 cm
58. Find the distance between (5, 6) and (8, 10).  
A) 7 B) 4  
C) 5 D) 25
59. A bag contains 8 red and 9 blue balls. One ball is selected at random. What is P(red)?  
A) 9/17 B) 8/9  
C) 1/17 D) 8/17
60. How many different pairs can be selected from 10 people?  
A) 90 B) 12  
C) 10 D) 45

#### SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. The chamber of the human heart with the thickest wall is the:  
A) Right atrium B) Left ventricle  
C) Left atrium D) Right ventricle
62. Arteries generally carry blood:  
A) towards the heart only B) without pressure  
C) away from the heart D) only in the lungs
63. Gas exchange in the lungs occurs mainly in the:  
A) Diaphragm B) Pleura  
C) Trachea D) Alveoli
64. The functional unit of the kidney is the:  
A) Nephron B) Alveolus  
C) Neuron D) Sarcomere
65. The structural and functional unit of the nervous system is the:  
A) Villus B) Alveolus  
C) Neuron D) Nephron
66. A rapid automatic response to a stimulus is called a:  
A) Transpiration B) Voluntary action  
C) Fertilization D) Reflex action
67. Most nutrient absorption in humans occurs in the:  
A) Mouth B) Oesophagus  
C) Large intestine D) Small intestine

68. Xylem transports mainly:

- A) water and mineral ions    B) hormones from animals  
C) sugars only    D) oxygen to roots

69. Phloem transports mainly:

- A) water only    B) carbon dioxide only  
C) mineral salts only    D) organic food such as sucrose

70. Stomata regulate:

- A) gas exchange and water loss    B) pollination  
C) mineral absorption by roots only    D) seed germination only

## SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of chlorine has atomic number 17. How many protons does it contain?

- A) 15    B) 18  
C) 16    D) 17

72. Isotopes of the same element have:

- A) different chemical symbols only    B) the same numbers of protons and neutrons  
C) different atomic numbers and identical mass numbers    D) the same number of protons but different numbers of neutrons

73. What is the maximum number of electrons in the third electron shell according to  $2n^2$ ?

- A) 9    B) 10  
C) 18    D) 20

74. An ionic bond is formed mainly by:

- A) equal sharing of electrons only    B) transfer of electrons from one atom to another  
C) overlap without electron involvement    D) transfer of neutrons

75. What is the mass of 3 mol of  $\text{NH}_3$  if its molar mass is  $17 \text{ g mol}^{-1}$ ?

- A) 51 g    B) 54 g  
C) 48 g    D) 8.5 g

76. How many moles are present in 51 g of  $\text{NH}_3$  (molar mass  $17 \text{ g mol}^{-1}$ )?

- A) 1.5 mol    B) 4 mol  
C) 17 mol    D) 3 mol

77. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-6} \text{ mol dm}^{-3}$ ?

- A) 8    B) None of these  
C) 7    D) 6

78. Oxidation is best described as:

- A) loss of electrons    B) gain of electrons  
C) no change in oxidation state    D) gain of neutrons

79. Which functional group characterizes an amine?

- A) terminal carbonyl group ( $-\text{CHO}$ )    B) carbonyl group within the chain ( $>\text{C}=\text{O}$ )  
C) amino group ( $-\text{NH}_2$ )    D) hydroxyl group ( $-\text{OH}$ )

80. The standard hydrogen electrode is assigned a potential of:

- A) 0.00 V    B)  $-1.00 \text{ V}$   
C) 0.50 V    D) 1.00 V

## SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. Which of the following is an SI base quantity?

- A) Power    B) Mass  
C) Force    D) Pressure

82. A vehicle travels 84 m in 6 s at constant speed. What is its speed?

- A) 14 m/s    B) 84 m/s  
C) 16 m/s    D) 90 m/s

83. What force is required to accelerate a 6 kg mass at  $7 \text{ m/s}^2$ ?

- A) 49 N    B) 13 N  
C) 42 N    D) 0.86 N

84. Find the kinetic energy of a 10 kg object moving at 6 m/s.

- A) 180 J    B) 186 J  
C) 360 J    D) 16 J

85. What is the momentum of a 6 kg object moving at 7 m/s?

- A) 21  $\text{kg}\cdot\text{m/s}$     B) 1.17  $\text{kg}\cdot\text{m/s}$   
C) 294  $\text{kg}\cdot\text{m/s}$     D) 42  $\text{kg}\cdot\text{m/s}$

86. A sample has mass 42 kg and volume  $6 \text{ m}^3$ . What is its density?

- A)  $8 \text{ kg/m}^3$     B)  $36 \text{ kg/m}^3$   
C)  $7 \text{ kg/m}^3$     D)  $0.14 \text{ kg/m}^3$

87. A force of 180 N acts uniformly over an area of  $2 \text{ m}^2$ . What pressure is produced?

- A) 180 Pa    B) 0.01 Pa  
C) 92 Pa    D) 90 Pa

88. An electrical device operates at 14 V and draws 2 A. What is its power?

- A) 7.00 W    B) 30 W  
C) 16 W    D) 28 W

89. A wave has frequency 9 Hz and wavelength 6 m. What is its speed?

- A) 15 m/s    B) 0.67 m/s  
C) 54 m/s    D) 63 m/s

90. A more stable nucleus generally has:

- A) more electrons than protons    B) no neutrons  
C) a larger physical volume only    D) greater binding energy per nucleon

**ANSWER KEY - PRE MEDICAL MODEL PAPER 5***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. C  | 2. D  | 3. D  | 4. C  | 5. D  | 6. D  | 7. A  | 8. D  | 9. B  | 10. C |
| 11. C | 12. D | 13. D | 14. C | 15. B | 16. B | 17. D | 18. D | 19. C | 20. C |
| 21. D | 22. B | 23. A | 24. A | 25. D | 26. B | 27. B | 28. C | 29. A | 30. D |
| 31. D | 32. D | 33. C | 34. D | 35. D | 36. D | 37. D | 38. D | 39. D | 40. A |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. C | 63. D | 64. A | 65. C | 66. D | 67. D | 68. A | 69. D | 70. A |
| 71. D | 72. D | 73. C | 74. B | 75. A | 76. D | 77. D | 78. A | 79. C | 80. A |
| 81. B | 82. A | 83. C | 84. A | 85. D | 86. C | 87. D | 88. D | 89. C | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |



**PRE-MEDICAL - MODEL PAPER 6**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 6

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) is    B) were  
C) are    D) be

2. At present, the students \_\_\_\_ for the test.

- A) have prepare    B) is preparing  
C) are preparing    D) were prepare

3. Omer \_\_\_\_ the presentation already.

- A) is completing since Monday    B) completed yesterday  
C) has completed    D) have completed

4. By the time the supervisor arrived, Pari \_\_\_\_ the computer program.

- A) checks    B) had checked  
C) was check    D) will have checked

5. By next Friday, the team \_\_\_\_ the presentation.

- A) will completed    B) had completed  
C) will have completed    D) has completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is    B) have  
C) be    D) were being

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) has    B) do  
C) have    D) are having

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having    B) has  
C) possess    D) have

9. There \_\_\_\_ several reasons for the delay.

- A) has    B) are  
C) is    D) was

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled    B) would boil  
C) boils    D) will boil always

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) will play    B) would have played  
C) would play    D) played

12. If I knew the answer, I \_\_\_\_ Omer.

- A) will tell    B) would have told  
C) had told    D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) would catch    B) will catch  
C) caught    D) would have caught

14. Choose the correct passive form: "The technician checks the presentation."

- A) The presentation has checked by the technician.    B) The presentation is being checked by the technician.  
C) The presentation will be checked by the technician.    D) The presentation is checked by the technician.

15. Choose the correct passive form: "The technician is checking the computer program."

- A) The computer program is checked by the technician.    B) The computer program has been checked by the technician.  
C) The computer program is been checked by the technician.    D) The computer program is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the presentation."

- A) The presentation has processed by the clerk.    B) The presentation was processed by the clerk.  
C) The presentation will be processed by the clerk.    D) The presentation was being processed by the clerk.

17. Choose the correct passive form: "The committee has approved the computer program."

- A) The computer program is approved by the committee.    B) The computer program was approved by the committee.  
C) The computer program has being approved by the committee.    D) The computer program has been approved by the committee.

18. Choose the correct passive form: "The office will issue the presentation."

- A) The presentation would be issued by the office.    B) The presentation will issued by the office.  
C) The presentation will be issued by the office.    D) The presentation will have issued by the office.

19. Select the correct indirect form: Omer said, "I will complete the presentation."

- A) Omer said that he would complete the presentation.    B) Omer told that the presentation would complete.  
C) Omer said that I would complete the presentation.    D) Omer said that he had complete the presentation.

20. Select the correct indirect form: Pari said, "I am checking the computer program."

- A) Pari told that she was checking the computer program.    B) Pari said that she is checking the computer program.  
C) Pari said that she was checking the computer program.    D) Pari said that I was checking the computer program.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L6: 6 candidates in a straight row - Questions 21-24**

6 candidates—Cyrus, Bushra, Adeel, Dua, Fahad, and Ghazal—sit in a straight row, all facing north. 1. Cyrus occupies the extreme left seat. 2. Ghazal sits at the extreme right. 3. Bushra is immediately to the right of Cyrus. 4. Dua sits immediately to the right of Adeel. 5. Fahad sits between Dua and Ghazal, adjacent to both.

21. Which pair occupies the two end seats?

- A) Bushra and Ghazal    B) Cyrus and Ghazal  
C) Cyrus and Fahad    D) Dua and Fahad

22. Who sits second to the right of Bushra?

- A) Adeel B) Cyrus  
C) Ghazal D) Dua

23. Which statement is consistent with the completed arrangement?

- A) Adeel sits at an end B) Dua sits second from the left  
C) Bushra sits immediately left of Cyrus D) Fahad sits immediately left of Ghazal

24. If everyone now faces south without changing seats, who is immediately to the left of Dua?

- A) Bushra B) Fahad  
C) Cyrus D) Ghazal

**Analytical Set C6: 6 participants around a round table - Questions 25-28**

6 participants—Cem, Dalia, Aariz, Bina, Fiza, and Ehsan—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Cem occupies the top seat. 2. Dalia sits immediately clockwise of Cem. 3. Aariz sits immediately clockwise of Dalia. 4. Bina sits directly opposite Cem. 5. Fiza sits immediately clockwise of Bina. 6. Ehsan sits immediately clockwise of Fiza.

25. Which pair are the immediate neighbours of Cem?

- A) Aariz and Ehsan B) Ehsan and Dalia  
C) Dalia and Bina D) Cem and Aariz

26. Identify the participant opposite Aariz.

- A) Ehsan B) Dalia  
C) Bina D) Fiza

27. Who sits between Cem and Aariz on the shorter arc?

- A) Dalia B) Fiza  
C) Aariz D) Bina

28. If everyone turns to face outward, who is immediately to the left of Fiza?

- A) Dalia B) Aariz  
C) Bina D) Ehsan

**Analytical Set S6: 6 subjects in fixed slots - Questions 29-32**

The following 6 subjects are assigned one per slot: Drawing, English, Physics, Algebra, Chemistry, and Biology. 1. Drawing is scheduled in Monday. 2. Biology is scheduled in Saturday. 3. English occurs immediately after Drawing. 4. Algebra occurs immediately after Physics. 5. Chemistry is between Algebra and Biology, consecutive with both.

29. What is the first scheduled activity?

- A) Biology B) Algebra  
C) Chemistry D) Drawing

30. When does Chemistry take place?

- A) Wednesday B) Thursday  
C) Monday D) Friday

31. Which pair occurs in two consecutive slots in the stated order?

- A) Drawing followed by Biology B) Physics followed by Algebra  
C) Drawing followed by Physics D) English followed by Chemistry

32. If English and Chemistry exchange slots, which activity occupies Tuesday?

- A) Drawing B) Physics  
C) Algebra D) Chemistry

**Analytical Set D6: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the proposal is funded, then the audit begins. 2. If the audit begins, then the report is drafted. 3. If the report is drafted, then the board meets. 4. If a security hold is imposed, then the report is not drafted. 5. If an alert is issued, then a security hold is imposed.

33. If the proposal is funded, which outcome must eventually follow?

- A) A security hold is imposed B) The audit does not begin  
C) The report is not drafted D) The board meets

34. Suppose the board does not meet. Which conclusion is unavoidable?

- A) The report is drafted B) The audit begins  
C) The proposal is not funded D) A security hold is imposed

35. If an alert is issued, what must be true about the second condition?

- A) The audit begins B) The report is drafted  
C) The board meets D) The audit does not begin

36. Which pair cannot both be true under the stated rules?

- A) The proposal is funded and the audit begins B) A security hold is imposed and an alert is issued  
C) The proposal is funded and a security hold is imposed D) The audit begins and the board meets

**Analytical Set B6: The family of Rauf and Shazia - Questions 37-40**

Rauf and Shazia are married. Their children are Adnan, a son, and Bina, a daughter. Adnan is married to Naila; their children are Iqra, a son, and Junaid, a daughter. Bina is married to Hamid; their child is Komal, a son.

37. How is Shazia related to Junaid?

- A) Mother-in-law B) Maternal aunt  
C) Maternal grandmother D) Paternal grandmother

38. What is Bina's relation to Iqra?

- A) Maternal aunt B) Sister-in-law  
C) Sister D) Paternal aunt

39. How is Komal related to Junaid?

- A) Uncle B) Brother-in-law  
C) Cousin D) Sibling

40. How is Naila related to Bina?

- A) Maternal aunt B) Paternal aunt  
C) Mother-in-law D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $19 + 9 \times 5 - 8$ .

- A) 56 B) -8  
C) 132 D) 65

42. Find  $13/17 + 1/19$  in simplest form.

- A)  $7/18$  B)  $264/323$   
C)  $230/323$  D)  $14/323$

43. What is 40% of 350?

- A)  $39/10$  B)  $35/4$   
C) 140 D) 210

44. A price of Rs. 740 is increased by 5%. What is the new price?

- A) Rs. 37 B) Rs. 745  
C) Rs. 703 D) Rs. 777

45. Rs. 234 is divided in the ratio 3:6. What is the larger share?

- A) 78 B) 117  
C) 9 D) 156

46. If 5 identical notebooks cost Rs. 340, what will 9 notebooks cost at the same rate?

- A) 612 B) 349  
C) 3060 D) 408

47. Find the arithmetic mean of 23, 24, 25, 26, 27.

- A) 125 B) 25  
C) 24 D) 26

48. A student scores 56 in a 2-credit course and 76 in a 5-credit course. Find the weighted mean.

- A) 66 B) 246  
C) 70.29 D) 49.2

49. A vehicle travels 168 km at a constant speed of 42 km/h. How long does the journey take?

- A) 210 hours B) 126 hours  
C)  $1/4$  hours D) 4 hours

50. Worker A can complete a job in 10 days and Worker B in 19 days. Working together, how many days will they take?

- A)  $29/2$  days B)  $29/190$  days  
C)  $190/9$  days D)  $190/29$  days

51. An item costs Rs. 520 and is sold at a profit of 35%. Find the selling price.

- A) Rs. 702 B) Rs. 182  
C) Rs. 338 D) Rs. 555

52. Find the simple interest on Rs. 1600 at 10% per year for 4 years.

- A) Rs. 160 B) Rs. 640  
C) Rs. 64 D) Rs. 2240

53. Solve  $8x + 11 = 83$ .

- A) 72 B)  $72/11$   
C) 9 D) 10

54. What is the larger root of  $x^2 - 19x + 88 = 0$ ?

- A) 8 B) 19  
C) 88 D) 11

55. Find the 14th term of the arithmetic sequence with first term 15 and common difference 3.

- A) 57 B) 51  
C) 252 D) 54

56. If  $8^x = 64$ , find  $x$ .

- A) 2 B) 8  
C) 64 D) 3

57. Find the area of a rectangle of length 14 cm and width 9 cm.

- A)  $46 \text{ cm}^2$  B)  $126 \text{ cm}^2$   
C)  $23 \text{ cm}^2$  D)  $252 \text{ cm}^2$

58. Find the slope of the line through (6, 8) and (10, 16).

- A)  $1/2$  B) 8  
C) 2 D) 4

59. A bag contains 9 red and 10 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $10/19$  B)  $9/10$   
C)  $1/19$  D)  $9/19$

60. How many different pairs can be selected from 11 people?

- A) 110 B) 13  
C) 11 D) 55

## SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. Bacteria and fungi that break down dead matter are:

- A) Pollinators B) Decomposers  
C) Producers D) Predators

62. A group of organisms of the same species living in one area is a:

- A) Population B) Community  
C) Ecosystem D) Biome

63. All interacting populations in an area form a:

- A) Tissue B) Organ  
C) Species D) Community

64. An ecosystem includes:

- A) only non-living factors B) only consumers  
C) a community and its physical environment D) one species only

65. Natural selection favours individuals that:

- A) acquire traits solely through use B) are always physically largest  
C) never show variation D) leave more surviving offspring in a given environment

66. Viruses can reproduce only:

- A) in distilled water B) inside crystals only  
C) inside living host cells D) on nutrient agar without cells

67. Fertilization is the fusion of:

- A) two chromosomes only    B) two embryos  
C) male and female gametes    D) two somatic cells

68. The testes produce:

- A) bile and enzymes    B) urine and urea  
C) insulin and glucagon    D) sperm and testosterone

69. The ovaries produce:

- A) bile    B) red blood cells  
C) thyroxine only    D) ova and female sex hormones

70. The placenta allows exchange of materials between:

- A) two neurons    B) the lungs and heart only  
C) the stomach and liver    D) mother and developing fetus

## SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of calcium has atomic number 20. How many protons does it contain?

- A) 40    B) 18  
C) 21    D) 20

72. Isotopes of the same element have:

- A) different chemical symbols only    B) the same numbers of protons and neutrons  
C) the same number of protons but different numbers of neutrons    D) different atomic numbers and identical mass numbers

73. What is the maximum number of electrons in the fourth electron shell according to  $2n^2$ ?

- A) 17    B) 34  
C) 32    D) 30

74. An ionic bond is formed mainly by:

- A) sharing of protons    B) overlap without electron involvement  
C) transfer of neutrons    D) transfer of electrons from one atom to another

75. What is the mass of 4 mol of  $\text{CaCO}_3$  if its molar mass is  $100 \text{ g mol}^{-1}$ ?

- A) 404 g    B) 50 g  
C) 396 g    D) 400 g

76. How many moles are present in 400 g of  $\text{CaCO}_3$  (molar mass  $100 \text{ g mol}^{-1}$ )?

- A) 100 mol    B) 2 mol  
C) 400 mol    D) 4 mol

77. A solution contains 2 mol of solute in  $3 \text{ dm}^3$ . What is its concentration?

- A)  $0.666667 \text{ mol dm}^{-3}$     B)  $1.5 \text{ mol dm}^{-3}$   
C)  $1.66667 \text{ mol dm}^{-3}$     D)  $5 \text{ mol dm}^{-3}$

78. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-2} \text{ mol dm}^{-3}$ ?

- A) 3    B) 12  
C) 2    D) 1

79. Oxidation is best described as:

- A) loss of protons    B) loss of electrons  
C) gain of neutrons    D) gain of electrons

80. Which functional group characterizes an alcohol?

- A) carbonyl group within the chain ( $>\text{C}=\text{O}$ )    B) amino group ( $-\text{NH}_2$ )  
C) hydroxyl group ( $-\text{OH}$ )    D) terminal carbonyl group ( $-\text{CHO}$ )

## SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. A vehicle travels 30 m in 2 s at constant speed. What is its speed?

- A)  $2/30 \text{ m/s}$     B)  $15 \text{ m/s}$   
C)  $17 \text{ m/s}$     D)  $30 \text{ m/s}$

82. An object's velocity changes from 2 m/s to 14 m/s in 4 s. What is its acceleration?

- A)  $12 \text{ m/s}^2$     B)  $4 \text{ m/s}^2$   
C)  $3.5 \text{ m/s}^2$     D)  $3 \text{ m/s}^2$

83. What force is required to accelerate a 7 kg mass at  $3 \text{ m/s}^2$ ?

- A) 21 N    B) 2.33 N  
C) 10 N    D) 10.5 N

84. What is the momentum of a 7 kg object moving at 8 m/s?

- A)  $56 \text{ kg} \cdot \text{m/s}$     B)  $28 \text{ kg} \cdot \text{m/s}$   
C)  $448 \text{ kg} \cdot \text{m/s}$     D)  $1.14 \text{ kg} \cdot \text{m/s}$

85. A sample has mass 16 kg and volume  $2 \text{ m}^3$ . What is its density?

- A)  $32 \text{ kg/m}^3$     B)  $14 \text{ kg/m}^3$   
C)  $9 \text{ kg/m}^3$     D)  $8 \text{ kg/m}^3$

86. A force of 300 N acts uniformly over an area of  $3 \text{ m}^2$ . What pressure is produced?

- A) 900 Pa    B) 0.01 Pa  
C) 300 Pa    D) 100 Pa

87. A resistor of  $8 \Omega$  carries a current of 2 A. What potential difference is across it?

- A) 24 V    B) 10 V  
C) 16 V    D) 4.00 V

88. An electrical device operates at 16 V and draws 3 A. What is its power?

- A) 48 W    B) 5.33 W  
C) 51 W    D) 0.19 W

89. A wave has frequency 10 Hz and wavelength 2 m. What is its speed?

- A)  $12 \text{ m/s}$     B)  $0.20 \text{ m/s}$   
C)  $30 \text{ m/s}$     D)  $20 \text{ m/s}$

90. The photoelectric effect supports the idea that light energy is carried in:

- A) neutrons    B) sound pulses  
C) magnetic poles    D) photons

**ANSWER KEY - PRE MEDICAL MODEL PAPER 6***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. A  | 2. C  | 3. C  | 4. B  | 5. C  | 6. A  | 7. A  | 8. B  | 9. B  | 10. C |
| 11. A | 12. D | 13. D | 14. D | 15. D | 16. B | 17. D | 18. C | 19. A | 20. C |
| 21. B | 22. D | 23. D | 24. B | 25. B | 26. A | 27. A | 28. C | 29. D | 30. D |
| 31. B | 32. D | 33. D | 34. C | 35. D | 36. C | 37. D | 38. D | 39. C | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. A | 63. D | 64. C | 65. D | 66. C | 67. C | 68. D | 69. D | 70. D |
| 71. D | 72. C | 73. C | 74. D | 75. D | 76. D | 77. A | 78. C | 79. B | 80. C |
| 81. B | 82. D | 83. A | 84. A | 85. D | 86. D | 87. C | 88. A | 89. D | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |

**PRE-MEDICAL - MODEL PAPER 7**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 7

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) is    B) are  
C) have    D) be

2. At present, the technicians \_\_\_\_ for the test.

- A) prepared    B) were prepare  
C) have prepare    D) are preparing

3. Sadia \_\_\_\_ the survey form already.

- A) has completed    B) have completed  
C) had complete    D) completed yesterday

4. By the time the supervisor arrived, Taimur \_\_\_\_ the experiment log.

- A) was check    B) had checked  
C) will have checked    D) checks

5. By next Friday, the team \_\_\_\_ the survey form.

- A) had completed    B) has completed  
C) would complete    D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is    B) be  
C) were being    D) have

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do    B) have  
C) were    D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having    B) have  
C) were given by    D) has

9. There \_\_\_\_ several reasons for the delay.

- A) are    B) was  
C) has    D) be

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) will boil always    B) boiled  
C) boils    D) would boil

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) will play    B) played  
C) would play    D) had played

12. If I knew the answer, I \_\_\_\_ Sadia.

- A) will tell    B) would tell  
C) told    D) would have told

13. If they had left earlier, they \_\_\_\_ the train.

- A) had caught    B) would have caught  
C) would catch    D) caught

14. Choose the correct passive form: "The technician checks the survey form."

- A) The survey form will be checked by the technician.    B) The survey form has checked by the technician.  
C) The survey form is checked by the technician.    D) The survey form was checked by the technician.

15. Choose the correct passive form: "The technician is checking the experiment log."

- A) The experiment log has been checked by the technician.    B) The experiment log is being checked by the technician.  
C) The experiment log is been checked by the technician.    D) The experiment log is checked by the technician.

16. Choose the correct passive form: "The clerk processed the survey form."

- A) The survey form will be processed by the clerk.    B) The survey form was being processed by the clerk.  
C) The survey form was processed by the clerk.    D) The survey form has processed by the clerk.

17. Choose the correct passive form: "The committee has approved the experiment log."

- A) The experiment log had approved by the committee.    B) The experiment log was approved by the committee.  
C) The experiment log is approved by the committee.    D) The experiment log has been approved by the committee.

18. Choose the correct passive form: "The office will issue the survey form."

- A) The survey form will be issued by the office.    B) The survey form would be issued by the office.  
C) The survey form will issued by the office.    D) The survey form will have issued by the office.

19. Select the correct indirect form: Sadia said, "I will complete the survey form."

- A) Sadia said that she will complete the survey form.    B) Sadia said that she would complete the survey form.  
C) Sadia said that she had complete the survey form.    D) Sadia said that I would complete the survey form.

20. Select the correct indirect form: Taimur said, "I am checking the experiment log."

- A) Taimur said that he is checking the experiment log.    B) Taimur said that I was checking the experiment log.  
C) Taimur told that he was checking the experiment log.    D) Taimur said that he was checking the experiment log.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L7: 7 candidates in a straight row - Questions 21-24**

7 candidates—Laiba, Noreen, Iqra, Muneeb, Jibran, Hammad, and Komal—sit in a straight row, all facing north. 1. Noreen is second from the left. 2. Hammad is second from the right. 3. Laiba sits immediately left of Noreen. 4. Iqra sits immediately right of Noreen. 5. Muneeb occupies the central seat. 6. Jibran is immediately right of Muneeb. 7. Komal is immediately right of Hammad.

21. Who is in the left-middle seat of this row?

- A) Laiba    B) Komal  
C) Iqra    D) Hammad

22. Who sits exactly between Noreen and Muneeb?

- A) Laiba B) Iqra  
C) Jibran D) Hammad

23. Who is third from the right end?

- A) Hammad B) Noreen  
C) Muneeb D) Jibran

24. If Noreen and Hammad exchange seats, who occupies seat 2 from the left?

- A) Noreen B) Hammad  
C) Komal D) Muneeb

**Analytical Set C7: 8 participants around a round table - Questions 25-28**

8 participants—Irtaza, Laila, Hiba, Mahir, Joya, Nida, Gibran, and Kashan—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Irtaza sits at the top. 2. Kashan is immediately anticlockwise from Irtaza. 3. Gibran is immediately anticlockwise from Kashan. 4. Joya is opposite Irtaza. 5. Mahir is immediately anticlockwise from Joya. 6. Hiba is immediately anticlockwise from Mahir. 7. Laila sits between Irtaza and Hiba, adjacent to both. 8. Nida is immediately clockwise from Joya.

25. Who occupies the bottom seat, directly across from the top seat?

- A) Laila B) Irtaza  
C) Hiba D) Joya

26. Who is second anticlockwise from Irtaza?

- A) Nida B) Joya  
C) Hiba D) Gibran

27. Which pair sits in consecutive clockwise seats?

- A) Mahir and Kashan B) Irtaza and Nida  
C) Irtaza and Mahir D) Hiba and Mahir

28. If Laila exchanges seats with the person opposite, who then sits immediately clockwise of Irtaza?

- A) Irtaza B) Gibran  
C) Mahir D) Nida

**Analytical Set S7: 7 sessions in fixed slots - Questions 29-32**

The following 7 sessions are assigned one per slot: Audit, Guidance, Design, Briefing, Coding, Finance, and Evaluation. 1. Briefing is scheduled in the middle slot, Thursday. 2. Audit opens the schedule. 3. Evaluation closes the schedule. 4. Guidance immediately follows Audit. 5. Design immediately precedes Briefing. 6. Coding immediately follows Briefing. 7. Finance immediately precedes Evaluation.

29. Which activity is assigned to Thursday?

- A) Design B) Briefing  
C) Finance D) Evaluation

30. What comes immediately after Design?

- A) Coding B) Evaluation  
C) Guidance D) Briefing

31. Which pair occupies the first and last slots respectively?

- A) Guidance and Design B) Design and Finance  
C) Guidance and Coding D) Audit and Evaluation

32. If Guidance is postponed by two slots and intervening activities shift earlier, what occupies Wednesday?

- A) Guidance B) Audit  
C) Briefing D) Design

**Analytical Set D7: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the student qualifies, then the interview is scheduled. 2. If the student qualifies, then the documents are verified. 3. If the interview is scheduled, then the fee voucher is issued. 4. If the documents are verified, then the admission file opens. 5. If the fee voucher is issued, then the final list includes the student.

33. When the student qualifies, which later result is guaranteed?

- A) The final list includes the student B) The fee voucher is not issued  
C) The documents are not verified D) The interview is not scheduled

34. If the admission file does not open, what must be concluded?

- A) The student does not qualify B) The interview is scheduled  
C) The student qualifies D) The documents are verified

35. Given that the fee voucher is not issued, which earlier condition must be false?

- A) The documents are verified B) The admission file opens  
C) The student qualifies D) The interview is not scheduled

36. If the student qualifies, which pair must both be true?

- A) The fee voucher is issued and the admission file does not open B) The interview is scheduled and the documents are not verified  
C) The fee voucher is not issued and the final list includes the student D) The fee voucher is issued and the admission file opens

**Analytical Set B7: The family of Tariq and Uzma - Questions 37-40**

Tariq and Uzma are married. Their children are Bilal, a son, and Celia, a daughter. Bilal is married to Dua; their children are Gul, a son, and Haris, a daughter. Celia is married to Fahad; their child is Ilma, a son.

37. How is Uzma related to Haris?

- A) Paternal aunt B) Paternal grandmother  
C) Maternal aunt D) Maternal grandmother

38. What is Celia's relation to Gul?

- A) Maternal aunt B) Niece  
C) Paternal aunt D) Sister-in-law

39. How is Ilma related to Haris?

- A) Uncle B) Nephew  
C) Brother-in-law D) Cousin

40. How is Dua related to Celia?

- A) Mother-in-law B) Paternal aunt  
C) Sister-in-law D) Maternal aunt

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $21 + 3 \times 6 - 9$ .

- A) 30 B) 12  
C) 135 D) 33



42. Find  $5/11 + 3/20$  in simplest form.

- A)  $8/31$  B)  $133/220$   
C)  $67/220$  D)  $2/55$

43. What is 45% of 375?

- A)  $21/5$  B)  $25/3$   
C)  $675/4$  D)  $825/4$

44. A price of Rs. 780 is increased by 10%. What is the new price?

- A) Rs. 78 B) Rs. 790  
C) Rs. 702 D) Rs. 858

45. Rs. 324 is divided in the ratio 4:8. What is the larger share?

- A) 108 B) 162  
C) 12 D) 216

46. If 6 identical notebooks cost Rs. 426, what will 11 notebooks cost at the same rate?

- A) 781 B) 437  
C) 4686 D) 497

47. Find the arithmetic mean of 26, 28, 30, 32, 34.

- A) 150 B) 30  
C) 28 D) 32

48. A student scores 57 in a 3-credit course and 77 in a 6-credit course. Find the weighted mean.

- A) 67 B) 316.5  
C) 70.33 D) 35.17

49. A vehicle travels 220 km at a constant speed of 44 km/h. How long does the journey take?

- A) 264 hours B) 176 hours  
C)  $1/5$  hours D) 5 hours

50. Worker A can complete a job in 11 days and Worker B in 21 days. Working together, how many days will they take?

- A) 16 days B)  $32/231$  days  
C)  $231/10$  days D)  $231/32$  days

51. An item costs Rs. 540 and is sold at a profit of 40%. Find the selling price.

- A) Rs. 756 B) Rs. 216  
C) Rs. 324 D) Rs. 580

52. Find the simple interest on Rs. 1700 at 4% per year for 5 years.

- A) Rs. 68 B) Rs. 340  
C) Rs. 85 D) Rs. 2040

53. Solve  $2x + 12 = 32$ .

- A) 20 B)  $5/3$   
C) 10 D) 11

54. What is the larger root of  $x^2 - 14x + 24 = 0$ ?

- A) 2 B) 14  
C) 24 D) 12

55. Find the 15th term of the arithmetic sequence with first term 17 and common difference 4.

- A) 77 B) 69  
C) 315 D) 73

56. If  $9^x = 729$ , find x.

- A) 3 B) 9  
C) 729 D) 4

57. Find the area of a triangle with base 17 cm and height 11 cm.

- A)  $187 \text{ cm}^2$  B)  $187/2 \text{ cm}^2$   
C)  $28 \text{ cm}^2$  D)  $187/4 \text{ cm}^2$

58. Find the midpoint of the segment joining (7, 9) and (13, 17).

- A) (6, 8) B) (20, 26)  
C) (10, 13) D) (3, 4)

59. A bag contains 10 red and 4 blue balls. One ball is selected at random. What is P(red)?

- A)  $2/7$  B)  $5/2$   
C)  $1/14$  D)  $5/7$

60. How many different pairs can be selected from 12 people?

- A) 132 B) 14  
C) 12 D) 66

## SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. Which organelle is the main site of aerobic respiration?

- A) Lysosome B) Ribosome  
C) Mitochondrion D) Nucleus

62. Which structure controls the movement of substances into and out of a cell?

- A) Centriole B) Chromosome  
C) Nucleolus D) Cell membrane

63. Protein synthesis occurs on:

- A) Lysosomes B) Vacuoles  
C) Centrioles D) Ribosomes

64. Photosynthesis occurs mainly in the:

- A) Nuclei B) Chloroplasts  
C) Ribosomes D) Mitochondria

65. Diffusion is the net movement of particles from:

- A) lower concentration to higher concentration without energy B) one organ to another through blood only  
C) solid to liquid only D) higher concentration to lower concentration

66. Mitosis normally produces:

- A) two genetically similar daughter cells B) one haploid cell  
C) two cells with half the chromosome number D) gametes only



67. Meiosis is important because it:

- A) doubles chromosome number in gametes    B) produces identical somatic cells  
C) produces haploid gametes and introduces variation    D) occurs only in bacteria

68. The basic unit of heredity is the:

- A) Organ    B) Enzyme  
C) Hormone    D) Gene

69. A dominant allele is expressed in:

- A) the homozygous recessive condition only    B) males only  
C) both homozygous and heterozygous conditions    D) gametes only

70. White blood cells are primarily involved in:

- A) digestion of fats    B) production of urine  
C) defence against disease    D) oxygen transport

## SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of iron has atomic number 26. How many protons does it contain?

- A) 26    B) 25  
C) 52    D) 27

72. Isotopes of the same element have:

- A) different numbers of protons and the same number of neutrons    B) different atomic numbers and identical mass numbers  
C) the same numbers of protons and neutrons    D) the same number of protons but different numbers of neutrons

73. What is the maximum number of electrons in the second electron shell according to  $2n^2$ ?

- A) 8    B) 10  
C) 6    D) 5

74. An ionic bond is formed mainly by:

- A) transfer of electrons from one atom to another    B) overlap without electron involvement  
C) sharing of protons    D) equal sharing of electrons only

75. What is the mass of 2 mol of  $\text{CH}_4$  if its molar mass is  $16 \text{ g mol}^{-1}$ ?

- A) 34 g    B) 8 g  
C) 64 g    D) 32 g

76. How many moles are present in 32 g of  $\text{CH}_4$  (molar mass  $16 \text{ g mol}^{-1}$ )?

- A) 2 mol    B) 32 mol  
C) 16 mol    D) 1 mol

77. A solution contains 3 mol of solute in  $4 \text{ dm}^3$ . What is its concentration?

- A)  $0.75 \text{ mol dm}^{-3}$     B)  $12 \text{ mol dm}^{-3}$   
C)  $1.75 \text{ mol dm}^{-3}$     D)  $1.33333 \text{ mol dm}^{-3}$

78. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$ ?

- A) 4    B) 7  
C) 11    D) 3

79. Oxidation is best described as:

- A) loss of protons    B) loss of electrons  
C) gain of neutrons    D) gain of electrons

80. Which functional group characterizes a carboxylic acid?

- A) carboxyl group ( $-\text{COOH}$ )    B) terminal carbonyl group ( $-\text{CHO}$ )  
C) carbonyl group within the chain ( $>\text{C}=\text{O}$ )    D) amino group ( $-\text{NH}_2$ )

## SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. Which of the following is an SI base quantity?

- A) Pressure    B) Energy  
C) Power    D) Mass

82. A vehicle travels 48 m in 3 s at constant speed. What is its speed?

- A) 51 m/s    B) 16 m/s  
C) 18 m/s    D) 48 m/s

83. What force is required to accelerate a 2 kg mass at  $4 \text{ m/s}^2$ ?

- A) 0.50 N    B) 6 N  
C) 12 N    D) 8 N

84. Find the kinetic energy of a 4 kg object moving at 3 m/s.

- A) 21 J    B) 36 J  
C) 7 J    D) 18 J

85. What is the momentum of a 8 kg object moving at 3 m/s?

- A)  $0.38 \text{ kg}\cdot\text{m/s}$     B)  $72 \text{ kg}\cdot\text{m/s}$   
C)  $12 \text{ kg}\cdot\text{m/s}$     D)  $24 \text{ kg}\cdot\text{m/s}$

86. A sample has mass 9 kg and volume  $3 \text{ m}^3$ . What is its density?

- A)  $4 \text{ kg/m}^3$     B)  $0.33 \text{ kg/m}^3$   
C)  $27 \text{ kg/m}^3$     D)  $3 \text{ kg/m}^3$

87. A force of 200 N acts uniformly over an area of  $4 \text{ m}^2$ . What pressure is produced?

- A) 0.02 Pa    B) 800 Pa  
C) 54 Pa    D) 50 Pa

88. An electrical device operates at 18 V and draws 4 A. What is its power?

- A) 4.50 W    B) 0.22 W  
C) 76 W    D) 72 W

89. A wave has frequency 11 Hz and wavelength 3 m. What is its speed?

- A) 0.27 m/s    B) 14 m/s  
C) 44 m/s    D) 33 m/s

90. The SI unit of frequency is the:

- A) newton    B) coulomb  
C) hertz    D) pascal

**ANSWER KEY - PRE MEDICAL MODEL PAPER 7***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. A  | 2. D  | 3. A  | 4. B  | 5. D  | 6. A  | 7. D  | 8. D  | 9. A  | 10. C |
| 11. A | 12. B | 13. B | 14. C | 15. B | 16. C | 17. D | 18. A | 19. B | 20. D |
| 21. C | 22. B | 23. D | 24. B | 25. D | 26. D | 27. D | 28. D | 29. B | 30. D |
| 31. D | 32. C | 33. A | 34. A | 35. D | 36. D | 37. B | 38. C | 39. D | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. D | 63. D | 64. B | 65. D | 66. A | 67. C | 68. D | 69. C | 70. C |
| 71. A | 72. D | 73. A | 74. A | 75. D | 76. A | 77. A | 78. D | 79. B | 80. A |
| 81. D | 82. B | 83. D | 84. D | 85. D | 86. D | 87. D | 88. D | 89. D | 90. C |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |

**PRE-MEDICAL - MODEL PAPER 8**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 8

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) were    B) is  
C) have    D) be

2. At present, the candidates \_\_\_\_ for the test.

- A) is preparing    B) were prepare  
C) are preparing    D) have prepare

3. Wania \_\_\_\_ the admission file already.

- A) have completed    B) is completing since Monday  
C) had complete    D) has completed

4. By the time the supervisor arrived, Yahya \_\_\_\_ the attendance sheet.

- A) was check    B) has checked  
C) will have checked    D) had checked

5. By next Friday, the team \_\_\_\_ the admission file.

- A) will have completed    B) will completed  
C) would complete    D) has completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) have    B) be  
C) are    D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) has    B) have  
C) were    D) are having

8. Each of the candidates \_\_\_\_ an admit card.

- A) possess    B) have  
C) were given by    D) has

9. There \_\_\_\_ several reasons for the delay.

- A) was    B) be  
C) is    D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) will boil always    B) boiled  
C) boils    D) would boil

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play    B) will play  
C) played    D) had played

12. If I knew the answer, I \_\_\_\_ Wania.

- A) would tell    B) would have told  
C) will tell    D) told

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught    B) would have caught  
C) will catch    D) had caught

14. Choose the correct passive form: "The technician checks the admission file."

- A) The admission file is checked by the technician.    B) The admission file will be checked by the technician.  
C) The admission file was checked by the technician.    D) The admission file is being checked by the technician.

15. Choose the correct passive form: "The technician is checking the attendance sheet."

- A) The attendance sheet was being checked by the technician.    B) The attendance sheet has been checked by the technician.  
C) The attendance sheet is checked by the technician.    D) The attendance sheet is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the admission file."

- A) The admission file is processed by the clerk.    B) The admission file was being processed by the clerk.  
C) The admission file has processed by the clerk.    D) The admission file was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the attendance sheet."

- A) The attendance sheet was approved by the committee.    B) The attendance sheet has been approved by the committee.  
C) The attendance sheet is approved by the committee.    D) The attendance sheet has being approved by the committee.

18. Choose the correct passive form: "The office will issue the admission file."

- A) The admission file is issued by the office.    B) The admission file will be issued by the office.  
C) The admission file would be issued by the office.    D) The admission file will have issued by the office.

19. Select the correct indirect form: Wania said, "I will complete the admission file."

- A) Wania said that she would complete the admission file.    B) Wania said that she had complete the admission file.  
C) Wania told that the admission file would complete.    D) Wania said that I would complete the admission file.

20. Select the correct indirect form: Yahya said, "I am checking the attendance sheet."

- A) Yahya said that he is checking the attendance sheet.    B) Yahya said that I was checking the attendance sheet.  
C) Yahya said that he had checked the attendance sheet.    D) Yahya said that he was checking the attendance sheet.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L8: 8 candidates in a straight row - Questions 21-24**

8 candidates—Parveen, Wania, Umar, Tania, Owais, Qadir, Saad, and Rida—sit in a straight row, all facing north. 1. Parveen is at the extreme left. 2. Rida is at the extreme right. 3. Umar occupies the third seat. 4. Wania sits immediately left of Umar. 5. Tania sits immediately right of Umar. 6. Qadir is third from the right. 7. Owais is immediately left of Qadir. 8. Saad is immediately right of Qadir.

21. Which pair is seated next to each other?

- A) Parveen and Umar    B) Parveen and Qadir  
C) Umar and Tania    D) Umar and Rida

22. Who is farthest from Parveen?

- A) Owais B) Qadir  
C) Saad D) Rida

23. How many seats lie strictly between Umar and Rida?

- A) 4 B) 1  
C) 2 D) 0

24. If Rida moves to the left end and everyone else shifts one seat right, who becomes fourth from the left?

- A) Umar B) Rida  
C) Saad D) Parveen

**Analytical Set C8: 6 participants around a round table - Questions 25-28**

6 participants—Rania, Qais, Shah, Pina, Talia, and Omar—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Rania occupies the top seat. 2. Qais sits immediately clockwise of Rania. 3. Shah sits immediately clockwise of Qais. 4. Pina sits directly opposite Rania. 5. Talia sits immediately clockwise of Pina. 6. Omar sits immediately clockwise of Talia.

25. Who is the clockwise neighbour of Talia?

- A) Shah B) Rania  
C) Talia D) Omar

26. Which person is separated from Pina by exactly half the circle?

- A) Rania B) Talia  
C) Qais D) Pina

27. With everyone facing inward, who is on the immediate right of Qais?

- A) Rania B) Omar  
C) Shah D) Pina

28. If the clockwise order is reversed while the top person remains fixed, who becomes third clockwise from the top?

- A) Rania B) Talia  
C) Shah D) Qais

**Analytical Set S8: 6 presentations in fixed slots - Questions 29-32**

The following 6 presentations are assigned one per slot: Karachi, Peshawar, Multan, Lahore, Rawalpindi, and Quetta. 1. Karachi is scheduled in 8:00 a.m.. 2. Quetta is scheduled in 1:00 p.m.. 3. Peshawar occurs immediately after Karachi. 4. Lahore occurs immediately after Multan. 5. Rawalpindi is between Lahore and Quetta, consecutive with both.

29. Identify the slot assigned to Peshawar.

- A) 10:00 a.m. B) 9:00 a.m.  
C) 11:00 a.m. D) 12:00 noon

30. Which activity closes the schedule?

- A) Multan B) Quetta  
C) Lahore D) Rawalpindi

31. Which activity falls between Peshawar and Lahore?

- A) Peshawar B) Lahore  
C) Karachi D) Multan

32. If the final three activities are conducted in reverse order, which activity becomes second-last?

- A) Rawalpindi B) Lahore  
C) Peshawar D) Multan

**Analytical Set D8: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the server starts, then the network connects. 2. If the network connects, then the server starts. 3. If the network connects, then the database loads. 4. If the database loads, then the dashboard does not appear. 5. If maintenance mode is active, then the dashboard appears. 6. If the warning lamp glows, then maintenance mode is active.

33. If the server starts, which statement must be true?

- A) The warning lamp glows B) The network does not connect  
C) The dashboard does not appear D) Maintenance mode is active

34. Assume the dashboard appears. Which condition must fail?

- A) The server does not start B) The server starts  
C) Maintenance mode is active D) The network connects

35. What follows necessarily when the warning lamp glows?

- A) The dashboard appears B) The database loads  
C) The dashboard does not appear D) The server starts

36. Which pair is logically incompatible?

- A) The server starts and the network connects B) The server starts and the database loads  
C) The network connects and maintenance mode is active D) The dashboard appears and maintenance mode is active

**Analytical Set B8: The family of Waseem and Yasmeen - Questions 37-40**

Waseem and Yasmeen are married. Their children are Kamran, a son, and Laraib, a daughter. Kamran is married to Maha; their children are Omaira, a son, and Parsa, a daughter. Laraib is married to Nabeel; their child is Qadir, a son.

37. How is Yasmeen related to Parsa?

- A) Paternal grandmother B) Mother-in-law  
C) Paternal aunt D) Maternal aunt

38. What is Laraib's relation to Omaira?

- A) Niece B) Paternal aunt  
C) Sister-in-law D) Sister

39. How is Qadir related to Parsa?

- A) Cousin B) Brother-in-law  
C) Sibling D) Uncle

40. How is Maha related to Laraib?

- A) Maternal aunt B) Paternal aunt  
C) Sister-in-law D) Cousin

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $23 + 4 \times 7 - 10$ .

- A) 41 B) 11  
C) 179 D) 45

42. Find  $6/12 + 5/21$  in simplest form.

- A)  $1/3$  B)  $31/42$   
C)  $11/42$  D)  $11/252$

43. What is 10% of 400?

- A)  $41/10$  B) 360  
C) 40 D) 400

44. A price of Rs. 820 is increased by 15%. What is the new price?

- A) Rs. 123 B) Rs. 835  
C) Rs. 697 D) Rs. 943

45. Rs. 308 is divided in the ratio 5:6. What is the larger share?

- A) 140 B) 154  
C) 11 D) 168

46. If 7 identical notebooks cost Rs. 518, what will 9 notebooks cost at the same rate?

- A) 666 B) 527  
C) 4662 D) 592

47. Find the arithmetic mean of 29, 32, 35, 38, 41.

- A) 175 B) 35  
C) 32 D) 38

48. A student scores 58 in a 4-credit course and 78 in a 3-credit course. Find the weighted mean.

- A) 68 B) 233  
C) 66.57 D) 38.83

49. A vehicle travels 92 km at a constant speed of 46 km/h. How long does the journey take?

- A) 138 hours B) 46 hours  
C)  $1/2$  hours D) 2 hours

50. Worker A can complete a job in 12 days and Worker B in 23 days. Working together, how many days will they take?

- A)  $35/2$  days B)  $35/276$  days  
C)  $276/11$  days D)  $276/35$  days

51. An item costs Rs. 560 and is sold at a profit of 5%. Find the selling price.

- A) Rs. 588 B) Rs. 28  
C) Rs. 532 D) Rs. 565

52. Find the simple interest on Rs. 1800 at 5% per year for 2 years.

- A) Rs. 90 B) Rs. 180  
C) Rs. 36 D) Rs. 1980

53. Solve  $3x + 13 = 46$ .

- A) 33 B)  $33/13$   
C) 11 D) 12

54. What is the larger root of  $x^2 - 16x + 39 = 0$ ?

- A) 3 B) 16  
C) 39 D) 13

55. Find the 16th term of the arithmetic sequence with first term 19 and common difference 5.

- A) 99 B) 89  
C) 384 D) 94

56. If  $10^x = 10000$ , find x.

- A) 4 B) 10  
C) 10000 D) 5

57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 63 cm.

- A) 12474 cm B) 396 cm  
C) 198 cm D) 126 cm

58. Find the distance between (8, 9) and (11, 13).

- A) 7 B) 4  
C) 5 D) 25

59. A bag contains 3 red and 5 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $5/8$  B)  $3/5$   
C)  $1/8$  D)  $3/8$

60. How many different pairs can be selected from 13 people?

- A) 156 B) 15  
C) 13 D) 78

## SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. The chamber of the human heart with the thickest wall is the:

- A) Right atrium B) Right ventricle  
C) Left atrium D) Left ventricle

62. Arteries generally carry blood:

- A) towards the heart only B) away from the heart  
C) only when oxygenated D) without pressure

63. Gas exchange in the lungs occurs mainly in the:

- A) Pleura B) Trachea  
C) Alveoli D) Bronchi

64. The functional unit of the kidney is the:

- A) Sarcomere B) Neuron  
C) Alveolus D) Nephron

65. The structural and functional unit of the nervous system is the:

- A) Neuron B) Osteon  
C) Alveolus D) Villus

66. A rapid automatic response to a stimulus is called a:

- A) Fertilization B) Voluntary action  
C) Reflex action D) Transpiration

67. Most nutrient absorption in humans occurs in the:

- A) Large intestine B) Small intestine  
C) Mouth D) Stomach

68. Xylem transports mainly:

- A) water and mineral ions B) amino acids only  
C) sugars only D) hormones from animals

69. Phloem transports mainly:

- A) mineral salts only B) oxygen only  
C) water only D) organic food such as sucrose

70. Stomata regulate:

- A) gas exchange and water loss B) cell division  
C) mineral absorption by roots only D) seed germination only

## SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of copper has atomic number 29. How many protons does it contain?

- A) 58 B) 30  
C) 27 D) 29

72. Isotopes of the same element have:

- A) the same numbers of protons and neutrons B) different atomic numbers and identical mass numbers  
C) different chemical symbols only D) the same number of protons but different numbers of neutrons

73. An ionic bond is formed mainly by:

- A) sharing of protons B) transfer of electrons from one atom to another  
C) overlap without electron involvement D) equal sharing of electrons only

74. What is the mass of 3 mol of  $\text{H}_2\text{SO}_4$  if its molar mass is  $98 \text{ g mol}^{-1}$ ?

- A) 297 g B) 294 g  
C) 49 g D) 588 g

75. How many moles are present in 294 g of  $\text{H}_2\text{SO}_4$  (molar mass  $98 \text{ g mol}^{-1}$ )?

- A) 4 mol B) 1.5 mol  
C) 98 mol D) 3 mol

76. A solution contains 4 mol of solute in  $5 \text{ dm}^3$ . What is its concentration?

- A)  $0.8 \text{ mol dm}^{-3}$  B)  $20 \text{ mol dm}^{-3}$   
C)  $1.8 \text{ mol dm}^{-3}$  D)  $1.25 \text{ mol dm}^{-3}$

77. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-4} \text{ mol dm}^{-3}$ ?

- A) 7 B) 10  
C) 5 D) 4

78. Oxidation is best described as:

- A) gain of electrons B) no change in oxidation state  
C) loss of protons D) loss of electrons

79. Which functional group characterizes an aldehyde?

- A) amino group ( $-\text{NH}_2$ ) B) terminal carbonyl group ( $-\text{CHO}$ )  
C) hydroxyl group ( $-\text{OH}$ ) D) carbonyl group within the chain ( $>\text{C}=\text{O}$ )

80. The standard hydrogen electrode is assigned a potential of:

- A) 0.50 V B) 0.00 V  
C)  $-1.00 \text{ V}$  D) 14.00 V

## SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. A vehicle travels 68 m in 4 s at constant speed. What is its speed?

- A) 72 m/s B) 17 m/s  
C) 68 m/s D) 4/68 m/s

82. An object's velocity changes from 4 m/s to 34 m/s in 6 s. What is its acceleration?

- A)  $30 \text{ m/s}^2$  B)  $5.7 \text{ m/s}^2$   
C)  $5 \text{ m/s}^2$  D)  $10 \text{ m/s}^2$

83. What force is required to accelerate a 3 kg mass at  $5 \text{ m/s}^2$ ?

- A) 20 N B) 0.60 N  
C) 8 N D) 15 N

84. Find the kinetic energy of a 6 kg object moving at 4 m/s.

- A) 24 J B) 96 J  
C) 52 J D) 48 J

85. What is the momentum of a 2 kg object moving at 4 m/s?

- A)  $32 \text{ kg}\cdot\text{m/s}$  B)  $2.00 \text{ kg}\cdot\text{m/s}$   
C)  $4 \text{ kg}\cdot\text{m/s}$  D)  $8 \text{ kg}\cdot\text{m/s}$

86. A sample has mass 16 kg and volume  $4 \text{ m}^3$ . What is its density?

- A)  $64 \text{ kg/m}^3$  B)  $12 \text{ kg/m}^3$   
C)  $0.25 \text{ kg/m}^3$  D)  $4 \text{ kg/m}^3$

87. A force of 300 N acts uniformly over an area of  $5 \text{ m}^2$ . What pressure is produced?

- A) 60 Pa B) 1500 Pa  
C) 0.02 Pa D) 65 Pa

88. An electrical device operates at 20 V and draws 5 A. What is its power?

- A) 105 W B) 25 W  
C) 0.25 W D) 100 W

89. A wave has frequency 12 Hz and wavelength 4 m. What is its speed?

- A) 60 m/s B) 0.33 m/s  
C) 48 m/s D) 3.00 m/s

90. A convex lens can form a real image when the object is:

- A) at the optical centre only B) between the lens and focal point only  
C) behind the lens D) outside its focal point

**ANSWER KEY - PRE MEDICAL MODEL PAPER 8***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. C  | 3. D  | 4. D  | 5. A  | 6. D  | 7. A  | 8. D  | 9. D  | 10. C |
| 11. B | 12. A | 13. B | 14. A | 15. D | 16. D | 17. B | 18. B | 19. A | 20. D |
| 21. C | 22. D | 23. A | 24. A | 25. D | 26. A | 27. A | 28. B | 29. B | 30. B |
| 31. D | 32. A | 33. C | 34. A | 35. A | 36. C | 37. A | 38. B | 39. A | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. B | 63. C | 64. D | 65. A | 66. C | 67. B | 68. A | 69. D | 70. A |
| 71. D | 72. D | 73. B | 74. B | 75. D | 76. A | 77. D | 78. D | 79. B | 80. B |
| 81. B | 82. C | 83. D | 84. D | 85. D | 86. D | 87. A | 88. D | 89. C | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |

**PRE-MEDICAL - MODEL PAPER 9**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 9

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) be B) were  
C) are D) is

2. At present, the researchers \_\_\_\_ for the test.

- A) prepared B) were prepare  
C) have prepare D) are preparing

3. Lubna \_\_\_\_ the equipment list already.

- A) has completed B) is completing since Monday  
C) have completed D) completed yesterday

4. By the time the supervisor arrived, Noman \_\_\_\_ the data table.

- A) will have checked B) checks  
C) was check D) had checked

5. By next Friday, the team \_\_\_\_ the equipment list.

- A) has completed B) will completed  
C) will have completed D) had completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) were being B) be  
C) is D) are

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do B) have  
C) are having D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) have B) possess  
C) were given by D) has

9. There \_\_\_\_ several reasons for the delay.

- A) are B) is  
C) be D) was

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would boil B) will boil always  
C) would have boiled D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play B) played  
C) will play D) would have played

12. If I knew the answer, I \_\_\_\_ Lubna.

- A) had told B) told  
C) would have told D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) will catch  
C) would catch D) would have caught

14. Choose the correct passive form: "The technician checks the equipment list."

- A) The equipment list has checked by the technician. B) The equipment list will be checked by the technician.  
C) The equipment list is being checked by the technician. D) The equipment list is checked by the technician.

15. Choose the correct passive form: "The technician is checking the data table."

- A) The data table has been checked by the technician. B) The data table was being checked by the technician.  
C) The data table is being checked by the technician. D) The data table is checked by the technician.

16. Choose the correct passive form: "The clerk processed the equipment list."

- A) The equipment list has processed by the clerk. B) The equipment list is processed by the clerk.  
C) The equipment list will be processed by the clerk. D) The equipment list was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the data table."

- A) The data table has being approved by the committee. B) The data table is approved by the committee.  
C) The data table was approved by the committee. D) The data table has been approved by the committee.

18. Choose the correct passive form: "The office will issue the equipment list."

- A) The equipment list is issued by the office. B) The equipment list will be issued by the office.  
C) The equipment list will have issued by the office. D) The equipment list would be issued by the office.

19. Select the correct indirect form: Lubna said, "I will complete the equipment list."

- A) Lubna said that she would complete the equipment list. B) Lubna said that I would complete the equipment list.  
C) Lubna said that she had complete the equipment list. D) Lubna said that she will complete the equipment list.

20. Select the correct indirect form: Noman said, "I am checking the data table."

- A) Noman said that he had checked the data table. B) Noman said that I was checking the data table.  
C) Noman said that he was checking the data table. D) Noman said that he is checking the data table.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L9: 6 candidates in a straight row - Questions 21-24**

6 candidates—Basit, Zain, Celia, Waleed, Areeba, and Yusra—sit in a straight row, all facing north. 1. Basit occupies the extreme left seat. 2. Yusra sits at the extreme right. 3. Zain is immediately to the right of Basit. 4. Waleed sits immediately to the right of Celia. 5. Areeba sits between Waleed and Yusra, adjacent to both.

21. Identify the person sitting in seat 5.

- A) Celia B) Areeba  
C) Basit D) Yusra



22. Who is the immediate left neighbour of Areeba?

- A) Yusra B) Celia  
C) Areeba D) Waleed

23. Which pair is NOT seated adjacently?

- A) Zain and Celia B) Basit and Zain  
C) Waleed and Areeba D) Basit and Celia

24. If the entire row is viewed from the opposite end, who appears third from the left?

- A) Yusra B) Waleed  
C) Basit D) Celia

**Analytical Set C9: 8 participants around a round table - Questions 25-28**

8 participants—Vania, Waseem, Adil, Zainab, Ubaid, Yara, Cyrus, and Bisma—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Vania sits at the top. 2. Bisma is immediately anticlockwise from Vania. 3. Cyrus is immediately anticlockwise from Bisma. 4. Ubaid is opposite Vania. 5. Zainab is immediately anticlockwise from Ubaid. 6. Adil is immediately anticlockwise from Zainab. 7. Waseem sits between Vania and Adil, adjacent to both. 8. Yara is immediately clockwise from Ubaid.

25. Who sits one place clockwise from Vania?

- A) Adil B) Bisma  
C) Waseem D) Cyrus

26. For Set C9, which pair sits opposite each other?

- A) Zainab and Cyrus B) Adil and Cyrus  
C) Waseem and Bisma D) Ubaid and Bisma

27. Who sits immediately clockwise of Bisma, crossing the top position?

- A) Bisma B) Yara  
C) Vania D) Cyrus

28. If all participants face outward, who is immediately to the right of Adil?

- A) Zainab B) Cyrus  
C) Bisma D) Yara

**Analytical Set S9: 7 classes in fixed slots - Questions 29-32**

The following 7 classes are assigned one per slot: Physics, Calculus, Aptitude, Writing, Logic, Grammar, and Vocabulary. 1. Writing is scheduled in the middle slot, Period 4. 2. Physics opens the schedule. 3. Vocabulary closes the schedule. 4. Calculus immediately follows Physics. 5. Aptitude immediately precedes Writing. 6. Logic immediately follows Writing. 7. Grammar immediately precedes Vocabulary.

29. What is scheduled during Period 5?

- A) Writing B) Aptitude  
C) Logic D) Physics

30. Which activity directly precedes Logic?

- A) Physics B) Grammar  
C) Aptitude D) Writing

31. How many activities are scheduled between Physics and Writing?

- A) 3 B) 2  
C) 0 D) 1

32. If the opening activity is shifted to the end and all others move one slot earlier, which activity is last?

- A) Calculus B) Grammar  
C) Physics D) Vocabulary

**Analytical Set D9: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the train departs, then the signal turns green. 2. If the crossing closes, then the signal turns green. 3. If the signal turns green, then the platform announcement plays. 4. If the platform announcement does not play, then an obstruction is detected. 5. If an obstruction is detected, then the alarm sounds.

33. Which result is forced if the train departs?

- A) The signal does not turn green B) An obstruction is detected  
C) The alarm sounds D) The platform announcement plays

34. If the platform announcement does not play, which pair of statements must both be true?

- A) The train does not depart and the crossing does not close B) The train departs and the crossing closes  
C) The crossing closes and the alarm sounds D) The signal turns green and an obstruction is detected

35. If the signal does not turn green, which conclusion follows immediately?

- A) An obstruction is detected B) The train does not depart  
C) The platform announcement plays D) The crossing closes

36. Suppose an obstruction is detected. What must occur next in the implication chain?

- A) The signal turns green B) The platform announcement plays  
C) The crossing closes D) The alarm sounds

**Analytical Set B9: The family of Zubair and Afsheen - Questions 37-40**

Zubair and Afsheen are married. Their children are Rameez, a son, and Sonia, a daughter. Rameez is married to Tuba; their children are Vania, a son, and Wajid, a daughter. Sonia is married to Usman; their child is Yumna, a son.

37. How is Afsheen related to Wajid?

- A) Paternal aunt B) Mother-in-law  
C) Maternal aunt D) Paternal grandmother

38. What is Sonia's relation to Vania?

- A) Niece B) Maternal aunt  
C) Sister-in-law D) Paternal aunt

39. How is Yumna related to Wajid?

- A) Sibling B) Uncle  
C) Brother-in-law D) Cousin

40. How is Tuba related to Sonia?

- A) Paternal aunt B) Cousin  
C) Maternal aunt D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $25 + 5 \times 8 - 2$ .

- A) 63 B) 55  
C) 238 D) 68

42. Find  $7/13 + 4/13$  in simplest form.

- A)  $11/26$  B)  $11/13$   
C)  $3/13$  D)  $11/169$

43. What is 15% of 425?

- A)  $22/5$  B)  $85/3$   
C)  $255/4$  D)  $1445/4$

44. A price of Rs. 860 is increased by 20%. What is the new price?

- A) Rs. 172 B) Rs. 880  
C) Rs. 688 D) Rs. 1032

45. Rs. 406 is divided in the ratio 6:8. What is the larger share?

- A) 174 B) 203  
C) 14 D) 232

46. If 8 identical notebooks cost Rs. 616, what will 11 notebooks cost at the same rate?

- A) 847 B) 627  
C) 6776 D) 693

47. Find the arithmetic mean of 32, 36, 40, 44, 48.

- A) 200 B) 40  
C) 36 D) 44

48. A student scores 59 in a 2-credit course and 79 in a 4-credit course. Find the weighted mean.

- A) 69 B) 217  
C) 72.33 D) 54.25

49. A vehicle travels 144 km at a constant speed of 48 km/h. How long does the journey take?

- A) 192 hours B) 96 hours  
C)  $1/3$  hours D) 3 hours

50. Worker A can complete a job in 13 days and Worker B in 25 days. Working together, how many days will they take?

- A) 19 days B)  $38/325$  days  
C)  $325/12$  days D)  $325/38$  days

51. An item costs Rs. 580 and is sold at a profit of 10%. Find the selling price.

- A) Rs. 638 B) Rs. 58  
C) Rs. 522 D) Rs. 590

52. Find the simple interest on Rs. 1900 at 6% per year for 3 years.

- A) Rs. 114 B) Rs. 342  
C) Rs. 57 D) Rs. 2242

53. Solve  $4x + 14 = 62$ .

- A) 48 B)  $24/7$   
C) 12 D) 13

54. What is the larger root of  $x^2 - 18x + 56 = 0$ ?

- A) 4 B) 18  
C) 56 D) 14

55. Find the 17th term of the arithmetic sequence with first term 21 and common difference 6.

- A) 123 B) 111  
C) 459 D) 117

56. If  $11^x = 121$ , find x.

- A) 2 B) 11  
C) 121 D) 3

57. Find the area of a rectangle of length 17 cm and width 5 cm.

- A)  $44 \text{ cm}^2$  B)  $85 \text{ cm}^2$   
C)  $22 \text{ cm}^2$  D)  $170 \text{ cm}^2$

58. Find the slope of the line through (9, 11) and (13, 19).

- A)  $1/2$  B) 8  
C) 2 D) 4

59. A bag contains 4 red and 6 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $3/5$  B)  $2/3$   
C)  $1/10$  D)  $2/5$

60. How many different pairs can be selected from 14 people?

- A) 182 B) 16  
C) 14 D) 91

#### SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. Bacteria and fungi that break down dead matter are:

- A) Pollinators B) Decomposers  
C) Producers D) Primary consumers

62. A group of organisms of the same species living in one area is a:

- A) Population B) Biome  
C) Ecosystem D) Community

63. All interacting populations in an area form a:

- A) Community B) Gene pool only  
C) Tissue D) Species

64. An ecosystem includes:

- A) only non-living factors B) only producers  
C) one species only D) a community and its physical environment

65. Natural selection favours individuals that:

- A) leave more surviving offspring in a given environment B) acquire traits solely through use  
C) avoid reproduction D) never show variation

66. Viruses can reproduce only:

- A) inside crystals only B) inside living host cells  
C) on nutrient agar without cells D) in distilled water

67. Fertilization is the fusion of:

- A) male and female gametes    B) two somatic cells  
C) two chromosomes only    D) two embryos

68. The testes produce:

- A) urine and urea    B) insulin and glucagon  
C) ova and oestrogen    D) sperm and testosterone

69. The ovaries produce:

- A) bile    B) sperm and testosterone  
C) ova and female sex hormones    D) red blood cells

70. The placenta allows exchange of materials between:

- A) xylem and phloem    B) the lungs and heart only  
C) mother and developing fetus    D) the stomach and liver

## SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of carbon has atomic number 6. How many protons does it contain?

- A) 6    B) 5  
C) 12    D) 4

72. Isotopes of the same element have:

- A) different atomic numbers and identical mass numbers    B) different chemical symbols only  
C) different numbers of protons and the same number of neutrons    D) the same number of protons but different numbers of neutrons

73. What is the maximum number of electrons in the fourth electron shell according to  $2n^2$ ?

- A) 16    B) 30  
C) 32    D) 34

74. An ionic bond is formed mainly by:

- A) transfer of neutrons    B) transfer of electrons from one atom to another  
C) sharing of protons    D) equal sharing of electrons only

75. Across a period from left to right, atomic radius generally:

- A) depends only on mass number    B) first becomes zero  
C) increases    D) decreases

76. What is the mass of 4 mol of  $H_2O$  if its molar mass is  $18 \text{ g mol}^{-1}$ ?

- A) 144 g    B) 9 g  
C) 68 g    D) 72 g

77. How many moles are present in 72 g of  $H_2O$  (molar mass  $18 \text{ g mol}^{-1}$ )?

- A) 4 mol    B) 2 mol  
C) 18 mol    D) 5 mol

78. What is the pH of a solution with  $[H^+] = 1.0 \times 10^{-5} \text{ mol dm}^{-3}$ ?

- A) 5    B) 6  
C) 4    D) 9

79. Oxidation is best described as:

- A) loss of protons    B) no change in oxidation state  
C) loss of electrons    D) gain of neutrons

80. Which functional group characterizes an ketone?

- A) terminal carbonyl group ( $-CHO$ )    B) amino group ( $-NH_2$ )  
C) hydroxyl group ( $-OH$ )    D) carbonyl group within the chain ( $>C=O$ )

## SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. Which of the following is an SI base quantity?

- A) Energy    B) Pressure  
C) Mass    D) Power

82. A vehicle travels 90 m in 5 s at constant speed. What is its speed?

- A) 20 m/s    B) 90 m/s  
C) 95 m/s    D) 18 m/s

83. An object's velocity changes from 5 m/s to 11 m/s in 3 s. What is its acceleration?

- A)  $8 \text{ m/s}^2$     B)  $2 \text{ m/s}^2$   
C)  $3.7 \text{ m/s}^2$     D)  $3 \text{ m/s}^2$

84. What force is required to accelerate a 4 kg mass at  $6 \text{ m/s}^2$ ?

- A) 12 N    B) 24 N  
C) 10 N    D) 0.67 N

85. Find the kinetic energy of a 8 kg object moving at 5 m/s.

- A) 13 J    B) 100 J  
C) 105 J    D) 40 J

86. What is the momentum of a 3 kg object moving at 5 m/s?

- A)  $8 \text{ kg} \cdot \text{m/s}$     B)  $75 \text{ kg} \cdot \text{m/s}$   
C)  $7.5 \text{ kg} \cdot \text{m/s}$     D)  $15 \text{ kg} \cdot \text{m/s}$

87. A sample has mass 25 kg and volume  $5 \text{ m}^3$ . What is its density?

- A)  $125 \text{ kg/m}^3$     B)  $6 \text{ kg/m}^3$   
C)  $20 \text{ kg/m}^3$     D)  $5 \text{ kg/m}^3$

88. A force of 140 N acts uniformly over an area of  $2 \text{ m}^2$ . What pressure is produced?

- A) 280 Pa    B) 70 Pa  
C) 140 Pa    D) 72 Pa

89. An electrical device operates at 6 V and draws 2 A. What is its power?

- A) 12 W    B) 3.00 W  
C) 8 W    D) 0.33 W

90. The direction of conventional current is taken as the direction of motion of:

- A) photons    B) electrons only  
C) atoms    D) positive charge

**ANSWER KEY - PRE MEDICAL MODEL PAPER 9***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. D  | 3. A  | 4. D  | 5. C  | 6. C  | 7. D  | 8. D  | 9. A  | 10. D |
| 11. C | 12. D | 13. D | 14. D | 15. C | 16. D | 17. D | 18. B | 19. A | 20. C |
| 21. B | 22. D | 23. D | 24. B | 25. C | 26. B | 27. C | 28. A | 29. C | 30. D |
| 31. B | 32. C | 33. D | 34. A | 35. B | 36. D | 37. D | 38. D | 39. D | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. A | 63. A | 64. D | 65. A | 66. B | 67. A | 68. D | 69. C | 70. C |
| 71. A | 72. D | 73. C | 74. B | 75. D | 76. D | 77. A | 78. A | 79. C | 80. D |
| 81. C | 82. D | 83. B | 84. B | 85. B | 86. D | 87. D | 88. B | 89. A | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |

**PRE-MEDICAL - MODEL PAPER 10**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Medical 10

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) were    B) is  
C) have    D) are

2. At present, the workers \_\_\_\_ for the test.

- A) is preparing    B) were prepare  
C) are preparing    D) prepared

3. Shazia \_\_\_\_ the research summary already.

- A) had complete    B) has completed  
C) completed yesterday    D) is completing since Monday

4. By the time the supervisor arrived, Rafay \_\_\_\_ the question paper.

- A) was check    B) checks  
C) has checked    D) had checked

5. By next Friday, the team \_\_\_\_ the research summary.

- A) will have completed    B) will completed  
C) would complete    D) has completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is    B) are  
C) have    D) be

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do    B) have  
C) were    D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having    B) have  
C) possess    D) has

9. There \_\_\_\_ several reasons for the delay.

- A) is    B) has  
C) be    D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled    B) boils  
C) would boil    D) boiled

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play    B) will play  
C) played    D) would have played

12. If I knew the answer, I \_\_\_\_ Shazia.

- A) would tell    B) will tell  
C) would have told    D) had told

13. If they had left earlier, they \_\_\_\_ the train.

- A) had caught    B) will catch  
C) would have caught    D) would catch

14. Choose the correct passive form: "The technician checks the research summary."

- A) The research summary has checked by the technician.    B) The research summary is being checked by the technician.  
C) The research summary was checked by the technician.    D) The research summary is checked by the technician.

15. Choose the correct passive form: "The technician is checking the question paper."

- A) The question paper is checked by the technician.    B) The question paper is been checked by the technician.  
C) The question paper has been checked by the technician.    D) The question paper is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the research summary."

- A) The research summary was processed by the clerk.    B) The research summary has processed by the clerk.  
C) The research summary will be processed by the clerk.    D) The research summary was being processed by the clerk.

17. Choose the correct passive form: "The committee has approved the question paper."

- A) The question paper has being approved by the committee.    B) The question paper has been approved by the committee.  
C) The question paper is approved by the committee.    D) The question paper had approved by the committee.

18. Choose the correct passive form: "The office will issue the research summary."

- A) The research summary will issued by the office.    B) The research summary would be issued by the office.  
C) The research summary is issued by the office.    D) The research summary will be issued by the office.

19. Select the correct indirect form: Shazia said, "I will complete the research summary."

- A) Shazia said that she will complete the research summary.    B) Shazia said that I would complete the research summary.  
C) Shazia said that she had complete the research summary.    D) Shazia said that she would complete the research summary.

20. Select the correct indirect form: Rafay said, "I am checking the question paper."

- A) Rafay said that I was checking the question paper.    B) Rafay said that he was checking the question paper.  
C) Rafay said that he is checking the question paper.    D) Rafay told that he was checking the question paper.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L10: 7 candidates in a straight row - Questions 21-24**

7 candidates—Kashif, Faizan, Hina, Javeria, Esha, Imran, and Daniyal—sit in a straight row, all facing north. 1. Faizan is second from the left. 2. Imran is second from the right. 3. Kashif sits immediately left of Faizan. 4. Hina sits immediately right of Faizan. 5. Javeria occupies the central seat. 6. Esha is immediately right of Javeria. 7. Daniyal is immediately right of Imran.

21. Who occupies the fifth seat from the left?

- A) Esha    B) Hina  
C) Imran    D) Kashif

22. What is the position of Imran in the row?

- A) First from the left    B) Fifth from the left  
C) Sixth from the left    D) Third from the left

23. Who sits immediately to the left of Javeria?

- A) Hina    B) Imran  
C) Esha    D) Daniyal

24. How many people sit between Faizan and Imran?

- A) 4    B) 1  
C) 2    D) 3

**Analytical Set C10: 6 participants around a round table - Questions 25-28**

6 participants—Haris, Gul, Eman, Fahim, Danish, and Iqra—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Haris occupies the top seat. 2. Gul sits immediately clockwise of Haris. 3. Eman sits immediately clockwise of Gul. 4. Fahim sits directly opposite Haris. 5. Danish sits immediately clockwise of Fahim. 6. Iqra sits immediately clockwise of Danish.

25. Who sits immediately clockwise of Gul?

- A) Gul    B) Danish  
C) Eman    D) Iqra

26. Who sits directly opposite Haris?

- A) Danish    B) Gul  
C) Fahim    D) Haris

27. Who is second clockwise from Iqra?

- A) Gul    B) Iqra  
C) Danish    D) Haris

28. All participants face the centre. Who is immediately to the right of Fahim?

- A) Gul    B) Haris  
C) Danish    D) Eman

**Analytical Set S10: 6 meetings in fixed slots - Questions 29-32**

The following 6 meetings are assigned one per slot: Energy, Data, Budget, Grants, Faculty, and Campus. 1. Energy is scheduled in Monday. 2. Campus is scheduled in Saturday. 3. Data occurs immediately after Energy. 4. Grants occurs immediately after Budget. 5. Faculty is between Grants and Campus, consecutive with both.

29. On which slot is Budget scheduled?

- A) Thursday    B) Tuesday  
C) Wednesday    D) Monday

30. Which activity is scheduled in Friday?

- A) Grants    B) Data  
C) Energy    D) Faculty

31. Which activity occurs immediately before Grants?

- A) Campus    B) Energy  
C) Budget    D) Grants

32. How many complete slots lie between Data and Campus?

- A) 3    B) 1  
C) 0    D) 4

**Analytical Set D10: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the experiment begins, then the heater switches on. 2. If the heater switches on, then the sample does not warm. 3. If the sensor records data, then the sample warms. 4. If the safety lock engages, then the sensor records data. 5. If the technician presses reset, then the experiment begins.

33. If the technician presses reset, which statement is certain?

- A) The experiment does not begin    B) The safety lock engages  
C) The sensor records data    D) The sample does not warm

34. Given that the sample warms, what can be deduced about the last condition?

- A) The heater switches on    B) The technician does not press reset  
C) The sensor records data    D) The experiment begins

35. What must be true when the safety lock engages?

- A) The sample does not warm    B) The heater switches on  
C) The experiment begins    D) The heater does not switch on

36. Which two conditions cannot both hold?

- A) The technician presses reset and the experiment begins    B) The sensor records data and the safety lock engages  
C) The experiment begins and the heater switches on    D) The experiment begins and the sensor records data

**Analytical Set B10: The family of Feroz and Ghazala - Questions 37-40**

Feroz and Ghazala are married. Their children are Hasan, a son, and Inaya, a daughter. Hasan is married to Jalal; their children are Latif, a son, and Maira, a daughter. Inaya is married to Kiran; their child is Noman, a son.

37. How is Ghazala related to Maira?

- A) Paternal aunt    B) Maternal grandmother  
C) Maternal aunt    D) Paternal grandmother

38. What is Inaya's relation to Latif?

- A) Paternal aunt    B) Niece  
C) Maternal aunt    D) Sister

39. How is Noman related to Maira?

- A) Nephew    B) Cousin  
C) Sibling    D) Brother-in-law

40. How is Jalal related to Inaya?

- A) Cousin    B) Paternal aunt  
C) Mother-in-law    D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $27 + 6 \times 4 - 3$ .

- A) 48    B) 33  
C) 129    D) 54

42. Find  $8/14 + 5/14$  in simplest form.

- A)  $13/28$  B)  $13/14$   
C)  $3/14$  D)  $13/196$

43. What is 20% of 450?

- A)  $47/10$  B)  $45/2$   
C) 90 D) 360

44. A price of Rs. 900 is increased by 25%. What is the new price?

- A) Rs. 225 B) Rs. 925  
C) Rs. 675 D) Rs. 1125

45. Rs. 210 is divided in the ratio 2:5. What is the larger share?

- A) 60 B) 105  
C) 7 D) 150

46. If 4 identical notebooks cost Rs. 320, what will 8 notebooks cost at the same rate?

- A) 640 B) 328  
C) 2560 D) 400

47. Find the arithmetic mean of 35, 40, 45, 50, 55.

- A) 225 B) 45  
C) 40 D) 50

48. A student scores 60 in a 3-credit course and 80 in a 5-credit course. Find the weighted mean.

- A) 70 B) 290  
C) 72.5 D) 38.67

49. A vehicle travels 200 km at a constant speed of 50 km/h. How long does the journey take?

- A) 250 hours B) 150 hours  
C)  $1/4$  hours D) 4 hours

50. Worker A can complete a job in 14 days and Worker B in 27 days. Working together, how many days will they take?

- A)  $41/2$  days B)  $41/378$  days  
C)  $378/13$  days D)  $378/41$  days

51. An item costs Rs. 600 and is sold at a profit of 15%. Find the selling price.

- A) Rs. 690 B) Rs. 90  
C) Rs. 510 D) Rs. 615

52. Find the simple interest on Rs. 2000 at 7% per year for 4 years.

- A) Rs. 140 B) Rs. 560  
C) Rs. 80 D) Rs. 2560

53. Solve  $5x + 15 = 80$ .

- A) 65 B)  $13/3$   
C) 13 D) 14

54. What is the larger root of  $x^2 - 20x + 75 = 0$ ?

- A) 5 B) 20  
C) 75 D) 15

55. Find the 8th term of the arithmetic sequence with first term 23 and common difference 2.

- A) 39 B) 35  
C) 200 D) 37

56. If  $12^x = 1728$ , find x.

- A) 3 B) 12  
C) 1728 D) 4

57. Find the area of a triangle with base 20 cm and height 5 cm.

- A)  $100 \text{ cm}^2$  B)  $50 \text{ cm}^2$   
C)  $25 \text{ cm}^2$  D)  $101/2 \text{ cm}^2$

58. Find the midpoint of the segment joining (10, 12) and (16, 20).

- A) (6, 8) B) (26, 32)  
C) (13, 16) D) (3, 4)

59. A bag contains 5 red and 7 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $7/12$  B)  $5/7$   
C)  $1/12$  D)  $5/12$

60. How many different pairs can be selected from 15 people?

- A) 210 B) 17  
C) 15 D) 105

#### SECTION IV-A: BIOLOGY | 10 QUESTIONS | Questions 61-70

61. Which organelle is the main site of aerobic respiration?

- A) Golgi apparatus B) Ribosome  
C) Nucleus D) Mitochondrion

62. Which structure controls the movement of substances into and out of a cell?

- A) Nucleolus B) Cell wall  
C) Chromosome D) Cell membrane

63. Protein synthesis occurs on:

- A) Vacuoles B) Chloroplasts  
C) Lysosomes D) Ribosomes

64. Photosynthesis occurs mainly in the:

- A) Mitochondria B) Chloroplasts  
C) Ribosomes D) Nuclei

65. Diffusion is the net movement of particles from:

- A) solid to liquid only B) higher concentration to lower concentration  
C) one organ to another through blood only D) lower concentration to higher concentration without energy

66. Mitosis normally produces:

- A) gametes only B) two genetically similar daughter cells  
C) two cells with half the chromosome number D) four genetically different cells



67. Meiosis is important because it:

- A) repairs body tissues only    B) produces haploid gametes and introduces variation  
C) produces identical somatic cells    D) occurs only in bacteria

68. The basic unit of heredity is the:

- A) Enzyme    B) Hormone  
C) Gene    D) Tissue

69. A dominant allele is expressed in:

- A) both homozygous and heterozygous conditions    B) mutated cells only  
C) males only    D) gametes only

70. White blood cells are primarily involved in:

- A) blood clotting only    B) production of urine  
C) defence against disease    D) digestion of fats

## SECTION IV-B: CHEMISTRY | 10 QUESTIONS | Questions 71-80

71. An atom of oxygen has atomic number 8. How many protons does it contain?

- A) 8    B) 16  
C) 7    D) 6

72. Isotopes of the same element have:

- A) different atomic numbers and identical mass numbers    B) the same number of protons but different numbers of neutrons  
C) the same numbers of protons and neutrons    D) different chemical symbols only

73. What is the maximum number of electrons in the second electron shell according to  $2n^2$ ?

- A) 4    B) 10  
C) 5    D) 8

74. An ionic bond is formed mainly by:

- A) transfer of neutrons    B) equal sharing of electrons only  
C) overlap without electron involvement    D) transfer of electrons from one atom to another

75. What is the mass of 2 mol of  $\text{CO}_2$  if its molar mass is  $44 \text{ g mol}^{-1}$ ?

- A) 176 g    B) 88 g  
C) 90 g    D) 86 g

76. How many moles are present in 88 g of  $\text{CO}_2$  (molar mass  $44 \text{ g mol}^{-1}$ )?

- A) 88 mol    B) 44 mol  
C) 2 mol    D) 1 mol

77. A solution contains 2 mol of solute in  $3 \text{ dm}^3$ . What is its concentration?

- A)  $5 \text{ mol dm}^{-3}$     B)  $1.5 \text{ mol dm}^{-3}$   
C)  $0.666667 \text{ mol dm}^{-3}$     D)  $1.66667 \text{ mol dm}^{-3}$

78. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-6} \text{ mol dm}^{-3}$ ?

- A) 8    B) 7  
C) 5    D) 6

79. Oxidation is best described as:

- A) gain of electrons    B) no change in oxidation state  
C) loss of protons    D) loss of electrons

80. Which functional group characterizes an amine?

- A) carboxyl group ( $-\text{COOH}$ )    B) carbonyl group within the chain ( $>\text{C}=\text{O}$ )  
C) amino group ( $-\text{NH}_2$ )    D) terminal carbonyl group ( $-\text{CHO}$ )

## SECTION IV-C: PHYSICS | 10 QUESTIONS | Questions 81-90

81. A vehicle travels 114 m in 6 s at constant speed. What is its speed?

- A) 114 m/s    B) 19 m/s  
C) 21 m/s    D) 120 m/s

82. An object's velocity changes from 6 m/s to 18 m/s in 4 s. What is its acceleration?

- A)  $4 \text{ m/s}^2$     B)  $4.5 \text{ m/s}^2$   
C)  $12 \text{ m/s}^2$     D)  $3 \text{ m/s}^2$

83. What force is required to accelerate a 5 kg mass at  $7 \text{ m/s}^2$ ?

- A) 42 N    B) 35 N  
C) 12 N    D) 0.71 N

84. A machine does 280 J of work in 8 s. What is its power?

- A) 0.03 W    B) 43 W  
C) 35 W    D) 280 W

85. Find the kinetic energy of a 10 kg object moving at 6 m/s.

- A) 60 J    B) 16 J  
C) 180 J    D) 186 J

86. What is the momentum of a 4 kg object moving at 6 m/s?

- A)  $144 \text{ kg}\cdot\text{m/s}$     B)  $10 \text{ kg}\cdot\text{m/s}$   
C)  $1.50 \text{ kg}\cdot\text{m/s}$     D)  $24 \text{ kg}\cdot\text{m/s}$

87. A sample has mass 36 kg and volume  $6 \text{ m}^3$ . What is its density?

- A)  $7 \text{ kg/m}^3$     B)  $6 \text{ kg/m}^3$   
C)  $0.17 \text{ kg/m}^3$     D)  $216 \text{ kg/m}^3$

88. A force of 240 N acts uniformly over an area of  $3 \text{ m}^2$ . What pressure is produced?

- A) 0.01 Pa    B) 80 Pa  
C) 83 Pa    D) 720 Pa

89. An electrical device operates at 8 V and draws 3 A. What is its power?

- A) 27 W    B) 11 W  
C) 24 W    D) 2.67 W

90. Radioactive half-life is the time required for:

- A) the temperature to halve    B) the mass to double  
C) all nuclei to decay    D) half the unstable nuclei in a sample to decay



**ANSWER KEY - PRE MEDICAL MODEL PAPER 10***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. C  | 3. B  | 4. D  | 5. A  | 6. A  | 7. D  | 8. D  | 9. D  | 10. B |
| 11. B | 12. A | 13. C | 14. D | 15. D | 16. A | 17. B | 18. D | 19. D | 20. B |
| 21. A | 22. C | 23. A | 24. D | 25. C | 26. C | 27. A | 28. D | 29. C | 30. D |
| 31. C | 32. A | 33. D | 34. B | 35. D | 36. D | 37. D | 38. A | 39. B | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. D | 63. D | 64. B | 65. B | 66. B | 67. B | 68. C | 69. A | 70. C |
| 71. A | 72. B | 73. D | 74. D | 75. B | 76. C | 77. C | 78. D | 79. D | 80. C |
| 81. B | 82. D | 83. B | 84. C | 85. C | 86. D | 87. B | 88. B | 89. C | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | BIOLOGY   | CHEMISTRY | PHYSICS   |
|-----------|------------|---------------|-----------|-----------|-----------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10 |



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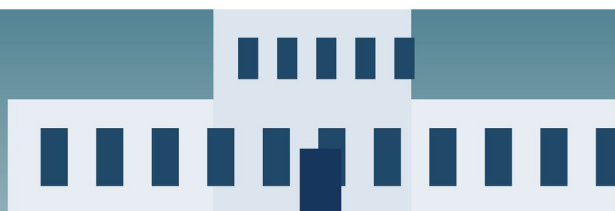
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## NTU ECAT - PRE-ENGINEERING MODEL PAPERS

**Revised paper structure: English 20 | Analytical Reasoning 20 | Mathematics-Based Quantitative Reasoning 20 | Three group subjects 10 each | Total 90 MCQs | Time 120 minutes | Four options A-D**

**Ten complete model papers | 90 MCQs per paper | Four options A-D | Time: 2 Hours | Total Marks: 90**

**English 25 | Analytical Reasoning 10 | Quantitative Reasoning 20 | Chemistry 15 | Physics 15 | Mathematics 15**

**Questions are varied across this model-paper group. Core concepts may recur with different wording, contexts, or numerical values to strengthen revision and prevent memorisation of a fixed sequence.**

**PRE-ENGINEERING - MODEL PAPER 1**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 1

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) be B) were  
C) are D) is

2. At present, the students \_\_\_\_ for the test.

- A) prepared B) have prepare  
C) were prepare D) are preparing

3. Imran \_\_\_\_ the test schedule already.

- A) completed yesterday B) have completed  
C) has completed D) is completing since Monday

4. By the time the supervisor arrived, Gohar \_\_\_\_ the safety checklist.

- A) will have checked B) has checked  
C) had checked D) checks

5. By next Friday, the team \_\_\_\_ the test schedule.

- A) will completed B) had completed  
C) has completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) are  
C) were being D) be

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do B) have  
C) were D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having B) possess  
C) were given by D) has

9. There \_\_\_\_ several reasons for the delay.

- A) has B) are  
C) is D) was

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would boil B) boiled  
C) would have boiled D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would have played B) will play  
C) played D) would play

12. If I knew the answer, I \_\_\_\_ Imran.

- A) told B) will tell  
C) would tell D) had told

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) had caught  
C) would have caught D) will catch

14. Choose the correct passive form: "The technician checks the test schedule."

- A) The test schedule was checked by the technician. B) The test schedule is checked by the technician.  
C) The test schedule will be checked by the technician. D) The test schedule is being checked by the technician.

15. Choose the correct passive form: "The technician is checking the safety checklist."

- A) The safety checklist was being checked by the technician. B) The safety checklist is checked by the technician.  
C) The safety checklist has been checked by the technician. D) The safety checklist is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the test schedule."

- A) The test schedule will be processed by the clerk. B) The test schedule has processed by the clerk.  
C) The test schedule is processed by the clerk. D) The test schedule was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the safety checklist."

- A) The safety checklist has been approved by the committee. B) The safety checklist had approved by the committee.  
C) The safety checklist was approved by the committee. D) The safety checklist has being approved by the committee.

18. Choose the correct passive form: "The office will issue the test schedule."

- A) The test schedule will issued by the office. B) The test schedule would be issued by the office.  
C) The test schedule will be issued by the office. D) The test schedule will have issued by the office.

19. Select the correct indirect form: Imran said, "I will complete the test schedule."

- A) Imran said that I would complete the test schedule. B) Imran said that he would complete the test schedule.  
C) Imran said that he will complete the test schedule. D) Imran said that he had complete the test schedule.

20. Select the correct indirect form: Gohar said, "I am checking the safety checklist."

- A) Gohar said that she is checking the safety checklist. B) Gohar said that I was checking the safety checklist.  
C) Gohar said that she had checked the safety checklist. D) Gohar said that she was checking the safety checklist.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L1: Six students in one row - Questions 21-24**

Six students—Amina, Bilal, Camil, Danish, Eman, and Farah—sit in a straight row, all facing north. 1. Amina sits at the extreme left. 2. Farah sits at the extreme right. 3. Camil sits immediately to the right of Bilal. 4. Danish sits second to the right of Bilal. 5. Eman sits immediately to the left of Farah.

21. Who occupies the third seat from the left?

- A) Bilal B) Camil  
C) Eman D) Farah

22. Which pair sits next to each other in that left-to-right order?

- A) Camil and Eman    B) Bilal and Danish  
C) Amina and Camil    D) Danish and Eman

23. How many students sit between Bilal and Eman?

- A) Two    B) One  
C) None    D) Four

24. If Amina and Farah exchange seats, who will sit immediately to the left of Bilal?

- A) Amina    B) Eman  
C) Camil    D) Farah

**Analytical Set C1: Six people around a circular table - Questions 25-28**

Six people—Adeel, Bushra, Chetan, Dalia, Ehsan, and Farah—sit around a circular table facing the centre. Adeel's seat is taken as the top reference point. 1. Bushra sits immediately clockwise from Adeel. 2. Dalia sits opposite Adeel. 3. Ehsan sits immediately clockwise from Dalia. 4. Chetan sits immediately clockwise from Bushra.

25. Who sits immediately anticlockwise from Dalia?

- A) Farah    B) Chetan  
C) Ehsan    D) Adeel

26. Which person sits opposite Bushra?

- A) Chetan    B) Ehsan  
C) Farah    D) Dalia

27. Who are Adeel's immediate neighbours?

- A) Bushra and Chetan    B) Dalia and Farah  
C) Ehsan and Farah    D) Bushra and Farah

28. If Chetan and Farah exchange seats, who will sit immediately anticlockwise from Adeel?

- A) Chetan    B) Dalia  
C) Ehsan    D) Farah

**Analytical Set S1: Six subjects across a week - Questions 29-32**

A student studies one subject each day from Monday to Saturday: Mathematics, Physics, Chemistry, English, Computer Science, and Biology. 1. Mathematics is studied on Monday. 2. Biology is studied on Saturday. 3. Physics is studied immediately after Mathematics. 4. English is studied immediately after Chemistry. 5. Computer Science is studied on Friday.

29. On which day is Chemistry studied?

- A) Monday    B) Tuesday  
C) Thursday    D) Wednesday

30. Which subject is studied immediately before Biology?

- A) English    B) Computer Science  
C) Mathematics    D) Chemistry

31. How many days occur between Physics and Computer Science?

- A) Four    B) Two  
C) None    D) Three

32. If English and Computer Science exchange days, what is studied on Thursday?

- A) Physics    B) Chemistry  
C) Computer Science    D) Biology

**Analytical Set D1: Symbolic implication chain - Questions 33-36**

Use the following rules: 1. If A is true, then B is true. 2. If B is true, then C is true. 3. If C is true, then D is true. 4. If D is false, then E is true. A conclusion is valid only when it must follow from the rules.

33. If A is true, which statement must also be true?

- A) D is true    B) C is false  
C) E is false    D) D is false

34. Suppose C is false. What must be true about B?

- A) Nothing can be known    B) B is false  
C) B may only be true    D) B is true

35. If D is false, which conclusion follows directly?

- A) B is true    B) A is true  
C) C is true    D) E is true

36. When B is true, which outcome is guaranteed?

- A) E is true    B) B is false  
C) A is true    D) D is true

**Analytical Set B1: Ahmed's family - Questions 37-40**

Ahmed and Sara are married. They have two children: Bilal, a son, and Hina, a daughter. Bilal is married to Nida, and their son is Owais. Hina is married to Kamran, and their daughter is Laiba.

37. How is Sara related to Owais?

- A) Mother-in-law    B) Paternal aunt  
C) Maternal aunt    D) Paternal grandmother

38. What is Kamran's relation to Bilal?

- A) Cousin    B) Son-in-law  
C) Maternal uncle    D) Brother-in-law

39. How is Laiba related to Bilal?

- A) Sister    B) Daughter  
C) Niece    D) Cousin

40. What is Nida's relation to Hina?

- A) Sister    B) Daughter-in-law  
C) Aunt    D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $29 + 7 \times 5 - 4$ .

- A) 60    B) 36  
C) 176    D) 67

42. Find  $9/15 + 6/15$  in simplest form.

- A)  $1/2$     B) 1  
C)  $1/5$     D)  $1/15$

43. What is 25% of 475?  
A) 5 B) 19  
C)  $475/4$  D)  $1425/4$
44. A price of Rs. 940 is increased by 30%. What is the new price?  
A) Rs. 282 B) Rs. 970  
C) Rs. 658 D) Rs. 1222
45. Rs. 310 is divided in the ratio 3:7. What is the larger share?  
A) 93 B) 155  
C) 10 D) 217
46. If 5 identical notebooks cost Rs. 415, what will 10 notebooks cost at the same rate?  
A) 830 B) 425  
C) 4150 D) 498
47. Find the arithmetic mean of 38, 44, 50, 56, 62.  
A) 250 B) 50  
C) 44 D) 56
48. A student scores 61 in a 4-credit course and 81 in a 6-credit course. Find the weighted mean.  
A) 71 B) 365  
C) 73 D) 30.42
49. A vehicle travels 260 km at a constant speed of 52 km/h. How long does the journey take?  
A) 312 hours B) 208 hours  
C)  $1/5$  hours D) 5 hours
50. Worker A can complete a job in 15 days and Worker B in 29 days. Working together, how many days will they take?  
A) 22 days B)  $44/435$  days  
C)  $435/14$  days D)  $435/44$  days
51. An item costs Rs. 620 and is sold at a profit of 20%. Find the selling price.  
A) Rs. 744 B) Rs. 124  
C) Rs. 496 D) Rs. 640
52. Find the simple interest on Rs. 2100 at 8% per year for 5 years.  
A) Rs. 168 B) Rs. 840  
C) Rs. 105 D) Rs. 2940
53. Solve  $6x + 5 = 89$ .  
A) 84 B)  $84/5$   
C) 14 D) 15
54. What is the larger root of  $x^2 - 22x + 96 = 0$ ?  
A) 6 B) 22  
C) 96 D) 16
55. Find the 9th term of the arithmetic sequence with first term 25 and common difference 3.  
A) 52 B) 46  
C) 252 D) 49
56. If  $13^x = 28561$ , find x.  
A) 4 B) 13  
C) 28561 D) 5
57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 84 cm.  
A) 22176 cm B) 528 cm  
C) 264 cm D) 168 cm
58. Find the distance between (11, 12) and (14, 16).  
A) 7 B) 4  
C) 5 D) 25
59. A bag contains 6 red and 8 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?  
A)  $4/7$  B)  $3/4$   
C)  $1/14$  D)  $3/7$
60. How many different pairs can be selected from 16 people?  
A) 240 B) 18  
C) 16 D) 120

#### SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of sodium has atomic number 11. How many protons does it contain?  
A) 9 B) 11  
C) 12 D) 10
62. Isotopes of the same element have:  
A) the same number of protons but different numbers of neutrons B) different chemical symbols only  
C) the same numbers of protons and neutrons D) different atomic numbers and identical mass numbers
63. An ionic bond is formed mainly by:  
A) overlap without electron involvement B) transfer of electrons from one atom to another  
C) transfer of neutrons D) sharing of protons
64. What is the mass of 3 mol of NaOH if its molar mass is  $40 \text{ g mol}^{-1}$ ?  
A) 117 g B) 120 g  
C) 20 g D) 240 g
65. How many moles are present in 120 g of NaOH (molar mass  $40 \text{ g mol}^{-1}$ )?  
A) 120 mol B) 1.5 mol  
C) 4 mol D) 3 mol
66. A solution contains 3 mol of solute in  $4 \text{ dm}^3$ . What is its concentration?  
A)  $1.33333 \text{ mol dm}^{-3}$  B)  $12 \text{ mol dm}^{-3}$   
C)  $0.75 \text{ mol dm}^{-3}$  D)  $7 \text{ mol dm}^{-3}$
67. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-2} \text{ mol dm}^{-3}$ ?  
A) 1 B) 2  
C) 12 D) 7

68. Oxidation is best described as:

- A) no change in oxidation state    B) gain of electrons  
C) loss of protons    D) loss of electrons

69. Which functional group characterizes an alcohol?

- A) amino group ( $-\text{NH}_2$ )    B) terminal carbonyl group ( $-\text{CHO}$ )  
C) hydroxyl group ( $-\text{OH}$ )    D) carboxyl group ( $-\text{COOH}$ )

70. The standard hydrogen electrode is assigned a potential of:

- A) 1.00 V    B) -1.00 V  
C) 0.00 V    D) 14.00 V

### SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. Which of the following is an SI base quantity?

- A) Power    B) Pressure  
C) Energy    D) Mass

72. A vehicle travels 40 m in 2 s at constant speed. What is its speed?

- A) 40 m/s    B) 20 m/s  
C) 42 m/s    D) 2/40 m/s

73. An object's velocity changes from 2 m/s to 22 m/s in 5 s. What is its acceleration?

- A) 7 m/s<sup>2</sup>    B) 20 m/s<sup>2</sup>  
C) 5 m/s<sup>2</sup>    D) 4 m/s<sup>2</sup>

74. What is the momentum of a 5 kg object moving at 7 m/s?

- A) 35 kg·m/s    B) 12 kg·m/s  
C) 17.5 kg·m/s    D) 1.40 kg·m/s

75. A sample has mass 14 kg and volume 2 m<sup>3</sup>. What is its density?

- A) 8 kg/m<sup>3</sup>    B) 12 kg/m<sup>3</sup>  
C) 0.14 kg/m<sup>3</sup>    D) 7 kg/m<sup>3</sup>

76. A force of 360 N acts uniformly over an area of 4 m<sup>2</sup>. What pressure is produced?

- A) 1440 Pa    B) 360 Pa  
C) 0.01 Pa    D) 90 Pa

77. A resistor of 7  $\Omega$  carries a current of 2 A. What potential difference is across it?

- A) 9 V    B) 21 V  
C) 3.50 V    D) 14 V

78. An electrical device operates at 10 V and draws 4 A. What is its power?

- A) 2.50 W    B) 14 W  
C) 0.40 W    D) 40 W

79. A wave has frequency 7 Hz and wavelength 2 m. What is its speed?

- A) 3.50 m/s    B) 0.29 m/s  
C) 21 m/s    D) 14 m/s

80. Which statement about sound is correct?

- A) Sound cannot be reflected.    B) Sound is an electromagnetic wave.  
C) Sound travels fastest in a vacuum.    D) Sound requires a material medium to travel.

### SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. Solve  $2x + 4 = 10$ .

- A) 4    B) 6  
C) 5    D) 3

82. What is the larger root of  $x^2 - 7x + 10 = 0$ ?

- A) 10    B) 5  
C) 2    D) 7

83. y varies directly as x. If y = 6 when x = 3, find y when x = 5.

- A) 30    B) 10  
C) 11    D) 8

84. Find the midpoint of the segment joining (0, 2) and (6, 6).

- A) (3, 5)    B) (6, 4)  
C) (2, 5)    D) (3, 4)

85. Find the distance between (0, 0) and (3, 4).

- A) 6    B) 25  
C) 4    D) 5

86. Find the area of a triangle with base 8 cm and perpendicular height 5 cm.

- A) 26 cm<sup>2</sup>    B) 10 cm<sup>2</sup>  
C) 13 cm<sup>2</sup>    D) 20 cm<sup>2</sup>

87. A bag contains 3 red and 4 blue balls. One ball is selected at random. What is P(red)?

- A) 1/7    B) 4/7  
C) 3/7    D) 7/3

88. How many different pairs can be selected from 6 people?

- A) 8    B) 6  
C) 15    D) 21

89. What is  $\sin 30^\circ$ ?

- A) 1    B) 0  
C) 1/2    D)  $\sqrt{2}/2$

90. Find the determinant of the matrix  $\begin{bmatrix} 2 & 1 \\ 3 & 2 \end{bmatrix}$ .

- A) 1    B) 7  
C) 4    D) 2

**ANSWER KEY - PRE ENGINEERING MODEL PAPER 1***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. D  | 3. C  | 4. C  | 5. D  | 6. A  | 7. D  | 8. D  | 9. B  | 10. D |
| 11. B | 12. C | 13. C | 14. B | 15. D | 16. D | 17. A | 18. C | 19. B | 20. D |
| 21. B | 22. D | 23. A | 24. D | 25. B | 26. B | 27. D | 28. A | 29. D | 30. B |
| 31. B | 32. C | 33. A | 34. B | 35. D | 36. D | 37. D | 38. D | 39. C | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. A | 63. B | 64. B | 65. D | 66. C | 67. B | 68. D | 69. C | 70. C |
| 71. D | 72. B | 73. D | 74. A | 75. D | 76. D | 77. D | 78. D | 79. D | 80. D |
| 81. D | 82. B | 83. B | 84. D | 85. D | 86. D | 87. C | 88. C | 89. C | 90. A |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |

**PRE-ENGINEERING - MODEL PAPER 2**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 2

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) be  
C) were D) is

2. At present, the technicians \_\_\_\_ for the test.

- A) were prepare B) are preparing  
C) is preparing D) have prepare

3. Veena \_\_\_\_ the design brief already.

- A) has completed B) is completing since Monday  
C) had complete D) completed yesterday

4. By the time the supervisor arrived, Wahaj \_\_\_\_ the library record.

- A) had checked B) has checked  
C) checks D) will have checked

5. By next Friday, the team \_\_\_\_ the design brief.

- A) would complete B) will have completed  
C) will completed D) had completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) were being B) have  
C) are D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) has  
C) have D) do

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having B) has  
C) possess D) were given by

9. There \_\_\_\_ several reasons for the delay.

- A) was B) are  
C) be D) has

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would boil B) would have boiled  
C) will boil always D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) had played B) will play  
C) played D) would play

12. If I knew the answer, I \_\_\_\_ Veena.

- A) would have told B) would tell  
C) told D) had told

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) had caught  
C) will catch D) would have caught

14. Choose the correct passive form: "The technician checks the design brief."

- A) The design brief was checked by the technician. B) The design brief is being checked by the technician.  
C) The design brief has checked by the technician. D) The design brief is checked by the technician.

15. Choose the correct passive form: "The technician is checking the library record."

- A) The library record is being checked by the technician. B) The library record has been checked by the technician.  
C) The library record is checked by the technician. D) The library record was being checked by the technician.

16. Choose the correct passive form: "The clerk processed the design brief."

- A) The design brief is processed by the clerk. B) The design brief has processed by the clerk.  
C) The design brief was processed by the clerk. D) The design brief will be processed by the clerk.

17. Choose the correct passive form: "The committee has approved the library record."

- A) The library record is approved by the committee. B) The library record has been approved by the committee.  
C) The library record had approved by the committee. D) The library record has being approved by the committee.

18. Choose the correct passive form: "The office will issue the design brief."

- A) The design brief will have issued by the office. B) The design brief will issued by the office.  
C) The design brief would be issued by the office. D) The design brief will be issued by the office.

19. Select the correct indirect form: Veena said, "I will complete the design brief."

- A) Veena said that she had complete the design brief. B) Veena said that she will complete the design brief.  
C) Veena told that the design brief would complete. D) Veena said that she would complete the design brief.

20. Select the correct indirect form: Wahaj said, "I am checking the library record."

- A) Wahaj told that she was checking the library record. B) Wahaj said that I was checking the library record.  
C) Wahaj said that she is checking the library record. D) Wahaj said that she was checking the library record.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L2: Seven candidates in a row - Questions 21-24**

Seven candidates—Haris, Iqra, Junaid, Kiran, Lubna, Moiz, and Nadia—sit in a row facing north. 1. Kiran occupies the middle seat. 2. Haris and Nadia sit at the two ends, with Haris on the left. 3. Iqra sits immediately to the left of Junaid. 4. Lubna sits immediately to the right of Kiran. 5. Moiz sits immediately to the left of Nadia.

21. Who sits second from the right end?

- A) Lubna B) Kiran  
C) Moiz D) Nadia



22. Which candidate sits exactly between Junaaid and Lubna?

- A) Haris B) Nadia  
C) Moiz D) Kiran

23. Which pair is NOT adjacent in the final arrangement?

- A) Iqra and Junaid B) Junaid and Lubna  
C) Moiz and Nadia D) Haris and Iqra

24. If Iqra and Lubna swap places, who will be immediately to the right of Kiran?

- A) Lubna B) Moiz  
C) Iqra D) Nadia

**Analytical Set C2: Eight officers in a circle - Questions 25-28**

Eight officers—Gohar, Hina, Imran, Javeria, Kamal, Laila, Musa, and Noreen—sit around a circular table facing the centre. Gohar is fixed at the top. 1. Hina sits immediately clockwise from Gohar. 2. Javeria sits third clockwise from Gohar. 3. Kamal sits immediately clockwise from Javeria. 4. Imran sits between Hina and Javeria. 5. Laila sits opposite Hina. 6. Musa sits immediately clockwise from Laila.

25. Who sits opposite Gohar?

- A) Noreen B) Laila  
C) Kamal D) Musa

26. Who is immediately anticlockwise from Noreen?

- A) Kamal B) Musa  
C) Gohar D) Hina

27. Which pair sits opposite each other?

- A) Imran and Musa B) Hina and Musa  
C) Javeria and Noreen D) Kamal and Laila

28. Starting at Javeria and moving clockwise, who is the third person reached?

- A) Musa B) Kamal  
C) Noreen D) Gohar

**Analytical Set S2: Five interviews - Questions 29-32**

Five applicants—Areeba, Bilal, Celine, Dawood, and Eman—are interviewed from Monday to Friday, one per day. 1. Celine is interviewed on Wednesday. 2. Areeba is interviewed on Monday. 3. Bilal is interviewed after Areeba but before Celine. 4. Dawood is interviewed immediately after Celine. 5. Eman is interviewed on Friday.

29. Who is interviewed on Tuesday?

- A) Eman B) Bilal  
C) Dawood D) Areeba

30. Whose interview is immediately before Eman's?

- A) Areeba B) No applicant  
C) Bilal D) Dawood

31. Which applicant is interviewed exactly two days after Bilal?

- A) Eman B) Areeba  
C) No applicant D) Dawood

32. If Wednesday is declared a holiday and all later interviews move one working day forward, on which day is Eman interviewed?

- A) Monday of the next week B) Saturday of the same week  
C) Tuesday of the next week D) Friday of the same week

**Analytical Set D2: Admission requirements - Questions 33-36**

Use these rules: 1. If a candidate qualifies (Q), the candidate passes Mathematics (M). 2. If a candidate qualifies (Q), the candidate passes the interview (I). 3. If the interview is passed (I), the documents are complete (D). 4. If the documents are complete (D), verification is approved (V).

33. A candidate qualifies. Which final result must occur?

- A) Verification is rejected B) Verification is approved  
C) Documents are incomplete D) The interview is failed

34. The documents are not complete. What must be concluded about the interview?

- A) The interview was repeated B) The interview was postponed  
C) The interview was passed D) The interview was not passed

35. A candidate did not pass Mathematics. Which conclusion is forced?

- A) The interview was passed B) The candidate qualified  
C) Verification was approved D) The candidate did not qualify

36. Verification is not approved. Which status is impossible under the rules?

- A) The candidate does not qualify B) The candidate qualifies  
C) The interview is not passed D) The candidate fails Mathematics

**Analytical Set B2: Farooq's family - Questions 37-40**

Farooq and Ayesha are married. Their children are Hamza, a son, and Iman, a daughter. Hamza is married to Zara; their daughters are Kiran and Mehak. Iman is married to Usman; their son is Danish.

37. How is Ayesha related to Danish?

- A) Paternal aunt B) Mother-in-law  
C) Paternal grandmother D) Maternal grandmother

38. What is Danish's relation to Hamza?

- A) Uncle B) Nephew  
C) Son D) Cousin

39. How is Zara related to Iman?

- A) Sister B) Niece  
C) Sister-in-law D) Cousin

40. What is Kiran's relation to Danish?

- A) Sister B) Cousin  
C) Niece D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $31 + 8 \times 6 - 5$ .

- A) 74 B) 39  
C) 229 D) 82

42. Find  $10/16 + 7/16$  in simplest form.

- A)  $17/32$  B)  $17/16$   
C)  $3/16$  D)  $17/256$

43. What is 30% of 500?

- A) 53/10    B) 50/3  
C) 150    D) 350

44. A price of Rs. 980 is increased by 5%. What is the new price?

- A) Rs. 49    B) Rs. 985  
C) Rs. 931    D) Rs. 1029

45. Rs. 288 is divided in the ratio 4:5. What is the larger share?

- A) 128    B) 144  
C) 9    D) 160

46. If 6 identical notebooks cost Rs. 516, what will 8 notebooks cost at the same rate?

- A) 688    B) 524  
C) 4128    D) 602

47. Find the arithmetic mean of 41, 42, 43, 44, 45.

- A) 215    B) 43  
C) 42    D) 44

48. A student scores 62 in a 2-credit course and 82 in a 3-credit course. Find the weighted mean.

- A) 72    B) 185  
C) 74    D) 61.67

49. A vehicle travels 108 km at a constant speed of 54 km/h. How long does the journey take?

- A) 162 hours    B) 54 hours  
C) 1/2 hours    D) 2 hours

50. Worker A can complete a job in 16 days and Worker B in 31 days. Working together, how many days will they take?

- A) 47/2 days    B) 47/496 days  
C) 496/15 days    D) 496/47 days

51. An item costs Rs. 640 and is sold at a profit of 25%. Find the selling price.

- A) Rs. 800    B) Rs. 160  
C) Rs. 480    D) Rs. 665

52. Find the simple interest on Rs. 2200 at 9% per year for 2 years.

- A) Rs. 198    B) Rs. 396  
C) Rs. 44    D) Rs. 2596

53. Solve  $7x + 6 = 111$ .

- A) 105    B) 35/2  
C) 15    D) 16

54. What is the larger root of  $x^2 - 24x + 119 = 0$ ?

- A) 7    B) 24  
C) 119    D) 17

55. Find the 10th term of the arithmetic sequence with first term 27 and common difference 4.

- A) 67    B) 59  
C) 310    D) 63

56. If  $14^x = 196$ , find x.

- A) 2    B) 14  
C) 196    D) 3

57. Find the area of a rectangle of length 20 cm and width 8 cm.

- A)  $56 \text{ cm}^2$     B)  $160 \text{ cm}^2$   
C)  $28 \text{ cm}^2$     D)  $320 \text{ cm}^2$

58. Find the slope of the line through (12, 14) and (16, 22).

- A) 1/2    B) 8  
C) 2    D) 4

59. A bag contains 7 red and 9 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A) 9/16    B) 7/9  
C) 1/16    D) 7/16

60. How many different pairs can be selected from 17 people?

- A) 272    B) 19  
C) 17    D) 136

## SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of magnesium has atomic number 12. How many protons does it contain?

- A) 10    B) 13  
C) 12    D) 11

62. Isotopes of the same element have:

- A) the same number of protons but different numbers of neutrons    B) different chemical symbols only  
C) the same numbers of protons and neutrons    D) different numbers of protons and the same number of neutrons

63. What is the maximum number of electrons in the fourth electron shell according to  $2n^2$ ?

- A) 16    B) 30  
C) 34    D) 32

64. An ionic bond is formed mainly by:

- A) sharing of protons    B) transfer of neutrons  
C) equal sharing of electrons only    D) transfer of electrons from one atom to another

65. What is the mass of 4 mol of NaCl if its molar mass is  $58.5 \text{ g mol}^{-1}$ ?

- A) 238 g    B) 468 g  
C) 230 g    D) 234 g

66. How many moles are present in 234 g of NaCl (molar mass  $58.5 \text{ g mol}^{-1}$ )?

- A) 5 mol    B) 2 mol  
C) 234 mol    D) 4 mol

67. A solution contains 4 mol of solute in  $5 \text{ dm}^3$ . What is its concentration?

- A)  $9 \text{ mol dm}^{-3}$     B)  $20 \text{ mol dm}^{-3}$   
C)  $1.25 \text{ mol dm}^{-3}$     D)  $0.8 \text{ mol dm}^{-3}$

68. What is the pH of a solution with  $[H^+] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$ ?

- A) 2    B) 11  
C) 4    D) 3

69. Oxidation is best described as:

- A) loss of electrons    B) gain of neutrons  
C) gain of electrons    D) no change in oxidation state

70. Which functional group characterizes an carboxylic acid?

- A) carboxyl group ( $-\text{COOH}$ )    B) carbonyl group within the chain ( $>\text{C}=\text{O}$ )  
C) amino group ( $-\text{NH}_2$ )    D) terminal carbonyl group ( $-\text{CHO}$ )

### SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. A vehicle travels 30 m in 3 s at constant speed. What is its speed?

- A) 3/30 m/s    B) 33 m/s  
C) 30 m/s    D) 10 m/s

72. An object's velocity changes from 3 m/s to 33 m/s in 6 s. What is its acceleration?

- A) 6 m/s<sup>2</sup>    B) 5 m/s<sup>2</sup>  
C) 9 m/s<sup>2</sup>    D) 30 m/s<sup>2</sup>

73. What force is required to accelerate a 7 kg mass at 4 m/s<sup>2</sup>?

- A) 11 N    B) 28 N  
C) 1.75 N    D) 14 N

74. Find the kinetic energy of a 4 kg object moving at 3 m/s.

- A) 7 J    B) 12 J  
C) 18 J    D) 21 J

75. What is the momentum of a 6 kg object moving at 8 m/s?

- A) 384 kg·m/s    B) 1.33 kg·m/s  
C) 24 kg·m/s    D) 48 kg·m/s

76. A sample has mass 24 kg and volume 3 m<sup>3</sup>. What is its density?

- A) 21 kg/m<sup>3</sup>    B) 8 kg/m<sup>3</sup>  
C) 9 kg/m<sup>3</sup>    D) 72 kg/m<sup>3</sup>

77. A force of 500 N acts uniformly over an area of 5 m<sup>2</sup>. What pressure is produced?

- A) 2500 Pa    B) 500 Pa  
C) 105 Pa    D) 100 Pa

78. An electrical device operates at 12 V and draws 5 A. What is its power?

- A) 60 W    B) 65 W  
C) 2.40 W    D) 0.42 W

79. A wave has frequency 8 Hz and wavelength 3 m. What is its speed?

- A) 11 m/s    B) 32 m/s  
C) 0.38 m/s    D) 24 m/s

80. A transformer operates using:

- A) static electric charge    B) chemical energy only  
C) nuclear decay    D) alternating current

### SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. Solve  $3x + 5 = 20$ .

- A) 15    B) 5  
C) 4    D) 20/3

82. What is the larger root of  $x^2 - 10x + 21 = 0$ ?

- A) -7    B) 7  
C) 10    D) 21

83. Find the 5th term of the geometric sequence with first term 3 and common ratio 3.

- A) 729    B) 243  
C) 45    D) 240

84. Find the slope of the line through (2, 3) and (5, 9).

- A) 1/2    B) 7  
C) 3    D) 2

85. Find the midpoint of the segment joining (1, 3) and (7, 7).

- A) (4, 5)    B) (6, 4)  
C) (4, 6)    D) (7, 7)

86. Find the distance between (1, 1) and (7, 9).

- A) 11    B) 10  
C) 100    D) 8

87. Find the area of a triangle with base 9 cm and perpendicular height 6 cm.

- A) 27 cm<sup>2</sup>    B) 30 cm<sup>2</sup>  
C) 27/2 cm<sup>2</sup>    D) 15 cm<sup>2</sup>

88. How many different pairs can be selected from 7 people?

- A) 7    B) 28  
C) 42    D) 21

89. What is  $\cos 60^\circ$ ?

- A) 1    B)  $\sqrt{3}/2$   
C)  $\sqrt{2}/2$     D) 1/2

90. Find the determinant of the matrix  $\begin{bmatrix} 3 & 2 \\ 4 & 3 \end{bmatrix}$ .

- A) 1    B) 17  
C) -1    D) 2

**ANSWER KEY - PRE ENGINEERING MODEL PAPER 2***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. B  | 3. A  | 4. A  | 5. B  | 6. D  | 7. B  | 8. B  | 9. B  | 10. D |
| 11. B | 12. B | 13. D | 14. D | 15. A | 16. C | 17. B | 18. D | 19. D | 20. D |
| 21. C | 22. D | 23. B | 24. C | 25. C | 26. B | 27. A | 28. A | 29. B | 30. D |
| 31. D | 32. A | 33. B | 34. D | 35. D | 36. B | 37. D | 38. B | 39. C | 40. B |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. A | 63. D | 64. D | 65. D | 66. D | 67. D | 68. D | 69. A | 70. A |
| 71. D | 72. B | 73. B | 74. C | 75. D | 76. B | 77. D | 78. A | 79. D | 80. D |
| 81. B | 82. B | 83. B | 84. D | 85. A | 86. B | 87. A | 88. D | 89. D | 90. A |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |

**PRE-ENGINEERING - MODEL PAPER 3**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 3

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) are B) have  
C) is D) be

2. At present, the candidates \_\_\_\_ for the test.

- A) prepared B) are preparing  
C) have prepare D) were prepare

3. Sameer \_\_\_\_ the computer program already.

- A) had complete B) has completed  
C) completed yesterday D) is completing since Monday

4. By the time the supervisor arrived, Tuba \_\_\_\_ the workshop plan.

- A) was check B) will have checked  
C) had checked D) checks

5. By next Friday, the team \_\_\_\_ the computer program.

- A) will have completed B) will completed  
C) has completed D) had completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) are  
C) were being D) be

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) has B) do  
C) have D) were

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having B) were given by  
C) have D) has

9. There \_\_\_\_ several reasons for the delay.

- A) was B) is  
C) has D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boiled B) would boil  
C) will boil always D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play B) had played  
C) played D) will play

12. If I knew the answer, I \_\_\_\_ Sameer.

- A) would tell B) had told  
C) will tell D) told

13. If they had left earlier, they \_\_\_\_ the train.

- A) would have caught B) will catch  
C) had caught D) caught

14. Choose the correct passive form: "The technician checks the computer program."

- A) The computer program was checked by the technician. B) The computer program is checked by the technician.  
C) The computer program is being checked by the technician. D) The computer program has checked by the technician.

15. Choose the correct passive form: "The technician is checking the workshop plan."

- A) The workshop plan is been checked by the technician. B) The workshop plan is checked by the technician.  
C) The workshop plan has been checked by the technician. D) The workshop plan is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the computer program."

- A) The computer program was being processed by the clerk. B) The computer program is processed by the clerk.  
C) The computer program was processed by the clerk. D) The computer program will be processed by the clerk.

17. Choose the correct passive form: "The committee has approved the workshop plan."

- A) The workshop plan had approved by the committee. B) The workshop plan is approved by the committee.  
C) The workshop plan has being approved by the committee. D) The workshop plan has been approved by the committee.

18. Choose the correct passive form: "The office will issue the computer program."

- A) The computer program is issued by the office. B) The computer program will have issued by the office.  
C) The computer program would be issued by the office. D) The computer program will be issued by the office.

19. Select the correct indirect form: Sameer said, "I will complete the computer program."

- A) Sameer told that the computer program would complete. B) Sameer said that he will complete the computer program.  
C) Sameer said that he would complete the computer program. D) Sameer said that I would complete the computer program.

20. Select the correct indirect form: Tuba said, "I am checking the workshop plan."

- A) Tuba told that she was checking the workshop plan. B) Tuba said that she is checking the workshop plan.  
C) Tuba said that she was checking the workshop plan. D) Tuba said that I was checking the workshop plan.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L3: Eight delegates in a row - Questions 21-24**

Eight delegates—Omer, Pari, Qasim, Rabia, Salman, Tehmina, Usman, and Warda—sit in a row facing north. 1. Omer and Warda sit at the left and right ends respectively. 2. Pari sits immediately to the right of Omer. 3. Rabia sits immediately to the right of Qasim. 4. Salman sits immediately to the right of Rabia. 5. Tehmina sits immediately to the right of Salman. 6. Usman sits immediately to the left of Warda.

21. Who is fifth from the left?

- A) Tehmina B) Qasim  
C) Rabia D) Salman

22. How many delegates sit between Pari and Tehmina?

- A) One B) Four  
C) Three D) Two

23. Who sits immediately to the left of Usman?

- A) Salman B) Tehmina  
C) Warda D) Qasim

24. If Omer leaves and everyone to his right shifts one seat left, who becomes fourth from the left?

- A) Rabia B) Usman  
C) Salman D) Tehmina

**Analytical Set C3: Six students in a circle - Questions 25-28**

Six students—Owais, Parsa, Qasim, Rida, Saad, and Tania—sit around a circular table facing the centre. Owais is fixed at the top. 1. Qasim sits second clockwise from Owais. 2. Rida sits opposite Owais. 3. Saad sits immediately clockwise from Rida. 4. Parsa sits between Owais and Qasim on the clockwise side.

25. Who sits immediately clockwise from Qasim?

- A) Parsa B) Rida  
C) Saad D) Tania

26. Who sits opposite Parsa?

- A) Owais B) Rida  
C) Qasim D) Saad

27. Which two students are immediate neighbours of Tania?

- A) Rida and Saad B) Qasim and Rida  
C) Saad and Owais D) Parsa and Qasim

28. If everyone moves two seats clockwise, who occupies Owais's original seat?

- A) Saad B) Tania  
C) Qasim D) Rida

**Analytical Set S3: March calendar - Questions 29-32**

In a particular year, 1 March falls on a Tuesday. Use the ordinary seven-day weekly cycle for all four questions.

29. What day of the week is 8 March?

- A) Wednesday B) Friday  
C) Tuesday D) Thursday

30. On which weekday does 17 March fall?

- A) Friday B) Thursday  
C) Saturday D) Tuesday

31. Which weekday is 31 March?

- A) Saturday B) Sunday  
C) Wednesday D) Thursday

32. What day is 1 April?

- A) Monday B) Sunday  
C) Saturday D) Friday

**Analytical Set D3: Exclusive choice and implications - Questions 33-36**

Use these rules: 1. Exactly one of P and Q is true. 2. If P is true, R is true. 3. If Q is true, S is true. 4. If R is false, T is true.

33. If P is true, which statement must be false?

- A) R is true B) R may be true  
C) P is true D) Q is true

34. If S is false, which statement must be true?

- A) R is true B) P is false  
C) R is false D) T is false

35. Assume R is false. Which result must follow?

- A) P is true B) Q is false  
C) S is false D) S is true

36. If T is false, what follows necessarily?

- A) S is false B) R is true  
C) R is false D) Q is true

**Analytical Set B3: Rashid's family - Questions 37-40**

Rashid and Mariam are married. Their children are Sameer, a son, and Nadia, a daughter. Sameer is married to Huma; their children are Taimur, a son, and Rida, a daughter. Nadia is married to Asif; their son is Zain.

37. How is Mariam related to Rida?

- A) Paternal grandmother B) Great-grandmother  
C) Paternal aunt D) Maternal grandmother

38. What is Zain's relation to Sameer?

- A) Nephew B) Uncle  
C) Son D) Brother

39. How is Huma related to Nadia?

- A) Maternal aunt B) Sister-in-law  
C) Cousin D) Daughter-in-law

40. What is Taimur's relation to Zain?

- A) Nephew B) Uncle  
C) Cousin D) Brother-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $33 + 9 \times 7 - 6$ .

- A) 90 B) 42  
C) 288 D) 99

42. Find  $\frac{11}{17} + \frac{8}{17}$  in simplest form.

- A)  $\frac{19}{34}$  B)  $\frac{19}{17}$   
C)  $\frac{3}{17}$  D)  $\frac{19}{289}$

43. What is 35% of 525?

- A)  $\frac{28}{5}$  B) 15  
C)  $\frac{735}{4}$  D)  $\frac{1365}{4}$

44. A price of Rs. 1020 is increased by 10%. What is the new price?  
A) Rs. 102 B) Rs. 1030  
C) Rs. 918 D) Rs. 1122
45. Rs. 396 is divided in the ratio 5:7. What is the larger share?  
A) 165 B) 198  
C) 12 D) 231
46. If 7 identical notebooks cost Rs. 623, what will 10 notebooks cost at the same rate?  
A) 890 B) 633  
C) 6230 D) 712
47. Find the arithmetic mean of 44, 46, 48, 50, 52.  
A) 240 B) 48  
C) 46 D) 50
48. A student scores 63 in a 3-credit course and 83 in a 4-credit course. Find the weighted mean.  
A) 73 B) 260.5  
C) 74.43 D) 43.42
49. A vehicle travels 168 km at a constant speed of 56 km/h. How long does the journey take?  
A) 224 hours B) 112 hours  
C) 1/3 hours D) 3 hours
50. Worker A can complete a job in 17 days and Worker B in 33 days. Working together, how many days will they take?  
A) 25 days B) 50/561 days  
C) 561/16 days D) 561/50 days
51. An item costs Rs. 660 and is sold at a profit of 30%. Find the selling price.  
A) Rs. 858 B) Rs. 198  
C) Rs. 462 D) Rs. 690
52. Find the simple interest on Rs. 2300 at 10% per year for 3 years.  
A) Rs. 230 B) Rs. 690  
C) Rs. 69 D) Rs. 2990
53. Solve  $8x + 7 = 135$ .  
A) 128 B) 128/7  
C) 16 D) 17
54. What is the larger root of  $x^2 - 26x + 144 = 0$ ?  
A) 8 B) 26  
C) 144 D) 18
55. Find the 11th term of the arithmetic sequence with first term 29 and common difference 5.  
A) 84 B) 74  
C) 374 D) 79
56. If  $15^x = 3375$ , find x.  
A) 3 B) 15  
C) 3375 D) 4
57. Find the area of a triangle with base 23 cm and height 8 cm.  
A) 184 cm<sup>2</sup> B) 92 cm<sup>2</sup>  
C) 31 cm<sup>2</sup> D) 46 cm<sup>2</sup>
58. Find the midpoint of the segment joining (13, 15) and (19, 23).  
A) (6, 8) B) (32, 38)  
C) (16, 19) D) (3, 4)
59. A bag contains 8 red and 10 blue balls. One ball is selected at random. What is P(red)?  
A) 5/9 B) 4/5  
C) 1/18 D) 4/9
60. How many different pairs can be selected from 18 people?  
A) 306 B) 20  
C) 18 D) 153

#### SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of chlorine has atomic number 17. How many protons does it contain?  
A) 34 B) 17  
C) 15 D) 16
62. Isotopes of the same element have:  
A) different chemical symbols only B) the same number of protons but different numbers of neutrons  
C) different numbers of protons and the same number of neutrons D) different atomic numbers and identical mass numbers
63. What is the maximum number of electrons in the second electron shell according to  $2n^2$ ?  
A) 6 B) 5  
C) 8 D) 4
64. An ionic bond is formed mainly by:  
A) sharing of protons B) transfer of neutrons  
C) equal sharing of electrons only D) transfer of electrons from one atom to another
65. Across a period from left to right, atomic radius generally:  
A) increases B) depends only on mass number  
C) first becomes zero D) decreases
66. What is the mass of 2 mol of  $\text{NH}_3$  if its molar mass is  $17 \text{ g mol}^{-1}$ ?  
A) 32 g B) 68 g  
C) 8.5 g D) 34 g
67. How many moles are present in 34 g of  $\text{NH}_3$  (molar mass  $17 \text{ g mol}^{-1}$ )?  
A) 17 mol B) 1 mol  
C) 34 mol D) 2 mol
68. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-4} \text{ mol dm}^{-3}$ ?  
A) 4 B) 5  
C) 10 D) 7



69. Oxidation is best described as:

- A) gain of neutrons    B) no change in oxidation state  
C) loss of electrons    D) gain of electrons

70. Which functional group characterizes an aldehyde?

- A) hydroxyl group ( $-\text{OH}$ )    B) terminal carbonyl group ( $-\text{CHO}$ )  
C) carbonyl group within the chain ( $>\text{C}=\text{O}$ )    D) amino group ( $-\text{NH}_2$ )

## SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. Which of the following is an SI base quantity?

- A) Energy    B) Force  
C) Mass    D) Pressure

72. A vehicle travels 44 m in 4 s at constant speed. What is its speed?

- A) 48 m/s    B) 4/44 m/s  
C) 44 m/s    D) 11 m/s

73. What force is required to accelerate a 2 kg mass at  $5 \text{ m/s}^2$ ?

- A) 0.40 N    B) 15 N  
C) 7 N    D) 10 N

74. Find the kinetic energy of a 6 kg object moving at 4 m/s.

- A) 96 J    B) 52 J  
C) 10 J    D) 48 J

75. What is the momentum of a 7 kg object moving at 3 m/s?

- A)  $10.5 \text{ kg}\cdot\text{m/s}$     B)  $63 \text{ kg}\cdot\text{m/s}$   
C)  $0.43 \text{ kg}\cdot\text{m/s}$     D)  $21 \text{ kg}\cdot\text{m/s}$

76. A sample has mass 12 kg and volume  $4 \text{ m}^3$ . What is its density?

- A)  $0.33 \text{ kg/m}^3$     B)  $4 \text{ kg/m}^3$   
C)  $8 \text{ kg/m}^3$     D)  $3 \text{ kg/m}^3$

77. A force of 100 N acts uniformly over an area of  $2 \text{ m}^2$ . What pressure is produced?

- A) 50 Pa    B) 0.02 Pa  
C) 52 Pa    D) 100 Pa

78. An electrical device operates at 14 V and draws 2 A. What is its power?

- A) 16 W    B) 7.00 W  
C) 30 W    D) 28 W

79. A wave has frequency 9 Hz and wavelength 4 m. What is its speed?

- A) 2.25 m/s    B) 45 m/s  
C) 0.44 m/s    D) 36 m/s

80. The image formed by a plane mirror is:

- A) virtual, upright and the same size as the object    B) real and magnified  
C) real and inverted    D) virtual and inverted

## SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. Solve  $4x + 6 = 34$ .

- A)  $17/2$     B) 7  
C) 6    D) 8

82. What is the larger root of  $x^2 - 13x + 36 = 0$ ?

- A) 4    B) 9  
C) 36    D) 13

83. Find the 6th term of the geometric sequence with first term 4 and common ratio 2.

- A) 130    B) 128  
C) 256    D) 48

84. y varies directly as x. If  $y = 20$  when  $x = 5$ , find y when  $x = 7$ .

- A) 28    B) 27  
C) 140    D) 22

85. Find the midpoint of the segment joining (2, 4) and (8, 8).

- A) (6, 4)    B) (4, 7)  
C) (5, 6)    D) (5, 7)

86. Find the distance between (2, 2) and (11, 14).

- A) 16    B) 9  
C) 225    D) 15

87. Find the area of a triangle with base 10 cm and perpendicular height 7 cm.

- A)  $35 \text{ cm}^2$     B)  $70 \text{ cm}^2$   
C)  $35/2 \text{ cm}^2$     D)  $34 \text{ cm}^2$

88. How many different pairs can be selected from 8 people?

- A) 28    B) 56  
C) 8    D) 10

89. What is  $\tan 45^\circ$ ?

- A)  $1/2$     B)  $\sqrt{3}$   
C) Undefined    D) 1

90. Find the determinant of the matrix  $\begin{bmatrix} 4 & 3 \\ 5 & 4 \end{bmatrix}$ .

- A) 8    B) 2  
C) 31    D) 1



**ANSWER KEY - PRE ENGINEERING MODEL PAPER 3***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. C  | 2. B  | 3. B  | 4. C  | 5. A  | 6. A  | 7. A  | 8. D  | 9. D  | 10. D |
| 11. D | 12. A | 13. A | 14. B | 15. D | 16. C | 17. D | 18. D | 19. C | 20. C |
| 21. D | 22. C | 23. B | 24. C | 25. B | 26. D | 27. C | 28. A | 29. C | 30. B |
| 31. D | 32. D | 33. D | 34. A | 35. D | 36. B | 37. A | 38. A | 39. B | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. B | 63. C | 64. D | 65. D | 66. D | 67. D | 68. A | 69. C | 70. B |
| 71. C | 72. D | 73. D | 74. D | 75. D | 76. D | 77. A | 78. D | 79. D | 80. A |
| 81. B | 82. B | 83. B | 84. A | 85. C | 86. D | 87. A | 88. A | 89. D | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |

**PRE-ENGINEERING - MODEL PAPER 4**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 4

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) is  
C) are D) be

2. At present, the researchers \_\_\_\_ for the test.

- A) prepared B) are preparing  
C) is preparing D) were prepare

3. Pina \_\_\_\_ the experiment log already.

- A) had complete B) completed yesterday  
C) have completed D) has completed

4. By the time the supervisor arrived, Qais \_\_\_\_ the report.

- A) had checked B) has checked  
C) was check D) will have checked

5. By next Friday, the team \_\_\_\_ the experiment log.

- A) will completed B) will have completed  
C) had completed D) has completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) were being  
C) be D) have

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) have  
C) do D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) has B) were given by  
C) are having D) have

9. There \_\_\_\_ several reasons for the delay.

- A) be B) are  
C) has D) is

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boils B) will boil always  
C) would boil D) would have boiled

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would have played B) had played  
C) will play D) played

12. If I knew the answer, I \_\_\_\_ Pina.

- A) told B) would tell  
C) had told D) would have told

13. If they had left earlier, they \_\_\_\_ the train.

- A) will catch B) had caught  
C) would have caught D) would catch

14. Choose the correct passive form: "The technician checks the experiment log."

- A) The experiment log is being checked by the technician. B) The experiment log was checked by the technician.  
C) The experiment log is checked by the technician. D) The experiment log has checked by the technician.

15. Choose the correct passive form: "The technician is checking the report."

- A) The report is been checked by the technician. B) The report was being checked by the technician.  
C) The report is checked by the technician. D) The report is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the experiment log."

- A) The experiment log will be processed by the clerk. B) The experiment log was processed by the clerk.  
C) The experiment log is processed by the clerk. D) The experiment log was being processed by the clerk.

17. Choose the correct passive form: "The committee has approved the report."

- A) The report has being approved by the committee. B) The report has been approved by the committee.  
C) The report is approved by the committee. D) The report was approved by the committee.

18. Choose the correct passive form: "The office will issue the experiment log."

- A) The experiment log is issued by the office. B) The experiment log will be issued by the office.  
C) The experiment log will issued by the office. D) The experiment log would be issued by the office.

19. Select the correct indirect form: Pina said, "I will complete the experiment log."

- A) Pina said that she would complete the experiment log. B) Pina said that I would complete the experiment log.  
C) Pina said that she had complete the experiment log. D) Pina told that the experiment log would complete.

20. Select the correct indirect form: Qais said, "I am checking the report."

- A) Qais said that he had checked the report. B) Qais said that he was checking the report.  
C) Qais said that he is checking the report. D) Qais told that he was checking the report.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L4: Six friends in a row - Questions 21-24**

Six friends—Ali, Beenish, Chaman, Dua, Ehsan, and Fiza—stand in a line facing north. 1. Fiza is at the extreme right. 2. Ehsan is immediately to the left of Fiza. 3. Chaman is two places to the right of Ali. 4. Beenish sits immediately between Ali and Chaman. 5. Dua is immediately to the right of Chaman.

21. Who stands at the extreme left?

- A) Chaman B) Ehsan  
C) Dua D) Ali

22. Which person is third from the right?

- A) Ali B) Dua  
C) Beenish D) Ehsan

23. Who is positioned between Beenish and Dua?

- A) Chaman B) Ali  
C) Ehsan D) No one

24. If the row is viewed from the north side, who appears second from the left to the observer?

- A) Fiza B) Beenish  
C) Dua D) Ehsan

**Analytical Set C4: Eight friends around a table - Questions 25-28**

Eight friends—Umar, Vaneeza, Wasif, Xara, Yasir, Zara, Adil, and Bushra—sit around a circular table facing the centre. Umar is fixed at the top. 1. Yasir sits opposite Umar. 2. Vaneeza sits immediately clockwise from Umar. 3. Wasif sits immediately clockwise from Vaneeza. 4. Xara sits immediately anticlockwise from Yasir. 5. Zara sits immediately clockwise from Yasir. 6. Adil sits immediately clockwise from Zara.

25. Who sits immediately anticlockwise from Bushra?

- A) Umar B) Yasir  
C) Adil D) Zara

26. Which friend sits opposite Wasif?

- A) Bushra B) Xara  
C) Zara D) Adil

27. How many people sit between Vaneeza and Yasir along the shorter route?

- A) Four B) Two  
C) None D) One

28. If Umar and Yasir swap seats, who will be immediately clockwise from Umar?

- A) Vaneeza B) Xara  
C) Bushra D) Zara

**Analytical Set S4: Seven-day workshop plan - Questions 29-32**

A seven-day workshop runs from Monday to Sunday. One session is held each day: Logic, English, Mathematics, Physics, Chemistry, Computer, and Review. 1. Logic is on Monday. 2. Review is on Sunday. 3. English is immediately after Logic. 4. Physics is immediately after Mathematics. 5. Chemistry is on Friday. 6. Computer is immediately before Review.

29. On which day is Mathematics scheduled?

- A) Saturday B) Friday  
C) Thursday D) Wednesday

30. Which session is held on Saturday?

- A) Computer B) Chemistry  
C) Review D) English

31. How many sessions occur between English and Chemistry?

- A) Three B) Two  
C) One D) None

32. If Mathematics is cancelled and Physics moves one day earlier, what session remains on Thursday?

- A) Review B) No session  
C) Physics D) Computer

**Analytical Set D4: Library security system - Questions 33-36**

Use these rules: 1. If the library is open (L), the guard is present (G). 2. If the guard is present (G), the cameras are on (C). 3. If the power fails (P), the cameras are off. 4. If the cameras are on (C), the alarm is active (A).

33. The library is open. Which condition must be present?

- A) The guard is absent B) The library is closed  
C) The alarm is active D) The power has failed

34. If the alarm is not active, what must be true about the library?

- A) The library is open B) The guard is present  
C) The power is normal D) The library is not open

35. The power fails. Which statement is forced if all rules remain consistent?

- A) The library is open B) The guard is present  
C) The library is not open D) The alarm is active

36. The guard is present and the power has not failed. What follows from the rules?

- A) The alarm is active B) The cameras are off  
C) The library is open D) The guard is absent

**Analytical Set B4: Akbar's family - Questions 37-40**

Akbar and Bushra are married. They have three children: Danish, a son; Esha, a daughter; and Faraz, a son. Danish is married to Gohar, and their daughter is Hira. Esha is married to Imran, and their son is Junaid. Faraz is unmarried.

37. How is Hira related to Faraz?

- A) Sister B) Daughter  
C) Niece D) Aunt

38. What is Junaid's relation to Bushra?

- A) Nephew B) Grandson  
C) Son D) Brother

39. How is Imran related to Danish?

- A) Brother-in-law B) Cousin  
C) Paternal uncle D) Maternal uncle

40. What is Gohar's relation to Esha?

- A) Aunt B) Sister-in-law  
C) Cousin D) Niece

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $35 + 3 \times 8 - 7$ .

- A) 52 B) 38  
C) 297 D) 55

42. Find  $9/11 + 9/18$  in simplest form.

- A)  $18/29$  B)  $29/22$   
C)  $7/22$  D)  $1/11$

43. What is 40% of 550?  
A) 59/10 B) 55/4  
C) 220 D) 330
44. A price of Rs. 1060 is increased by 15%. What is the new price?  
A) Rs. 159 B) Rs. 1075  
C) Rs. 901 D) Rs. 1219
45. Rs. 510 is divided in the ratio 6:9. What is the larger share?  
A) 204 B) 255  
C) 15 D) 306
46. If 8 identical notebooks cost Rs. 736, what will 12 notebooks cost at the same rate?  
A) 1104 B) 748  
C) 8832 D) 828
47. Find the arithmetic mean of 47, 50, 53, 56, 59.  
A) 265 B) 53  
C) 50 D) 56
48. A student scores 64 in a 4-credit course and 84 in a 5-credit course. Find the weighted mean.  
A) 74 B) 338  
C) 75.11 D) 33.8
49. A vehicle travels 232 km at a constant speed of 58 km/h. How long does the journey take?  
A) 290 hours B) 174 hours  
C) 1/4 hours D) 4 hours
50. Worker A can complete a job in 18 days and Worker B in 35 days. Working together, how many days will they take?  
A) 53/2 days B) 53/630 days  
C) 630/17 days D) 630/53 days
51. An item costs Rs. 680 and is sold at a profit of 35%. Find the selling price.  
A) Rs. 918 B) Rs. 238  
C) Rs. 442 D) Rs. 715
52. Find the simple interest on Rs. 2400 at 4% per year for 4 years.  
A) Rs. 96 B) Rs. 384  
C) Rs. 2784 D) Rs. 3840
53. Solve  $2x + 8 = 42$ .  
A) 34 B) 17/4  
C) 17 D) 18
54. What is the larger root of  $x^2 - 21x + 38 = 0$ ?  
A) 2 B) 21  
C) 38 D) 19
55. Find the 12th term of the arithmetic sequence with first term 31 and common difference 6.  
A) 103 B) 91  
C) 444 D) 97
56. If  $16^x = 65536$ , find x.  
A) 4 B) 16  
C) 65536 D) 5
57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 105 cm.  
A) 34650 cm B) 660 cm  
C) 330 cm D) 210 cm
58. Find the distance between (14, 15) and (17, 19).  
A) 7 B) 4  
C) 5 D) 25
59. A bag contains 9 red and 4 blue balls. One ball is selected at random. What is P(red)?  
A) 4/13 B) 9/4  
C) 1/13 D) 9/13
60. How many different pairs can be selected from 19 people?  
A) 342 B) 21  
C) 19 D) 171

#### SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of calcium has atomic number 20. How many protons does it contain?  
A) 21 B) 19  
C) 20 D) 18
62. Isotopes of the same element have:  
A) different chemical symbols only B) different numbers of protons and the same number of neutrons  
C) the same numbers of protons and neutrons D) the same number of protons but different numbers of neutrons
63. An ionic bond is formed mainly by:  
A) transfer of neutrons B) equal sharing of electrons only  
C) sharing of protons D) transfer of electrons from one atom to another
64. What is the mass of 3 mol of  $\text{CaCO}_3$  if its molar mass is  $100 \text{ g mol}^{-1}$ ?  
A) 297 g B) 50 g  
C) 300 g D) 303 g
65. How many moles are present in 300 g of  $\text{CaCO}_3$  (molar mass  $100 \text{ g mol}^{-1}$ )?  
A) 4 mol B) 1.5 mol  
C) 100 mol D) 3 mol
66. A solution contains 2 mol of solute in  $3 \text{ dm}^3$ . What is its concentration?  
A)  $1.5 \text{ mol dm}^{-3}$  B)  $6 \text{ mol dm}^{-3}$   
C)  $5 \text{ mol dm}^{-3}$  D)  $0.666667 \text{ mol dm}^{-3}$
67. What is the pH of a solution with  $[\text{H}^+] = 1.0 \times 10^{-5} \text{ mol dm}^{-3}$ ?  
A) 7 B) 4  
C) 9 D) 5

68. Oxidation is best described as:

- A) loss of electrons    B) loss of protons  
C) gain of neutrons    D) gain of electrons

69. Which functional group characterizes an ketone?

- A) amino group ( $-\text{NH}_2$ )    B) hydroxyl group ( $-\text{OH}$ )  
C) carbonyl group within the chain ( $>\text{C}=\text{O}$ )    D) terminal carbonyl group ( $-\text{CHO}$ )

70. The standard hydrogen electrode is assigned a potential of:

- A) 14.00 V    B)  $-1.00$  V  
C) 0.50 V    D) 0.00 V

#### SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. A vehicle travels 60 m in 5 s at constant speed. What is its speed?

- A) 5/60 m/s    B) 12 m/s  
C) 14 m/s    D) 65 m/s

72. An object's velocity changes from 5 m/s to 17 m/s in 4 s. What is its acceleration?

- A)  $9 \text{ m/s}^2$     B)  $4.2 \text{ m/s}^2$   
C)  $3 \text{ m/s}^2$     D)  $12 \text{ m/s}^2$

73. Find the kinetic energy of a 8 kg object moving at 5 m/s.

- A) 40 J    B) 100 J  
C) 105 J    D) 200 J

74. What is the momentum of a 8 kg object moving at 4 m/s?

- A)  $12 \text{ kg}\cdot\text{m/s}$     B)  $16 \text{ kg}\cdot\text{m/s}$   
C)  $32 \text{ kg}\cdot\text{m/s}$     D)  $128 \text{ kg}\cdot\text{m/s}$

75. A sample has mass 20 kg and volume  $5 \text{ m}^3$ . What is its density?

- A)  $15 \text{ kg/m}^3$     B)  $100 \text{ kg/m}^3$   
C)  $0.25 \text{ kg/m}^3$     D)  $4 \text{ kg/m}^3$

76. A force of 180 N acts uniformly over an area of  $3 \text{ m}^2$ . What pressure is produced?

- A) 0.02 Pa    B) 60 Pa  
C) 180 Pa    D) 540 Pa

77. A resistor of  $4 \Omega$  carries a current of 5 A. What potential difference is across it?

- A) 9 V    B) 0.80 V  
C) 1.25 V    D) 20 V

78. An electrical device operates at 16 V and draws 3 A. What is its power?

- A) 48 W    B) 51 W  
C) 0.19 W    D) 5.33 W

79. A wave has frequency 10 Hz and wavelength 5 m. What is its speed?

- A) 15 m/s    B) 50 m/s  
C) 0.50 m/s    D) 60 m/s

80. In an isolated system, total momentum:

- A) is converted entirely into heat    B) always becomes zero  
C) depends only on mass    D) remains constant

#### SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. Solve  $5x + 7 = 52$ .

- A) 9    B) 10  
C) 45    D)  $52/5$

82. What is the larger root of  $x^2 - 16x + 55 = 0$ ?

- A) -11    B) 55  
C) 5    D) 11

83. If  $\log_2 32 = x$ , find x.

- A) 2    B) 5  
C) 6    D) 32

84. y varies directly as x. If  $y = 30$  when  $x = 6$ , find y when  $x = 8$ .

- A) 40    B) 240  
C) 32    D) 13

85. Find the slope of the line through (4, 5) and (7, 17).

- A)  $1/4$     B) -4  
C) 4    D) 3

86. Find the midpoint of the segment joining (3, 5) and (9, 9).

- A) (6, 4)    B) (6, 8)  
C) (9, 9)    D) (6, 7)

87. Find the distance between (0, 3) and (12, 19).

- A) 12    B) 21  
C) 20    D) 16

88. Find the area of a triangle with base 11 cm and perpendicular height 8 cm.

- A)  $88 \text{ cm}^2$     B)  $22 \text{ cm}^2$   
C)  $44 \text{ cm}^2$     D)  $19 \text{ cm}^2$

89. How many different pairs can be selected from 9 people?

- A) 9    B) 72  
C) 36    D) 45

90. Find the determinant of the matrix  $\begin{bmatrix} 5 & 1 \\ 6 & 5 \end{bmatrix}$ .

- A) -19    B) 20  
C) 31    D) 19

**ANSWER KEY - PRE ENGINEERING MODEL PAPER 4***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. B  | 3. D  | 4. A  | 5. B  | 6. A  | 7. D  | 8. A  | 9. B  | 10. A |
| 11. C | 12. B | 13. C | 14. C | 15. D | 16. B | 17. B | 18. B | 19. A | 20. B |
| 21. D | 22. B | 23. A | 24. D | 25. C | 26. D | 27. B | 28. D | 29. D | 30. A |
| 31. B | 32. B | 33. C | 34. D | 35. C | 36. A | 37. C | 38. B | 39. A | 40. B |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. D | 63. D | 64. C | 65. D | 66. D | 67. D | 68. A | 69. C | 70. D |
| 71. B | 72. C | 73. B | 74. C | 75. D | 76. B | 77. D | 78. A | 79. B | 80. D |
| 81. A | 82. D | 83. B | 84. A | 85. C | 86. D | 87. C | 88. C | 89. C | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |

**PRE-ENGINEERING - MODEL PAPER 5**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 5

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) is  
C) be D) were

2. At present, the workers \_\_\_\_ for the test.

- A) is preparing B) were prepare  
C) prepared D) are preparing

3. Shah \_\_\_\_ the attendance sheet already.

- A) completed yesterday B) is completing since Monday  
C) have completed D) has completed

4. By the time the supervisor arrived, Talia \_\_\_\_ the assignment.

- A) has checked B) will have checked  
C) had checked D) was check

5. By next Friday, the team \_\_\_\_ the attendance sheet.

- A) has completed B) would complete  
C) had completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) be B) is  
C) were being D) are

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) has B) are having  
C) do D) were

8. Each of the candidates \_\_\_\_ an admit card.

- A) have B) are having  
C) possess D) has

9. There \_\_\_\_ several reasons for the delay.

- A) is B) be  
C) are D) has

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boiled B) will boil always  
C) would boil D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would have played B) will play  
C) would play D) had played

12. If I knew the answer, I \_\_\_\_ Shah.

- A) would have told B) told  
C) will tell D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) will catch  
C) would catch D) would have caught

14. Choose the correct passive form: "The technician checks the attendance sheet."

- A) The attendance sheet is being checked by the technician. B) The attendance sheet was checked by the technician.  
C) The attendance sheet is checked by the technician. D) The attendance sheet will be checked by the technician.

15. Choose the correct passive form: "The technician is checking the assignment."

- A) The assignment was being checked by the technician. B) The assignment has been checked by the technician.  
C) The assignment is being checked by the technician. D) The assignment is been checked by the technician.

16. Choose the correct passive form: "The clerk processed the attendance sheet."

- A) The attendance sheet was processed by the clerk. B) The attendance sheet is processed by the clerk.  
C) The attendance sheet was being processed by the clerk. D) The attendance sheet has processed by the clerk.

17. Choose the correct passive form: "The committee has approved the assignment."

- A) The assignment is approved by the committee. B) The assignment had approved by the committee.  
C) The assignment was approved by the committee. D) The assignment has been approved by the committee.

18. Choose the correct passive form: "The office will issue the attendance sheet."

- A) The attendance sheet will have issued by the office. B) The attendance sheet is issued by the office.  
C) The attendance sheet will issued by the office. D) The attendance sheet will be issued by the office.

19. Select the correct indirect form: Shah said, "I will complete the attendance sheet."

- A) Shah said that he had complete the attendance sheet. B) Shah said that I would complete the attendance sheet.  
C) Shah told that the attendance sheet would complete. D) Shah said that he would complete the attendance sheet.

20. Select the correct indirect form: Talia said, "I am checking the assignment."

- A) Talia said that she is checking the assignment. B) Talia told that she was checking the assignment.  
C) Talia said that I was checking the assignment. D) Talia said that she was checking the assignment.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L5: Seven students in a row - Questions 21-24**

Seven students—Gul, Hamza, Inaya, Jawad, Komal, Laiba, and Mustafa—sit in a row facing north. 1. Jawad sits in the middle. 2. Gul sits third to the left of Jawad. 3. Mustafa sits third to the right of Jawad. 4. Hamza sits immediately to the left of Inaya. 5. Komal sits immediately to the right of Jawad. 6. Laiba sits immediately to the right of Komal.

21. Which student is seated in position three when counted from the left?

- A) Hamza B) Jawad  
C) Komal D) Inaya

22. Which student sits two places to the right of Inaya?

- A) Hamza B) Komal  
C) Jawad D) Laiba

23. How many people are seated between Gul and Jawad?

- A) Two B) One  
C) None D) Three

24. If Jawad moves to Mustafa's seat and everyone between them shifts one place left, who will sit in the middle?

- A) Komal B) Mustafa  
C) Jawad D) Inaya

**Analytical Set C5: Six participants around a round table - Questions 25-28**

Six participants—Cyrus, Daniyal, Esha, Faizan, Ghazal, and Hammad—sit around a round table facing the centre. Cyrus is fixed at the top. 1. Faizan sits opposite Cyrus. 2. Daniyal sits immediately clockwise from Cyrus. 3. Esha sits between Daniyal and Faizan on the clockwise side. 4. Ghazal sits immediately clockwise from Faizan.

25. Who sits immediately anticlockwise from Cyrus?

- A) Esha B) Daniyal  
C) Ghazal D) Hammad

26. Who is opposite Esha?

- A) Daniyal B) Hammad  
C) Faizan D) Cyrus

27. Which pair forms Faizan's immediate neighbours?

- A) Ghazal and Hammad B) Esha and Ghazal  
C) Daniyal and Esha D) Cyrus and Ghazal

28. After a one-seat anticlockwise rotation by everyone, who takes Daniyal's original position?

- A) Ghazal B) Hammad  
C) Esha D) Faizan

**Analytical Set S5: Six class periods - Questions 29-32**

Six lessons—Accounting, Biology, Chemistry, Drawing, English, and French—are placed in periods 1 to 6. 1. Accounting is in period 1. 2. French is in period 6. 3. Biology is immediately before Chemistry. 4. English is immediately after Drawing. 5. Chemistry is earlier than Drawing.

29. Which lesson is in period 3?

- A) Chemistry B) French  
C) Drawing D) English

30. What lesson immediately follows Drawing?

- A) Accounting B) French  
C) Chemistry D) English

31. How many periods separate Biology and English?

- A) Three B) None  
C) One D) Two

32. If the Biology-Chemistry pair swaps places with the Drawing-English pair, which lesson will be in period 2?

- A) Accounting B) Chemistry  
C) English D) Drawing

**Analytical Set D5: Train and meeting chain - Questions 33-36**

Use these rules: 1. If the train is late (T), the meeting is delayed (M). 2. If the meeting is delayed (M), the manager calls (C). 3. If the manager calls (C), the staff wait (W). 4. If the staff do not wait, the report is sent (R).

33. The train is late. Which result must eventually occur?

- A) The report is not sent B) The staff leave immediately  
C) The staff wait D) The manager does not call

34. The manager does not call. What must be true about the train?

- A) The train is late B) The meeting is delayed  
C) The report is not sent D) The train is not late

35. If the staff do not wait, which conclusion follows directly?

- A) The train is late B) The meeting is delayed  
C) The report is withheld D) The report is sent

36. The report is not sent. What must be true?

- A) The staff do not wait B) The train is late  
C) The meeting is delayed D) The staff wait

**Analytical Set B5: Khalid's family - Questions 37-40**

Khalid and Salma are married. Their daughter Lubna is married to Noman and has two children, Omer and Pari. Their son Majid is married to Qurat and has one son, Raza.

37. What is Omer's relation to Majid?

- A) Brother B) Uncle  
C) Cousin D) Nephew

38. How is Salma related to Pari?

- A) Mother-in-law B) Maternal aunt  
C) Paternal grandmother D) Maternal grandmother

39. What is Raza's relation to Pari?

- A) Uncle B) Brother  
C) Nephew D) Cousin

40. How is Qurat related to Lubna?

- A) Sister-in-law B) Maternal aunt  
C) Daughter-in-law D) Sister

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $37 + 4 \times 4 - 8$ .

- A) 45 B) 21  
C) 156 D) 49

42. Find  $\frac{9}{12} + \frac{10}{19}$  in simplest form.

- A)  $\frac{19}{31}$  B)  $\frac{97}{76}$   
C)  $\frac{17}{76}$  D)  $\frac{1}{12}$



43. What is 45% of 575?  
A) 31/5 B) 115/9  
C) 1035/4 D) 1265/4
44. A price of Rs. 1100 is increased by 20%. What is the new price?  
A) Rs. 220 B) Rs. 1120  
C) Rs. 880 D) Rs. 1320
45. Rs. 280 is divided in the ratio 2:6. What is the larger share?  
A) 70 B) 140  
C) 8 D) 210
46. If 4 identical notebooks cost Rs. 380, what will 9 notebooks cost at the same rate?  
A) 855 B) 389  
C) 3420 D) 475
47. Find the arithmetic mean of 50, 54, 58, 62, 66.  
A) 290 B) 58  
C) 54 D) 62
48. A student scores 65 in a 2-credit course and 85 in a 6-credit course. Find the weighted mean.  
A) 75 B) 320  
C) 80 D) 53.33
49. A vehicle travels 300 km at a constant speed of 60 km/h. How long does the journey take?  
A) 360 hours B) 240 hours  
C) 1/5 hours D) 5 hours
50. Worker A can complete a job in 19 days and Worker B in 37 days. Working together, how many days will they take?  
A) 28 days B) 56/703 days  
C) 703/18 days D) 703/56 days
51. An item costs Rs. 700 and is sold at a profit of 40%. Find the selling price.  
A) Rs. 980 B) Rs. 280  
C) Rs. 420 D) Rs. 740
52. Find the simple interest on Rs. 2500 at 5% per year for 5 years.  
A) Rs. 125 B) Rs. 625  
C) Rs. 3125 D) Rs. 6250
53. Solve  $3x + 9 = 63$ .  
A) 54 B) 6  
C) 18 D) 19
54. What is the larger root of  $x^2 - 23x + 60 = 0$ ?  
A) 3 B) 23  
C) 60 D) 20
55. Find the 13th term of the arithmetic sequence with first term 33 and common difference 2.  
A) 59 B) 55  
C) 455 D) 57
56. If  $17^x = 289$ , find x.  
A) 2 B) 17  
C) 289 D) 3
57. Find the area of a rectangle of length 23 cm and width 4 cm.  
A) 54 cm<sup>2</sup> B) 92 cm<sup>2</sup>  
C) 27 cm<sup>2</sup> D) 184 cm<sup>2</sup>
58. Find the slope of the line through (15, 17) and (19, 25).  
A) 1/2 B) 8  
C) 2 D) 4
59. A bag contains 10 red and 5 blue balls. One ball is selected at random. What is P(red)?  
A) 1/3 B) 2  
C) 1/15 D) 2/3
60. How many different pairs can be selected from 20 people?  
A) 380 B) 22  
C) 20 D) 190

#### SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of iron has atomic number 26. How many protons does it contain?  
A) 52 B) 27  
C) 26 D) 25
62. Isotopes of the same element have:  
A) different chemical symbols only B) the same numbers of protons and neutrons  
C) different atomic numbers and identical mass numbers D) the same number of protons but different numbers of neutrons
63. What is the maximum number of electrons in the fourth electron shell according to  $2n^2$ ?  
A) 34 B) 17  
C) 30 D) 32
64. An ionic bond is formed mainly by:  
A) transfer of neutrons B) sharing of protons  
C) transfer of electrons from one atom to another D) equal sharing of electrons only
65. What is the mass of 4 mol of CH<sub>4</sub> if its molar mass is 16 g mol<sup>-1</sup>?  
A) 60 g B) 8 g  
C) 128 g D) 64 g
66. How many moles are present in 64 g of CH<sub>4</sub> (molar mass 16 g mol<sup>-1</sup>)?  
A) 2 mol B) 64 mol  
C) 16 mol D) 4 mol
67. A solution contains 3 mol of solute in 4 dm<sup>3</sup>. What is its concentration?  
A) 7 mol dm<sup>-3</sup> B) 0.75 mol dm<sup>-3</sup>  
C) 1.75 mol dm<sup>-3</sup> D) 1.33333 mol dm<sup>-3</sup>

68. What is the pH of a solution with  $[H^+] = 1.0 \times 10^{-6} \text{ mol dm}^{-3}$ ?

- A) 5    B) 7  
C) 6    D) 8

69. Oxidation is best described as:

- A) gain of neutrons    B) loss of protons  
C) loss of electrons    D) gain of electrons

70. Which functional group characterizes an amine?

- A) amino group ( $-NH_2$ )    B) carbonyl group within the chain ( $>C=O$ )  
C) terminal carbonyl group ( $-CHO$ )    D) hydroxyl group ( $-OH$ )

## SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. Which of the following is an SI base quantity?

- A) Mass    B) Pressure  
C) Power    D) Force

72. A vehicle travels 78 m in 6 s at constant speed. What is its speed?

- A) 6/78 m/s    B) 13 m/s  
C) 84 m/s    D) 15 m/s

73. What force is required to accelerate a 4 kg mass at  $7 \text{ m/s}^2$ ?

- A) 35 N    B) 0.57 N  
C) 14 N    D) 28 N

74. Find the kinetic energy of a 10 kg object moving at 6 m/s.

- A) 16 J    B) 360 J  
C) 180 J    D) 60 J

75. What is the momentum of a 2 kg object moving at 5 m/s?

- A) 50 kg·m/s    B) 10 kg·m/s  
C) 5 kg·m/s    D) 7 kg·m/s

76. A sample has mass 30 kg and volume  $6 \text{ m}^3$ . What is its density?

- A) 180 kg/m<sup>3</sup>    B) 24 kg/m<sup>3</sup>  
C) 0.20 kg/m<sup>3</sup>    D) 5 kg/m<sup>3</sup>

77. A force of 280 N acts uniformly over an area of  $4 \text{ m}^2$ . What pressure is produced?

- A) 0.01 Pa    B) 70 Pa  
C) 74 Pa    D) 1120 Pa

78. An electrical device operates at 18 V and draws 4 A. What is its power?

- A) 76 W    B) 22 W  
C) 4.50 W    D) 72 W

79. A wave has frequency 11 Hz and wavelength 6 m. What is its speed?

- A) 77 m/s    B) 17 m/s  
C) 66 m/s    D) 1.83 m/s

80. A more stable nucleus generally has:

- A) zero mass defect    B) more electrons than protons  
C) a larger physical volume only    D) greater binding energy per nucleon

## SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. Solve  $6x + 8 = 74$ .

- A) 11    B) 66  
C) 37/3    D) 12

82. What is the larger root of  $x^2 - 15x + 54 = 0$ ?

- A) -9    B) 15  
C) 54    D) 9

83. Find the 5th term of the geometric sequence with first term 3 and common ratio 2.

- A) 96    B) 46  
C) 30    D) 48

84. y varies directly as x. If  $y = 42$  when  $x = 7$ , find y when  $x = 9$ .

- A) 51    B) 378  
C) 15    D) 54

85. Find the midpoint of the segment joining (4, 2) and (10, 6).

- A) (10, 6)    B) (7, 5)  
C) (6, 4)    D) (7, 4)

86. Find the distance between (1, 0) and (4, 4).

- A) 25    B) 5  
C) 6    D) 3

87. Find the area of a triangle with base 12 cm and perpendicular height 9 cm.

- A) 54 cm<sup>2</sup>    B) 21 cm<sup>2</sup>  
C) 108 cm<sup>2</sup>    D) 42 cm<sup>2</sup>

88. How many different pairs can be selected from 10 people?

- A) 90    B) 12  
C) 10    D) 45

89. What is  $\sin 30^\circ$ ?

- A) 1/2    B)  $\sqrt{3}/2$   
C)  $\sqrt{2}/2$     D) 1

90. Find the determinant of the matrix  $\begin{bmatrix} 2 & 2 \\ 7 & 2 \end{bmatrix}$ .

- A) -10    B) 10  
C) 4    D) 18

**ANSWER KEY - PRE ENGINEERING MODEL PAPER 5***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. D  | 3. D  | 4. C  | 5. D  | 6. B  | 7. A  | 8. D  | 9. C  | 10. D |
| 11. B | 12. D | 13. D | 14. C | 15. C | 16. A | 17. D | 18. D | 19. D | 20. D |
| 21. D | 22. B | 23. A | 24. A | 25. D | 26. B | 27. B | 28. C | 29. A | 30. D |
| 31. D | 32. D | 33. C | 34. D | 35. D | 36. D | 37. D | 38. D | 39. D | 40. A |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. D | 63. D | 64. C | 65. D | 66. D | 67. B | 68. C | 69. C | 70. A |
| 71. A | 72. B | 73. D | 74. C | 75. B | 76. D | 77. B | 78. D | 79. C | 80. D |
| 81. A | 82. D | 83. D | 84. D | 85. D | 86. B | 87. A | 88. D | 89. A | 90. A |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |

**PRE-ENGINEERING - MODEL PAPER 6**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 6

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) be  
C) are D) is

2. At present, the students \_\_\_\_ for the test.

- A) were prepare B) prepared  
C) are preparing D) have prepare

3. Cem \_\_\_\_ the data table already.

- A) has completed B) have completed  
C) had complete D) is completing since Monday

4. By the time the supervisor arrived, Dalia \_\_\_\_ the project.

- A) will have checked B) checks  
C) had checked D) has checked

5. By next Friday, the team \_\_\_\_ the data table.

- A) will have completed B) had completed  
C) has completed D) will completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) have B) are  
C) were being D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do B) has  
C) are having D) were

8. Each of the candidates \_\_\_\_ an admit card.

- A) have B) possess  
C) are having D) has

9. There \_\_\_\_ several reasons for the delay.

- A) be B) was  
C) are D) is

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) boils  
C) boiled D) will boil always

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) will play B) played  
C) would play D) had played

12. If I knew the answer, I \_\_\_\_ Cem.

- A) had told B) would tell  
C) would have told D) told

13. If they had left earlier, they \_\_\_\_ the train.

- A) would catch B) caught  
C) would have caught D) will catch

14. Choose the correct passive form: "The technician checks the data table."

- A) The data table was checked by the technician. B) The data table has checked by the technician.  
C) The data table is checked by the technician. D) The data table is being checked by the technician.

15. Choose the correct passive form: "The technician is checking the project."

- A) The project is been checked by the technician. B) The project has been checked by the technician.  
C) The project was being checked by the technician. D) The project is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the data table."

- A) The data table has processed by the clerk. B) The data table is processed by the clerk.  
C) The data table will be processed by the clerk. D) The data table was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the project."

- A) The project is approved by the committee. B) The project was approved by the committee.  
C) The project has being approved by the committee. D) The project has been approved by the committee.

18. Choose the correct passive form: "The office will issue the data table."

- A) The data table would be issued by the office. B) The data table will issued by the office.  
C) The data table will be issued by the office. D) The data table will have issued by the office.

19. Select the correct indirect form: Cem said, "I will complete the data table."

- A) Cem said that he would complete the data table. B) Cem said that he had complete the data table.  
C) Cem said that he will complete the data table. D) Cem told that the data table would complete.

20. Select the correct indirect form: Dalia said, "I am checking the project."

- A) Dalia said that she was checking the project. B) Dalia said that she had checked the project.  
C) Dalia said that I was checking the project. D) Dalia told that she was checking the project.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L6: 6 candidates in a straight row - Questions 21-24**

6 candidates—Cyrus, Bushra, Adeel, Dua, Fahad, and Ghazal—sit in a straight row, all facing north. 1. Cyrus occupies the extreme left seat. 2. Ghazal sits at the extreme right. 3. Bushra is immediately to the right of Cyrus. 4. Dua sits immediately to the right of Adeel. 5. Fahad sits between Dua and Ghazal, adjacent to both.

21. Which pair occupies the two end seats?

- A) Bushra and Ghazal B) Cyrus and Ghazal  
C) Cyrus and Fahad D) Dua and Fahad

22. Who sits second to the right of Bushra?

- A) Adeel B) Cyrus  
C) Ghazal D) Dua

23. Which statement is consistent with the completed arrangement?

- A) Adeel sits at an end B) Dua sits second from the left  
C) Bushra sits immediately left of Cyrus D) Fahad sits immediately left of Ghazal

24. If everyone now faces south without changing seats, who is immediately to the left of Dua?

- A) Bushra B) Fahad  
C) Cyrus D) Ghazal

**Analytical Set C6: 6 participants around a round table - Questions 25-28**

6 participants—Cem, Dalia, Aariz, Bina, Fiza, and Ehsan—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Cem occupies the top seat. 2. Dalia sits immediately clockwise of Cem. 3. Aariz sits immediately clockwise of Dalia. 4. Bina sits directly opposite Cem. 5. Fiza sits immediately clockwise of Bina. 6. Ehsan sits immediately clockwise of Fiza.

25. Which pair are the immediate neighbours of Cem?

- A) Aariz and Ehsan B) Ehsan and Dalia  
C) Dalia and Bina D) Cem and Aariz

26. Identify the participant opposite Aariz.

- A) Ehsan B) Dalia  
C) Bina D) Fiza

27. Who sits between Cem and Aariz on the shorter arc?

- A) Dalia B) Fiza  
C) Aariz D) Bina

28. If everyone turns to face outward, who is immediately to the left of Fiza?

- A) Dalia B) Aariz  
C) Bina D) Ehsan

**Analytical Set S6: 6 subjects in fixed slots - Questions 29-32**

The following 6 subjects are assigned one per slot: Drawing, English, Physics, Algebra, Chemistry, and Biology. 1. Drawing is scheduled in Monday. 2. Biology is scheduled in Saturday. 3. English occurs immediately after Drawing. 4. Algebra occurs immediately after Physics. 5. Chemistry is between Algebra and Biology, consecutive with both.

29. What is the first scheduled activity?

- A) Biology B) Algebra  
C) Chemistry D) Drawing

30. When does Chemistry take place?

- A) Wednesday B) Thursday  
C) Monday D) Friday

31. Which pair occurs in two consecutive slots in the stated order?

- A) Drawing followed by Biology B) Physics followed by Algebra  
C) Drawing followed by Physics D) English followed by Chemistry

32. If English and Chemistry exchange slots, which activity occupies Tuesday?

- A) Drawing B) Physics  
C) Algebra D) Chemistry

**Analytical Set D6: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the proposal is funded, then the audit begins. 2. If the audit begins, then the report is drafted. 3. If the report is drafted, then the board meets. 4. If a security hold is imposed, then the report is not drafted. 5. If an alert is issued, then a security hold is imposed.

33. If the proposal is funded, which outcome must eventually follow?

- A) A security hold is imposed B) The audit does not begin  
C) The report is not drafted D) The board meets

34. Suppose the board does not meet. Which conclusion is unavoidable?

- A) The report is drafted B) The audit begins  
C) The proposal is not funded D) A security hold is imposed

35. If an alert is issued, what must be true about the second condition?

- A) The audit begins B) The report is drafted  
C) The board meets D) The audit does not begin

36. Which pair cannot both be true under the stated rules?

- A) The proposal is funded and the audit begins B) A security hold is imposed and an alert is issued  
C) The proposal is funded and a security hold is imposed D) The audit begins and the board meets

**Analytical Set B6: The family of Rauf and Shazia - Questions 37-40**

Rauf and Shazia are married. Their children are Adnan, a son, and Bina, a daughter. Adnan is married to Naila; their children are Iqra, a son, and Junaid, a daughter. Bina is married to Hamid; their child is Komal, a son.

37. How is Shazia related to Junaid?

- A) Mother-in-law B) Maternal aunt  
C) Maternal grandmother D) Paternal grandmother

38. What is Bina's relation to Iqra?

- A) Maternal aunt B) Sister-in-law  
C) Sister D) Paternal aunt

39. How is Komal related to Junaid?

- A) Uncle B) Brother-in-law  
C) Cousin D) Sibling

40. How is Naila related to Bina?

- A) Maternal aunt B) Paternal aunt  
C) Mother-in-law D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $39 + 5 \times 5 - 9$ .

- A) 55 B) 19  
C) 211 D) 60

42. Find  $9/13 + 11/20$  in simplest form.  
A)  $20/33$  B)  $323/260$   
C)  $37/260$  D)  $1/13$
43. What is 10% of 600?  
A)  $61/10$  B) 540  
C) 60 D) 600
44. A price of Rs. 1140 is increased by 25%. What is the new price?  
A) Rs. 285 B) Rs. 1165  
C) Rs. 855 D) Rs. 1425
45. Rs. 252 is divided in the ratio 3:4. What is the larger share?  
A) 108 B) 126  
C) 7 D) 144
46. If 5 identical notebooks cost Rs. 490, what will 7 notebooks cost at the same rate?  
A) 686 B) 497  
C) 3430 D) 588
47. Find the arithmetic mean of 53, 58, 63, 68, 73.  
A) 315 B) 63  
C) 58 D) 68
48. A student scores 66 in a 3-credit course and 86 in a 3-credit course. Find the weighted mean.  
A) 228 B) 50.67  
C) 76 D) 76.5
49. A vehicle travels 124 km at a constant speed of 62 km/h. How long does the journey take?  
A) 186 hours B) 62 hours  
C)  $1/2$  hours D) 2 hours
50. Worker A can complete a job in 20 days and Worker B in 39 days. Working together, how many days will they take?  
A)  $59/2$  days B)  $59/780$  days  
C)  $780/19$  days D)  $780/59$  days
51. An item costs Rs. 720 and is sold at a profit of 5%. Find the selling price.  
A) Rs. 756 B) Rs. 36  
C) Rs. 684 D) Rs. 725
52. Find the simple interest on Rs. 2600 at 6% per year for 2 years.  
A) Rs. 156 B) Rs. 312  
C) Rs. 52 D) Rs. 2912
53. Solve  $4x + 10 = 86$ .  
A) 76 B)  $38/5$   
C) 19 D) 20
54. What is the larger root of  $x^2 - 25x + 84 = 0$ ?  
A) 4 B) 25  
C) 84 D) 21
55. Find the 14th term of the arithmetic sequence with first term 35 and common difference 3.  
A) 77 B) 71  
C) 532 D) 74
56. If  $18^x = 5832$ , find x.  
A) 3 B) 18  
C) 5832 D) 4
57. Find the area of a triangle with base 26 cm and height 11 cm.  
A)  $286 \text{ cm}^2$  B)  $143 \text{ cm}^2$   
C)  $37 \text{ cm}^2$  D)  $143/2 \text{ cm}^2$
58. Find the midpoint of the segment joining (16, 18) and (22, 26).  
A) (6, 8) B) (38, 44)  
C) (19, 22) D) (3, 4)
59. A bag contains 3 red and 6 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?  
A)  $2/3$  B)  $1/2$   
C)  $1/9$  D)  $1/3$
60. How many different pairs can be selected from 21 people?  
A) 420 B) 23  
C) 21 D) 210

#### SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of copper has atomic number 29. How many protons does it contain?  
A) 30 B) 58  
C) 28 D) 29
62. Isotopes of the same element have:  
A) the same numbers of protons and neutrons B) the same number of protons but different numbers of neutrons  
C) different atomic numbers and identical mass numbers D) different numbers of protons and the same number of neutrons
63. What is the maximum number of electrons in the second electron shell according to  $2n^2$ ?  
A) 5 B) 6  
C) 10 D) 8
64. An ionic bond is formed mainly by:  
A) transfer of electrons from one atom to another B) overlap without electron involvement  
C) transfer of neutrons D) sharing of protons
65. What is the mass of 2 mol of  $\text{H}_2\text{SO}_4$  if its molar mass is  $98 \text{ g mol}^{-1}$ ?  
A) 198 g B) 49 g  
C) 392 g D) 196 g
66. How many moles are present in 196 g of  $\text{H}_2\text{SO}_4$  (molar mass  $98 \text{ g mol}^{-1}$ )?  
A) 1 mol B) 98 mol  
C) 196 mol D) 2 mol

67. A solution contains 4 mol of solute in 5 dm<sup>3</sup>. What is its concentration?

- A) 9 mol dm<sup>-3</sup> B) 0.8 mol dm<sup>-3</sup>  
C) 1.25 mol dm<sup>-3</sup> D) 1.8 mol dm<sup>-3</sup>

68. What is the pH of a solution with  $[H^+] = 1.0 \times 10^{-2}$  mol dm<sup>-3</sup>?

- A) 12 B) 2  
C) 7 D) 3

69. Oxidation is best described as:

- A) loss of protons B) gain of neutrons  
C) no change in oxidation state D) loss of electrons

70. Which functional group characterizes an alcohol?

- A) hydroxyl group (-OH) B) carbonyl group within the chain (>C=O)  
C) amino group (-NH<sub>2</sub>) D) carboxyl group (-COOH)

## SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. A vehicle travels 28 m in 2 s at constant speed. What is its speed?

- A) 14 m/s B) 30 m/s  
C) 28 m/s D) 2/28 m/s

72. An object's velocity changes from 2 m/s to 32 m/s in 6 s. What is its acceleration?

- A) 30 m/s<sup>2</sup> B) 6 m/s<sup>2</sup>  
C) 5 m/s<sup>2</sup> D) 5.3 m/s<sup>2</sup>

73. What force is required to accelerate a 5 kg mass at 3 m/s<sup>2</sup>?

- A) 18 N B) 15 N  
C) 8 N D) 1.67 N

74. What is the momentum of a 3 kg object moving at 6 m/s?

- A) 9 kg·m/s B) 108 kg·m/s  
C) 18 kg·m/s D) None of these

75. A sample has mass 12 kg and volume 2 m<sup>3</sup>. What is its density?

- A) 6 kg/m<sup>3</sup> B) 10 kg/m<sup>3</sup>  
C) 24 kg/m<sup>3</sup> D) 7 kg/m<sup>3</sup>

76. A force of 400 N acts uniformly over an area of 5 m<sup>2</sup>. What pressure is produced?

- A) 80 Pa B) 2000 Pa  
C) 400 Pa D) 85 Pa

77. A resistor of 6 Ω carries a current of 2 A. What potential difference is across it?

- A) 3.00 V B) 12 V  
C) 8 V D) 0.33 V

78. An electrical device operates at 20 V and draws 5 A. What is its power?

- A) 0.25 W B) 4.00 W  
C) 100 W D) 105 W

79. A wave has frequency 12 Hz and wavelength 2 m. What is its speed?

- A) 36 m/s B) 14 m/s  
C) 0.17 m/s D) 24 m/s

80. The photoelectric effect supports the idea that light energy is carried in:

- A) continuous mechanical waves only B) photons  
C) magnetic poles D) neutrons

## SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. Solve  $2x + 9 = 17$ .

- A) 17/2 B) 5  
C) 3 D) 4

82. What is the larger root of  $x^2 - 18x + 77 = 0$ ?

- A) 7 B) -11  
C) 11 D) 77

83. If  $\log_5 125 = x$ , find  $x$ .

- A) 125 B) 4  
C) 5 D) 3

84.  $y$  varies directly as  $x$ . If  $y = 16$  when  $x = 8$ , find  $y$  when  $x = 10$ .

- A) 20 B) 12  
C) 26 D) 160

85. Find the slope of the line through (2, 2) and (5, 8).

- A) -2 B) 3  
C) 7 D) 2

86. Find the midpoint of the segment joining (0, 3) and (6, 7).

- A) (3, 6) B) (6, 7)  
C) (2, 6) D) (3, 5)

87. Find the distance between (2, 1) and (8, 9).

- A) 6 B) 10  
C) 11 D) 8

88. Find the area of a triangle with base 13 cm and perpendicular height 10 cm.

- A) 65/2 cm<sup>2</sup> B) 130 cm<sup>2</sup>  
C) 23 cm<sup>2</sup> D) 65 cm<sup>2</sup>

89. How many different pairs can be selected from 11 people?

- A) 66 B) 13  
C) 55 D) 11

90. What is  $\cos 60^\circ$ ?

- A) 1/2 B) 0  
C)  $\sqrt{2}/2$  D) 1

**ANSWER KEY - PRE ENGINEERING MODEL PAPER 6***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. C  | 3. A  | 4. C  | 5. A  | 6. D  | 7. B  | 8. D  | 9. C  | 10. B |
| 11. A | 12. B | 13. C | 14. C | 15. D | 16. D | 17. D | 18. C | 19. A | 20. A |
| 21. B | 22. D | 23. D | 24. B | 25. B | 26. A | 27. A | 28. C | 29. D | 30. D |
| 31. B | 32. D | 33. D | 34. C | 35. D | 36. C | 37. D | 38. D | 39. C | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. B | 63. D | 64. A | 65. D | 66. D | 67. B | 68. B | 69. D | 70. A |
| 71. A | 72. C | 73. B | 74. C | 75. A | 76. A | 77. B | 78. C | 79. D | 80. B |
| 81. D | 82. C | 83. D | 84. A | 85. D | 86. D | 87. B | 88. D | 89. C | 90. A |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |



**PRE-ENGINEERING - MODEL PAPER 7**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 7

Questions: 30

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) are B) be  
C) have D) is

2. At present, the technicians \_\_\_\_ for the test.

- A) are preparing B) is preparing  
C) prepared D) were prepare

3. Bina \_\_\_\_ the question paper already.

- A) is completing since Monday B) has completed  
C) completed yesterday D) had complete

4. By the time the supervisor arrived, Fiza \_\_\_\_ the application.

- A) was check B) has checked  
C) checks D) had checked

5. By next Friday, the team \_\_\_\_ the question paper.

- A) had completed B) would complete  
C) will completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) were being B) have  
C) be D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) have B) are having  
C) has D) were

8. Each of the candidates \_\_\_\_ an admit card.

- A) were given by B) possess  
C) have D) has

9. There \_\_\_\_ several reasons for the delay.

- A) are B) be  
C) was D) has

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) would boil  
C) boils D) will boil always

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) had played B) would play  
C) will play D) would have played

12. If I knew the answer, I \_\_\_\_ Bina.

- A) would tell B) will tell  
C) told D) had told

13. If they had left earlier, they \_\_\_\_ the train.

- A) would catch B) caught  
C) would have caught D) had caught

14. Choose the correct passive form: "The technician checks the question paper."

- A) The question paper will be checked by the technician. B) The question paper has checked by the technician.  
C) The question paper was checked by the technician. D) The question paper is checked by the technician.

15. Choose the correct passive form: "The technician is checking the application."

- A) The application was being checked by the technician. B) The application has been checked by the technician.  
C) The application is being checked by the technician. D) The application is been checked by the technician.

16. Choose the correct passive form: "The clerk processed the question paper."

- A) The question paper was processed by the clerk. B) The question paper is processed by the clerk.  
C) The question paper has processed by the clerk. D) The question paper will be processed by the clerk.

17. Choose the correct passive form: "The committee has approved the application."

- A) The application has being approved by the committee. B) The application had approved by the committee.  
C) The application has been approved by the committee. D) The application is approved by the committee.

18. Choose the correct passive form: "The office will issue the question paper."

- A) The question paper would be issued by the office. B) The question paper will be issued by the office.  
C) The question paper will have issued by the office. D) The question paper will issued by the office.

19. Select the correct indirect form: Bina said, "I will complete the question paper."

- A) Bina said that she had complete the question paper. B) Bina said that I would complete the question paper.  
C) Bina told that the question paper would complete. D) Bina said that she would complete the question paper.

20. Select the correct indirect form: Fiza said, "I am checking the application."

- A) Fiza said that she had checked the application. B) Fiza told that she was checking the application.  
C) Fiza said that I was checking the application. D) Fiza said that she was checking the application.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L7: 7 candidates in a straight row - Questions 21-24**

7 candidates—Laiba, Noreen, Iqra, Muneeb, Jibran, Hammad, and Komal—sit in a straight row, all facing north. 1. Noreen is second from the left. 2. Hammad is second from the right. 3. Laiba sits immediately left of Noreen. 4. Iqra sits immediately right of Noreen. 5. Muneeb occupies the central seat. 6. Jibran is immediately right of Muneeb. 7. Komal is immediately right of Hammad.

21. Who is in the left-middle seat of this row?

- A) Laiba B) Komal  
C) Iqra D) Hammad

22. Who sits exactly between Noreen and Muneeb?

- A) Laiba B) Iqra  
C) Jibran D) Hammad

23. Who is third from the right end?

- A) Hammad B) Noreen  
C) Muneeb D) Jibran

24. If Noreen and Hammad exchange seats, who occupies seat 2 from the left?

- A) Noreen B) Hammad  
C) Komal D) Muneeb

**Analytical Set C7: 8 participants around a round table - Questions 25-28**

8 participants—Irtaza, Laila, Hiba, Mahir, Joya, Nida, Gibran, and Kashan—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Irtaza sits at the top. 2. Kashan is immediately anticlockwise from Irtaza. 3. Gibran is immediately anticlockwise from Kashan. 4. Joya is opposite Irtaza. 5. Mahir is immediately anticlockwise from Joya. 6. Hiba is immediately anticlockwise from Mahir. 7. Laila sits between Irtaza and Hiba, adjacent to both. 8. Nida is immediately clockwise from Joya.

25. Who occupies the bottom seat, directly across from the top seat?

- A) Laila B) Irtaza  
C) Hiba D) Joya

26. Who is second anticlockwise from Irtaza?

- A) Nida B) Joya  
C) Hiba D) Gibran

27. Which pair sits in consecutive clockwise seats?

- A) Mahir and Kashan B) Irtaza and Nida  
C) Irtaza and Mahir D) Hiba and Mahir

28. If Laila exchanges seats with the person opposite, who then sits immediately clockwise of Irtaza?

- A) Irtaza B) Gibran  
C) Mahir D) Nida

**Analytical Set S7: 7 sessions in fixed slots - Questions 29-32**

The following 7 sessions are assigned one per slot: Audit, Guidance, Design, Briefing, Coding, Finance, and Evaluation. 1. Briefing is scheduled in the middle slot, Thursday. 2. Audit opens the schedule. 3. Evaluation closes the schedule. 4. Guidance immediately follows Audit. 5. Design immediately precedes Briefing. 6. Coding immediately follows Briefing. 7. Finance immediately precedes Evaluation.

29. Which activity is assigned to Thursday?

- A) Design B) Briefing  
C) Finance D) Evaluation

30. What comes immediately after Design?

- A) Coding B) Evaluation  
C) Guidance D) Briefing

31. Which pair occupies the first and last slots respectively?

- A) Guidance and Design B) Design and Finance  
C) Guidance and Coding D) Audit and Evaluation

32. If Guidance is postponed by two slots and intervening activities shift earlier, what occupies Wednesday?

- A) Guidance B) Audit  
C) Briefing D) Design

**Analytical Set D7: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the student qualifies, then the interview is scheduled. 2. If the student qualifies, then the documents are verified. 3. If the interview is scheduled, then the fee voucher is issued. 4. If the documents are verified, then the admission file opens. 5. If the fee voucher is issued, then the final list includes the student.

33. When the student qualifies, which later result is guaranteed?

- A) The final list includes the student B) The fee voucher is not issued  
C) The documents are not verified D) The interview is not scheduled

34. If the admission file does not open, what must be concluded?

- A) The student does not qualify B) The interview is scheduled  
C) The student qualifies D) The documents are verified

35. Given that the fee voucher is not issued, which earlier condition must be false?

- A) The documents are verified B) The admission file opens  
C) The student qualifies D) The interview is not scheduled

36. If the student qualifies, which pair must both be true?

- A) The fee voucher is issued and the admission file does not open B) The interview is scheduled and the documents are not verified  
C) The fee voucher is not issued and the final list includes the student D) The fee voucher is issued and the admission file opens

**Analytical Set B7: The family of Tariq and Uzma - Questions 37-40**

Tariq and Uzma are married. Their children are Bilal, a son, and Celia, a daughter. Bilal is married to Dua; their children are Gul, a son, and Haris, a daughter. Celia is married to Fahad; their child is Ilma, a son.

37. How is Uzma related to Haris?

- A) Paternal aunt B) Paternal grandmother  
C) Maternal aunt D) Maternal grandmother

38. What is Celia's relation to Gul?

- A) Maternal aunt B) Niece  
C) Paternal aunt D) Sister-in-law

39. How is Ilma related to Haris?

- A) Uncle B) Nephew  
C) Brother-in-law D) Cousin

40. How is Dua related to Celia?

- A) Mother-in-law B) Paternal aunt  
C) Sister-in-law D) Maternal aunt

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $41 + 6 \times 6 - 10$ .

- A) 67 B) 17  
C) 272 D) 73

42. Find  $9/14 + 12/21$  in simplest form.  
A)  $3/5$  B)  $17/14$   
C)  $1/14$  D)  $51/5$
43. What is 15% of 625?  
A)  $32/5$  B)  $125/3$   
C)  $375/4$  D)  $2125/4$
44. A price of Rs. 1180 is increased by 30%. What is the new price?  
A) Rs. 354 B) Rs. 1210  
C) Rs. 826 D) Rs. 1534
45. Rs. 370 is divided in the ratio 4:6. What is the larger share?  
A) 148 B) 185  
C) 10 D) 222
46. If 6 identical notebooks cost Rs. 606, what will 9 notebooks cost at the same rate?  
A) 909 B) 615  
C) 5454 D) 707
47. Find the arithmetic mean of 56, 62, 68, 74, 80.  
A) 340 B) 68  
C) 62 D) 74
48. A student scores 67 in a 4-credit course and 87 in a 4-credit course. Find the weighted mean.  
A) 308 B) 38.5  
C) 77 D) 77.5
49. A vehicle travels 192 km at a constant speed of 64 km/h. How long does the journey take?  
A) 256 hours B) 128 hours  
C)  $1/3$  hours D) 3 hours
50. Worker A can complete a job in 21 days and Worker B in 41 days. Working together, how many days will they take?  
A) 31 days B)  $62/861$  days  
C)  $861/20$  days D)  $861/62$  days
51. An item costs Rs. 740 and is sold at a profit of 10%. Find the selling price.  
A) Rs. 814 B) Rs. 74  
C) Rs. 666 D) Rs. 750
52. Find the simple interest on Rs. 2700 at 7% per year for 3 years.  
A) Rs. 189 B) Rs. 567  
C) Rs. 81 D) Rs. 3267
53. Solve  $5x + 11 = 111$ .  
A) 100 B)  $100/11$   
C) 20 D) 21
54. What is the larger root of  $x^2 - 27x + 110 = 0$ ?  
A) 5 B) 27  
C) 110 D) 22
55. Find the 15th term of the arithmetic sequence with first term 37 and common difference 4.  
A) 97 B) 89  
C) 615 D) 93
56. If  $19^x = 130321$ , find x.  
A) 4 B) 19  
C) 130321 D) 5
57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 126 cm.  
A) 49896 cm B) 792 cm  
C) 396 cm D) 252 cm
58. Find the distance between (17, 18) and (20, 22).  
A) 7 B) 4  
C) 5 D) 25
59. A bag contains 4 red and 7 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?  
A)  $7/11$  B)  $4/7$   
C)  $1/11$  D)  $4/11$
60. How many different pairs can be selected from 22 people?  
A) 462 B) 24  
C) 22 D) 231

#### SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of carbon has atomic number 6. How many protons does it contain?  
A) 4 B) 7  
C) 5 D) 6
62. Isotopes of the same element have:  
A) the same number of protons but different numbers of neutrons B) different numbers of protons and the same number of neutrons  
C) different atomic numbers and identical mass numbers D) different chemical symbols only
63. What is the maximum number of electrons in the third electron shell according to  $2n^2$ ?  
A) 16 B) 9  
C) 18 D) 20
64. An ionic bond is formed mainly by:  
A) sharing of protons B) transfer of neutrons  
C) equal sharing of electrons only D) transfer of electrons from one atom to another
65. What is the mass of 3 mol of  $\text{H}_2\text{O}$  if its molar mass is  $18 \text{ g mol}^{-1}$ ?  
A) 51 g B) 108 g  
C) 57 g D) 54 g
66. How many moles are present in 54 g of  $\text{H}_2\text{O}$  (molar mass  $18 \text{ g mol}^{-1}$ )?  
A) 3 mol B) 1.5 mol  
C) 54 mol D) 18 mol

67. What is the pH of a solution with  $[H^+] = 1.0 \times 10^{-3} \text{ mol dm}^{-3}$ ?

- A) 2 B) 11  
C) 3 D) 7

68. Oxidation is best described as:

- A) loss of protons B) gain of electrons  
C) gain of neutrons D) loss of electrons

69. Which functional group characterizes an carboxylic acid?

- A) amino group ( $-NH_2$ ) B) carbonyl group within the chain ( $>C=O$ )  
C) terminal carbonyl group ( $-CHO$ ) D) carboxyl group ( $-COOH$ )

70. The standard hydrogen electrode is assigned a potential of:

- A) 14.00 V B) 0.50 V  
C) 0.00 V D) -1.00 V

## SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. Which of the following is an SI base quantity?

- A) Energy B) Pressure  
C) Force D) Mass

72. A vehicle travels 45 m in 3 s at constant speed. What is its speed?

- A) 15 m/s B) 17 m/s  
C) 48 m/s D) 3/45 m/s

73. What force is required to accelerate a 6 kg mass at  $4 \text{ m/s}^2$ ?

- A) 1.50 N B) 10 N  
C) 24 N D) 12 N

74. Find the kinetic energy of a 4 kg object moving at 3 m/s.

- A) 21 J B) 36 J  
C) 7 J D) 18 J

75. What is the momentum of a 4 kg object moving at 7 m/s?

- A) 11 kg·m/s B) 28 kg·m/s  
C) 1.75 kg·m/s D) 14 kg·m/s

76. A sample has mass 21 kg and volume  $3 \text{ m}^3$ . What is its density?

- A) 63 kg/m<sup>3</sup> B) 18 kg/m<sup>3</sup>  
C) 7 kg/m<sup>3</sup> D) 0.14 kg/m<sup>3</sup>

77. A force of 180 N acts uniformly over an area of  $2 \text{ m}^2$ . What pressure is produced?

- A) 92 Pa B) 90 Pa  
C) 180 Pa D) 0.01 Pa

78. An electrical device operates at 6 V and draws 2 A. What is its power?

- A) 0.33 W B) 3.00 W  
C) 14 W D) 12 W

79. A wave has frequency 5 Hz and wavelength 3 m. What is its speed?

- A) 15 m/s B) 8 m/s  
C) 1.67 m/s D) 20 m/s

80. The SI unit of frequency is the:

- A) newton B) coulomb  
C) joule D) hertz

## SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. Solve  $3x + 10 = 28$ .

- A) 18 B) 7  
C) 28/3 D) 6

82. What is the larger root of  $x^2 - 9x + 14 = 0$ ?

- A) 7 B) 14  
C) -7 D) 2

83. If  $\log_2 16 = x$ , find x.

- A) 2 B) 16  
C) 3 D) 4

84. y varies directly as x. If y = 9 when x = 3, find y when x = 5.

- A) 11 B) 45  
C) 14 D) 15

85. Find the midpoint of the segment joining (1, 4) and (7, 8).

- A) (4, 6) B) (3, 7)  
C) (4, 7) D) (7, 8)

86. Find the distance between (0, 2) and (9, 14).

- A) 9 B) 15  
C) 12 D) 225

87. Find the area of a triangle with base 14 cm and perpendicular height 5 cm.

- A) 35 cm<sup>2</sup> B) 19 cm<sup>2</sup>  
C) 38 cm<sup>2</sup> D) 70 cm<sup>2</sup>

88. How many different pairs can be selected from 12 people?

- A) 14 B) 12  
C) 78 D) 66

89. What is  $\tan 45^\circ$ ?

- A) 1/2 B) 0  
C) 1 D) Undefined

90. Find the determinant of the matrix  $\begin{bmatrix} 4 & 1 \\ 4 & 4 \end{bmatrix}$ .

- A) 20 B) 13  
C) 12 D) 8

**ANSWER KEY - PRE ENGINEERING MODEL PAPER 7***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. A  | 3. B  | 4. D  | 5. D  | 6. D  | 7. C  | 8. D  | 9. A  | 10. C |
| 11. C | 12. A | 13. C | 14. D | 15. C | 16. A | 17. C | 18. B | 19. D | 20. D |
| 21. C | 22. B | 23. D | 24. B | 25. D | 26. D | 27. D | 28. D | 29. B | 30. D |
| 31. D | 32. C | 33. A | 34. A | 35. D | 36. D | 37. B | 38. C | 39. D | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. A | 63. C | 64. D | 65. D | 66. A | 67. C | 68. D | 69. D | 70. C |
| 71. D | 72. A | 73. C | 74. D | 75. B | 76. C | 77. B | 78. D | 79. A | 80. D |
| 81. D | 82. A | 83. D | 84. D | 85. A | 86. B | 87. A | 88. D | 89. C | 90. C |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |

**PRE-ENGINEERING - MODEL PAPER 8**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 8

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) is    B) were  
C) be    D) are

2. At present, the candidates \_\_\_\_ for the test.

- A) are preparing    B) prepared  
C) is preparing    D) were prepare

3. Ayesha \_\_\_\_ the safety checklist already.

- A) have completed    B) has completed  
C) had complete    D) completed yesterday

4. By the time the supervisor arrived, Hamza \_\_\_\_ the laboratory record.

- A) checks    B) had checked  
C) has checked    D) was check

5. By next Friday, the team \_\_\_\_ the safety checklist.

- A) would complete    B) will have completed  
C) has completed    D) will completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) were being    B) are  
C) have    D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) have    B) has  
C) are having    D) do

8. Each of the candidates \_\_\_\_ an admit card.

- A) possess    B) are having  
C) were given by    D) has

9. There \_\_\_\_ several reasons for the delay.

- A) be    B) was  
C) is    D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boiled    B) will boil always  
C) would boil    D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play    B) had played  
C) played    D) will play

12. If I knew the answer, I \_\_\_\_ Ayesha.

- A) will tell    B) would tell  
C) had told    D) would have told

13. If they had left earlier, they \_\_\_\_ the train.

- A) will catch    B) would catch  
C) would have caught    D) had caught

14. Choose the correct passive form: "The technician checks the safety checklist."

- A) The safety checklist has checked by the technician.    B) The safety checklist will be checked by the technician.  
C) The safety checklist is checked by the technician.    D) The safety checklist was checked by the technician.

15. Choose the correct passive form: "The technician is checking the laboratory record."

- A) The laboratory record is been checked by the technician.    B) The laboratory record is checked by the technician.  
C) The laboratory record was being checked by the technician.    D) The laboratory record is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the safety checklist."

- A) The safety checklist has processed by the clerk.    B) The safety checklist was processed by the clerk.  
C) The safety checklist was being processed by the clerk.    D) The safety checklist is processed by the clerk.

17. Choose the correct passive form: "The committee has approved the laboratory record."

- A) The laboratory record is approved by the committee.    B) The laboratory record had approved by the committee.  
C) The laboratory record has being approved by the committee.    D) The laboratory record has been approved by the committee.

18. Choose the correct passive form: "The office will issue the safety checklist."

- A) The safety checklist is issued by the office.    B) The safety checklist would be issued by the office.  
C) The safety checklist will be issued by the office.    D) The safety checklist will have issued by the office.

19. Select the correct indirect form: Ayesha said, "I will complete the safety checklist."

- A) Ayesha said that she will complete the safety checklist.    B) Ayesha said that she had complete the safety checklist.  
C) Ayesha said that she would complete the safety checklist.    D) Ayesha said that I would complete the safety checklist.

20. Select the correct indirect form: Hamza said, "I am checking the laboratory record."

- A) Hamza told that he was checking the laboratory record.    B) Hamza said that he is checking the laboratory record.  
C) Hamza said that he was checking the laboratory record.    D) Hamza said that I was checking the laboratory record.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L8: 8 candidates in a straight row - Questions 21-24**

8 candidates—Parveen, Vania, Umar, Tania, Owais, Qadir, Saad, and Rida—sit in a straight row, all facing north. 1. Parveen is at the extreme left. 2. Rida is at the extreme right. 3. Umar occupies the third seat. 4. Vania sits immediately left of Umar. 5. Tania sits immediately right of Umar. 6. Qadir is third from the right. 7. Owais is immediately left of Qadir. 8. Saad is immediately right of Qadir.

21. Which pair is seated next to each other?

- A) Parveen and Umar    B) Parveen and Qadir  
C) Umar and Tania    D) Umar and Rida

22. Who is farthest from Parveen?

- A) Owais B) Qadir  
C) Saad D) Rida

23. How many seats lie strictly between Umar and Rida?

- A) 4 B) 1  
C) 2 D) 0

24. If Rida moves to the left end and everyone else shifts one seat right, who becomes fourth from the left?

- A) Umar B) Rida  
C) Saad D) Parveen

**Analytical Set C8: 6 participants around a round table - Questions 25-28**

6 participants—Rania, Qais, Shah, Pina, Talia, and Omar—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Rania occupies the top seat. 2. Qais sits immediately clockwise of Rania. 3. Shah sits immediately clockwise of Qais. 4. Pina sits directly opposite Rania. 5. Talia sits immediately clockwise of Pina. 6. Omar sits immediately clockwise of Talia.

25. Who is the clockwise neighbour of Talia?

- A) Shah B) Rania  
C) Talia D) Omar

26. Which person is separated from Pina by exactly half the circle?

- A) Rania B) Talia  
C) Qais D) Pina

27. With everyone facing inward, who is on the immediate right of Qais?

- A) Rania B) Omar  
C) Shah D) Pina

28. If the clockwise order is reversed while the top person remains fixed, who becomes third clockwise from the top?

- A) Rania B) Talia  
C) Shah D) Qais

**Analytical Set S8: 6 presentations in fixed slots - Questions 29-32**

The following 6 presentations are assigned one per slot: Karachi, Peshawar, Multan, Lahore, Rawalpindi, and Quetta. 1. Karachi is scheduled in 8:00 a.m.. 2. Quetta is scheduled in 1:00 p.m.. 3. Peshawar occurs immediately after Karachi. 4. Lahore occurs immediately after Multan. 5. Rawalpindi is between Lahore and Quetta, consecutive with both.

29. Identify the slot assigned to Peshawar.

- A) 10:00 a.m. B) 9:00 a.m.  
C) 11:00 a.m. D) 12:00 noon

30. Which activity closes the schedule?

- A) Multan B) Quetta  
C) Lahore D) Rawalpindi

31. Which activity falls between Peshawar and Lahore?

- A) Peshawar B) Lahore  
C) Karachi D) Multan

32. If the final three activities are conducted in reverse order, which activity becomes second-last?

- A) Rawalpindi B) Lahore  
C) Peshawar D) Multan

**Analytical Set D8: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the server starts, then the network connects. 2. If the network connects, then the server starts. 3. If the network connects, then the database loads. 4. If the database loads, then the dashboard does not appear. 5. If maintenance mode is active, then the dashboard appears. 6. If the warning lamp glows, then maintenance mode is active.

33. If the server starts, which statement must be true?

- A) The warning lamp glows B) The network does not connect  
C) The dashboard does not appear D) Maintenance mode is active

34. Assume the dashboard appears. Which condition must fail?

- A) The server does not start B) The server starts  
C) Maintenance mode is active D) The network connects

35. What follows necessarily when the warning lamp glows?

- A) The dashboard appears B) The database loads  
C) The dashboard does not appear D) The server starts

36. Which pair is logically incompatible?

- A) The server starts and the network connects B) The server starts and the database loads  
C) The network connects and maintenance mode is active D) The dashboard appears and maintenance mode is active

**Analytical Set B8: The family of Waseem and Yasmeen - Questions 37-40**

Waseem and Yasmeen are married. Their children are Kamran, a son, and Laraib, a daughter. Kamran is married to Maha; their children are Omaira, a son, and Parsa, a daughter. Laraib is married to Nabeel; their child is Qadir, a son.

37. How is Yasmeen related to Parsa?

- A) Paternal grandmother B) Mother-in-law  
C) Paternal aunt D) Maternal aunt

38. What is Laraib's relation to Omaira?

- A) Niece B) Paternal aunt  
C) Sister-in-law D) Sister

39. How is Qadir related to Parsa?

- A) Cousin B) Brother-in-law  
C) Sibling D) Uncle

40. How is Maha related to Laraib?

- A) Maternal aunt B) Paternal aunt  
C) Sister-in-law D) Cousin

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $43 + 7 \times 7 - 2$ .

- A) 90 B) 78  
C) 348 D) 97



42. Find  $9/15 + 7/13$  in simplest form.

- A)  $4/7$  B)  $74/65$   
C)  $4/65$  D)  $16/195$

43. What is 20% of 650?

- A)  $67/10$  B)  $65/2$   
C) 130 D) 520

44. A price of Rs. 1220 is increased by 5%. What is the new price?

- A) Rs. 61 B) Rs. 1225  
C) Rs. 1159 D) Rs. 1281

45. Rs. 494 is divided in the ratio 5:8. What is the larger share?

- A) 190 B) 247  
C) 13 D) 304

46. If 7 identical notebooks cost Rs. 728, what will 11 notebooks cost at the same rate?

- A) 1144 B) 739  
C) 8008 D) 832

47. Find the arithmetic mean of 59, 60, 61, 62, 63.

- A) 305 B) 61  
C) 60 D) 62

48. A student scores 68 in a 2-credit course and 88 in a 5-credit course. Find the weighted mean.

- A) 78 B) 288  
C) 82.29 D) 57.6

49. A vehicle travels 264 km at a constant speed of 66 km/h. How long does the journey take?

- A) 330 hours B) 198 hours  
C)  $1/4$  hours D) 4 hours

50. Worker A can complete a job in 22 days and Worker B in 43 days. Working together, how many days will they take?

- A)  $65/2$  days B)  $65/946$  days  
C)  $946/21$  days D)  $946/65$  days

51. An item costs Rs. 760 and is sold at a profit of 15%. Find the selling price.

- A) Rs. 874 B) Rs. 114  
C) Rs. 646 D) Rs. 775

52. Find the simple interest on Rs. 2800 at 8% per year for 4 years.

- A) Rs. 224 B) Rs. 896  
C) Rs. 112 D) Rs. 3696

53. Solve  $6x + 12 = 138$ .

- A) 126 B)  $21/2$   
C) 21 D) 22

54. What is the larger root of  $x^2 - 29x + 138 = 0$ ?

- A) 6 B) 29  
C) 138 D) 23

55. Find the 16th term of the arithmetic sequence with first term 39 and common difference 5.

- A) 119 B) 109  
C) 704 D) 114

56. If  $20^x = 400$ , find x.

- A) 2 B) 20  
C) 400 D) 3

57. Find the area of a rectangle of length 26 cm and width 7 cm.

- A)  $66 \text{ cm}^2$  B)  $182 \text{ cm}^2$   
C)  $33 \text{ cm}^2$  D)  $364 \text{ cm}^2$

58. Find the slope of the line through (18, 20) and (22, 28).

- A)  $1/2$  B) 8  
C) 2 D) 4

59. A bag contains 5 red and 8 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $8/13$  B)  $5/8$   
C)  $1/13$  D)  $5/13$

60. How many different pairs can be selected from 23 people?

- A) 506 B) 25  
C) 23 D) 253

#### SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of oxygen has atomic number 8. How many protons does it contain?

- A) 16 B) 7  
C) 8 D) 6

62. Isotopes of the same element have:

- A) the same number of protons but different numbers of neutrons B) different chemical symbols only  
C) different atomic numbers and identical mass numbers D) different numbers of protons and the same number of neutrons

63. What is the maximum number of electrons in the fourth electron shell according to  $2n^2$ ?

- A) 34 B) 30  
C) 16 D) 32

64. An ionic bond is formed mainly by:

- A) equal sharing of electrons only B) transfer of electrons from one atom to another  
C) sharing of protons D) transfer of neutrons

65. What is the mass of 4 mol of  $\text{CO}_2$  if its molar mass is  $44 \text{ g mol}^{-1}$ ?

- A) 180 g B) 176 g  
C) 352 g D) 172 g

66. How many moles are present in 176 g of  $\text{CO}_2$  (molar mass  $44 \text{ g mol}^{-1}$ )?

- A) 5 mol B) 4 mol  
C) 2 mol D) 44 mol



67. A solution contains 2 mol of solute in 3 dm<sup>3</sup>. What is its concentration?

- A) 6 mol dm<sup>-3</sup> B) 1.66667 mol dm<sup>-3</sup>  
C) 0.666667 mol dm<sup>-3</sup> D) 5 mol dm<sup>-3</sup>

68. What is the pH of a solution with  $[H^+] = 1.0 \times 10^{-4}$  mol dm<sup>-3</sup>?

- A) 5 B) 10  
C) 7 D) 4

69. Oxidation is best described as:

- A) loss of protons B) no change in oxidation state  
C) gain of electrons D) loss of electrons

70. Which functional group characterizes an aldehyde?

- A) hydroxyl group (-OH) B) carbonyl group within the chain (>C=O)  
C) amino group (-NH<sub>2</sub>) D) terminal carbonyl group (-CHO)

## SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. A vehicle travels 64 m in 4 s at constant speed. What is its speed?

- A) 68 m/s B) 4/64 m/s  
C) 64 m/s D) 16 m/s

72. What force is required to accelerate a 7 kg mass at 5 m/s<sup>2</sup>?

- A) 12 N B) 35 N  
C) 17.5 N D) 1.40 N

73. Find the kinetic energy of a 6 kg object moving at 4 m/s.

- A) 48 J B) 52 J  
C) 24 J D) 96 J

74. What is the momentum of a 5 kg object moving at 8 m/s?

- A) 1.60 kg·m/s B) 320 kg·m/s  
C) 13 kg·m/s D) 40 kg·m/s

75. A sample has mass 32 kg and volume 4 m<sup>3</sup>. What is its density?

- A) 9 kg/m<sup>3</sup> B) 0.12 kg/m<sup>3</sup>  
C) 128 kg/m<sup>3</sup> D) 8 kg/m<sup>3</sup>

76. A force of 300 N acts uniformly over an area of 3 m<sup>2</sup>. What pressure is produced?

- A) 103 Pa B) 0.01 Pa  
C) 900 Pa D) 100 Pa

77. A resistor of 8 Ω carries a current of 4 A. What potential difference is across it?

- A) 32 V B) 40 V  
C) 2.00 V D) 12 V

78. An electrical device operates at 8 V and draws 3 A. What is its power?

- A) 11 W B) 0.38 W  
C) 24 W D) 2.67 W

79. A wave has frequency 6 Hz and wavelength 4 m. What is its speed?

- A) 24 m/s B) 1.50 m/s  
C) 30 m/s D) 10 m/s

80. A convex lens can form a real image when the object is:

- A) at infinity only B) outside its focal point  
C) at the optical centre only D) behind the lens

## SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. What is the larger root of  $x^2 - 12x + 27 = 0$ ?

- A) -9 B) 27  
C) 12 D) 9

82. If  $\log_3 243 = x$ , find  $x$ .

- A) 6 B) 3  
C) 4 D) 5

83.  $y$  varies directly as  $x$ . If  $y = 16$  when  $x = 4$ , find  $y$  when  $x = 6$ .

- A) 10 B) 24  
C) 96 D) 22

84. Find the slope of the line through (4, 4) and (7, 16).

- A)  $\frac{1}{4}$  B) 3  
C) 4 D) 13

85. Find the midpoint of the segment joining (2, 5) and (8, 9).

- A) (4, 8) B) (8, 9)  
C) (5, 7) D) (5, 8)

86. Find the distance between (1, 3) and (13, 19).

- A) 21 B) 12  
C) 16 D) 20

87. Find the area of a triangle with base 15 cm and perpendicular height 6 cm.

- A) 42 cm<sup>2</sup> B) 90 cm<sup>2</sup>  
C) 21 cm<sup>2</sup> D) 45 cm<sup>2</sup>

88. How many different pairs can be selected from 13 people?

- A) 91 B) 13  
C) 156 D) 78

89. What is  $\sin 90^\circ$ ?

- A) 1 B) 0  
C)  $\frac{\sqrt{2}}{2}$  D)  $\frac{1}{2}$

90. Find the determinant of the matrix  $\begin{bmatrix} 5 & 2 \\ 5 & 5 \end{bmatrix}$ .

- A) 35 B) -15  
C) 10 D) 15

**ANSWER KEY - PRE ENGINEERING MODEL PAPER 8***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. A  | 2. A  | 3. B  | 4. B  | 5. B  | 6. D  | 7. B  | 8. D  | 9. D  | 10. D |
| 11. D | 12. B | 13. C | 14. C | 15. D | 16. B | 17. D | 18. C | 19. C | 20. C |
| 21. C | 22. D | 23. A | 24. A | 25. D | 26. A | 27. A | 28. B | 29. B | 30. B |
| 31. D | 32. A | 33. C | 34. A | 35. A | 36. C | 37. A | 38. B | 39. A | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. A | 63. D | 64. B | 65. B | 66. B | 67. C | 68. D | 69. D | 70. D |
| 71. D | 72. B | 73. A | 74. D | 75. D | 76. D | 77. A | 78. C | 79. A | 80. B |
| 81. D | 82. D | 83. B | 84. C | 85. C | 86. D | 87. D | 88. D | 89. A | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |

**PRE-ENGINEERING - MODEL PAPER 9**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 9

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) be B) are  
C) have D) is

2. At present, the researchers \_\_\_\_ for the test.

- A) have prepare B) is preparing  
C) were prepare D) are preparing

3. Ali \_\_\_\_ the library record already.

- A) has completed B) have completed  
C) completed yesterday D) is completing since Monday

4. By the time the supervisor arrived, Hira \_\_\_\_ the presentation.

- A) had checked B) has checked  
C) was check D) checks

5. By next Friday, the team \_\_\_\_ the library record.

- A) will completed B) will have completed  
C) would complete D) had completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) have  
C) be D) are

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) were B) do  
C) have D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) were given by B) has  
C) are having D) have

9. There \_\_\_\_ several reasons for the delay.

- A) is B) was  
C) has D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) will boil always  
C) boiled D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play B) played  
C) would have played D) will play

12. If I knew the answer, I \_\_\_\_ Ali.

- A) will tell B) would tell  
C) told D) would have told

13. If they had left earlier, they \_\_\_\_ the train.

- A) would have caught B) had caught  
C) will catch D) would catch

14. Choose the correct passive form: "The technician checks the library record."

- A) The library record was checked by the technician. B) The library record is being checked by the technician.  
C) The library record is checked by the technician. D) The library record will be checked by the technician.

15. Choose the correct passive form: "The technician is checking the presentation."

- A) The presentation is being checked by the technician. B) The presentation is been checked by the technician.  
C) The presentation has been checked by the technician. D) The presentation was being checked by the technician.

16. Choose the correct passive form: "The clerk processed the library record."

- A) The library record has processed by the clerk. B) The library record will be processed by the clerk.  
C) The library record was being processed by the clerk. D) The library record was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the presentation."

- A) The presentation has been approved by the committee. B) The presentation has being approved by the committee.  
C) The presentation was approved by the committee. D) The presentation had approved by the committee.

18. Choose the correct passive form: "The office will issue the library record."

- A) The library record will be issued by the office. B) The library record will issued by the office.  
C) The library record would be issued by the office. D) The library record is issued by the office.

19. Select the correct indirect form: Ali said, "I will complete the library record."

- A) Ali said that he had complete the library record. B) Ali said that he would complete the library record.  
C) Ali told that the library record would complete. D) Ali said that he will complete the library record.

20. Select the correct indirect form: Hira said, "I am checking the presentation."

- A) Hira said that she was checking the presentation. B) Hira told that she was checking the presentation.  
C) Hira said that she had checked the presentation. D) Hira said that she is checking the presentation.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L9: 6 candidates in a straight row - Questions 21-24**

6 candidates—Basit, Zain, Celia, Waleed, Areeba, and Yusra—sit in a straight row, all facing north. 1. Basit occupies the extreme left seat. 2. Yusra sits at the extreme right. 3. Zain is immediately to the right of Basit. 4. Waleed sits immediately to the right of Celia. 5. Areeba sits between Waleed and Yusra, adjacent to both.

21. Identify the person sitting in seat 5.

- A) Celia B) Areeba  
C) Basit D) Yusra

22. Who is the immediate left neighbour of Areeba?

- A) Yusra B) Celia  
C) Areeba D) Waleed

23. Which pair is NOT seated adjacently?

- A) Zain and Celia B) Basit and Zain  
C) Waleed and Areeba D) Basit and Celia

24. If the entire row is viewed from the opposite end, who appears third from the left?

- A) Yusra B) Waleed  
C) Basit D) Celia

**Analytical Set C9: 8 participants around a round table - Questions 25-28**

8 participants—Vania, Waseem, Adil, Zainab, Ubaid, Yara, Cyrus, and Bisma—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Vania sits at the top. 2. Bisma is immediately anticlockwise from Vania. 3. Cyrus is immediately anticlockwise from Bisma. 4. Ubaid is opposite Vania. 5. Zainab is immediately anticlockwise from Ubaid. 6. Adil is immediately anticlockwise from Zainab. 7. Waseem sits between Vania and Adil, adjacent to both. 8. Yara is immediately clockwise from Ubaid.

25. Who sits one place clockwise from Vania?

- A) Adil B) Bisma  
C) Waseem D) Cyrus

26. For Set C9, which pair sits opposite each other?

- A) Zainab and Cyrus B) Adil and Cyrus  
C) Waseem and Bisma D) Ubaid and Bisma

27. Who sits immediately clockwise of Bisma, crossing the top position?

- A) Bisma B) Yara  
C) Vania D) Cyrus

28. If all participants face outward, who is immediately to the right of Adil?

- A) Zainab B) Cyrus  
C) Bisma D) Yara

**Analytical Set S9: 7 classes in fixed slots - Questions 29-32**

The following 7 classes are assigned one per slot: Physics, Calculus, Aptitude, Writing, Logic, Grammar, and Vocabulary. 1. Writing is scheduled in the middle slot, Period 4. 2. Physics opens the schedule. 3. Vocabulary closes the schedule. 4. Calculus immediately follows Physics. 5. Aptitude immediately precedes Writing. 6. Logic immediately follows Writing. 7. Grammar immediately precedes Vocabulary.

29. What is scheduled during Period 5?

- A) Writing B) Aptitude  
C) Logic D) Physics

30. Which activity directly precedes Logic?

- A) Physics B) Grammar  
C) Aptitude D) Writing

31. How many activities are scheduled between Physics and Writing?

- A) 3 B) 2  
C) 0 D) 1

32. If the opening activity is shifted to the end and all others move one slot earlier, which activity is last?

- A) Calculus B) Grammar  
C) Physics D) Vocabulary

**Analytical Set D9: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the train departs, then the signal turns green. 2. If the crossing closes, then the signal turns green. 3. If the signal turns green, then the platform announcement plays. 4. If the platform announcement does not play, then an obstruction is detected. 5. If an obstruction is detected, then the alarm sounds.

33. Which result is forced if the train departs?

- A) The signal does not turn green B) An obstruction is detected  
C) The alarm sounds D) The platform announcement plays

34. If the platform announcement does not play, which pair of statements must both be true?

- A) The train does not depart and the crossing does not close B) The train departs and the crossing closes  
C) The crossing closes and the alarm sounds D) The signal turns green and an obstruction is detected

35. If the signal does not turn green, which conclusion follows immediately?

- A) An obstruction is detected B) The train does not depart  
C) The platform announcement plays D) The crossing closes

36. Suppose an obstruction is detected. What must occur next in the implication chain?

- A) The signal turns green B) The platform announcement plays  
C) The crossing closes D) The alarm sounds

**Analytical Set B9: The family of Zubair and Afsheen - Questions 37-40**

Zubair and Afsheen are married. Their children are Rameez, a son, and Sonia, a daughter. Rameez is married to Tuba; their children are Vania, a son, and Wajid, a daughter. Sonia is married to Usman; their child is Yumna, a son.

37. How is Afsheen related to Wajid?

- A) Paternal aunt B) Mother-in-law  
C) Maternal aunt D) Paternal grandmother

38. What is Sonia's relation to Vania?

- A) Niece B) Maternal aunt  
C) Sister-in-law D) Paternal aunt

39. How is Yumna related to Wajid?

- A) Sibling B) Uncle  
C) Brother-in-law D) Cousin

40. How is Tuba related to Sonia?

- A) Paternal aunt B) Cousin  
C) Maternal aunt D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $45 + 8 \times 8 - 3$ .

- A) 106 B) 85  
C) 421 D) 114

42. Find  $9/16 + 6/14$  in simplest form.

- A)  $1/2$  B)  $111/112$   
C)  $15/112$  D)  $15/224$

43. What is 25% of 675?

- A) 7 B) 27  
C)  $675/4$  D)  $2025/4$

44. A price of Rs. 1260 is increased by 10%. What is the new price?

- A) Rs. 126 B) Rs. 1270  
C) Rs. 1134 D) Rs. 1386

45. Rs. 624 is divided in the ratio 6:10. What is the larger share?

- A) 234 B) 312  
C) 16 D) 390

46. If 8 identical notebooks cost Rs. 856, what will 13 notebooks cost at the same rate?

- A) 1391 B) 869  
C) 11128 D) 963

47. Find the arithmetic mean of 62, 64, 66, 68, 70.

- A) 330 B) 66  
C) 64 D) 68

48. A student scores 69 in a 3-credit course and 89 in a 6-credit course. Find the weighted mean.

- A) 79 B) 370.5  
C) 82.33 D) 41.17

49. A vehicle travels 340 km at a constant speed of 68 km/h. How long does the journey take?

- A) 408 hours B) 272 hours  
C)  $1/5$  hours D) 5 hours

50. Worker A can complete a job in 23 days and Worker B in 45 days. Working together, how many days will they take?

- A) 34 days B)  $68/1035$  days  
C)  $1035/22$  days D)  $1035/68$  days

51. An item costs Rs. 780 and is sold at a profit of 20%. Find the selling price.

- A) Rs. 936 B) Rs. 156  
C) Rs. 624 D) Rs. 800

52. Find the simple interest on Rs. 2900 at 9% per year for 5 years.

- A) Rs. 261 B) Rs. 1305  
C) Rs. 145 D) Rs. 4205

53. Solve  $7x + 13 = 167$ .

- A) 154 B)  $154/13$   
C) 22 D) 23

54. What is the larger root of  $x^2 - 31x + 168 = 0$ ?

- A) 7 B) 31  
C) 168 D) 24

55. Find the 17th term of the arithmetic sequence with first term 41 and common difference 6.

- A) 143 B) 131  
C) 799 D) 137

56. If  $21^x = 9261$ , find x.

- A) 3 B) 21  
C) 9261 D) 4

57. Find the area of a triangle with base 29 cm and height 5 cm.

- A)  $145 \text{ cm}^2$  B)  $145/2 \text{ cm}^2$   
C)  $34 \text{ cm}^2$  D)  $145/4 \text{ cm}^2$

58. Find the midpoint of the segment joining (19, 21) and (25, 29).

- A) (6, 8) B) (44, 50)  
C) (22, 25) D) (3, 4)

59. A bag contains 6 red and 9 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $3/5$  B)  $2/3$   
C)  $1/15$  D)  $2/5$

60. How many different pairs can be selected from 24 people?

- A) 552 B) 26  
C) 24 D) 276

#### SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of sodium has atomic number 11. How many protons does it contain?

- A) 22 B) 11  
C) 10 D) 12

62. Isotopes of the same element have:

- A) different chemical symbols only B) the same numbers of protons and neutrons  
C) the same number of protons but different numbers of neutrons D) different numbers of protons and the same number of neutrons

63. What is the maximum number of electrons in the second electron shell according to  $2n^2$ ?

- A) 8 B) 4  
C) 10 D) 6

64. An ionic bond is formed mainly by:

- A) overlap without electron involvement B) transfer of electrons from one atom to another  
C) sharing of protons D) equal sharing of electrons only

65. What is the mass of 2 mol of NaOH if its molar mass is  $40 \text{ g mol}^{-1}$ ?

- A) 82 g B) 160 g  
C) 78 g D) 80 g

66. How many moles are present in 80 g of NaOH (molar mass  $40 \text{ g mol}^{-1}$ )?

- A) 80 mol B) 3 mol  
C) 1 mol D) 2 mol

67. A solution contains 3 mol of solute in 4 dm<sup>3</sup>. What is its concentration?

- A) 1.75 mol dm<sup>-3</sup> B) 12 mol dm<sup>-3</sup>  
C) 7 mol dm<sup>-3</sup> D) 0.75 mol dm<sup>-3</sup>

68. What is the pH of a solution with  $[H^+] = 1.0 \times 10^{-5}$  mol dm<sup>-3</sup>?

- A) 6 B) 5  
C) 9 D) 7

69. Oxidation is best described as:

- A) gain of electrons B) no change in oxidation state  
C) loss of protons D) loss of electrons

70. Which functional group characterizes an ketone?

- A) hydroxyl group (-OH) B) carboxyl group (-COOH)  
C) carbonyl group within the chain (>C=O) D) terminal carbonyl group (-CHO)

## SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. Which of the following is an SI base quantity?

- A) Force B) Mass  
C) Energy D) Power

72. A vehicle travels 85 m in 5 s at constant speed. What is its speed?

- A) 90 m/s B) 19 m/s  
C) 17 m/s D) 5/85 m/s

73. What force is required to accelerate a 2 kg mass at 6 m/s<sup>2</sup>?

- A) 8 N B) 0.33 N  
C) 6 N D) 12 N

74. Find the kinetic energy of a 8 kg object moving at 5 m/s.

- A) 105 J B) 40 J  
C) 200 J D) 100 J

75. A sample has mass 15 kg and volume 5 m<sup>3</sup>. What is its density?

- A) 75 kg/m<sup>3</sup> B) 4 kg/m<sup>3</sup>  
C) 10 kg/m<sup>3</sup> D) 3 kg/m<sup>3</sup>

76. A force of 200 N acts uniformly over an area of 4 m<sup>2</sup>. What pressure is produced?

- A) 0.02 Pa B) 54 Pa  
C) 200 Pa D) 50 Pa

77. A resistor of 3  $\Omega$  carries a current of 5 A. What potential difference is across it?

- A) 8 V B) 1.67 V  
C) 15 V D) 0.60 V

78. An electrical device operates at 10 V and draws 4 A. What is its power?

- A) 40 W B) 14 W  
C) 2.50 W D) 44 W

79. A wave has frequency 7 Hz and wavelength 5 m. What is its speed?

- A) 35 m/s B) 0.71 m/s  
C) 42 m/s D) 1.40 m/s

80. The direction of conventional current is taken as the direction of motion of:

- A) neutrons B) photons  
C) atoms D) positive charge

## SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. What is the larger root of  $x^2 - 11x + 28 = 0$ ?

- A) -7 B) 7  
C) 28 D) 4

82. Find the 6th term of the geometric sequence with first term 4 and common ratio 2.

- A) 48 B) 130  
C) 256 D) 128

83. If  $\log_5 25 = x$ , find x.

- A) 2 B) 25  
C) 5 D) 1

84. y varies directly as x. If y = 25 when x = 5, find y when x = 7.

- A) 32 B) 175  
C) 12 D) 35

85. Find the distance between (2, 0) and (5, 4).

- A) 4 B) 25  
C) 3 D) 5

86. Find the area of a triangle with base 8 cm and perpendicular height 7 cm.

- A) 15 cm<sup>2</sup> B) 14 cm<sup>2</sup>  
C) 28 cm<sup>2</sup> D) 56 cm<sup>2</sup>

87. A bag contains 5 red and 6 blue balls. One ball is selected at random. What is P(red)?

- A) 6/11 B) 11/5  
C) 5/6 D) 5/11

88. How many different pairs can be selected from 6 people?

- A) 6 B) 21  
C) 30 D) 15

89. What is  $\sin 30^\circ$ ?

- A)  $\sqrt{2}/2$  B) 0  
C)  $\sqrt{3}/2$  D)  $1/2$

90. Find the determinant of the matrix  $\begin{bmatrix} 2 & 3 \\ 6 & 2 \end{bmatrix}$ .

- A) -14 B) 14  
C) -13 D) 22

**ANSWER KEY - PRE ENGINEERING MODEL PAPER 9***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. D  | 3. A  | 4. A  | 5. B  | 6. A  | 7. D  | 8. B  | 9. D  | 10. D |
| 11. D | 12. B | 13. A | 14. C | 15. A | 16. D | 17. A | 18. A | 19. B | 20. A |
| 21. B | 22. D | 23. D | 24. B | 25. C | 26. B | 27. C | 28. A | 29. C | 30. D |
| 31. B | 32. C | 33. D | 34. A | 35. B | 36. D | 37. D | 38. D | 39. D | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. C | 63. A | 64. B | 65. D | 66. D | 67. D | 68. B | 69. D | 70. C |
| 71. B | 72. C | 73. D | 74. D | 75. D | 76. D | 77. C | 78. A | 79. A | 80. D |
| 81. B | 82. D | 83. A | 84. D | 85. D | 86. C | 87. D | 88. D | 89. D | 90. A |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |

**PRE-ENGINEERING - MODEL PAPER 10**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: Pre-Engineering 10

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) are B) have  
C) be D) is

2. At present, the workers \_\_\_\_ for the test.

- A) have prepare B) prepared  
C) is preparing D) are preparing

3. Sara \_\_\_\_ the workshop plan already.

- A) is completing since Monday B) have completed  
C) completed yesterday D) has completed

4. By the time the supervisor arrived, Ahmed \_\_\_\_ the survey form.

- A) will have checked B) was check  
C) had checked D) checks

5. By next Friday, the team \_\_\_\_ the workshop plan.

- A) will completed B) has completed  
C) will have completed D) had completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) are B) were being  
C) have D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) do  
C) has D) were

8. Each of the candidates \_\_\_\_ an admit card.

- A) has B) were given by  
C) are having D) possess

9. There \_\_\_\_ several reasons for the delay.

- A) be B) are  
C) has D) was

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boiled B) boils  
C) would have boiled D) will boil always

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play B) had played  
C) played D) will play

12. If I knew the answer, I \_\_\_\_ Sara.

- A) had told B) told  
C) will tell D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) will catch B) caught  
C) had caught D) would have caught

14. Choose the correct passive form: "The technician checks the workshop plan."

- A) The workshop plan was checked by the technician. B) The workshop plan is being checked by the technician.  
C) The workshop plan is checked by the technician. D) The workshop plan has checked by the technician.

15. Choose the correct passive form: "The technician is checking the survey form."

- A) The survey form was being checked by the technician. B) The survey form is been checked by the technician.  
C) The survey form has been checked by the technician. D) The survey form is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the workshop plan."

- A) The workshop plan was being processed by the clerk. B) The workshop plan has processed by the clerk.  
C) The workshop plan is processed by the clerk. D) The workshop plan was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the survey form."

- A) The survey form had approved by the committee. B) The survey form is approved by the committee.  
C) The survey form has being approved by the committee. D) The survey form has been approved by the committee.

18. Choose the correct passive form: "The office will issue the workshop plan."

- A) The workshop plan will have issued by the office. B) The workshop plan would be issued by the office.  
C) The workshop plan is issued by the office. D) The workshop plan will be issued by the office.

19. Select the correct indirect form: Sara said, "I will complete the workshop plan."

- A) Sara said that she had complete the workshop plan. B) Sara told that the workshop plan would complete.  
C) Sara said that she will complete the workshop plan. D) Sara said that she would complete the workshop plan.

20. Select the correct indirect form: Ahmed said, "I am checking the survey form."

- A) Ahmed said that he had checked the survey form. B) Ahmed said that I was checking the survey form.  
C) Ahmed said that he is checking the survey form. D) Ahmed said that he was checking the survey form.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L10: 7 candidates in a straight row - Questions 21-24**

7 candidates—Kashif, Faizan, Hina, Javeria, Esha, Imran, and Daniyal—sit in a straight row, all facing north. 1. Faizan is second from the left. 2. Imran is second from the right. 3. Kashif sits immediately left of Faizan. 4. Hina sits immediately right of Faizan. 5. Javeria occupies the central seat. 6. Esha is immediately right of Javeria. 7. Daniyal is immediately right of Imran.

21. Who occupies the fifth seat from the left?

- A) Esha B) Hina  
C) Imran D) Kashif



22. What is the position of Imran in the row?

- A) First from the left    B) Fifth from the left  
C) Sixth from the left    D) Third from the left

23. Who sits immediately to the left of Javeria?

- A) Hina    B) Imran  
C) Esha    D) Daniyal

24. How many people sit between Faizan and Imran?

- A) 4    B) 1  
C) 2    D) 3

**Analytical Set C10: 6 participants around a round table - Questions 25-28**

6 participants—Haris, Gul, Eman, Fahim, Danish, and Iqra—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Haris occupies the top seat. 2. Gul sits immediately clockwise of Haris. 3. Eman sits immediately clockwise of Gul. 4. Fahim sits directly opposite Haris. 5. Danish sits immediately clockwise of Fahim. 6. Iqra sits immediately clockwise of Danish.

25. Who sits immediately clockwise of Gul?

- A) Gul    B) Danish  
C) Eman    D) Iqra

26. Who sits directly opposite Haris?

- A) Danish    B) Gul  
C) Fahim    D) Haris

27. Who is second clockwise from Iqra?

- A) Gul    B) Iqra  
C) Danish    D) Haris

28. All participants face the centre. Who is immediately to the right of Fahim?

- A) Gul    B) Haris  
C) Danish    D) Eman

**Analytical Set S10: 6 meetings in fixed slots - Questions 29-32**

The following 6 meetings are assigned one per slot: Energy, Data, Budget, Grants, Faculty, and Campus. 1. Energy is scheduled in Monday. 2. Campus is scheduled in Saturday. 3. Data occurs immediately after Energy. 4. Grants occurs immediately after Budget. 5. Faculty is between Grants and Campus, consecutive with both.

29. On which slot is Budget scheduled?

- A) Thursday    B) Tuesday  
C) Wednesday    D) Monday

30. Which activity is scheduled in Friday?

- A) Grants    B) Data  
C) Energy    D) Faculty

31. Which activity occurs immediately before Grants?

- A) Campus    B) Energy  
C) Budget    D) Grants

32. How many complete slots lie between Data and Campus?

- A) 3    B) 1  
C) 0    D) 4

**Analytical Set D10: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the experiment begins, then the heater switches on. 2. If the heater switches on, then the sample does not warm. 3. If the sensor records data, then the sample warms. 4. If the safety lock engages, then the sensor records data. 5. If the technician presses reset, then the experiment begins.

33. If the technician presses reset, which statement is certain?

- A) The experiment does not begin    B) The safety lock engages  
C) The sensor records data    D) The sample does not warm

34. Given that the sample warms, what can be deduced about the last condition?

- A) The heater switches on    B) The technician does not press reset  
C) The sensor records data    D) The experiment begins

35. What must be true when the safety lock engages?

- A) The sample does not warm    B) The heater switches on  
C) The experiment begins    D) The heater does not switch on

36. Which two conditions cannot both hold?

- A) The technician presses reset and the experiment begins    B) The sensor records data and the safety lock engages  
C) The experiment begins and the heater switches on    D) The experiment begins and the sensor records data

**Analytical Set B10: The family of Feroz and Ghazala - Questions 37-40**

Feroz and Ghazala are married. Their children are Hasan, a son, and Inaya, a daughter. Hasan is married to Jalal; their children are Latif, a son, and Maira, a daughter. Inaya is married to Kiran; their child is Noman, a son.

37. How is Ghazala related to Maira?

- A) Paternal aunt    B) Maternal grandmother  
C) Maternal aunt    D) Paternal grandmother

38. What is Inaya's relation to Latif?

- A) Paternal aunt    B) Niece  
C) Maternal aunt    D) Sister

39. How is Noman related to Maira?

- A) Nephew    B) Cousin  
C) Sibling    D) Brother-in-law

40. How is Jalal related to Inaya?

- A) Cousin    B) Paternal aunt  
C) Mother-in-law    D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $47 + 9 \times 4 - 4$ .

- A) 79    B) 47  
C) 220    D) 88

42. Find  $9/17 + 5/15$  in simplest form.

- A)  $7/16$  B)  $44/51$   
C)  $10/51$  D)  $14/255$

43. What is 30% of 700?

- A)  $73/10$  B)  $70/3$   
C) 210 D) 490

44. A price of Rs. 1300 is increased by 15%. What is the new price?

- A) Rs. 195 B) Rs. 1315  
C) Rs. 1105 D) Rs. 1495

45. Rs. 200 is divided in the ratio 2:3. What is the larger share?

- A) 80 B) 100  
C) 5 D) 120

46. If 4 identical notebooks cost Rs. 440, what will 6 notebooks cost at the same rate?

- A) 660 B) 446  
C) 2640 D) 550

47. Find the arithmetic mean of 65, 68, 71, 74, 77.

- A) 355 B) 71  
C) 68 D) 74

48. A student scores 70 in a 4-credit course and 90 in a 3-credit course. Find the weighted mean.

- A) 80 B) 275  
C) 78.57 D) 45.83

49. A vehicle travels 140 km at a constant speed of 70 km/h. How long does the journey take?

- A) 210 hours B) 70 hours  
C)  $1/2$  hours D) 2 hours

50. Worker A can complete a job in 24 days and Worker B in 47 days. Working together, how many days will they take?

- A)  $71/2$  days B)  $71/1128$  days  
C)  $1128/23$  days D)  $1128/71$  days

51. An item costs Rs. 800 and is sold at a profit of 25%. Find the selling price.

- A) Rs. 1000 B) Rs. 200  
C) Rs. 600 D) Rs. 825

52. Find the simple interest on Rs. 3000 at 10% per year for 2 years.

- A) Rs. 300 B) Rs. 600  
C) Rs. 60 D) Rs. 3600

53. Solve  $8x + 14 = 198$ .

- A) 184 B)  $92/7$   
C) 23 D) 24

54. What is the larger root of  $x^2 - 33x + 200 = 0$ ?

- A) 8 B) 33  
C) 200 D) 25

55. Find the 8th term of the arithmetic sequence with first term 43 and common difference 2.

- A) 59 B) 55  
C) 360 D) 57

56. If  $22^x = 234256$ , find x.

- A) 4 B) 22  
C) 234256 D) 5

57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 147 cm.

- A) 67914 cm B) 924 cm  
C) 462 cm D) 294 cm

58. Find the distance between (20, 21) and (23, 25).

- A) 7 B) 4  
C) 5 D) 25

59. A bag contains 7 red and 10 blue balls. One ball is selected at random. What is P(red)?

- A)  $10/17$  B)  $7/10$   
C)  $1/17$  D)  $7/17$

60. How many different pairs can be selected from 25 people?

- A) 600 B) 27  
C) 25 D) 300

#### SECTION IV-A: CHEMISTRY | 10 QUESTIONS | Questions 61-70

61. An atom of magnesium has atomic number 12. How many protons does it contain?

- A) 10 B) 24  
C) 11 D) 12

62. Isotopes of the same element have:

- A) different chemical symbols only B) the same numbers of protons and neutrons  
C) the same number of protons but different numbers of neutrons D) different numbers of protons and the same number of neutrons

63. What is the maximum number of electrons in the third electron shell according to  $2n^2$ ?

- A) 20 B) 10  
C) 9 D) 18

64. An ionic bond is formed mainly by:

- A) equal sharing of electrons only B) transfer of neutrons  
C) overlap without electron involvement D) transfer of electrons from one atom to another

65. What is the mass of 3 mol of NaCl if its molar mass is  $58.5 \text{ g mol}^{-1}$ ?

- A) 175.5 g B) 351 g  
C) 178.5 g D) 172.5 g

66. How many moles are present in 175.5 g of NaCl (molar mass  $58.5 \text{ g mol}^{-1}$ )?

- A) 4 mol B) 1.5 mol  
C) 3 mol D) 175.5 mol

67. A solution contains 4 mol of solute in 5 dm<sup>3</sup>. What is its concentration?

- A) 20 mol dm<sup>-3</sup> B) 1.25 mol dm<sup>-3</sup>  
C) 9 mol dm<sup>-3</sup> D) 0.8 mol dm<sup>-3</sup>

68. Oxidation is best described as:

- A) gain of electrons B) gain of neutrons  
C) loss of electrons D) no change in oxidation state

69. Which functional group characterizes an amine?

- A) terminal carbonyl group (–CHO) B) amino group (–NH<sub>2</sub>)  
C) carboxyl group (–COOH) D) hydroxyl group (–OH)

70. The standard hydrogen electrode is assigned a potential of:

- A) 1.00 V B) 0.50 V  
C) 0.00 V D) –1.00 V

#### SECTION IV-B: PHYSICS | 10 QUESTIONS | Questions 71-80

71. A vehicle travels 108 m in 6 s at constant speed. What is its speed?

- A) 108 m/s B) 114 m/s  
C) 18 m/s D) 6/108 m/s

72. What force is required to accelerate a 3 kg mass at 7 m/s<sup>2</sup>?

- A) 10 N B) 21 N  
C) 10.5 N D) 28 N

73. Find the kinetic energy of a 10 kg object moving at 6 m/s.

- A) 16 J B) 180 J  
C) 60 J D) 186 J

74. What is the momentum of a 7 kg object moving at 4 m/s?

- A) 14 kg·m/s B) 112 kg·m/s  
C) 0.57 kg·m/s D) 28 kg·m/s

75. A sample has mass 24 kg and volume 6 m<sup>3</sup>. What is its density?

- A) 4 kg/m<sup>3</sup> B) 5 kg/m<sup>3</sup>  
C) 0.25 kg/m<sup>3</sup> D) 144 kg/m<sup>3</sup>

76. A force of 300 N acts uniformly over an area of 5 m<sup>2</sup>. What pressure is produced?

- A) 65 Pa B) 1500 Pa  
C) 300 Pa D) 60 Pa

77. A resistor of 4 Ω carries a current of 6 A. What potential difference is across it?

- A) 1.50 V B) 10 V  
C) 28 V D) 24 V

78. An electrical device operates at 12 V and draws 5 A. What is its power?

- A) 17 W B) 60 W  
C) 2.40 W D) 65 W

79. A wave has frequency 8 Hz and wavelength 6 m. What is its speed?

- A) 14 m/s B) 1.33 m/s  
C) 0.75 m/s D) 48 m/s

80. Radioactive half-life is the time required for:

- A) the temperature to halve B) the activity to become zero  
C) the mass to double D) half the unstable nuclei in a sample to decay

#### SECTION IV-C: MATHEMATICS | 10 QUESTIONS | Questions 81-90

81. What is the larger root of  $x^2 - 14x + 45 = 0$ ?

- A) -9 B) 14  
C) 5 D) 9

82. Find the 4th term of the geometric sequence with first term 2 and common ratio 3.

- A) 24 B) 51  
C) 162 D) 54

83. y varies directly as x. If y = 36 when x = 6, find y when x = 8.

- A) 14 B) 288  
C) 44 D) 48

84. Find the slope of the line through (2, 6) and (5, 12).

- A) 1/2 B) 7  
C) 3 D) 2

85. Find the midpoint of the segment joining (4, 3) and (10, 7).

- A) (10, 7) B) (6, 6)  
C) (6, 4) D) (7, 5)

86. Find the distance between (0, 1) and (6, 9).

- A) 100 B) 10  
C) 6 D) 8

87. Find the area of a triangle with base 9 cm and perpendicular height 8 cm.

- A) 72 cm<sup>2</sup> B) 17 cm<sup>2</sup>  
C) 34 cm<sup>2</sup> D) 36 cm<sup>2</sup>

88. How many different pairs can be selected from 7 people?

- A) 42 B) 7  
C) 21 D) 9

89. What is  $\cos 60^\circ$ ?

- A)  $\sqrt{2}/2$  B) 1  
C) 0 D) 1/2

90. Find the determinant of the matrix  $\begin{bmatrix} 3 & 1 \\ 7 & 3 \end{bmatrix}$ .

- A) 6 B) 16  
C) 3 D) 2

**ANSWER KEY - PRE ENGINEERING MODEL PAPER 10***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. D  | 3. D  | 4. C  | 5. C  | 6. D  | 7. C  | 8. A  | 9. B  | 10. B |
| 11. D | 12. D | 13. D | 14. C | 15. D | 16. D | 17. D | 18. D | 19. D | 20. D |
| 21. A | 22. C | 23. A | 24. D | 25. C | 26. C | 27. A | 28. D | 29. C | 30. D |
| 31. C | 32. A | 33. D | 34. B | 35. D | 36. D | 37. D | 38. A | 39. B | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. C | 63. D | 64. D | 65. A | 66. C | 67. D | 68. C | 69. B | 70. C |
| 71. C | 72. B | 73. B | 74. D | 75. A | 76. D | 77. D | 78. B | 79. D | 80. D |
| 81. D | 82. D | 83. D | 84. D | 85. D | 86. B | 87. D | 88. C | 89. D | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | CHEMISTRY | PHYSICS   | MATHEMATICS |
|-----------|------------|---------------|-----------|-----------|-------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10 | ____ / 10   |



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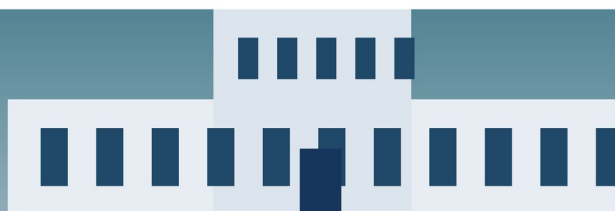
## MODEL PAPER BOOK

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## NTU ECAT - ICS-PHYSICS MODEL PAPERS

**Revised paper structure: English 20 | Analytical Reasoning 20 | Mathematics-Based Quantitative Reasoning 20 | Three group subjects 10 each | Total 90 MCQs | Time 120 minutes | Four options A-D**

**Ten complete model papers | 90 MCQs per paper | Four options A-D | Time: 2 Hours | Total Marks: 90**

**English 25 | Analytical Reasoning 10 | Quantitative Reasoning 20 | Physics 15 | Mathematics 15 | Computer Science 15**

**Questions are varied across this model-paper group. Core concepts may recur with different wording, contexts, or numerical values to strengthen revision and prevent memorisation of a fixed sequence.**

## ICS-PHYSICS - MODEL PAPER 1

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 1

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) be B) were  
C) are D) is

2. At present, the students \_\_\_\_ for the test.

- A) prepared B) have prepare  
C) is preparing D) are preparing

3. Bilal \_\_\_\_ the report already.

- A) completed yesterday B) had complete  
C) is completing since Monday D) has completed

4. By the time the supervisor arrived, Fatima \_\_\_\_ the admission file.

- A) will have checked B) checks  
C) was check D) had checked

5. By next Friday, the team \_\_\_\_ the report.

- A) will completed B) would complete  
C) has completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) were being B) are  
C) be D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) have B) are having  
C) has D) were

8. Each of the candidates \_\_\_\_ an admit card.

- A) were given by B) are having  
C) possess D) has

9. There \_\_\_\_ several reasons for the delay.

- A) be B) has  
C) are D) was

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) boils  
C) boiled D) will boil always

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) played B) will play  
C) had played D) would have played

12. If I knew the answer, I \_\_\_\_ Bilal.

- A) would have told B) would tell  
C) told D) will tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) would catch B) caught  
C) will catch D) would have caught

14. Choose the correct passive form: "The technician checks the report."

- A) The report will be checked by the technician. B) The report is being checked by the technician.  
C) The report was checked by the technician. D) The report is checked by the technician.

15. Choose the correct passive form: "The technician is checking the admission file."

- A) The admission file is been checked by the technician. B) The admission file is checked by the technician.  
C) The admission file is being checked by the technician. D) The admission file has been checked by the technician.

16. Choose the correct passive form: "The clerk processed the report."

- A) The report is processed by the clerk. B) The report was being processed by the clerk.  
C) The report has processed by the clerk. D) The report was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the admission file."

- A) The admission file had approved by the committee. B) The admission file has been approved by the committee.  
C) The admission file was approved by the committee. D) The admission file is approved by the committee.

18. Choose the correct passive form: "The office will issue the report."

- A) The report will be issued by the office. B) The report would be issued by the office.  
C) The report will have issued by the office. D) The report is issued by the office.

19. Select the correct indirect form: Bilal said, "I will complete the report."

- A) Bilal said that he will complete the report. B) Bilal told that the report would complete.  
C) Bilal said that he would complete the report. D) Bilal said that I would complete the report.

20. Select the correct indirect form: Fatima said, "I am checking the admission file."

- A) Fatima told that she was checking the admission file. B) Fatima said that she was checking the admission file.  
C) Fatima said that I was checking the admission file. D) Fatima said that she had checked the admission file.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L1: Six students in one row - Questions 21-24

Six students—Amina, Bilal, Camil, Danish, Eman, and Farah—sit in a straight row, all facing north. 1. Amina sits at the extreme left. 2. Farah sits at the extreme right. 3. Camil sits immediately to the right of Bilal. 4. Danish sits second to the right of Bilal. 5. Eman sits immediately to the left of Farah.

21. Who occupies the third seat from the left?

- A) Bilal B) Camil  
C) Eman D) Farah

22. Which pair sits next to each other in that left-to-right order?

- A) Camil and Eman    B) Bilal and Danish  
C) Amina and Camil    D) Danish and Eman

23. How many students sit between Bilal and Eman?

- A) Two    B) One  
C) None    D) Four

24. If Amina and Farah exchange seats, who will sit immediately to the left of Bilal?

- A) Amina    B) Eman  
C) Camil    D) Farah

**Analytical Set C1: Six people around a circular table - Questions 25-28**

Six people—Adeel, Bushra, Chetan, Dalia, Ehsan, and Farah—sit around a circular table facing the centre. Adeel's seat is taken as the top reference point.  
1. Bushra sits immediately clockwise from Adeel. 2. Dalia sits opposite Adeel. 3. Ehsan sits immediately clockwise from Dalia. 4. Chetan sits immediately clockwise from Bushra.

25. Who sits immediately anticlockwise from Dalia?

- A) Farah    B) Chetan  
C) Ehsan    D) Adeel

26. Which person sits opposite Bushra?

- A) Chetan    B) Ehsan  
C) Farah    D) Dalia

27. Who are Adeel's immediate neighbours?

- A) Bushra and Chetan    B) Dalia and Farah  
C) Ehsan and Farah    D) Bushra and Farah

28. If Chetan and Farah exchange seats, who will sit immediately anticlockwise from Adeel?

- A) Chetan    B) Dalia  
C) Ehsan    D) Farah

**Analytical Set S1: Six subjects across a week - Questions 29-32**

A student studies one subject each day from Monday to Saturday: Mathematics, Physics, Chemistry, English, Computer Science, and Biology. 1. Mathematics is studied on Monday. 2. Biology is studied on Saturday. 3. Physics is studied immediately after Mathematics. 4. English is studied immediately after Chemistry. 5. Computer Science is studied on Friday.

29. On which day is Chemistry studied?

- A) Monday    B) Tuesday  
C) Thursday    D) Wednesday

30. Which subject is studied immediately before Biology?

- A) English    B) Computer Science  
C) Mathematics    D) Chemistry

31. How many days occur between Physics and Computer Science?

- A) Four    B) Two  
C) None    D) Three

32. If English and Computer Science exchange days, what is studied on Thursday?

- A) Physics    B) Chemistry  
C) Computer Science    D) Biology

**Analytical Set D1: Symbolic implication chain - Questions 33-36**

Use the following rules: 1. If A is true, then B is true. 2. If B is true, then C is true. 3. If C is true, then D is true. 4. If D is false, then E is true. A conclusion is valid only when it must follow from the rules.

33. If A is true, which statement must also be true?

- A) D is true    B) C is false  
C) E is false    D) D is false

34. Suppose C is false. What must be true about B?

- A) Nothing can be known    B) B is false  
C) B may only be true    D) B is true

35. If D is false, which conclusion follows directly?

- A) B is true    B) A is true  
C) C is true    D) E is true

36. When B is true, which outcome is guaranteed?

- A) E is true    B) B is false  
C) A is true    D) D is true

**Analytical Set B1: Ahmed's family - Questions 37-40**

Ahmed and Sara are married. They have two children: Bilal, a son, and Hina, a daughter. Bilal is married to Nida, and their son is Owais. Hina is married to Kamran, and their daughter is Laiba.

37. How is Sara related to Owais?

- A) Mother-in-law    B) Paternal aunt  
C) Maternal aunt    D) Paternal grandmother

38. What is Kamran's relation to Bilal?

- A) Cousin    B) Son-in-law  
C) Maternal uncle    D) Brother-in-law

39. How is Laiba related to Bilal?

- A) Sister    B) Daughter  
C) Niece    D) Cousin

40. What is Nida's relation to Hina?

- A) Sister    B) Daughter-in-law  
C) Aunt    D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $49 + 3 \times 5 - 5$ .

- A) 59    B) 49  
C) 255    D) 62

42. Find  $3/11 + 4/16$  in simplest form.

- A)  $7/27$     B)  $23/44$   
C)  $1/44$     D)  $7/176$



43. What is 35% of 725?  
A) 38/5 B) 145/7  
C) 1015/4 D) 1885/4
44. A price of Rs. 1340 is increased by 20%. What is the new price?  
A) Rs. 268 B) Rs. 1360  
C) Rs. 1072 D) Rs. 1608
45. Rs. 328 is divided in the ratio 3:5. What is the larger share?  
A) 123 B) 164  
C) 8 D) 205
46. If 5 identical notebooks cost Rs. 565, what will 8 notebooks cost at the same rate?  
A) 904 B) 573  
C) 4520 D) 678
47. Find the arithmetic mean of 68, 72, 76, 80, 84.  
A) 380 B) 76  
C) 72 D) 80
48. A student scores 71 in a 2-credit course and 70 in a 4-credit course. Find the weighted mean.  
A) 70.5 B) 211  
C) 70.33 D) 52.75
49. A vehicle travels 216 km at a constant speed of 72 km/h. How long does the journey take?  
A) 288 hours B) 144 hours  
C) 1/3 hours D) 3 hours
50. Worker A can complete a job in 25 days and Worker B in 49 days. Working together, how many days will they take?  
A) 37 days B) 74/1225 days  
C) 1225/24 days D) 1225/74 days
51. An item costs Rs. 820 and is sold at a profit of 30%. Find the selling price.  
A) Rs. 1066 B) Rs. 246  
C) Rs. 574 D) Rs. 850
52. Find the simple interest on Rs. 3100 at 4% per year for 3 years.  
A) Rs. 124 B) Rs. 372  
C) Rs. 93 D) Rs. 3472
53. Solve  $2x + 15 = 63$ .  
A) 48 B) 16/5  
C) 24 D) 25
54. What is the larger root of  $x^2 - 28x + 52 = 0$ ?  
A) 2 B) 28  
C) 52 D) 26
55. Find the 9th term of the arithmetic sequence with first term 45 and common difference 3.  
A) 72 B) 66  
C) 432 D) 69
56. If  $23^x = 529$ , find x.  
A) 2 B) 23  
C) 529 D) 3
57. Find the area of a rectangle of length 29 cm and width 3 cm.  
A) 64 cm<sup>2</sup> B) 87 cm<sup>2</sup>  
C) 32 cm<sup>2</sup> D) 174 cm<sup>2</sup>
58. Find the slope of the line through (21, 23) and (25, 31).  
A) 1/2 B) 8  
C) 2 D) 4
59. A bag contains 8 red and 4 blue balls. One ball is selected at random. What is P(red)?  
A) 1/3 B) 2  
C) 1/12 D) 2/3
60. How many different pairs can be selected from 26 people?  
A) 650 B) 28  
C) 26 D) 325

#### SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. Which of the following is an SI base quantity?  
A) Pressure B) Mass  
C) Power D) Energy
62. A vehicle travels 38 m in 2 s at constant speed. What is its speed?  
A) 19 m/s B) 21 m/s  
C) 38 m/s D) 40 m/s
63. An object's velocity changes from 2 m/s to 8 m/s in 3 s. What is its acceleration?  
A) 6 m/s<sup>2</sup> B) 2.7 m/s<sup>2</sup>  
C) 2 m/s<sup>2</sup> D) 5 m/s<sup>2</sup>
64. What force is required to accelerate a 4 kg mass at 3 m/s<sup>2</sup>?  
A) 6 N B) 7 N  
C) 12 N D) 1.33 N
65. What is the momentum of a 8 kg object moving at 5 m/s?  
A) 20 kg·m/s B) 13 kg·m/s  
C) 0.62 kg·m/s D) 40 kg·m/s
66. A sample has mass 10 kg and volume 2 m<sup>3</sup>. What is its density?  
A) 20 kg/m<sup>3</sup> B) 6 kg/m<sup>3</sup>  
C) 0.20 kg/m<sup>3</sup> D) 5 kg/m<sup>3</sup>
67. A force of 140 N acts uniformly over an area of 2 m<sup>2</sup>. What pressure is produced?  
A) 280 Pa B) 140 Pa  
C) 0.01 Pa D) 70 Pa



68. An electrical device operates at 14 V and draws 2 A. What is its power?

- A) 28 W    B) 16 W  
C) 7.00 W    D) 30 W

69. A wave has frequency 9 Hz and wavelength 2 m. What is its speed?

- A) 0.22 m/s    B) 11 m/s  
C) 27 m/s    D) 18 m/s

70. Which statement about sound is correct?

- A) Sound travels fastest in a vacuum.    B) Sound is an electromagnetic wave.  
C) Sound has no frequency.    D) Sound requires a material medium to travel.

### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $2x + 7 = 17$ .

- A) 5    B) 4  
C)  $17/2$     D) 6

72. What is the larger root of  $x^2 - 17x + 66 = 0$ ?

- A) -11    B) 17  
C) 66    D) 11

73. Find the 5th term of the geometric sequence with first term 3 and common ratio 2.

- A) 48    B) 96  
C) 50    D) 30

74.  $y$  varies directly as  $x$ . If  $y = 14$  when  $x = 7$ , find  $y$  when  $x = 9$ .

- A) 16    B) 23  
C) 126    D) 18

75. Find the midpoint of the segment joining (0, 4) and (6, 8).

- A) (3, 6)    B) (6, 8)  
C) (3, 7)    D) (2, 7)

76. Find the distance between (1, 2) and (10, 14).

- A) 225    B) 9  
C) 12    D) 15

77. Find the area of a triangle with base 10 cm and perpendicular height 9 cm.

- A)  $45/2 \text{ cm}^2$     B)  $38 \text{ cm}^2$   
C)  $19 \text{ cm}^2$     D)  $45 \text{ cm}^2$

78. How many different pairs can be selected from 8 people?

- A) 36    B) 8  
C) 10    D) 28

79. What is  $\tan 45^\circ$ ?

- A) 0    B) Undefined  
C)  $1/2$     D) 1

80. Find the determinant of the matrix  $\begin{bmatrix} 4 & 2 \\ 3 & 4 \end{bmatrix}$ .

- A) -10    B) 8  
C) 22    D) 10

### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The component that performs arithmetic and logical operations is the:

- A) Hard disk    B) Monitor  
C) Input unit    D) ALU

82. RAM is best described as:

- A) an input device    B) read-only firmware only  
C) a network protocol    D) volatile primary memory

83. ROM is commonly used to store:

- A) keyboard signals    B) internet addresses  
C) open application windows    D) firmware that should persist without power

84. A compiler generally translates:

- A) one instruction at a time during execution only    B) an entire high-level program into machine code  
C) data into hardware    D) machine code into English

85. An algorithm is:

- A) a network cable    B) a type of monitor  
C) a computer brand    D) a finite sequence of unambiguous steps for solving a problem

86. Pseudocode is used to:

- A) replace all testing    B) store images  
C) compile a program directly    D) describe an algorithm in structured, language-independent form

87. A syntax error occurs when:

- A) programming-language rules are violated    B) the program runs but gives the wrong result  
C) data are duplicated in a table    D) the computer loses power

88. A logic error causes a program to:

- A) have no variables    B) run but produce an incorrect result  
C) damage hardware necessarily    D) become an operating system

89. A variable is used to:

- A) store a value that may change during program execution    B) prevent all errors  
C) define a monitor size    D) draw a network cable

90. A function is useful because it:

- A) always runs before main memory    B) replaces all variables  
C) can contain no parameters    D) encapsulates a reusable block of code

**ANSWER KEY - ICS PHYSICS MODEL PAPER 1***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. D  | 3. D  | 4. D  | 5. D  | 6. D  | 7. C  | 8. D  | 9. C  | 10. B |
| 11. B | 12. B | 13. D | 14. D | 15. C | 16. D | 17. B | 18. A | 19. C | 20. B |
| 21. B | 22. D | 23. A | 24. D | 25. B | 26. B | 27. D | 28. A | 29. D | 30. B |
| 31. B | 32. C | 33. A | 34. B | 35. D | 36. D | 37. D | 38. D | 39. C | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. A | 63. C | 64. C | 65. D | 66. D | 67. D | 68. A | 69. D | 70. D |
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| 81. D | 82. D | 83. D | 84. B | 85. D | 86. D | 87. A | 88. B | 89. A | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |

## ICS-PHYSICS - MODEL PAPER 2

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 2

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) be B) are  
C) is D) have

2. At present, the technicians \_\_\_\_ for the test.

- A) were prepare B) have prepare  
C) are preparing D) is preparing

3. Iqra \_\_\_\_ the assignment already.

- A) is completing since Monday B) had complete  
C) completed yesterday D) has completed

4. By the time the supervisor arrived, Junaid \_\_\_\_ the equipment list.

- A) was check B) has checked  
C) will have checked D) had checked

5. By next Friday, the team \_\_\_\_ the assignment.

- A) will have completed B) has completed  
C) would complete D) had completed

6. The quality of the samples \_\_\_\_ satisfactory.

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7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) has  
C) do D) have

8. Each of the candidates \_\_\_\_ an admit card.

- A) possess B) were given by  
C) are having D) has

9. There \_\_\_\_ several reasons for the delay.

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10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would boil B) boils  
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11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) had played B) played  
C) would have played D) will play

12. If I knew the answer, I \_\_\_\_ Iqra.

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- A) The assignment has processed by the clerk. B) The assignment was processed by the clerk.  
C) The assignment is processed by the clerk. D) The assignment will be processed by the clerk.

17. Choose the correct passive form: "The committee has approved the equipment list."

- A) The equipment list has being approved by the committee. B) The equipment list has been approved by the committee.  
C) The equipment list is approved by the committee. D) The equipment list had approved by the committee.

18. Choose the correct passive form: "The office will issue the assignment."

- A) The assignment would be issued by the office. B) The assignment will be issued by the office.  
C) The assignment will have issued by the office. D) The assignment is issued by the office.

19. Select the correct indirect form: Iqra said, "I will complete the assignment."

- A) Iqra said that I would complete the assignment. B) Iqra said that she would complete the assignment.  
C) Iqra said that she will complete the assignment. D) Iqra said that she had complete the assignment.

20. Select the correct indirect form: Junaid said, "I am checking the equipment list."

- A) Junaid said that he had checked the equipment list. B) Junaid said that he was checking the equipment list.  
C) Junaid said that I was checking the equipment list. D) Junaid told that he was checking the equipment list.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L2: Seven candidates in a row - Questions 21-24

Seven candidates—Haris, Iqra, Junaid, Kiran, Lubna, Moiz, and Nadia—sit in a row facing north. 1. Kiran occupies the middle seat. 2. Haris and Nadia sit at the two ends, with Haris on the left. 3. Iqra sits immediately to the left of Junaid. 4. Lubna sits immediately to the right of Kiran. 5. Moiz sits immediately to the left of Nadia.

21. Who sits second from the right end?

- A) Lubna B) Kiran  
C) Moiz D) Nadia

22. Which candidate sits exactly between Junaaid and Lubna?

- A) Haris B) Nadia  
C) Moiz D) Kiran

23. Which pair is NOT adjacent in the final arrangement?

- A) Iqra and Junaid B) Junaid and Lubna  
C) Moiz and Nadia D) Haris and Iqra

24. If Iqra and Lubna swap places, who will be immediately to the right of Kiran?

- A) Lubna B) Moiz  
C) Iqra D) Nadia

**Analytical Set C2: Eight officers in a circle - Questions 25-28**

Eight officers—Gohar, Hina, Imran, Javeria, Kamal, Laila, Musa, and Noreen—sit around a circular table facing the centre. Gohar is fixed at the top. 1. Hina sits immediately clockwise from Gohar. 2. Javeria sits third clockwise from Gohar. 3. Kamal sits immediately clockwise from Javeria. 4. Imran sits between Hina and Javeria. 5. Laila sits opposite Hina. 6. Musa sits immediately clockwise from Laila.

25. Who sits opposite Gohar?

- A) Noreen B) Laila  
C) Kamal D) Musa

26. Who is immediately anticlockwise from Noreen?

- A) Kamal B) Musa  
C) Gohar D) Hina

27. Which pair sits opposite each other?

- A) Imran and Musa B) Hina and Musa  
C) Javeria and Noreen D) Kamal and Laila

28. Starting at Javeria and moving clockwise, who is the third person reached?

- A) Musa B) Kamal  
C) Noreen D) Gohar

**Analytical Set S2: Five interviews - Questions 29-32**

Five applicants—Areeba, Bilal, Celine, Dawood, and Eman—are interviewed from Monday to Friday, one per day. 1. Celine is interviewed on Wednesday. 2. Areeba is interviewed on Monday. 3. Bilal is interviewed after Areeba but before Celine. 4. Dawood is interviewed immediately after Celine. 5. Eman is interviewed on Friday.

29. Who is interviewed on Tuesday?

- A) Eman B) Bilal  
C) Dawood D) Areeba

30. Whose interview is immediately before Eman's?

- A) Areeba B) No applicant  
C) Bilal D) Dawood

31. Which applicant is interviewed exactly two days after Bilal?

- A) Eman B) Areeba  
C) No applicant D) Dawood

32. If Wednesday is declared a holiday and all later interviews move one working day forward, on which day is Eman interviewed?

- A) Monday of the next week B) Saturday of the same week  
C) Tuesday of the next week D) Friday of the same week

**Analytical Set D2: Admission requirements - Questions 33-36**

Use these rules: 1. If a candidate qualifies (Q), the candidate passes Mathematics (M). 2. If a candidate qualifies (Q), the candidate passes the interview (I). 3. If the interview is passed (I), the documents are complete (D). 4. If the documents are complete (D), verification is approved (V).

33. A candidate qualifies. Which final result must occur?

- A) Verification is rejected B) Verification is approved  
C) Documents are incomplete D) The interview is failed

34. The documents are not complete. What must be concluded about the interview?

- A) The interview was repeated B) The interview was postponed  
C) The interview was passed D) The interview was not passed

35. A candidate did not pass Mathematics. Which conclusion is forced?

- A) The interview was passed B) The candidate qualified  
C) Verification was approved D) The candidate did not qualify

36. Verification is not approved. Which status is impossible under the rules?

- A) The candidate does not qualify B) The candidate qualifies  
C) The interview is not passed D) The candidate fails Mathematics

**Analytical Set B2: Farooq's family - Questions 37-40**

Farooq and Ayesha are married. Their children are Hamza, a son, and Iman, a daughter. Hamza is married to Zara; their daughters are Kiran and Mehak. Iman is married to Usman; their son is Danish.

37. How is Ayesha related to Danish?

- A) Paternal aunt B) Mother-in-law  
C) Paternal grandmother D) Maternal grandmother

38. What is Danish's relation to Hamza?

- A) Uncle B) Nephew  
C) Son D) Cousin

39. How is Zara related to Iman?

- A) Sister B) Niece  
C) Sister-in-law D) Cousin

40. What is Kiran's relation to Danish?

- A) Sister B) Cousin  
C) Niece D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $51 + 4 \times 6 - 6$ .

- A) 69 B) 51  
C) 324 D) 73

42. Find  $1/12 + 3/17$  in simplest form.

- A)  $4/29$  B)  $53/204$   
C)  $-19/204$  D)  $1/51$

43. What is 40% of 750?  
A) 79/10 B) 75/4  
C) 300 D) 450
44. A price of Rs. 1380 is increased by 25%. What is the new price?  
A) Rs. 345 B) Rs. 1405  
C) Rs. 1035 D) Rs. 1725
45. Rs. 462 is divided in the ratio 4:7. What is the larger share?  
A) 168 B) 231  
C) 11 D) 294
46. If 6 identical notebooks cost Rs. 696, what will 10 notebooks cost at the same rate?  
A) 1160 B) 706  
C) 6960 D) 812
47. Find the arithmetic mean of 71, 76, 81, 86, 91.  
A) 405 B) 81  
C) 76 D) 86
48. A student scores 72 in a 3-credit course and 71 in a 5-credit course. Find the weighted mean.  
A) 71.5 B) 285.5  
C) 71.38 D) 38.07
49. A vehicle travels 296 km at a constant speed of 74 km/h. How long does the journey take?  
A) 370 hours B) 222 hours  
C) 1/4 hours D) 4 hours
50. Worker A can complete a job in 26 days and Worker B in 51 days. Working together, how many days will they take?  
A) 77/2 days B) 77/1326 days  
C) 1326/25 days D) 1326/77 days
51. An item costs Rs. 840 and is sold at a profit of 35%. Find the selling price.  
A) Rs. 1134 B) Rs. 294  
C) Rs. 546 D) Rs. 875
52. Find the simple interest on Rs. 3200 at 5% per year for 4 years.  
A) Rs. 160 B) Rs. 640  
C) Rs. 128 D) Rs. 3840
53. Solve  $3x + 5 = 80$ .  
A) 75 B) 15  
C) 25 D) 26
54. What is the larger root of  $x^2 - 30x + 81 = 0$ ?  
A) 3 B) 30  
C) 81 D) 27
55. Find the 10th term of the arithmetic sequence with first term 47 and common difference 4.  
A) 87 B) 79  
C) 510 D) 83
56. If  $24^x = 13824$ , find x.  
A) 3 B) 24  
C) 13824 D) 4
57. Find the area of a triangle with base 32 cm and height 8 cm.  
A)  $256 \text{ cm}^2$  B)  $128 \text{ cm}^2$   
C)  $40 \text{ cm}^2$  D)  $64 \text{ cm}^2$
58. Find the midpoint of the segment joining (22, 24) and (28, 32).  
A) (6, 8) B) (50, 56)  
C) (25, 28) D) (3, 4)
59. A bag contains 9 red and 5 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?  
A) 5/14 B) 9/5  
C) 1/14 D) 9/14
60. How many different pairs can be selected from 27 people?  
A) 702 B) 29  
C) 27 D) 351

#### SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. A vehicle travels 60 m in 3 s at constant speed. What is its speed?  
A) 3/60 m/s B) 20 m/s  
C) 63 m/s D) 60 m/s
62. An object's velocity changes from 3 m/s to 15 m/s in 4 s. What is its acceleration?  
A)  $3.8 \text{ m/s}^2$  B)  $12 \text{ m/s}^2$   
C)  $7 \text{ m/s}^2$  D)  $3 \text{ m/s}^2$
63. What force is required to accelerate a 5 kg mass at  $4 \text{ m/s}^2$ ?  
A) 24 N B) 20 N  
C) 1.25 N D) 9 N
64. Find the kinetic energy of a 4 kg object moving at 3 m/s.  
A) 12 J B) 7 J  
C) 18 J D) 21 J
65. What is the momentum of a 2 kg object moving at 6 m/s?  
A)  $3.00 \text{ kg}\cdot\text{m/s}$  B)  $12 \text{ kg}\cdot\text{m/s}$   
C)  $8 \text{ kg}\cdot\text{m/s}$  D)  $72 \text{ kg}\cdot\text{m/s}$
66. A sample has mass 18 kg and volume  $3 \text{ m}^3$ . What is its density?  
A)  $6 \text{ kg/m}^3$  B)  $0.17 \text{ kg/m}^3$   
C)  $7 \text{ kg/m}^3$  D)  $15 \text{ kg/m}^3$
67. A force of 240 N acts uniformly over an area of  $3 \text{ m}^2$ . What pressure is produced?  
A) 83 Pa B) 240 Pa  
C) 720 Pa D) 80 Pa

68. An electrical device operates at 16 V and draws 3 A. What is its power?

- A) 0.19 W    B) 48 W  
C) 5.33 W    D) 51 W

69. A wave has frequency 10 Hz and wavelength 3 m. What is its speed?

- A) 3.33 m/s    B) 0.30 m/s  
C) 13 m/s    D) 30 m/s

70. A transformer operates using:

- A) direct current only    B) chemical energy only  
C) nuclear decay    D) alternating current

### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $3x + 8 = 29$ .

- A) 8    B) 21  
C) 7    D) 6

72. What is the larger root of  $x^2 - 20x + 91 = 0$ ?

- A) 91    B) 20  
C) 13    D) -13

73. y varies directly as x. If  $y = 24$  when  $x = 8$ , find y when  $x = 10$ .

- A) 13    B) 34  
C) 30    D) 240

74. Find the slope of the line through (4, 3) and (7, 15).

- A) 13    B)  $\frac{1}{4}$   
C) 4    D) 3

75. Find the midpoint of the segment joining (1, 5) and (7, 9).

- A) (6, 4)    B) (4, 7)  
C) (4, 8)    D) (7, 9)

76. Find the distance between (2, 3) and (14, 19).

- A) 21    B) 20  
C) 16    D) 12

77. Find the area of a triangle with base 11 cm and perpendicular height 10 cm.

- A)  $55 \text{ cm}^2$     B)  $42 \text{ cm}^2$   
C)  $55/2 \text{ cm}^2$     D)  $110 \text{ cm}^2$

78. How many different pairs can be selected from 9 people?

- A) 45    B) 9  
C) 11    D) 36

79. What is  $\sin 90^\circ$ ?

- A) 1    B) 0  
C) Undefined    D)  $\sqrt{2}/2$

80. Find the determinant of the matrix  $\begin{bmatrix} 5 & 3 \\ 4 & 5 \end{bmatrix}$ .

- A) -13    B) 14  
C) 37    D) 13

### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The decimal number 15 is represented in binary as:

- A)  $1111_2$     B)  $1100_2$   
C)  $1010_2$     D)  $1110_2$

82. An AND gate outputs 1 only when:

- A) inputs are different    B) all inputs are 0  
C) at least one input is 1    D) all inputs are 1

83. An OR gate outputs 1 when:

- A) exactly two inputs are 0    B) all inputs are 0 only  
C) at least one input is 1    D) there is no power

84. A NOT gate:

- A) sorts records    B) reverses the input truth value  
C) adds two inputs    D) stores a byte

85. An IP address identifies:

- A) a file extension    B) a database row only  
C) a keyboard key    D) a device or interface on an IP network

86. In a database table, a row is called a:

- A) field    B) query  
C) data type    D) record

87. In a database table, a column is called a:

- A) report    B) record  
C) tuple only in every context    D) field

88. A primary key should:

- A) be left blank in every row    B) contain duplicate values  
C) uniquely identify each record    D) store images only

89. Database normalization helps to:

- A) prevent queries    B) convert tables into images  
C) increase duplicate data    D) reduce redundancy and update anomalies

90. Phishing is an attempt to:

- A) repair hardware automatically    B) create a backup  
C) improve processor speed    D) trick users into revealing sensitive information

**ANSWER KEY - ICS PHYSICS MODEL PAPER 2***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. C  | 2. C  | 3. D  | 4. D  | 5. A  | 6. B  | 7. B  | 8. D  | 9. B  | 10. B |
| 11. D | 12. A | 13. D | 14. D | 15. A | 16. B | 17. B | 18. B | 19. B | 20. B |
| 21. C | 22. D | 23. B | 24. C | 25. C | 26. B | 27. A | 28. A | 29. B | 30. D |
| 31. D | 32. A | 33. B | 34. D | 35. D | 36. B | 37. D | 38. B | 39. C | 40. B |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. D | 63. B | 64. C | 65. B | 66. A | 67. D | 68. B | 69. D | 70. D |
| 71. C | 72. C | 73. C | 74. C | 75. B | 76. B | 77. A | 78. D | 79. A | 80. D |
| 81. A | 82. D | 83. C | 84. B | 85. D | 86. D | 87. D | 88. C | 89. D | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |

## ICS-PHYSICS - MODEL PAPER 3

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 3

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) be  
C) are D) is

2. At present, the candidates \_\_\_\_ for the test.

- A) were prepare B) are preparing  
C) prepared D) have prepare

3. Omer \_\_\_\_ the project already.

- A) completed yesterday B) is completing since Monday  
C) have completed D) has completed

4. By the time the supervisor arrived, Pari \_\_\_\_ the research summary.

- A) had checked B) has checked  
C) was check D) checks

5. By next Friday, the team \_\_\_\_ the project.

- A) has completed B) would complete  
C) will completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) have B) are  
C) were being D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) have B) has  
C) are having D) do

8. Each of the candidates \_\_\_\_ an admit card.

- A) have B) has  
C) were given by D) possess

9. There \_\_\_\_ several reasons for the delay.

- A) was B) has  
C) be D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would boil B) would have boiled  
C) will boil always D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) had played B) would have played  
C) would play D) will play

12. If I knew the answer, I \_\_\_\_ Omer.

- A) told B) will tell  
C) would have told D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) would catch B) had caught  
C) would have caught D) will catch

14. Choose the correct passive form: "The technician checks the project."

- A) The project will be checked by the technician. B) The project was checked by the technician.  
C) The project is checked by the technician. D) The project has checked by the technician.

15. Choose the correct passive form: "The technician is checking the research summary."

- A) The research summary is been checked by the technician. B) The research summary is checked by the technician.  
C) The research summary is being checked by the technician. D) The research summary has been checked by the technician.

16. Choose the correct passive form: "The clerk processed the project."

- A) The project was processed by the clerk. B) The project was being processed by the clerk.  
C) The project has processed by the clerk. D) The project will be processed by the clerk.

17. Choose the correct passive form: "The committee has approved the research summary."

- A) The research summary has being approved by the committee. B) The research summary had approved by the committee.  
C) The research summary has been approved by the committee. D) The research summary is approved by the committee.

18. Choose the correct passive form: "The office will issue the project."

- A) The project will have issued by the office. B) The project is issued by the office.  
C) The project will be issued by the office. D) The project would be issued by the office.

19. Select the correct indirect form: Omer said, "I will complete the project."

- A) Omer said that he had complete the project. B) Omer said that I would complete the project.  
C) Omer told that the project would complete. D) Omer said that he would complete the project.

20. Select the correct indirect form: Pari said, "I am checking the research summary."

- A) Pari told that she was checking the research summary. B) Pari said that I was checking the research summary.  
C) Pari said that she had checked the research summary. D) Pari said that she was checking the research summary.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L3: Eight delegates in a row - Questions 21-24

Eight delegates—Omer, Pari, Qasim, Rabia, Salman, Tehmina, Usman, and Warda—sit in a row facing north. 1. Omer and Warda sit at the left and right ends respectively. 2. Pari sits immediately to the right of Omer. 3. Rabia sits immediately to the right of Qasim. 4. Salman sits immediately to the right of Rabia. 5. Tehmina sits immediately to the right of Salman. 6. Usman sits immediately to the left of Warda.

21. Who is fifth from the left?

- A) Tehmina B) Qasim  
C) Rabia D) Salman



22. How many delegates sit between Pari and Tehmina?

- A) One B) Four  
C) Three D) Two

23. Who sits immediately to the left of Usman?

- A) Salman B) Tehmina  
C) Warda D) Qasim

24. If Omer leaves and everyone to his right shifts one seat left, who becomes fourth from the left?

- A) Rabia B) Usman  
C) Salman D) Tehmina

**Analytical Set C3: Six students in a circle - Questions 25-28**

Six students—Owais, Parsa, Qasim, Rida, Saad, and Tania—sit around a circular table facing the centre. Owais is fixed at the top. 1. Qasim sits second clockwise from Owais. 2. Rida sits opposite Owais. 3. Saad sits immediately clockwise from Rida. 4. Parsa sits between Owais and Qasim on the clockwise side.

25. Who sits immediately clockwise from Qasim?

- A) Parsa B) Rida  
C) Saad D) Tania

26. Who sits opposite Parsa?

- A) Owais B) Rida  
C) Qasim D) Saad

27. Which two students are immediate neighbours of Tania?

- A) Rida and Saad B) Qasim and Rida  
C) Saad and Owais D) Parsa and Qasim

28. If everyone moves two seats clockwise, who occupies Owais's original seat?

- A) Saad B) Tania  
C) Qasim D) Rida

**Analytical Set S3: March calendar - Questions 29-32**

In a particular year, 1 March falls on a Tuesday. Use the ordinary seven-day weekly cycle for all four questions.

29. What day of the week is 8 March?

- A) Wednesday B) Friday  
C) Tuesday D) Thursday

30. On which weekday does 17 March fall?

- A) Friday B) Thursday  
C) Saturday D) Tuesday

31. Which weekday is 31 March?

- A) Saturday B) Sunday  
C) Wednesday D) Thursday

32. What day is 1 April?

- A) Monday B) Sunday  
C) Saturday D) Friday

**Analytical Set D3: Exclusive choice and implications - Questions 33-36**

Use these rules: 1. Exactly one of P and Q is true. 2. If P is true, R is true. 3. If Q is true, S is true. 4. If R is false, T is true.

33. If P is true, which statement must be false?

- A) R is true B) R may be true  
C) P is true D) Q is true

34. If S is false, which statement must be true?

- A) R is true B) P is false  
C) R is false D) T is false

35. Assume R is false. Which result must follow?

- A) P is true B) Q is false  
C) S is false D) S is true

36. If T is false, what follows necessarily?

- A) S is false B) R is true  
C) R is false D) Q is true

**Analytical Set B3: Rashid's family - Questions 37-40**

Rashid and Mariam are married. Their children are Sameer, a son, and Nadia, a daughter. Sameer is married to Huma; their children are Taimur, a son, and Rida, a daughter. Nadia is married to Asif; their son is Zain.

37. How is Mariam related to Rida?

- A) Paternal grandmother B) Great-grandmother  
C) Paternal aunt D) Maternal grandmother

38. What is Zain's relation to Sameer?

- A) Nephew B) Uncle  
C) Son D) Brother

39. How is Huma related to Nadia?

- A) Maternal aunt B) Sister-in-law  
C) Cousin D) Daughter-in-law

40. What is Taimur's relation to Zain?

- A) Nephew B) Uncle  
C) Cousin D) Brother-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $53 + 5 \times 7 - 7$ .

- A) 81 B) 53  
C) 399 D) 86

42. Find  $\frac{11}{13} + \frac{2}{18}$  in simplest form.

- A)  $\frac{13}{31}$  B)  $\frac{112}{117}$   
C)  $\frac{86}{117}$  D)  $\frac{1}{18}$

43. What is 45% of 775?

- A)  $\frac{41}{5}$  B)  $\frac{155}{9}$   
C)  $\frac{1395}{4}$  D)  $\frac{1705}{4}$

44. A price of Rs. 1420 is increased by 30%. What is the new price?  
A) Rs. 426 B) Rs. 1450  
C) Rs. 994 D) Rs. 1846
45. Rs. 602 is divided in the ratio 5:9. What is the larger share?  
A) 215 B) 301  
C) 14 D) 387
46. If 7 identical notebooks cost Rs. 833, what will 12 notebooks cost at the same rate?  
A) 1428 B) 845  
C) 9996 D) 952
47. Find the arithmetic mean of 74, 80, 86, 92, 98.  
A) 430 B) 86  
C) 80 D) 92
48. A student scores 73 in a 4-credit course and 72 in a 6-credit course. Find the weighted mean.  
A) 72.5 B) 362  
C) 72.4 D) 30.17
49. A vehicle travels 380 km at a constant speed of 76 km/h. How long does the journey take?  
A) 456 hours B) 304 hours  
C) 1/5 hours D) 5 hours
50. Worker A can complete a job in 27 days and Worker B in 53 days. Working together, how many days will they take?  
A) 40 days B) 80/1431 days  
C) 1431/26 days D) 1431/80 days
51. An item costs Rs. 860 and is sold at a profit of 40%. Find the selling price.  
A) Rs. 1204 B) Rs. 344  
C) Rs. 516 D) Rs. 900
52. Find the simple interest on Rs. 3300 at 6% per year for 5 years.  
A) Rs. 198 B) Rs. 990  
C) Rs. 165 D) Rs. 4290
53. Solve  $4x + 6 = 110$ .  
A) 104 B) 52/3  
C) 26 D) 27
54. What is the larger root of  $x^2 - 32x + 112 = 0$ ?  
A) 4 B) 32  
C) 112 D) 28
55. Find the 11th term of the arithmetic sequence with first term 49 and common difference 5.  
A) 104 B) 94  
C) 594 D) 99
56. If  $25^x = 390625$ , find x.  
A) 4 B) 25  
C) 390625 D) 5
57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 168 cm.  
A) 88704 cm B) 1056 cm  
C) 528 cm D) 336 cm
58. Find the distance between (23, 24) and (26, 28).  
A) 7 B) 4  
C) 5 D) 25
59. A bag contains 10 red and 6 blue balls. One ball is selected at random. What is P(red)?  
A) 3/8 B) 5/3  
C) 1/16 D) 5/8
60. How many different pairs can be selected from 28 people?  
A) 756 B) 30  
C) 28 D) 378

#### SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. Which of the following is an SI base quantity?  
A) Energy B) Force  
C) Pressure D) Mass
62. A vehicle travels 40 m in 4 s at constant speed. What is its speed?  
A) 44 m/s B) 12 m/s  
C) 10 m/s D) 4/40 m/s
63. What force is required to accelerate a 6 kg mass at 5 m/s<sup>2</sup>?  
A) 15 N B) 35 N  
C) 1.20 N D) 30 N
64. Find the kinetic energy of a 6 kg object moving at 4 m/s.  
A) 10 J B) 24 J  
C) 48 J D) 96 J
65. What is the momentum of a 3 kg object moving at 7 m/s?  
A) 2.33 kg·m/s B) 10 kg·m/s  
C) 10.5 kg·m/s D) 21 kg·m/s
66. A sample has mass 28 kg and volume 4 m<sup>3</sup>. What is its density?  
A) 24 kg/m<sup>3</sup> B) 112 kg/m<sup>3</sup>  
C) 8 kg/m<sup>3</sup> D) 7 kg/m<sup>3</sup>
67. A force of 360 N acts uniformly over an area of 4 m<sup>2</sup>. What pressure is produced?  
A) 1440 Pa B) 94 Pa  
C) 0.01 Pa D) 90 Pa
68. An electrical device operates at 18 V and draws 4 A. What is its power?  
A) 76 W B) 4.50 W  
C) 0.22 W D) 72 W

69. A wave has frequency 11 Hz and wavelength 4 m. What is its speed?

- A) 2.75 m/s    B) 44 m/s  
C) 55 m/s    D) 15 m/s

70. The image formed by a plane mirror is:

- A) real and inverted    B) real and magnified  
C) always smaller than the object    D) virtual, upright and the same size as the object

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $4x + 9 = 45$ .

- A) 9    B) 10  
C) 8    D)  $45/4$

72. What is the larger root of  $x^2 - 7x + 10 = 0$ ?

- A) 5    B) -5  
C) 7    D) 2

73.  $y$  varies directly as  $x$ . If  $y = 12$  when  $x = 3$ , find  $y$  when  $x = 5$ .

- A) 14    B) 20  
C) 60    D) 9

74. Find the midpoint of the segment joining (2, 2) and (8, 6).

- A) (8, 6)    B) (5, 4)  
C) (5, 5)    D) (6, 4)

75. Find the distance between (0, 0) and (3, 4).

- A) 4    B) 25  
C) 5    D) 6

76. Find the area of a triangle with base 12 cm and perpendicular height 5 cm.

- A)  $17 \text{ cm}^2$     B)  $30 \text{ cm}^2$   
C)  $60 \text{ cm}^2$     D)  $34 \text{ cm}^2$

77. A bag contains 3 red and 7 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $3/7$     B)  $3/10$   
C)  $7/10$     D)  $10/3$

78. How many different pairs can be selected from 10 people?

- A) 12    B) 55  
C) 45    D) 10

79. What is  $\sin 30^\circ$ ?

- A) 0    B)  $\sqrt{3}/2$   
C) 1    D)  $1/2$

80. Find the determinant of the matrix  $\begin{bmatrix} 2 & 1 \\ 5 & 2 \end{bmatrix}$ .

- A) -1    B) 1  
C) 4    D) 9

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. Encryption converts readable data into:

- A) ciphertext    B) a compiler  
C) a database key only    D) a monitor signal

82. A strong password should generally be:

- A) a common dictionary word    B) long, unique and difficult to guess  
C) the same for every account    D) shared publicly

83. Cloud computing provides resources:

- A) only from a local floppy disk    B) inside a keyboard  
C) over a network on demand    D) without any servers

84. Machine learning enables systems to:

- A) replace all hardware    B) operate without algorithms or data  
C) improve performance from data    D) guarantee perfect predictions

85. Supervised learning uses:

- A) labelled training examples    B) only random numbers  
C) unlabelled data exclusively    D) no data

86. A black-box model is difficult to:

- A) execute on a computer    B) store in memory  
C) train with data    D) interpret internally

87. The purpose of testing software is to:

- A) replace users    B) increase file size  
C) guarantee no future changes    D) find defects and verify expected behaviour

88. The expression  $14 \% 3$  in C evaluates to:

- A) 1    B) 2  
C) 4    D) 3

89. In C,  $\&\&$  represents logical:

- A) NOT    B) AND  
C) assignment    D) division

90. A for loop header normally contains:

- A) class, object and method    B) table, row and field  
C) input, output and storage    D) initialization, condition and update

**ANSWER KEY - ICS PHYSICS MODEL PAPER 3***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. B  | 3. D  | 4. A  | 5. D  | 6. D  | 7. B  | 8. B  | 9. D  | 10. D |
| 11. D | 12. D | 13. C | 14. C | 15. C | 16. A | 17. C | 18. C | 19. D | 20. D |
| 21. D | 22. C | 23. B | 24. C | 25. B | 26. D | 27. C | 28. A | 29. C | 30. B |
| 31. D | 32. D | 33. D | 34. A | 35. D | 36. B | 37. A | 38. A | 39. B | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. C | 63. D | 64. C | 65. D | 66. D | 67. D | 68. D | 69. B | 70. D |
| 71. A | 72. A | 73. B | 74. B | 75. C | 76. B | 77. B | 78. C | 79. D | 80. A |
| 81. A | 82. B | 83. C | 84. C | 85. A | 86. D | 87. D | 88. B | 89. B | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |

**ICS-PHYSICS - MODEL PAPER 4**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 4

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) is B) were  
C) are D) be

2. At present, the researchers \_\_\_\_ for the test.

- A) were prepare B) are preparing  
C) have prepare D) is preparing

3. Sadia \_\_\_\_ the application already.

- A) is completing since Monday B) have completed  
C) completed yesterday D) has completed

4. By the time the supervisor arrived, Taimur \_\_\_\_ the test schedule.

- A) checks B) was check  
C) has checked D) had checked

5. By next Friday, the team \_\_\_\_ the application.

- A) will have completed B) would complete  
C) will completed D) has completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) be  
C) were being D) have

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) have  
C) do D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) has B) have  
C) possess D) were given by

9. There \_\_\_\_ several reasons for the delay.

- A) has B) is  
C) be D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boils B) boiled  
C) will boil always D) would boil

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) had played B) will play  
C) would play D) would have played

12. If I knew the answer, I \_\_\_\_ Sadia.

- A) would tell B) would have told  
C) had told D) told

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) will catch  
C) would catch D) would have caught

14. Choose the correct passive form: "The technician checks the application."

- A) The application is being checked by the technician. B) The application was checked by the technician.  
C) The application is checked by the technician. D) The application will be checked by the technician.

15. Choose the correct passive form: "The technician is checking the test schedule."

- A) The test schedule has been checked by the technician. B) The test schedule was being checked by the technician.  
C) The test schedule is been checked by the technician. D) The test schedule is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the application."

- A) The application will be processed by the clerk. B) The application has processed by the clerk.  
C) The application was processed by the clerk. D) The application is processed by the clerk.

17. Choose the correct passive form: "The committee has approved the test schedule."

- A) The test schedule is approved by the committee. B) The test schedule has been approved by the committee.  
C) The test schedule had approved by the committee. D) The test schedule was approved by the committee.

18. Choose the correct passive form: "The office will issue the application."

- A) The application would be issued by the office. B) The application will issued by the office.  
C) The application will have issued by the office. D) The application will be issued by the office.

19. Select the correct indirect form: Sadia said, "I will complete the application."

- A) Sadia said that I would complete the application. B) Sadia told that the application would complete.  
C) Sadia said that she had complete the application. D) Sadia said that she would complete the application.

20. Select the correct indirect form: Taimur said, "I am checking the test schedule."

- A) Taimur told that he was checking the test schedule. B) Taimur said that he is checking the test schedule.  
C) Taimur said that I was checking the test schedule. D) Taimur said that he was checking the test schedule.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L4: Six friends in a row - Questions 21-24**

Six friends—Ali, Beenish, Chaman, Dua, Ehsan, and Fiza—stand in a line facing north. 1. Fiza is at the extreme right. 2. Ehsan is immediately to the left of Fiza. 3. Chaman is two places to the right of Ali. 4. Beenish sits immediately between Ali and Chaman. 5. Dua is immediately to the right of Chaman.

21. Who stands at the extreme left?

- A) Chaman B) Ehsan  
C) Dua D) Ali

22. Which person is third from the right?

- A) Ali B) Dua  
C) Beenish D) Ehsan

23. Who is positioned between Beenish and Dua?

- A) Chaman B) Ali  
C) Ehsan D) No one

24. If the row is viewed from the north side, who appears second from the left to the observer?

- A) Fiza B) Beenish  
C) Dua D) Ehsan

**Analytical Set C4: Eight friends around a table - Questions 25-28**

Eight friends—Umar, Vaneeza, Wasif, Xara, Yasir, Zara, Adil, and Bushra—sit around a circular table facing the centre. Umar is fixed at the top. 1. Yasir sits opposite Umar. 2. Vaneeza sits immediately clockwise from Umar. 3. Wasif sits immediately clockwise from Vaneeza. 4. Xara sits immediately anticlockwise from Yasir. 5. Zara sits immediately clockwise from Yasir. 6. Adil sits immediately clockwise from Zara.

25. Who sits immediately anticlockwise from Bushra?

- A) Umar B) Yasir  
C) Adil D) Zara

26. Which friend sits opposite Wasif?

- A) Bushra B) Xara  
C) Zara D) Adil

27. How many people sit between Vaneeza and Yasir along the shorter route?

- A) Four B) Two  
C) None D) One

28. If Umar and Yasir swap seats, who will be immediately clockwise from Umar?

- A) Vaneeza B) Xara  
C) Bushra D) Zara

**Analytical Set S4: Seven-day workshop plan - Questions 29-32**

A seven-day workshop runs from Monday to Sunday. One session is held each day: Logic, English, Mathematics, Physics, Chemistry, Computer, and Review. 1. Logic is on Monday. 2. Review is on Sunday. 3. English is immediately after Logic. 4. Physics is immediately after Mathematics. 5. Chemistry is on Friday. 6. Computer is immediately before Review.

29. On which day is Mathematics scheduled?

- A) Saturday B) Friday  
C) Thursday D) Wednesday

30. Which session is held on Saturday?

- A) Computer B) Chemistry  
C) Review D) English

31. How many sessions occur between English and Chemistry?

- A) Three B) Two  
C) One D) None

32. If Mathematics is cancelled and Physics moves one day earlier, what session remains on Thursday?

- A) Review B) No session  
C) Physics D) Computer

**Analytical Set D4: Library security system - Questions 33-36**

Use these rules: 1. If the library is open (L), the guard is present (G). 2. If the guard is present (G), the cameras are on (C). 3. If the power fails (P), the cameras are off. 4. If the cameras are on (C), the alarm is active (A).

33. The library is open. Which condition must be present?

- A) The guard is absent B) The library is closed  
C) The alarm is active D) The power has failed

34. If the alarm is not active, what must be true about the library?

- A) The library is open B) The guard is present  
C) The power is normal D) The library is not open

35. The power fails. Which statement is forced if all rules remain consistent?

- A) The library is open B) The guard is present  
C) The library is not open D) The alarm is active

36. The guard is present and the power has not failed. What follows from the rules?

- A) The alarm is active B) The cameras are off  
C) The library is open D) The guard is absent

**Analytical Set B4: Akbar's family - Questions 37-40**

Akbar and Bushra are married. They have three children: Danish, a son; Esha, a daughter; and Faraz, a son. Danish is married to Gohar, and their daughter is Hira. Esha is married to Imran, and their son is Junaid. Faraz is unmarried.

37. How is Hira related to Faraz?

- A) Sister B) Daughter  
C) Niece D) Aunt

38. What is Junaid's relation to Bushra?

- A) Nephew B) Grandson  
C) Son D) Brother

39. How is Imran related to Danish?

- A) Brother-in-law B) Cousin  
C) Paternal uncle D) Maternal uncle

40. What is Gohar's relation to Esha?

- A) Aunt B) Sister-in-law  
C) Cousin D) Niece

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $55 + 6 \times 8 - 8$ .

- A) 95 B) 55  
C) 480 D) 101

42. Find  $10/14 + 1/19$  in simplest form.

- A)  $1/3$  B)  $102/133$   
C)  $88/133$  D)  $11/266$

43. What is 10% of 800?  
A) 81/10 B) 720  
C) 80 D) 800
44. A price of Rs. 1460 is increased by 5%. What is the new price?  
A) Rs. 73 B) Rs. 1465  
C) Rs. 1387 D) Rs. 1533
45. Rs. 572 is divided in the ratio 6:7. What is the larger share?  
A) 264 B) 286  
C) 13 D) 308
46. If 8 identical notebooks cost Rs. 976, what will 10 notebooks cost at the same rate?  
A) 1220 B) 986  
C) 9760 D) 1098
47. Find the arithmetic mean of 77, 78, 79, 80, 81.  
A) 395 B) 79  
C) 78 D) 80
48. A student scores 74 in a 2-credit course and 73 in a 3-credit course. Find the weighted mean.  
A) 73.5 B) 183.5  
C) 73.4 D) 61.17
49. A vehicle travels 156 km at a constant speed of 78 km/h. How long does the journey take?  
A) 234 hours B) 78 hours  
C) 1/2 hours D) 2 hours
50. Worker A can complete a job in 28 days and Worker B in 55 days. Working together, how many days will they take?  
A) 83/2 days B) 83/1540 days  
C) 1540/27 days D) 1540/83 days
51. An item costs Rs. 880 and is sold at a profit of 5%. Find the selling price.  
A) Rs. 924 B) Rs. 44  
C) Rs. 836 D) Rs. 885
52. Find the simple interest on Rs. 3400 at 7% per year for 2 years.  
A) Rs. 238 B) Rs. 476  
C) Rs. 68 D) Rs. 3876
53. Solve  $5x + 7 = 142$ .  
A) 135 B) 135/7  
C) 27 D) 28
54. What is the larger root of  $x^2 - 34x + 145 = 0$ ?  
A) 5 B) 34  
C) 145 D) 29
55. Find the 12th term of the arithmetic sequence with first term 51 and common difference 6.  
A) 123 B) 111  
C) 684 D) 117
56. If  $26^x = 676$ , find  $x$ .  
A) 2 B) 26  
C) 676 D) 3
57. Find the area of a rectangle of length 32 cm and width 6 cm.  
A)  $76 \text{ cm}^2$  B)  $192 \text{ cm}^2$   
C)  $38 \text{ cm}^2$  D)  $384 \text{ cm}^2$
58. Find the slope of the line through (24, 26) and (28, 34).  
A) 1/2 B) 8  
C) 2 D) 4
59. A bag contains 3 red and 7 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?  
A) 7/10 B) 3/7  
C) 1/10 D) 3/10
60. How many different pairs can be selected from 29 people?  
A) 812 B) 31  
C) 29 D) 406

#### SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. A vehicle travels 55 m in 5 s at constant speed. What is its speed?  
A) 60 m/s B) 5/55 m/s  
C) 13 m/s D) 11 m/s
62. An object's velocity changes from 5 m/s to 35 m/s in 6 s. What is its acceleration?  
A)  $5 \text{ m/s}^2$  B)  $11 \text{ m/s}^2$   
C)  $5.8 \text{ m/s}^2$  D)  $30 \text{ m/s}^2$
63. What force is required to accelerate a 7 kg mass at  $6 \text{ m/s}^2$ ?  
A) 21 N B) 13 N  
C) 48 N D) 42 N
64. Find the kinetic energy of a 8 kg object moving at 5 m/s.  
A) 13 J B) 100 J  
C) 105 J D) 40 J
65. What is the momentum of a 4 kg object moving at 8 m/s?  
A)  $32 \text{ kg}\cdot\text{m/s}$  B)  $16 \text{ kg}\cdot\text{m/s}$   
C)  $2.00 \text{ kg}\cdot\text{m/s}$  D)  $256 \text{ kg}\cdot\text{m/s}$
66. A sample has mass 40 kg and volume  $5 \text{ m}^3$ . What is its density?  
A)  $8 \text{ kg/m}^3$  B)  $200 \text{ kg/m}^3$   
C)  $0.12 \text{ kg/m}^3$  D)  $35 \text{ kg/m}^3$
67. A force of 500 N acts uniformly over an area of  $5 \text{ m}^2$ . What pressure is produced?  
A) 105 Pa B) 0.01 Pa  
C) 100 Pa D) 500 Pa



68. A resistor of  $8\ \Omega$  carries a current of 5 A. What potential difference is across it?

- A) 13 V    B) 40 V  
C) 1.60 V    D) 0.62 V

69. An electrical device operates at 20 V and draws 5 A. What is its power?

- A) 25 W    B) 100 W  
C) 0.25 W    D) 4.00 W

70. A wave has frequency 12 Hz and wavelength 5 m. What is its speed?

- A) 17 m/s    B) 60 m/s  
C) 2.40 m/s    D) 0.42 m/s

### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $5x + 10 = 65$ .

- A) 13    B) 11  
C) 10    D) 55

72. What is the larger root of  $x^2 - 10x + 21 = 0$ ?

- A) 10    B) 7  
C) -7    D) 3

73.  $y$  varies directly as  $x$ . If  $y = 20$  when  $x = 4$ , find  $y$  when  $x = 6$ .

- A) 30    B) 22  
C) 120    D) 26

74. Find the slope of the line through (2, 5) and (5, 11).

- A)  $1/2$     B) 7  
C) -2    D) 2

75. Find the midpoint of the segment joining (3, 3) and (9, 7).

- A) (6, 4)    B) (9, 7)  
C) (5, 6)    D) (6, 5)

76. Find the distance between (1, 1) and (7, 9).

- A) 11    B) 100  
C) 6    D) 10

77. Find the area of a triangle with base 13 cm and perpendicular height 6 cm.

- A)  $39/2\text{ cm}^2$     B)  $78\text{ cm}^2$   
C)  $19\text{ cm}^2$     D)  $39\text{ cm}^2$

78. How many different pairs can be selected from 11 people?

- A) 11    B) 66  
C) 13    D) 55

79. What is  $\cos 60^\circ$ ?

- A)  $\sqrt{3}/2$     B)  $\sqrt{2}/2$   
C)  $1/2$     D) 1

80. Find the determinant of the matrix  $\begin{bmatrix} 3 & 2 \\ 6 & 3 \end{bmatrix}$ .

- A) 21    B) 6  
C) -3    D) 3

### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The component that performs arithmetic and logical operations is the:

- A) Input unit    B) ALU  
C) Hard disk    D) Control unit

82. RAM is best described as:

- A) an input device    B) permanent optical storage  
C) a network protocol    D) volatile primary memory

83. ROM is commonly used to store:

- A) firmware that should persist without power    B) temporary user data only  
C) keyboard signals    D) open application windows

84. A compiler generally translates:

- A) one instruction at a time during execution only    B) data into hardware  
C) machine code into English    D) an entire high-level program into machine code

85. An algorithm is:

- A) a computer brand    B) a network cable  
C) a finite sequence of unambiguous steps for solving a problem    D) a type of monitor

86. Pseudocode is used to:

- A) describe an algorithm in structured, language-independent form    B) encrypt a disk automatically  
C) store images    D) compile a program directly

87. A syntax error occurs when:

- A) programming-language rules are violated    B) the program runs but gives the wrong result  
C) a user forgets a password    D) data are duplicated in a table

88. A logic error causes a program to:

- A) fail grammar checking before compilation only    B) damage hardware necessarily  
C) become an operating system    D) run but produce an incorrect result

89. A variable is used to:

- A) store a value that may change during program execution    B) replace the CPU  
C) prevent all errors    D) define a monitor size

90. A function is useful because it:

- A) replaces all variables    B) is a hardware device  
C) always runs before main memory    D) encapsulates a reusable block of code



**ANSWER KEY - ICS PHYSICS MODEL PAPER 4***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. A  | 2. B  | 3. D  | 4. D  | 5. A  | 6. A  | 7. D  | 8. A  | 9. D  | 10. A |
| 11. B | 12. A | 13. D | 14. C | 15. D | 16. C | 17. B | 18. D | 19. D | 20. D |
| 21. D | 22. B | 23. A | 24. D | 25. C | 26. D | 27. B | 28. D | 29. D | 30. A |
| 31. B | 32. B | 33. C | 34. D | 35. C | 36. A | 37. C | 38. B | 39. A | 40. B |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. A | 63. D | 64. B | 65. A | 66. A | 67. C | 68. B | 69. B | 70. B |
| 71. B | 72. B | 73. A | 74. D | 75. D | 76. D | 77. D | 78. D | 79. C | 80. C |
| 81. B | 82. D | 83. A | 84. D | 85. C | 86. A | 87. A | 88. D | 89. A | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |

## ICS-PHYSICS - MODEL PAPER 5

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 5

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) were B) have  
C) are D) is

2. At present, the workers \_\_\_\_ for the test.

- A) prepared B) have prepare  
C) were prepare D) are preparing

3. Wania \_\_\_\_ the laboratory record already.

- A) had complete B) is completing since Monday  
C) completed yesterday D) has completed

4. By the time the supervisor arrived, Yahya \_\_\_\_ the design brief.

- A) has checked B) checks  
C) will have checked D) had checked

5. By next Friday, the team \_\_\_\_ the laboratory record.

- A) will completed B) had completed  
C) has completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) were being  
C) be D) have

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) has B) do  
C) have D) are having

8. Each of the candidates \_\_\_\_ an admit card.

- A) has B) are having  
C) have D) possess

9. There \_\_\_\_ several reasons for the delay.

- A) be B) has  
C) is D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boils B) would have boiled  
C) will boil always D) would boil

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) had played B) would have played  
C) played D) will play

12. If I knew the answer, I \_\_\_\_ Wania.

- A) told B) had told  
C) would have told D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) will catch B) caught  
C) would have caught D) had caught

14. Choose the correct passive form: "The technician checks the laboratory record."

- A) The laboratory record is being checked by the technician. B) The laboratory record is checked by the technician.  
C) The laboratory record will be checked by the technician. D) The laboratory record was checked by the technician.

15. Choose the correct passive form: "The technician is checking the design brief."

- A) The design brief was being checked by the technician. B) The design brief is been checked by the technician.  
C) The design brief is being checked by the technician. D) The design brief has been checked by the technician.

16. Choose the correct passive form: "The clerk processed the laboratory record."

- A) The laboratory record has processed by the clerk. B) The laboratory record was being processed by the clerk.  
C) The laboratory record was processed by the clerk. D) The laboratory record is processed by the clerk.

17. Choose the correct passive form: "The committee has approved the design brief."

- A) The design brief was approved by the committee. B) The design brief had approved by the committee.  
C) The design brief has been approved by the committee. D) The design brief has being approved by the committee.

18. Choose the correct passive form: "The office will issue the laboratory record."

- A) The laboratory record is issued by the office. B) The laboratory record would be issued by the office.  
C) The laboratory record will issued by the office. D) The laboratory record will be issued by the office.

19. Select the correct indirect form: Wania said, "I will complete the laboratory record."

- A) Wania said that she would complete the laboratory record. B) Wania said that she will complete the laboratory record.  
C) Wania told that the laboratory record would complete. D) Wania said that I would complete the laboratory record.

20. Select the correct indirect form: Yahya said, "I am checking the design brief."

- A) Yahya said that I was checking the design brief. B) Yahya said that he had checked the design brief.  
C) Yahya told that he was checking the design brief. D) Yahya said that he was checking the design brief.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L5: Seven students in a row - Questions 21-24

Seven students—Gul, Hamza, Inaya, Jawad, Komal, Laiba, and Mustafa—sit in a row facing north. 1. Jawad sits in the middle. 2. Gul sits third to the left of Jawad. 3. Mustafa sits third to the right of Jawad. 4. Hamza sits immediately to the left of Inaya. 5. Komal sits immediately to the right of Jawad. 6. Laiba sits immediately to the right of Komal.

21. Which student is seated in position three when counted from the left?

- A) Hamza B) Jawad  
C) Komal D) Inaya

22. Which student sits two places to the right of Inaya?

- A) Hamza B) Komal  
C) Jawad D) Laiba

23. How many people are seated between Gul and Jawad?

- A) Two B) One  
C) None D) Three

24. If Jawad moves to Mustafa's seat and everyone between them shifts one place left, who will sit in the middle?

- A) Komal B) Mustafa  
C) Jawad D) Inaya

**Analytical Set C5: Six participants around a round table - Questions 25-28**

Six participants—Cyrus, Daniyal, Esha, Faizan, Ghazal, and Hammad—sit around a round table facing the centre. Cyrus is fixed at the top. 1. Faizan sits opposite Cyrus. 2. Daniyal sits immediately clockwise from Cyrus. 3. Esha sits between Daniyal and Faizan on the clockwise side. 4. Ghazal sits immediately clockwise from Faizan.

25. Who sits immediately anticlockwise from Cyrus?

- A) Esha B) Daniyal  
C) Ghazal D) Hammad

26. Who is opposite Esha?

- A) Daniyal B) Hammad  
C) Faizan D) Cyrus

27. Which pair forms Faizan's immediate neighbours?

- A) Ghazal and Hammad B) Esha and Ghazal  
C) Daniyal and Esha D) Cyrus and Ghazal

28. After a one-seat anticlockwise rotation by everyone, who takes Daniyal's original position?

- A) Ghazal B) Hammad  
C) Esha D) Faizan

**Analytical Set S5: Six class periods - Questions 29-32**

Six lessons—Accounting, Biology, Chemistry, Drawing, English, and French—are placed in periods 1 to 6. 1. Accounting is in period 1. 2. French is in period 6. 3. Biology is immediately before Chemistry. 4. English is immediately after Drawing. 5. Chemistry is earlier than Drawing.

29. Which lesson is in period 3?

- A) Chemistry B) French  
C) Drawing D) English

30. What lesson immediately follows Drawing?

- A) Accounting B) French  
C) Chemistry D) English

31. How many periods separate Biology and English?

- A) Three B) None  
C) One D) Two

32. If the Biology-Chemistry pair swaps places with the Drawing-English pair, which lesson will be in period 2?

- A) Accounting B) Chemistry  
C) English D) Drawing

**Analytical Set D5: Train and meeting chain - Questions 33-36**

Use these rules: 1. If the train is late (T), the meeting is delayed (M). 2. If the meeting is delayed (M), the manager calls (C). 3. If the manager calls (C), the staff wait (W). 4. If the staff do not wait, the report is sent (R).

33. The train is late. Which result must eventually occur?

- A) The report is not sent B) The staff leave immediately  
C) The staff wait D) The manager does not call

34. The manager does not call. What must be true about the train?

- A) The train is late B) The meeting is delayed  
C) The report is not sent D) The train is not late

35. If the staff do not wait, which conclusion follows directly?

- A) The train is late B) The meeting is delayed  
C) The report is withheld D) The report is sent

36. The report is not sent. What must be true?

- A) The staff do not wait B) The train is late  
C) The meeting is delayed D) The staff wait

**Analytical Set B5: Khalid's family - Questions 37-40**

Khalid and Salma are married. Their daughter Lubna is married to Noman and has two children, Omer and Pari. Their son Majid is married to Qurat and has one son, Raza.

37. What is Omer's relation to Majid?

- A) Brother B) Uncle  
C) Cousin D) Nephew

38. How is Salma related to Pari?

- A) Mother-in-law B) Maternal aunt  
C) Paternal grandmother D) Maternal grandmother

39. What is Raza's relation to Pari?

- A) Uncle B) Brother  
C) Nephew D) Cousin

40. How is Qurat related to Lubna?

- A) Sister-in-law B) Maternal aunt  
C) Daughter-in-law D) Sister

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $57 + 7 \times 4 - 9$ .

- A) 76 B) 22  
C) 247 D) 83

42. Find  $\frac{9}{15} + \frac{19}{20}$  in simplest form.

- A)  $\frac{4}{5}$  B)  $\frac{31}{20}$   
C)  $-\frac{7}{20}$  D)  $\frac{7}{75}$

43. What is 15% of 825?  
A) 42/5 B) 55  
C) 495/4 D) 2805/4
44. A price of Rs. 1500 is increased by 10%. What is the new price?  
A) Rs. 150 B) Rs. 1510  
C) Rs. 1350 D) Rs. 1650
45. Rs. 270 is divided in the ratio 2:4. What is the larger share?  
A) 90 B) 135  
C) 6 D) 180
46. If 4 identical notebooks cost Rs. 500, what will 7 notebooks cost at the same rate?  
A) 875 B) 507  
C) 3500 D) 625
47. Find the arithmetic mean of 80, 82, 84, 86, 88.  
A) 420 B) 84  
C) 82 D) 86
48. A student scores 75 in a 3-credit course and 74 in a 4-credit course. Find the weighted mean.  
A) 74.5 B) 260.5  
C) 74.43 D) 43.42
49. A vehicle travels 240 km at a constant speed of 80 km/h. How long does the journey take?  
A) 320 hours B) 160 hours  
C) 1/3 hours D) 3 hours
50. Worker A can complete a job in 29 days and Worker B in 57 days. Working together, how many days will they take?  
A) 43 days B) 86/1653 days  
C) 1653/28 days D) 1653/86 days
51. An item costs Rs. 900 and is sold at a profit of 10%. Find the selling price.  
A) Rs. 990 B) Rs. 90  
C) Rs. 810 D) Rs. 910
52. Find the simple interest on Rs. 3500 at 8% per year for 3 years.  
A) Rs. 280 B) Rs. 840  
C) Rs. 105 D) Rs. 4340
53. Solve  $6x + 8 = 176$ .  
A) 168 B) 21  
C) 28 D) 29
54. What is the larger root of  $x^2 - 36x + 180 = 0$ ?  
A) 6 B) 36  
C) 180 D) 30
55. Find the 13th term of the arithmetic sequence with first term 53 and common difference 2.  
A) 79 B) 75  
C) 715 D) 77
56. If  $27^x = 19683$ , find x.  
A) 3 B) 27  
C) 19683 D) 4
57. Find the area of a triangle with base 35 cm and height 11 cm.  
A)  $385 \text{ cm}^2$  B)  $385/2 \text{ cm}^2$   
C)  $46 \text{ cm}^2$  D)  $385/4 \text{ cm}^2$
58. Find the midpoint of the segment joining (25, 27) and (31, 35).  
A) (6, 8) B) (56, 62)  
C) (28, 31) D) (3, 4)
59. A bag contains 4 red and 8 blue balls. One ball is selected at random. What is P(red)?  
A) 2/3 B) 1/2  
C) 1/12 D) 1/3
60. How many different pairs can be selected from 30 people?  
A) 870 B) 32  
C) 30 D) 435

#### SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. Which of the following is an SI base quantity?  
A) Force B) Energy  
C) Mass D) Power
62. A vehicle travels 72 m in 6 s at constant speed. What is its speed?  
A) 14 m/s B) 12 m/s  
C) 6/72 m/s D) 78 m/s
63. What force is required to accelerate a 2 kg mass at  $7 \text{ m/s}^2$ ?  
A) 9 N B) 7 N  
C) 14 N D) 0.29 N
64. Find the kinetic energy of a 10 kg object moving at 6 m/s.  
A) 186 J B) 180 J  
C) 360 J D) 60 J
65. What is the momentum of a 5 kg object moving at 3 m/s?  
A)  $15 \text{ kg}\cdot\text{m/s}$  B)  $8 \text{ kg}\cdot\text{m/s}$   
C)  $45 \text{ kg}\cdot\text{m/s}$  D)  $7.5 \text{ kg}\cdot\text{m/s}$
66. A sample has mass 18 kg and volume  $6 \text{ m}^3$ . What is its density?  
A)  $4 \text{ kg/m}^3$  B)  $108 \text{ kg/m}^3$   
C)  $12 \text{ kg/m}^3$  D)  $3 \text{ kg/m}^3$
67. A force of 100 N acts uniformly over an area of  $2 \text{ m}^2$ . What pressure is produced?  
A) 52 Pa B) 50 Pa  
C) 100 Pa D) 0.02 Pa

68. An electrical device operates at 6 V and draws 2 A. What is its power?

- A) 12 W   B) 14 W  
C) 3.00 W   D) 0.33 W

69. A wave has frequency 5 Hz and wavelength 6 m. What is its speed?

- A) 11 m/s   B) 35 m/s  
C) 1.20 m/s   D) 30 m/s

70. A more stable nucleus generally has:

- A) greater binding energy per nucleon   B) no neutrons  
C) more electrons than protons   D) a larger physical volume only

### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $6x + 4 = 28$ .

- A)  $14/3$    B) 5  
C) 24   D) 4

72. What is the larger root of  $x^2 - 13x + 36 = 0$ ?

- A) 36   B) 4  
C) 9   D) -9

73. Find the 6th term of the geometric sequence with first term 4 and common ratio 2.

- A) 48   B) 128  
C) 126   D) 130

74.  $y$  varies directly as  $x$ . If  $y = 30$  when  $x = 5$ , find  $y$  when  $x = 7$ .

- A) 13   B) 42  
C) 37   D) 210

75. Find the midpoint of the segment joining (4, 4) and (10, 8).

- A) (7, 6)   B) (6, 4)  
C) (6, 7)   D) (7, 7)

76. Find the distance between (2, 2) and (11, 14).

- A) 15   B) 12  
C) 225   D) 9

77. Find the area of a triangle with base 14 cm and perpendicular height 7 cm.

- A)  $49 \text{ cm}^2$    B)  $21 \text{ cm}^2$   
C)  $42 \text{ cm}^2$    D)  $49/2 \text{ cm}^2$

78. How many different pairs can be selected from 12 people?

- A) 66   B) 12  
C) 132   D) 78

79. What is  $\tan 45^\circ$ ?

- A) Undefined   B) 0  
C)  $1/2$    D) 1

80. Find the determinant of the matrix  $\begin{bmatrix} 4 & 3 \\ 7 & 4 \end{bmatrix}$ .

- A) 8   B) -5  
C) 5   D) 37

### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The decimal number 15 is represented in binary as:

- A)  $1100_2$    B)  $1010_2$   
C)  $1001_2$    D)  $1111_2$

82. An AND gate outputs 1 only when:

- A) at least one input is 1   B) inputs are different  
C) all inputs are 0   D) all inputs are 1

83. An OR gate outputs 1 when:

- A) exactly two inputs are 0   B) at least one input is 1  
C) all inputs are 0 only   D) there is no power

84. A NOT gate:

- A) sorts records   B) connects networks  
C) stores a byte   D) reverses the input truth value

85. An IP address identifies:

- A) a database row only   B) a device or interface on an IP network  
C) a keyboard key   D) a file extension

86. In a database table, a row is called a:

- A) form   B) query  
C) record   D) data type

87. In a database table, a column is called a:

- A) tuple only in every context   B) field  
C) program loop   D) record

88. A primary key should:

- A) store images only   B) always be a person's name  
C) be left blank in every row   D) uniquely identify each record

89. Database normalization helps to:

- A) prevent queries   B) increase duplicate data  
C) convert tables into images   D) reduce redundancy and update anomalies

90. Phishing is an attempt to:

- A) compress images losslessly   B) repair hardware automatically  
C) improve processor speed   D) trick users into revealing sensitive information

**ANSWER KEY - ICS PHYSICS MODEL PAPER 5***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. D  | 3. D  | 4. D  | 5. D  | 6. A  | 7. A  | 8. A  | 9. D  | 10. A |
| 11. D | 12. D | 13. C | 14. B | 15. C | 16. C | 17. C | 18. D | 19. A | 20. D |
| 21. D | 22. B | 23. A | 24. A | 25. D | 26. B | 27. B | 28. C | 29. A | 30. D |
| 31. D | 32. D | 33. C | 34. D | 35. D | 36. D | 37. D | 38. D | 39. D | 40. A |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. B | 63. C | 64. B | 65. A | 66. D | 67. B | 68. A | 69. D | 70. A |
| 71. D | 72. C | 73. B | 74. B | 75. A | 76. A | 77. A | 78. A | 79. D | 80. B |
| 81. D | 82. D | 83. B | 84. D | 85. B | 86. C | 87. B | 88. D | 89. D | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |

## ICS-PHYSICS - MODEL PAPER 6

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 6

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) be B) have  
C) were D) is

2. At present, the students \_\_\_\_ for the test.

- A) were prepare B) have prepare  
C) are preparing D) prepared

3. Lubna \_\_\_\_ the presentation already.

- A) is completing since Monday B) had complete  
C) have completed D) has completed

4. By the time the supervisor arrived, Noman \_\_\_\_ the computer program.

- A) has checked B) will have checked  
C) had checked D) was check

5. By next Friday, the team \_\_\_\_ the presentation.

- A) will completed B) has completed  
C) would complete D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) are B) is  
C) be D) have

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do B) have  
C) has D) are having

8. Each of the candidates \_\_\_\_ an admit card.

- A) were given by B) are having  
C) have D) has

9. There \_\_\_\_ several reasons for the delay.

- A) has B) be  
C) was D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) will boil always B) would boil  
C) would have boiled D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) will play B) would play  
C) would have played D) played

12. If I knew the answer, I \_\_\_\_ Lubna.

- A) had told B) would tell  
C) would have told D) will tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) had caught  
C) will catch D) would have caught

14. Choose the correct passive form: "The technician checks the presentation."

- A) The presentation is checked by the technician. B) The presentation will be checked by the technician.  
C) The presentation has checked by the technician. D) The presentation was checked by the technician.

15. Choose the correct passive form: "The technician is checking the computer program."

- A) The computer program has been checked by the technician. B) The computer program was being checked by the technician.  
C) The computer program is checked by the technician. D) The computer program is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the presentation."

- A) The presentation was being processed by the clerk. B) The presentation has processed by the clerk.  
C) The presentation was processed by the clerk. D) The presentation is processed by the clerk.

17. Choose the correct passive form: "The committee has approved the computer program."

- A) The computer program has been approved by the committee. B) The computer program had approved by the committee.  
C) The computer program has being approved by the committee. D) The computer program was approved by the committee.

18. Choose the correct passive form: "The office will issue the presentation."

- A) The presentation will be issued by the office. B) The presentation is issued by the office.  
C) The presentation will have issued by the office. D) The presentation would be issued by the office.

19. Select the correct indirect form: Lubna said, "I will complete the presentation."

- A) Lubna said that she had complete the presentation. B) Lubna said that she will complete the presentation.  
C) Lubna said that I would complete the presentation. D) Lubna said that she would complete the presentation.

20. Select the correct indirect form: Noman said, "I am checking the computer program."

- A) Noman said that he had checked the computer program. B) Noman told that he was checking the computer program.  
C) Noman said that he is checking the computer program. D) Noman said that he was checking the computer program.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L6: 6 candidates in a straight row - Questions 21-24

6 candidates—Cyrus, Bushra, Adeel, Dua, Fahad, and Ghazal—sit in a straight row, all facing north. 1. Cyrus occupies the extreme left seat. 2. Ghazal sits at the extreme right. 3. Bushra is immediately to the right of Cyrus. 4. Dua sits immediately to the right of Adeel. 5. Fahad sits between Dua and Ghazal, adjacent to both.

21. Which pair occupies the two end seats?

- A) Bushra and Ghazal B) Cyrus and Ghazal  
C) Cyrus and Fahad D) Dua and Fahad

22. Who sits second to the right of Bushra?

- A) Adeel B) Cyrus  
C) Ghazal D) Dua

23. Which statement is consistent with the completed arrangement?

- A) Adeel sits at an end B) Dua sits second from the left  
C) Bushra sits immediately left of Cyrus D) Fahad sits immediately left of Ghazal

24. If everyone now faces south without changing seats, who is immediately to the left of Dua?

- A) Bushra B) Fahad  
C) Cyrus D) Ghazal

**Analytical Set C6: 6 participants around a round table - Questions 25-28**

6 participants—Cem, Dalia, Aariz, Bina, Fiza, and Ehsan—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Cem occupies the top seat. 2. Dalia sits immediately clockwise of Cem. 3. Aariz sits immediately clockwise of Dalia. 4. Bina sits directly opposite Cem. 5. Fiza sits immediately clockwise of Bina. 6. Ehsan sits immediately clockwise of Fiza.

25. Which pair are the immediate neighbours of Cem?

- A) Aariz and Ehsan B) Ehsan and Dalia  
C) Dalia and Bina D) Cem and Aariz

26. Identify the participant opposite Aariz.

- A) Ehsan B) Dalia  
C) Bina D) Fiza

27. Who sits between Cem and Aariz on the shorter arc?

- A) Dalia B) Fiza  
C) Aariz D) Bina

28. If everyone turns to face outward, who is immediately to the left of Fiza?

- A) Dalia B) Aariz  
C) Bina D) Ehsan

**Analytical Set S6: 6 subjects in fixed slots - Questions 29-32**

The following 6 subjects are assigned one per slot: Drawing, English, Physics, Algebra, Chemistry, and Biology. 1. Drawing is scheduled in Monday. 2. Biology is scheduled in Saturday. 3. English occurs immediately after Drawing. 4. Algebra occurs immediately after Physics. 5. Chemistry is between Algebra and Biology, consecutive with both.

29. What is the first scheduled activity?

- A) Biology B) Algebra  
C) Chemistry D) Drawing

30. When does Chemistry take place?

- A) Wednesday B) Thursday  
C) Monday D) Friday

31. Which pair occurs in two consecutive slots in the stated order?

- A) Drawing followed by Biology B) Physics followed by Algebra  
C) Drawing followed by Physics D) English followed by Chemistry

32. If English and Chemistry exchange slots, which activity occupies Tuesday?

- A) Drawing B) Physics  
C) Algebra D) Chemistry

**Analytical Set D6: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the proposal is funded, then the audit begins. 2. If the audit begins, then the report is drafted. 3. If the report is drafted, then the board meets. 4. If a security hold is imposed, then the report is not drafted. 5. If an alert is issued, then a security hold is imposed.

33. If the proposal is funded, which outcome must eventually follow?

- A) A security hold is imposed B) The audit does not begin  
C) The report is not drafted D) The board meets

34. Suppose the board does not meet. Which conclusion is unavoidable?

- A) The report is drafted B) The audit begins  
C) The proposal is not funded D) A security hold is imposed

35. If an alert is issued, what must be true about the second condition?

- A) The audit begins B) The report is drafted  
C) The board meets D) The audit does not begin

36. Which pair cannot both be true under the stated rules?

- A) The proposal is funded and the audit begins B) A security hold is imposed and an alert is issued  
C) The proposal is funded and a security hold is imposed D) The audit begins and the board meets

**Analytical Set B6: The family of Rauf and Shazia - Questions 37-40**

Rauf and Shazia are married. Their children are Adnan, a son, and Bina, a daughter. Adnan is married to Naila; their children are Iqra, a son, and Junaid, a daughter. Bina is married to Hamid; their child is Komal, a son.

37. How is Shazia related to Junaid?

- A) Mother-in-law B) Maternal aunt  
C) Maternal grandmother D) Paternal grandmother

38. What is Bina's relation to Iqra?

- A) Maternal aunt B) Sister-in-law  
C) Sister D) Paternal aunt

39. How is Komal related to Junaid?

- A) Uncle B) Brother-in-law  
C) Cousin D) Sibling

40. How is Naila related to Bina?

- A) Maternal aunt B) Paternal aunt  
C) Mother-in-law D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $59 + 8 \times 5 - 10$ .

- A) 89 B) 19  
C) 325 D) 97



42. Find  $\frac{8}{16} + \frac{19}{21}$  in simplest form.

- A)  $\frac{27}{37}$  B)  $\frac{59}{42}$   
C)  $-\frac{17}{42}$  D)  $\frac{9}{112}$

43. What is 20% of 850?

- A)  $\frac{87}{10}$  B)  $\frac{85}{2}$   
C) 170 D) 680

44. A price of Rs. 1540 is increased by 15%. What is the new price?

- A) Rs. 231 B) Rs. 1555  
C) Rs. 1309 D) Rs. 1771

45. Rs. 414 is divided in the ratio 3:6. What is the larger share?

- A) 138 B) 207  
C) 9 D) 276

46. If 5 identical notebooks cost Rs. 640, what will 9 notebooks cost at the same rate?

- A) 1152 B) 649  
C) 5760 D) 768

47. Find the arithmetic mean of 83, 86, 89, 92, 95.

- A) 445 B) 89  
C) 86 D) 92

48. A student scores 76 in a 4-credit course and 75 in a 5-credit course. Find the weighted mean.

- A) 75.5 B) 339.5  
C) 75.44 D) 33.95

49. A vehicle travels 328 km at a constant speed of 82 km/h. How long does the journey take?

- A) 410 hours B) 246 hours  
C)  $\frac{1}{4}$  hours D) 4 hours

50. Worker A can complete a job in 30 days and Worker B in 59 days. Working together, how many days will they take?

- A)  $\frac{89}{2}$  days B)  $\frac{89}{1770}$  days  
C)  $\frac{1770}{29}$  days D)  $\frac{1770}{89}$  days

51. An item costs Rs. 920 and is sold at a profit of 15%. Find the selling price.

- A) Rs. 1058 B) Rs. 138  
C) Rs. 782 D) Rs. 935

52. Find the simple interest on Rs. 3600 at 9% per year for 4 years.

- A) Rs. 324 B) Rs. 1296  
C) Rs. 144 D) Rs. 4896

53. Solve  $7x + 9 = 212$ .

- A) 203 B)  $\frac{203}{9}$   
C) 29 D) 30

54. What is the larger root of  $x^2 - 38x + 217 = 0$ ?

- A) 7 B) 38  
C) 217 D) 31

55. Find the 14th term of the arithmetic sequence with first term 55 and common difference 3.

- A) 97 B) 91  
C) 812 D) 94

56. If  $28^x = 614656$ , find  $x$ .

- A) 4 B) 28  
C) 614656 D) 5

57. Using  $\pi = \frac{22}{7}$ , find the circumference of a circle of radius 189 cm.

- A) 112266 cm B) 1188 cm  
C) 594 cm D) 378 cm

58. Find the distance between (26, 27) and (29, 31).

- A) 7 B) 4  
C) 5 D) 25

59. A bag contains 5 red and 9 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $\frac{9}{14}$  B)  $\frac{5}{9}$   
C)  $\frac{1}{14}$  D)  $\frac{5}{14}$

60. How many different pairs can be selected from 31 people?

- A) 930 B) 33  
C) 31 D) 465

#### SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. A vehicle travels 26 m in 2 s at constant speed. What is its speed?

- A) 15 m/s B)  $\frac{2}{26}$  m/s  
C) 26 m/s D) 13 m/s

62. An object's velocity changes from 2 m/s to 14 m/s in 4 s. What is its acceleration?

- A)  $6 \text{ m/s}^2$  B)  $3 \text{ m/s}^2$   
C)  $4 \text{ m/s}^2$  D)  $12 \text{ m/s}^2$

63. What force is required to accelerate a 3 kg mass at  $3 \text{ m/s}^2$ ?

- A) 1.00 N B) 6 N  
C) 4.5 N D) 9 N

64. What is the momentum of a 6 kg object moving at 4 m/s?

- A)  $10 \text{ kg} \cdot \text{m/s}$  B)  $96 \text{ kg} \cdot \text{m/s}$   
C)  $24 \text{ kg} \cdot \text{m/s}$  D)  $12 \text{ kg} \cdot \text{m/s}$

65. A sample has mass 8 kg and volume  $2 \text{ m}^3$ . What is its density?

- A)  $6 \text{ kg/m}^3$  B)  $16 \text{ kg/m}^3$   
C)  $0.25 \text{ kg/m}^3$  D)  $4 \text{ kg/m}^3$

66. A force of 180 N acts uniformly over an area of  $3 \text{ m}^2$ . What pressure is produced?

- A) 180 Pa B) 0.02 Pa  
C) 63 Pa D) 60 Pa

67. A resistor of  $4\ \Omega$  carries a current of 2 A. What potential difference is across it?

- A) 0.50 V B) 2.00 V  
C) 12 V D) 8 V

68. An electrical device operates at 8 V and draws 3 A. What is its power?

- A) 11 W B) 27 W  
C) 0.38 W D) 24 W

69. A wave has frequency 6 Hz and wavelength 2 m. What is its speed?

- A) 3.00 m/s B) 12 m/s  
C) 18 m/s D) 0.33 m/s

70. The photoelectric effect supports the idea that light energy is carried in:

- A) magnetic poles B) neutrons  
C) photons D) sound pulses

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $2x + 5 = 17$ .

- A) 6 B) 12  
C) 5 D) 7

72. What is the larger root of  $x^2 - 16x + 55 = 0$ ?

- A) -11 B) 16  
C) 11 D) 5

73. If  $\log_2 32 = x$ , find x.

- A) 2 B) 6  
C) 32 D) 5

74. y varies directly as x. If  $y = 12$  when  $x = 6$ , find y when  $x = 8$ .

- A) 96 B) 20  
C) 10 D) 16

75. Find the slope of the line through (4, 2) and (7, 14).

- A) 3 B) 4  
C) -4 D) 13

76. Find the midpoint of the segment joining (0, 5) and (6, 9).

- A) (3, 7) B) (6, 4)  
C) (6, 9) D) (3, 8)

77. Find the distance between (0, 3) and (12, 19).

- A) 21 B) 12  
C) 400 D) 20

78. Find the area of a triangle with base 15 cm and perpendicular height 8 cm.

- A)  $46\text{ cm}^2$  B)  $30\text{ cm}^2$   
C)  $23\text{ cm}^2$  D)  $60\text{ cm}^2$

79. How many different pairs can be selected from 13 people?

- A) 15 B) 13  
C) 156 D) 78

80. Find the determinant of the matrix  $\begin{bmatrix} 5 & 1 \\ 3 & 5 \end{bmatrix}$ .

- A) 23 B) -22  
C) 22 D) 10

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. Encryption converts readable data into:

- A) a flowchart B) ciphertext  
C) a monitor signal D) a compiler

82. A strong password should generally be:

- A) the user's name only B) a common dictionary word  
C) shared publicly D) long, unique and difficult to guess

83. Cloud computing provides resources:

- A) without any servers B) inside a keyboard  
C) over a network on demand D) only from a local floppy disk

84. Machine learning enables systems to:

- A) improve performance from data B) avoid evaluation  
C) operate without algorithms or data D) replace all hardware

85. Supervised learning uses:

- A) hardware instructions B) no data  
C) unlabelled data exclusively D) labelled training examples

86. A black-box model is difficult to:

- A) train with data B) interpret internally  
C) execute on a computer D) represent numerically

87. The purpose of testing software is to:

- A) increase file size B) guarantee no future changes  
C) remove all documentation D) find defects and verify expected behaviour

88. The expression  $14 \% 3$  in C evaluates to:

- A) 4.67 B) 2  
C) 3 D) 1

89. In C,  $\&\&$  represents logical:

- A) NOT B) AND  
C) OR D) assignment

90. A for loop header normally contains:

- A) class, object and method B) initialization, condition and update  
C) source, destination and protocol D) table, row and field

**ANSWER KEY - ICS PHYSICS MODEL PAPER 6***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. C  | 3. D  | 4. C  | 5. D  | 6. B  | 7. C  | 8. D  | 9. D  | 10. D |
| 11. A | 12. B | 13. D | 14. A | 15. D | 16. C | 17. A | 18. A | 19. D | 20. D |
| 21. B | 22. D | 23. D | 24. B | 25. B | 26. A | 27. A | 28. C | 29. D | 30. D |
| 31. B | 32. D | 33. D | 34. C | 35. D | 36. C | 37. D | 38. D | 39. C | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. B | 63. D | 64. C | 65. D | 66. D | 67. D | 68. D | 69. B | 70. C |
| 71. A | 72. C | 73. D | 74. D | 75. B | 76. A | 77. D | 78. D | 79. D | 80. C |
| 81. B | 82. D | 83. C | 84. A | 85. D | 86. B | 87. D | 88. B | 89. B | 90. B |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |

## ICS-PHYSICS - MODEL PAPER 7

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 7

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) were B) are  
C) is D) have

2. At present, the technicians \_\_\_\_ for the test.

- A) were prepare B) is preparing  
C) have prepare D) are preparing

3. Shazia \_\_\_\_ the survey form already.

- A) had complete B) is completing since Monday  
C) completed yesterday D) has completed

4. By the time the supervisor arrived, Rafay \_\_\_\_ the experiment log.

- A) had checked B) has checked  
C) was check D) will have checked

5. By next Friday, the team \_\_\_\_ the survey form.

- A) would complete B) will completed  
C) had completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) have B) were being  
C) are D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do B) are having  
C) have D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having B) possess  
C) were given by D) has

9. There \_\_\_\_ several reasons for the delay.

- A) are B) was  
C) be D) is

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) will boil always  
C) would boil D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) played B) would play  
C) will play D) had played

12. If I knew the answer, I \_\_\_\_ Shazia.

- A) will tell B) would tell  
C) had told D) would have told

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) would catch  
C) would have caught D) had caught

14. Choose the correct passive form: "The technician checks the survey form."

- A) The survey form will be checked by the technician. B) The survey form was checked by the technician.  
C) The survey form is checked by the technician. D) The survey form has checked by the technician.

15. Choose the correct passive form: "The technician is checking the experiment log."

- A) The experiment log is been checked by the technician. B) The experiment log was being checked by the technician.  
C) The experiment log is being checked by the technician. D) The experiment log has been checked by the technician.

16. Choose the correct passive form: "The clerk processed the survey form."

- A) The survey form has processed by the clerk. B) The survey form was processed by the clerk.  
C) The survey form is processed by the clerk. D) The survey form was being processed by the clerk.

17. Choose the correct passive form: "The committee has approved the experiment log."

- A) The experiment log was approved by the committee. B) The experiment log had approved by the committee.  
C) The experiment log is approved by the committee. D) The experiment log has been approved by the committee.

18. Choose the correct passive form: "The office will issue the survey form."

- A) The survey form would be issued by the office. B) The survey form is issued by the office.  
C) The survey form will have issued by the office. D) The survey form will be issued by the office.

19. Select the correct indirect form: Shazia said, "I will complete the survey form."

- A) Shazia said that she would complete the survey form. B) Shazia said that she will complete the survey form.  
C) Shazia said that she had complete the survey form. D) Shazia said that I would complete the survey form.

20. Select the correct indirect form: Rafay said, "I am checking the experiment log."

- A) Rafay said that he was checking the experiment log. B) Rafay told that he was checking the experiment log.  
C) Rafay said that he is checking the experiment log. D) Rafay said that I was checking the experiment log.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L7: 7 candidates in a straight row - Questions 21-24

7 candidates—Laiba, Noreen, Iqra, Muneeb, Jibran, Hammad, and Komal—sit in a straight row, all facing north. 1. Noreen is second from the left. 2. Hammad is second from the right. 3. Laiba sits immediately left of Noreen. 4. Iqra sits immediately right of Noreen. 5. Muneeb occupies the central seat. 6. Jibran is immediately right of Muneeb. 7. Komal is immediately right of Hammad.

21. Who is in the left-middle seat of this row?

- A) Laiba B) Komal  
C) Iqra D) Hammad

22. Who sits exactly between Noreen and Muneeb?

- A) Laiba B) Iqra  
C) Jibran D) Hammad

23. Who is third from the right end?

- A) Hammad B) Noreen  
C) Muneeb D) Jibran

24. If Noreen and Hammad exchange seats, who occupies seat 2 from the left?

- A) Noreen B) Hammad  
C) Komal D) Muneeb

**Analytical Set C7: 8 participants around a round table - Questions 25-28**

8 participants—Irtaza, Laila, Hiba, Mahir, Joya, Nida, Gibran, and Kashan—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Irtaza sits at the top. 2. Kashan is immediately anticlockwise from Irtaza. 3. Gibran is immediately anticlockwise from Kashan. 4. Joya is opposite Irtaza. 5. Mahir is immediately anticlockwise from Joya. 6. Hiba is immediately anticlockwise from Mahir. 7. Laila sits between Irtaza and Hiba, adjacent to both. 8. Nida is immediately clockwise from Joya.

25. Who occupies the bottom seat, directly across from the top seat?

- A) Laila B) Irtaza  
C) Hiba D) Joya

26. Who is second anticlockwise from Irtaza?

- A) Nida B) Joya  
C) Hiba D) Gibran

27. Which pair sits in consecutive clockwise seats?

- A) Mahir and Kashan B) Irtaza and Nida  
C) Irtaza and Mahir D) Hiba and Mahir

28. If Laila exchanges seats with the person opposite, who then sits immediately clockwise of Irtaza?

- A) Irtaza B) Gibran  
C) Mahir D) Nida

**Analytical Set S7: 7 sessions in fixed slots - Questions 29-32**

The following 7 sessions are assigned one per slot: Audit, Guidance, Design, Briefing, Coding, Finance, and Evaluation. 1. Briefing is scheduled in the middle slot, Thursday. 2. Audit opens the schedule. 3. Evaluation closes the schedule. 4. Guidance immediately follows Audit. 5. Design immediately precedes Briefing. 6. Coding immediately follows Briefing. 7. Finance immediately precedes Evaluation.

29. Which activity is assigned to Thursday?

- A) Design B) Briefing  
C) Finance D) Evaluation

30. What comes immediately after Design?

- A) Coding B) Evaluation  
C) Guidance D) Briefing

31. Which pair occupies the first and last slots respectively?

- A) Guidance and Design B) Design and Finance  
C) Guidance and Coding D) Audit and Evaluation

32. If Guidance is postponed by two slots and intervening activities shift earlier, what occupies Wednesday?

- A) Guidance B) Audit  
C) Briefing D) Design

**Analytical Set D7: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the student qualifies, then the interview is scheduled. 2. If the student qualifies, then the documents are verified. 3. If the interview is scheduled, then the fee voucher is issued. 4. If the documents are verified, then the admission file opens. 5. If the fee voucher is issued, then the final list includes the student.

33. When the student qualifies, which later result is guaranteed?

- A) The final list includes the student B) The fee voucher is not issued  
C) The documents are not verified D) The interview is not scheduled

34. If the admission file does not open, what must be concluded?

- A) The student does not qualify B) The interview is scheduled  
C) The student qualifies D) The documents are verified

35. Given that the fee voucher is not issued, which earlier condition must be false?

- A) The documents are verified B) The admission file opens  
C) The student qualifies D) The interview is not scheduled

36. If the student qualifies, which pair must both be true?

- A) The fee voucher is issued and the admission file does not open B) The interview is scheduled and the documents are not verified  
C) The fee voucher is not issued and the final list includes the student D) The fee voucher is issued and the admission file opens

**Analytical Set B7: The family of Tariq and Uzma - Questions 37-40**

Tariq and Uzma are married. Their children are Bilal, a son, and Celia, a daughter. Bilal is married to Dua; their children are Gul, a son, and Haris, a daughter. Celia is married to Fahad; their child is Ilma, a son.

37. How is Uzma related to Haris?

- A) Paternal aunt B) Paternal grandmother  
C) Maternal aunt D) Maternal grandmother

38. What is Celia's relation to Gul?

- A) Maternal aunt B) Niece  
C) Paternal aunt D) Sister-in-law

39. How is Ilma related to Haris?

- A) Uncle B) Nephew  
C) Brother-in-law D) Cousin

40. How is Dua related to Celia?

- A) Mother-in-law B) Paternal aunt  
C) Sister-in-law D) Maternal aunt

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $61 + 9 \times 6 - 2$ .

- A) 113 B) 97  
C) 418 D) 122

42. Find  $7/17 + 10/13$  in simplest form.

- A)  $17/30$  B)  $261/221$   
C)  $-79/221$  D)  $1/13$

43. What is 25% of 875?

- A) 9 B) 35  
C)  $875/4$  D)  $2625/4$

44. A price of Rs. 1580 is increased by 20%. What is the new price?

- A) Rs. 316 B) Rs. 1600  
C) Rs. 1264 D) Rs. 1896

45. Rs. 564 is divided in the ratio 4:8. What is the larger share?

- A) 188 B) 282  
C) 12 D) 376

46. If 6 identical notebooks cost Rs. 786, what will 11 notebooks cost at the same rate?

- A) 1441 B) 797  
C) 8646 D) 917

47. Find the arithmetic mean of 86, 90, 94, 98, 102.

- A) 470 B) 94  
C) 90 D) 98

48. A student scores 77 in a 2-credit course and 76 in a 6-credit course. Find the weighted mean.

- A) 76.5 B) 305  
C) 76.25 D) 50.83

49. A vehicle travels 420 km at a constant speed of 84 km/h. How long does the journey take?

- A) 504 hours B) 336 hours  
C)  $1/5$  hours D) 5 hours

50. Worker A can complete a job in 31 days and Worker B in 61 days. Working together, how many days will they take?

- A) 46 days B)  $92/1891$  days  
C)  $1891/30$  days D)  $1891/92$  days

51. An item costs Rs. 940 and is sold at a profit of 20%. Find the selling price.

- A) Rs. 1128 B) Rs. 188  
C) Rs. 752 D) Rs. 960

52. Find the simple interest on Rs. 3700 at 10% per year for 5 years.

- A) Rs. 370 B) Rs. 1850  
C) Rs. 185 D) Rs. 5550

53. Solve  $8x + 10 = 250$ .

- A) 240 B) 24  
C) 30 D) 31

54. What is the larger root of  $x^2 - 40x + 256 = 0$ ?

- A) 8 B) 40  
C) 256 D) 32

55. Find the 15th term of the arithmetic sequence with first term 57 and common difference 4.

- A) 117 B) 109  
C) 915 D) 113

56. If  $29^x = 841$ , find x.

- A) 2 B) 29  
C) 841 D) 3

57. Find the area of a rectangle of length 35 cm and width 9 cm.

- A)  $88 \text{ cm}^2$  B)  $315 \text{ cm}^2$   
C)  $44 \text{ cm}^2$  D)  $630 \text{ cm}^2$

58. Find the slope of the line through (27, 29) and (31, 37).

- A)  $1/2$  B) 8  
C) 2 D) 4

59. A bag contains 6 red and 10 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $5/8$  B)  $3/5$   
C)  $1/16$  D)  $3/8$

60. How many different pairs can be selected from 32 people?

- A) 992 B) 34  
C) 32 D) 496

## SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. Which of the following is an SI base quantity?

- A) Pressure B) Power  
C) Mass D) Energy

62. A vehicle travels 42 m in 3 s at constant speed. What is its speed?

- A)  $3/42 \text{ m/s}$  B)  $42 \text{ m/s}$   
C)  $45 \text{ m/s}$  D)  $14 \text{ m/s}$

63. An object's velocity changes from 3 m/s to 23 m/s in 5 s. What is its acceleration?

- A)  $4 \text{ m/s}^2$  B)  $20 \text{ m/s}^2$   
C)  $4.6 \text{ m/s}^2$  D)  $5 \text{ m/s}^2$

64. Find the kinetic energy of a 4 kg object moving at 3 m/s.

- A) 21 J B) 18 J  
C) 12 J D) 36 J

65. What is the momentum of a 7 kg object moving at 5 m/s?

- A)  $35 \text{ kg}\cdot\text{m/s}$  B)  $17.5 \text{ kg}\cdot\text{m/s}$   
C)  $175 \text{ kg}\cdot\text{m/s}$  D)  $12 \text{ kg}\cdot\text{m/s}$

66. A sample has mass 15 kg and volume  $3 \text{ m}^3$ . What is its density?

- A)  $45 \text{ kg/m}^3$  B)  $5 \text{ kg/m}^3$   
C)  $12 \text{ kg/m}^3$  D)  $0.20 \text{ kg/m}^3$

67. A force of 280 N acts uniformly over an area of 4 m<sup>2</sup>. What pressure is produced?

- A) 1120 Pa    B) 70 Pa  
C) 0.01 Pa    D) 74 Pa

68. An electrical device operates at 10 V and draws 4 A. What is its power?

- A) 40 W    B) 44 W  
C) 14 W    D) 0.40 W

69. A wave has frequency 7 Hz and wavelength 3 m. What is its speed?

- A) 10 m/s    B) 2.33 m/s  
C) 0.43 m/s    D) 21 m/s

70. The SI unit of frequency is the:

- A) hertz    B) coulomb  
C) pascal    D) joule

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $3x + 6 = 30$ .

- A) 7    B) 24  
C) 9    D) 8

72. What is the larger root of  $x^2 - 15x + 54 = 0$ ?

- A) 54    B) -9  
C) 15    D) 9

73. Find the 5th term of the geometric sequence with first term 3 and common ratio 2.

- A) 30    B) 48  
C) 46    D) 50

74. y varies directly as x. If  $y = 21$  when  $x = 7$ , find y when  $x = 9$ .

- A) 30    B) 27  
C) 23    D) 12

75. Find the midpoint of the segment joining (1, 2) and (7, 6).

- A) (4, 4)    B) (3, 5)  
C) (4, 5)    D) (7, 6)

76. Find the distance between (1, 0) and (4, 4).

- A) 6    B) 4  
C) 3    D) 5

77. Find the area of a triangle with base 8 cm and perpendicular height 9 cm.

- A) 34 cm<sup>2</sup>    B) 17 cm<sup>2</sup>  
C) 72 cm<sup>2</sup>    D) 36 cm<sup>2</sup>

78. A bag contains 7 red and 8 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A) 15/7    B) 7/15  
C) 7/8    D) 8/15

79. How many different pairs can be selected from 6 people?

- A) 30    B) 15  
C) 8    D) 21

80. What is  $\sin 30^\circ$ ?

- A)  $1/2$     B)  $\sqrt{2}/2$   
C) 1    D) 0

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The component that performs arithmetic and logical operations is the:

- A) Monitor    B) Hard disk  
C) Control unit    D) ALU

82. RAM is best described as:

- A) permanent optical storage    B) an input device  
C) read-only firmware only    D) volatile primary memory

83. ROM is commonly used to store:

- A) internet addresses    B) open application windows  
C) temporary user data only    D) firmware that should persist without power

84. A compiler generally translates:

- A) machine code into English    B) data into hardware  
C) images into audio    D) an entire high-level program into machine code

85. An algorithm is:

- A) a computer brand    B) a network cable  
C) a type of monitor    D) a finite sequence of unambiguous steps for solving a problem

86. Pseudocode is used to:

- A) describe an algorithm in structured, language-independent form    B) replace all testing  
C) encrypt a disk automatically    D) store images

87. A syntax error occurs when:

- A) data are duplicated in a table    B) a user forgets a password  
C) programming-language rules are violated    D) the computer loses power

88. A logic error causes a program to:

- A) become an operating system    B) have no variables  
C) run but produce an incorrect result    D) damage hardware necessarily

89. A variable is used to:

- A) store a value that may change during program execution    B) define a monitor size  
C) draw a network cable    D) replace the CPU

90. A function is useful because it:

- A) encapsulates a reusable block of code    B) is a hardware device  
C) can contain no parameters    D) always runs before main memory

**ANSWER KEY - ICS PHYSICS MODEL PAPER 7***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. C  | 2. D  | 3. D  | 4. A  | 5. D  | 6. D  | 7. D  | 8. D  | 9. A  | 10. D |
| 11. C | 12. B | 13. C | 14. C | 15. C | 16. B | 17. D | 18. D | 19. A | 20. A |
| 21. C | 22. B | 23. D | 24. B | 25. D | 26. D | 27. D | 28. D | 29. B | 30. D |
| 31. D | 32. C | 33. A | 34. A | 35. D | 36. D | 37. B | 38. C | 39. D | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. D | 63. A | 64. B | 65. A | 66. B | 67. B | 68. A | 69. D | 70. A |
| 71. D | 72. D | 73. B | 74. B | 75. A | 76. D | 77. D | 78. B | 79. B | 80. A |
| 81. D | 82. D | 83. D | 84. D | 85. D | 86. A | 87. C | 88. C | 89. A | 90. A |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |



## ICS-PHYSICS - MODEL PAPER 8

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 8

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) be B) were  
C) is D) have

2. At present, the candidates \_\_\_\_ for the test.

- A) are preparing B) prepared  
C) were prepare D) is preparing

3. Imran \_\_\_\_ the admission file already.

- A) has completed B) have completed  
C) had complete D) is completing since Monday

4. By the time the supervisor arrived, Gohar \_\_\_\_ the attendance sheet.

- A) checks B) had checked  
C) has checked D) will have checked

5. By next Friday, the team \_\_\_\_ the admission file.

- A) would complete B) has completed  
C) will completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) were being B) be  
C) is D) have

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do B) were  
C) has D) are having

8. Each of the candidates \_\_\_\_ an admit card.

- A) were given by B) possess  
C) has D) have

9. There \_\_\_\_ several reasons for the delay.

- A) was B) has  
C) be D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) boils  
C) boiled D) would boil

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) will play B) would have played  
C) played D) would play

12. If I knew the answer, I \_\_\_\_ Imran.

- A) told B) would tell  
C) will tell D) had told

13. If they had left earlier, they \_\_\_\_ the train.

- A) had caught B) would have caught  
C) will catch D) caught

14. Choose the correct passive form: "The technician checks the admission file."

- A) The admission file is checked by the technician. B) The admission file will be checked by the technician.  
C) The admission file is being checked by the technician. D) The admission file was checked by the technician.

15. Choose the correct passive form: "The technician is checking the attendance sheet."

- A) The attendance sheet is been checked by the technician. B) The attendance sheet is checked by the technician.  
C) The attendance sheet was being checked by the technician. D) The attendance sheet is being checked by the technician.

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- A) The admission file will be processed by the clerk. B) The admission file was being processed by the clerk.  
C) The admission file was processed by the clerk. D) The admission file is processed by the clerk.

17. Choose the correct passive form: "The committee has approved the attendance sheet."

- A) The attendance sheet is approved by the committee. B) The attendance sheet had approved by the committee.  
C) The attendance sheet was approved by the committee. D) The attendance sheet has been approved by the committee.

18. Choose the correct passive form: "The office will issue the admission file."

- A) The admission file is issued by the office. B) The admission file would be issued by the office.  
C) The admission file will be issued by the office. D) The admission file will issued by the office.

19. Select the correct indirect form: Imran said, "I will complete the admission file."

- A) Imran told that the admission file would complete. B) Imran said that he will complete the admission file.  
C) Imran said that he had complete the admission file. D) Imran said that he would complete the admission file.

20. Select the correct indirect form: Gohar said, "I am checking the attendance sheet."

- A) Gohar told that she was checking the attendance sheet. B) Gohar said that I was checking the attendance sheet.  
C) Gohar said that she was checking the attendance sheet. D) Gohar said that she is checking the attendance sheet.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L8: 8 candidates in a straight row - Questions 21-24

8 candidates—Parveen, Vania, Umar, Tania, Owais, Qadir, Saad, and Rida—sit in a straight row, all facing north. 1. Parveen is at the extreme left. 2. Rida is at the extreme right. 3. Umar occupies the third seat. 4. Vania sits immediately left of Umar. 5. Tania sits immediately right of Umar. 6. Qadir is third from the right. 7. Owais is immediately left of Qadir. 8. Saad is immediately right of Qadir.

21. Which pair is seated next to each other?

- A) Parveen and Umar B) Parveen and Qadir  
C) Umar and Tania D) Umar and Rida

22. Who is farthest from Parveen?

- A) Owais B) Qadir  
C) Saad D) Rida

23. How many seats lie strictly between Umar and Rida?

- A) 4 B) 1  
C) 2 D) 0

24. If Rida moves to the left end and everyone else shifts one seat right, who becomes fourth from the left?

- A) Umar B) Rida  
C) Saad D) Parveen

**Analytical Set C8: 6 participants around a round table - Questions 25-28**

6 participants—Rania, Qais, Shah, Pina, Talia, and Omar—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Rania occupies the top seat. 2. Qais sits immediately clockwise of Rania. 3. Shah sits immediately clockwise of Qais. 4. Pina sits directly opposite Rania. 5. Talia sits immediately clockwise of Pina. 6. Omar sits immediately clockwise of Talia.

25. Who is the clockwise neighbour of Talia?

- A) Shah B) Rania  
C) Talia D) Omar

26. Which person is separated from Pina by exactly half the circle?

- A) Rania B) Talia  
C) Qais D) Pina

27. With everyone facing inward, who is on the immediate right of Qais?

- A) Rania B) Omar  
C) Shah D) Pina

28. If the clockwise order is reversed while the top person remains fixed, who becomes third clockwise from the top?

- A) Rania B) Talia  
C) Shah D) Qais

**Analytical Set S8: 6 presentations in fixed slots - Questions 29-32**

The following 6 presentations are assigned one per slot: Karachi, Peshawar, Multan, Lahore, Rawalpindi, and Quetta. 1. Karachi is scheduled in 8:00 a.m.. 2. Quetta is scheduled in 1:00 p.m.. 3. Peshawar occurs immediately after Karachi. 4. Lahore occurs immediately after Multan. 5. Rawalpindi is between Lahore and Quetta, consecutive with both.

29. Identify the slot assigned to Peshawar.

- A) 10:00 a.m. B) 9:00 a.m.  
C) 11:00 a.m. D) 12:00 noon

30. Which activity closes the schedule?

- A) Multan B) Quetta  
C) Lahore D) Rawalpindi

31. Which activity falls between Peshawar and Lahore?

- A) Peshawar B) Lahore  
C) Karachi D) Multan

32. If the final three activities are conducted in reverse order, which activity becomes second-last?

- A) Rawalpindi B) Lahore  
C) Peshawar D) Multan

**Analytical Set D8: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the server starts, then the network connects. 2. If the network connects, then the server starts. 3. If the network connects, then the database loads. 4. If the database loads, then the dashboard does not appear. 5. If maintenance mode is active, then the dashboard appears. 6. If the warning lamp glows, then maintenance mode is active.

33. If the server starts, which statement must be true?

- A) The warning lamp glows B) The network does not connect  
C) The dashboard does not appear D) Maintenance mode is active

34. Assume the dashboard appears. Which condition must fail?

- A) The server does not start B) The server starts  
C) Maintenance mode is active D) The network connects

35. What follows necessarily when the warning lamp glows?

- A) The dashboard appears B) The database loads  
C) The dashboard does not appear D) The server starts

36. Which pair is logically incompatible?

- A) The server starts and the network connects B) The server starts and the database loads  
C) The network connects and maintenance mode is active D) The dashboard appears and maintenance mode is active

**Analytical Set B8: The family of Waseem and Yasmeen - Questions 37-40**

Waseem and Yasmeen are married. Their children are Kamran, a son, and Laraib, a daughter. Kamran is married to Maha; their children are Omaira, a son, and Parsa, a daughter. Laraib is married to Nabeel; their child is Qadir, a son.

37. How is Yasmeen related to Parsa?

- A) Paternal grandmother B) Mother-in-law  
C) Paternal aunt D) Maternal aunt

38. What is Laraib's relation to Omaira?

- A) Niece B) Paternal aunt  
C) Sister-in-law D) Sister

39. How is Qadir related to Parsa?

- A) Cousin B) Brother-in-law  
C) Sibling D) Uncle

40. How is Maha related to Laraib?

- A) Maternal aunt B) Paternal aunt  
C) Sister-in-law D) Cousin

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $63 + 3 \times 7 - 3$ .

- A) 81 B) 75  
C) 459 D) 84

42. Find  $7/11 + 7/14$  in simplest form.

- A)  $14/25$  B)  $25/22$   
C)  $3/22$  D)  $1/11$

43. What is 30% of 900?

- A) 93/10 B) 30  
C) 270 D) 630

44. A price of Rs. 1620 is increased by 25%. What is the new price?

- A) Rs. 405 B) Rs. 1645  
C) Rs. 1215 D) Rs. 2025

45. Rs. 528 is divided in the ratio 5:6. What is the larger share?

- A) 240 B) 264  
C) 11 D) 288

46. If 7 identical notebooks cost Rs. 938, what will 9 notebooks cost at the same rate?

- A) 1206 B) 947  
C) 8442 D) 1072

47. Find the arithmetic mean of 89, 94, 99, 104, 109.

- A) 495 B) 99  
C) 94 D) 104

48. A student scores 78 in a 3-credit course and 77 in a 3-credit course. Find the weighted mean.

- A) 232.5 B) 51.67  
C) 77.5 D) 78

49. A vehicle travels 172 km at a constant speed of 86 km/h. How long does the journey take?

- A) 258 hours B) 86 hours  
C)  $1/2$  hours D) 2 hours

50. Worker A can complete a job in 32 days and Worker B in 63 days. Working together, how many days will they take?

- A)  $95/2$  days B)  $95/2016$  days  
C)  $2016/31$  days D)  $2016/95$  days

51. An item costs Rs. 960 and is sold at a profit of 25%. Find the selling price.

- A) Rs. 1200 B) Rs. 240  
C) Rs. 720 D) Rs. 985

52. Find the simple interest on Rs. 3800 at 4% per year for 2 years.

- A) Rs. 152 B) Rs. 304  
C) Rs. 76 D) Rs. 4104

53. Solve  $2x + 11 = 73$ .

- A) 62 B)  $62/11$   
C) 31 D) 32

54. What is the larger root of  $x^2 - 35x + 66 = 0$ ?

- A) 2 B) 35  
C) 66 D) 33

55. Find the 16th term of the arithmetic sequence with first term 59 and common difference 5.

- A) 139 B) 129  
C) 1024 D) 134

56. If  $30^x = 27000$ , find x.

- A) 3 B) 30  
C) 27000 D) 4

57. Find the area of a triangle with base 38 cm and height 5 cm.

- A)  $190 \text{ cm}^2$  B)  $95 \text{ cm}^2$   
C)  $43 \text{ cm}^2$  D)  $95/2 \text{ cm}^2$

58. Find the midpoint of the segment joining (28, 30) and (34, 38).

- A) (6, 8) B) (62, 68)  
C) (31, 34) D) (3, 4)

59. A bag contains 7 red and 4 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $4/11$  B)  $7/4$   
C)  $1/11$  D)  $7/11$

60. How many different pairs can be selected from 33 people?

- A) 1056 B) 35  
C) 33 D) 528

#### SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. A vehicle travels 60 m in 4 s at constant speed. What is its speed?

- A) 15 m/s B) 64 m/s  
C)  $4/60$  m/s D) 17 m/s

62. An object's velocity changes from 4 m/s to 34 m/s in 6 s. What is its acceleration?

- A)  $6 \text{ m/s}^2$  B)  $30 \text{ m/s}^2$   
C)  $5 \text{ m/s}^2$  D)  $5.7 \text{ m/s}^2$

63. What force is required to accelerate a 5 kg mass at  $5 \text{ m/s}^2$ ?

- A) 12.5 N B) 25 N  
C) 1.00 N D) 30 N

64. Find the kinetic energy of a 6 kg object moving at 4 m/s.

- A) 96 J B) 52 J  
C) 10 J D) 48 J

65. What is the momentum of a 8 kg object moving at 6 m/s?

- A)  $48 \text{ kg} \cdot \text{m/s}$  B)  $288 \text{ kg} \cdot \text{m/s}$   
C)  $14 \text{ kg} \cdot \text{m/s}$  D)  $24 \text{ kg} \cdot \text{m/s}$

66. A sample has mass 24 kg and volume  $4 \text{ m}^3$ . What is its density?

- A)  $6 \text{ kg/m}^3$  B)  $96 \text{ kg/m}^3$   
C)  $7 \text{ kg/m}^3$  D)  $20 \text{ kg/m}^3$

67. A force of 400 N acts uniformly over an area of 5 m<sup>2</sup>. What pressure is produced?

- A) 85 Pa    B) 0.01 Pa  
C) 2000 Pa    D) 80 Pa

68. An electrical device operates at 12 V and draws 5 A. What is its power?

- A) 65 W    B) 0.42 W  
C) 17 W    D) 60 W

69. A wave has frequency 8 Hz and wavelength 4 m. What is its speed?

- A) 2.00 m/s    B) 0.50 m/s  
C) 12 m/s    D) 32 m/s

70. A convex lens can form a real image when the object is:

- A) at infinity only    B) outside its focal point  
C) behind the lens    D) between the lens and focal point only

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $4x + 7 = 47$ .

- A) 10    B) 9  
C)  $47/4$     D) 11

72. What is the larger root of  $x^2 - 18x + 77 = 0$ ?

- A) 11    B) 18  
C) -11    D) 7

73. If  $\log_5 125 = x$ , find  $x$ .

- A) 3    B) 4  
C) 125    D) 2

74.  $y$  varies directly as  $x$ . If  $y = 32$  when  $x = 8$ , find  $y$  when  $x = 10$ .

- A) 34    B) 40  
C) 42    D) 14

75. Find the slope of the line through (2, 4) and (5, 10).

- A) 7    B) -2  
C) 2    D)  $1/2$

76. Find the midpoint of the segment joining (2, 3) and (8, 7).

- A) (8, 7)    B) (5, 5)  
C) (6, 4)    D) (5, 6)

77. Find the distance between (2, 1) and (8, 9).

- A) 6    B) 11  
C) 8    D) 10

78. Find the area of a triangle with base 9 cm and perpendicular height 10 cm.

- A) 90 cm<sup>2</sup>    B) 38 cm<sup>2</sup>  
C) 45 cm<sup>2</sup>    D) 19 cm<sup>2</sup>

79. How many different pairs can be selected from 7 people?

- A) 28    B) 42  
C) 9    D) 21

80. What is  $\cos 60^\circ$ ?

- A) 0    B)  $\sqrt{3}/2$   
C)  $1/2$     D)  $\sqrt{2}/2$

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The decimal number 15 is represented in binary as:

- A)  $1110_2$     B)  $1001_2$   
C)  $1100_2$     D)  $1111_2$

82. An AND gate outputs 1 only when:

- A) all inputs are 0    B) at least one input is 1  
C) inputs are different    D) all inputs are 1

83. An OR gate outputs 1 when:

- A) inputs are always equal    B) all inputs are 0 only  
C) exactly two inputs are 0    D) at least one input is 1

84. A NOT gate:

- A) adds two inputs    B) connects networks  
C) sorts records    D) reverses the input truth value

85. An IP address identifies:

- A) a device or interface on an IP network    B) a programming loop  
C) a database row only    D) a file extension

86. In a database table, a row is called a:

- A) field    B) data type  
C) record    D) query

87. In a database table, a column is called a:

- A) tuple only in every context    B) report  
C) program loop    D) field

88. A primary key should:

- A) contain duplicate values    B) be left blank in every row  
C) uniquely identify each record    D) store images only

89. Database normalization helps to:

- A) reduce redundancy and update anomalies    B) increase duplicate data  
C) prevent queries    D) remove all keys

90. Phishing is an attempt to:

- A) repair hardware automatically    B) improve processor speed  
C) create a backup    D) trick users into revealing sensitive information

**ANSWER KEY - ICS PHYSICS MODEL PAPER 8***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. C  | 2. A  | 3. A  | 4. B  | 5. D  | 6. C  | 7. C  | 8. C  | 9. D  | 10. B |
| 11. A | 12. B | 13. B | 14. A | 15. D | 16. C | 17. D | 18. C | 19. D | 20. C |
| 21. C | 22. D | 23. A | 24. A | 25. D | 26. A | 27. A | 28. B | 29. B | 30. B |
| 31. D | 32. A | 33. C | 34. A | 35. A | 36. C | 37. A | 38. B | 39. A | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. A | 62. C | 63. B | 64. D | 65. A | 66. A | 67. D | 68. D | 69. D | 70. B |
| 71. A | 72. A | 73. A | 74. B | 75. C | 76. B | 77. D | 78. C | 79. D | 80. C |
| 81. D | 82. D | 83. D | 84. D | 85. A | 86. C | 87. D | 88. C | 89. A | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |

## ICS-PHYSICS - MODEL PAPER 9

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 9

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) is B) have  
C) are D) were

2. At present, the researchers \_\_\_\_ for the test.

- A) were prepare B) prepared  
C) is preparing D) are preparing

3. Veena \_\_\_\_ the equipment list already.

- A) completed yesterday B) has completed  
C) is completing since Monday D) had complete

4. By the time the supervisor arrived, Wahaj \_\_\_\_ the data table.

- A) has checked B) will have checked  
C) was check D) had checked

5. By next Friday, the team \_\_\_\_ the equipment list.

- A) would complete B) had completed  
C) will have completed D) will completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) have  
C) be D) were being

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) have  
C) were D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) were given by B) have  
C) are having D) has

9. There \_\_\_\_ several reasons for the delay.

- A) be B) has  
C) was D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) will boil always  
C) boiled D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) played B) had played  
C) will play D) would play

12. If I knew the answer, I \_\_\_\_ Veena.

- A) will tell B) told  
C) had told D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) had caught B) would catch  
C) will catch D) would have caught

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- A) The equipment list is being checked by the technician. B) The equipment list was checked by the technician.  
C) The equipment list has checked by the technician. D) The equipment list is checked by the technician.

15. Choose the correct passive form: "The technician is checking the data table."

- A) The data table is being checked by the technician. B) The data table is checked by the technician.  
C) The data table was being checked by the technician. D) The data table has been checked by the technician.

16. Choose the correct passive form: "The clerk processed the equipment list."

- A) The equipment list was being processed by the clerk. B) The equipment list is processed by the clerk.  
C) The equipment list will be processed by the clerk. D) The equipment list was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the data table."

- A) The data table has been approved by the committee. B) The data table is approved by the committee.  
C) The data table was approved by the committee. D) The data table had approved by the committee.

18. Choose the correct passive form: "The office will issue the equipment list."

- A) The equipment list will be issued by the office. B) The equipment list will issued by the office.  
C) The equipment list is issued by the office. D) The equipment list would be issued by the office.

19. Select the correct indirect form: Veena said, "I will complete the equipment list."

- A) Veena told that the equipment list would complete. B) Veena said that I would complete the equipment list.  
C) Veena said that she will complete the equipment list. D) Veena said that she would complete the equipment list.

20. Select the correct indirect form: Wahaj said, "I am checking the data table."

- A) Wahaj said that she was checking the data table. B) Wahaj said that I was checking the data table.  
C) Wahaj said that she had checked the data table. D) Wahaj told that she was checking the data table.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L9: 6 candidates in a straight row - Questions 21-24

6 candidates—Basit, Zain, Celia, Waleed, Areeba, and Yusra—sit in a straight row, all facing north. 1. Basit occupies the extreme left seat. 2. Yusra sits at the extreme right. 3. Zain is immediately to the right of Basit. 4. Waleed sits immediately to the right of Celia. 5. Areeba sits between Waleed and Yusra, adjacent to both.

21. Identify the person sitting in seat 5.

- A) Celia B) Areeba  
C) Basit D) Yusra

22. Who is the immediate left neighbour of Areeba?

- A) Yusra B) Celia  
C) Areeba D) Waleed

23. Which pair is NOT seated adjacently?

- A) Zain and Celia B) Basit and Zain  
C) Waleed and Areeba D) Basit and Celia

24. If the entire row is viewed from the opposite end, who appears third from the left?

- A) Yusra B) Waleed  
C) Basit D) Celia

**Analytical Set C9: 8 participants around a round table - Questions 25-28**

8 participants—Vania, Waseem, Adil, Zainab, Ubaid, Yara, Cyrus, and Bisma—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Vania sits at the top. 2. Bisma is immediately anticlockwise from Vania. 3. Cyrus is immediately anticlockwise from Bisma. 4. Ubaid is opposite Vania. 5. Zainab is immediately anticlockwise from Ubaid. 6. Adil is immediately anticlockwise from Zainab. 7. Waseem sits between Vania and Adil, adjacent to both. 8. Yara is immediately clockwise from Ubaid.

25. Who sits one place clockwise from Vania?

- A) Adil B) Bisma  
C) Waseem D) Cyrus

26. For Set C9, which pair sits opposite each other?

- A) Zainab and Cyrus B) Adil and Cyrus  
C) Waseem and Bisma D) Ubaid and Bisma

27. Who sits immediately clockwise of Bisma, crossing the top position?

- A) Bisma B) Yara  
C) Vania D) Cyrus

28. If all participants face outward, who is immediately to the right of Adil?

- A) Zainab B) Cyrus  
C) Bisma D) Yara

**Analytical Set S9: 7 classes in fixed slots - Questions 29-32**

The following 7 classes are assigned one per slot: Physics, Calculus, Aptitude, Writing, Logic, Grammar, and Vocabulary. 1. Writing is scheduled in the middle slot, Period 4. 2. Physics opens the schedule. 3. Vocabulary closes the schedule. 4. Calculus immediately follows Physics. 5. Aptitude immediately precedes Writing. 6. Logic immediately follows Writing. 7. Grammar immediately precedes Vocabulary.

29. What is scheduled during Period 5?

- A) Writing B) Aptitude  
C) Logic D) Physics

30. Which activity directly precedes Logic?

- A) Physics B) Grammar  
C) Aptitude D) Writing

31. How many activities are scheduled between Physics and Writing?

- A) 3 B) 2  
C) 0 D) 1

32. If the opening activity is shifted to the end and all others move one slot earlier, which activity is last?

- A) Calculus B) Grammar  
C) Physics D) Vocabulary

**Analytical Set D9: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the train departs, then the signal turns green. 2. If the crossing closes, then the signal turns green. 3. If the signal turns green, then the platform announcement plays. 4. If the platform announcement does not play, then an obstruction is detected. 5. If an obstruction is detected, then the alarm sounds.

33. Which result is forced if the train departs?

- A) The signal does not turn green B) An obstruction is detected  
C) The alarm sounds D) The platform announcement plays

34. If the platform announcement does not play, which pair of statements must both be true?

- A) The train does not depart and the crossing does not close B) The train departs and the crossing closes  
C) The crossing closes and the alarm sounds D) The signal turns green and an obstruction is detected

35. If the signal does not turn green, which conclusion follows immediately?

- A) An obstruction is detected B) The train does not depart  
C) The platform announcement plays D) The crossing closes

36. Suppose an obstruction is detected. What must occur next in the implication chain?

- A) The signal turns green B) The platform announcement plays  
C) The crossing closes D) The alarm sounds

**Analytical Set B9: The family of Zubair and Afsheen - Questions 37-40**

Zubair and Afsheen are married. Their children are Rameez, a son, and Sonia, a daughter. Rameez is married to Tuba; their children are Vania, a son, and Wajid, a daughter. Sonia is married to Usman; their child is Yumna, a son.

37. How is Afsheen related to Wajid?

- A) Paternal aunt B) Mother-in-law  
C) Maternal aunt D) Paternal grandmother

38. What is Sonia's relation to Vania?

- A) Niece B) Maternal aunt  
C) Sister-in-law D) Paternal aunt

39. How is Yumna related to Wajid?

- A) Sibling B) Uncle  
C) Brother-in-law D) Cousin

40. How is Tuba related to Sonia?

- A) Paternal aunt B) Cousin  
C) Maternal aunt D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $65 + 4 \times 8 - 4$ .

- A) 93 B) 81  
C) 548 D) 97



42. Find  $\frac{4}{12} + \frac{4}{15}$  in simplest form.

- A)  $\frac{8}{27}$  B)  $\frac{3}{5}$   
C)  $\frac{1}{15}$  D)  $\frac{2}{45}$

43. What is 35% of 925?

- A)  $\frac{48}{5}$  B)  $\frac{185}{7}$   
C)  $\frac{1295}{4}$  D)  $\frac{2405}{4}$

44. A price of Rs. 1660 is increased by 30%. What is the new price?

- A) Rs. 498 B) Rs. 1690  
C) Rs. 1162 D) Rs. 2158

45. Rs. 686 is divided in the ratio 6:8. What is the larger share?

- A) 294 B) 343  
C) 14 D) 392

46. If 8 identical notebooks cost Rs. 1096, what will 11 notebooks cost at the same rate?

- A) 1507 B) 1107  
C) 12056 D) 1233

47. Find the arithmetic mean of 92, 98, 104, 110, 116.

- A) 520 B) 104  
C) 98 D) 110

48. A student scores 79 in a 4-credit course and 78 in a 4-credit course. Find the weighted mean.

- A) 314 B) 39.25  
C) 78.5 D) 79

49. A vehicle travels 264 km at a constant speed of 88 km/h. How long does the journey take?

- A) 352 hours B) 176 hours  
C)  $\frac{1}{3}$  hours D) 3 hours

50. Worker A can complete a job in 33 days and Worker B in 65 days. Working together, how many days will they take?

- A) 49 days B)  $\frac{98}{2145}$  days  
C)  $\frac{2145}{32}$  days D)  $\frac{2145}{98}$  days

51. An item costs Rs. 980 and is sold at a profit of 30%. Find the selling price.

- A) Rs. 1274 B) Rs. 294  
C) Rs. 686 D) Rs. 1010

52. Find the simple interest on Rs. 3900 at 5% per year for 3 years.

- A) Rs. 195 B) Rs. 585  
C) Rs. 117 D) Rs. 4485

53. Solve  $3x + 12 = 108$ .

- A) 96 B) 8  
C) 32 D) 33

54. What is the larger root of  $x^2 - 37x + 102 = 0$ ?

- A) 3 B) 37  
C) 102 D) 34

55. Find the 17th term of the arithmetic sequence with first term 61 and common difference 6.

- A) 163 B) 151  
C) 1139 D) 157

56. If  $31^x = 923521$ , find x.

- A) 4 B) 31  
C) 923521 D) 5

57. Using  $\pi = \frac{22}{7}$ , find the circumference of a circle of radius 210 cm.

- A) 138600 cm B) 1320 cm  
C) 660 cm D) 420 cm

58. Find the distance between (29, 30) and (32, 34).

- A) 7 B) 4  
C) 5 D) 25

59. A bag contains 8 red and 5 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $\frac{5}{13}$  B)  $\frac{8}{5}$   
C)  $\frac{1}{13}$  D)  $\frac{8}{13}$

60. How many different pairs can be selected from 34 people?

- A) 1122 B) 36  
C) 34 D) 561

## SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. Which of the following is an SI base quantity?

- A) Force B) Mass  
C) Pressure D) Power

62. A vehicle travels 80 m in 5 s at constant speed. What is its speed?

- A) 18 m/s B)  $\frac{5}{80}$  m/s  
C) 80 m/s D) 16 m/s

63. What force is required to accelerate a 6 kg mass at  $6 \text{ m/s}^2$ ?

- A) 18 N B) 1.00 N  
C) 36 N D) 42 N

64. Find the kinetic energy of a 8 kg object moving at 5 m/s.

- A) 105 J B) 13 J  
C) 200 J D) 100 J

65. What is the momentum of a 2 kg object moving at 7 m/s?

- A)  $9 \text{ kg} \cdot \text{m/s}$  B)  $7 \text{ kg} \cdot \text{m/s}$   
C)  $98 \text{ kg} \cdot \text{m/s}$  D)  $14 \text{ kg} \cdot \text{m/s}$

66. A sample has mass 35 kg and volume  $5 \text{ m}^3$ . What is its density?

- A)  $8 \text{ kg/m}^3$  B)  $0.14 \text{ kg/m}^3$   
C)  $175 \text{ kg/m}^3$  D)  $7 \text{ kg/m}^3$



67. A force of 180 N acts uniformly over an area of 2 m<sup>2</sup>. What pressure is produced?

- A) 180 Pa B) 90 Pa  
C) 0.01 Pa D) 360 Pa

68. An electrical device operates at 14 V and draws 2 A. What is its power?

- A) 0.14 W B) 16 W  
C) 30 W D) 28 W

69. A wave has frequency 9 Hz and wavelength 5 m. What is its speed?

- A) 54 m/s B) 14 m/s  
C) 1.80 m/s D) 45 m/s

70. The direction of conventional current is taken as the direction of motion of:

- A) photons B) positive charge  
C) electrons only D) atoms

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $5x + 8 = 23$ .

- A) 4 B) 2  
C) 15 D) 3

72. What is the larger root of  $x^2 - 9x + 14 = 0$ ?

- A) -7 B) 2  
C) 14 D) 7

73. If  $\log_2 16 = x$ , find x.

- A) 5 B) 3  
C) 2 D) 4

74. y varies directly as x. If y = 15 when x = 3, find y when x = 5.

- A) 75 B) 20  
C) 25 D) 10

75. Find the midpoint of the segment joining (3, 4) and (9, 8).

- A) (6, 4) B) (6, 7)  
C) (9, 8) D) (6, 6)

76. Find the distance between (0, 2) and (9, 14).

- A) 16 B) 225  
C) 9 D) 15

77. Find the area of a triangle with base 10 cm and perpendicular height 5 cm.

- A) 15 cm<sup>2</sup> B) 50 cm<sup>2</sup>  
C) 25/2 cm<sup>2</sup> D) 25 cm<sup>2</sup>

78. How many different pairs can be selected from 8 people?

- A) 36 B) 8  
C) 28 D) 56

79. What is  $\tan 45^\circ$ ?

- A) 1/2 B) Undefined  
C)  $\sqrt{3}$  D) 1

80. Find the determinant of the matrix  $\begin{bmatrix} 4 & 1 \\ 6 & 4 \end{bmatrix}$ .

- A) 8 B) 10  
C) -10 D) 11

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. Encryption converts readable data into:

- A) a monitor signal B) a database key only  
C) ciphertext D) a compiler

82. A strong password should generally be:

- A) long, unique and difficult to guess B) the user's name only  
C) the same for every account D) a common dictionary word

83. Cloud computing provides resources:

- A) over a network on demand B) inside a keyboard  
C) only from a local floppy disk D) without any servers

84. Machine learning enables systems to:

- A) guarantee perfect predictions B) improve performance from data  
C) replace all hardware D) avoid evaluation

85. Supervised learning uses:

- A) no data B) hardware instructions  
C) only random numbers D) labelled training examples

86. A black-box model is difficult to:

- A) train with data B) represent numerically  
C) execute on a computer D) interpret internally

87. The purpose of testing software is to:

- A) increase file size B) find defects and verify expected behaviour  
C) remove all documentation D) replace users

88. The expression  $14 \% 3$  in C evaluates to:

- A) 4.67 B) 1  
C) 4 D) 2

89. In C, && represents logical:

- A) assignment B) NOT  
C) division D) AND

90. A for loop header normally contains:

- A) source, destination and protocol B) initialization, condition and update  
C) input, output and storage D) class, object and method

**ANSWER KEY - ICS PHYSICS MODEL PAPER 9***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. A  | 2. D  | 3. B  | 4. D  | 5. C  | 6. A  | 7. D  | 8. D  | 9. D  | 10. D |
| 11. C | 12. D | 13. D | 14. D | 15. A | 16. D | 17. A | 18. A | 19. D | 20. A |
| 21. B | 22. D | 23. D | 24. B | 25. C | 26. B | 27. C | 28. A | 29. C | 30. D |
| 31. B | 32. C | 33. D | 34. A | 35. B | 36. D | 37. D | 38. D | 39. D | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. D | 63. C | 64. D | 65. D | 66. D | 67. B | 68. D | 69. D | 70. B |
| 71. D | 72. D | 73. D | 74. C | 75. D | 76. D | 77. D | 78. C | 79. D | 80. B |
| 81. C | 82. A | 83. A | 84. B | 85. D | 86. D | 87. B | 88. D | 89. D | 90. B |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |

**ICS-PHYSICS - MODEL PAPER 10**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Physics 10

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) are  
C) be D) is

2. At present, the workers \_\_\_\_ for the test.

- A) is preparing B) have prepare  
C) were prepare D) are preparing

3. Sameer \_\_\_\_ the research summary already.

- A) is completing since Monday B) has completed  
C) have completed D) completed yesterday

4. By the time the supervisor arrived, Tuba \_\_\_\_ the question paper.

- A) checks B) was check  
C) has checked D) had checked

5. By next Friday, the team \_\_\_\_ the research summary.

- A) would complete B) will completed  
C) will have completed D) had completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) were being B) be  
C) have D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do B) have  
C) were D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) were given by B) are having  
C) has D) have

9. There \_\_\_\_ several reasons for the delay.

- A) is B) be  
C) are D) has

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) boils  
C) would boil D) boiled

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play B) had played  
C) would have played D) will play

12. If I knew the answer, I \_\_\_\_ Sameer.

- A) would have told B) would tell  
C) will tell D) had told

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) would catch  
C) had caught D) would have caught

14. Choose the correct passive form: "The technician checks the research summary."

- A) The research summary was checked by the technician. B) The research summary will be checked by the technician.  
C) The research summary has checked by the technician. D) The research summary is checked by the technician.

15. Choose the correct passive form: "The technician is checking the question paper."

- A) The question paper is checked by the technician. B) The question paper has been checked by the technician.  
C) The question paper was being checked by the technician. D) The question paper is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the research summary."

- A) The research summary was being processed by the clerk. B) The research summary is processed by the clerk.  
C) The research summary was processed by the clerk. D) The research summary will be processed by the clerk.

17. Choose the correct passive form: "The committee has approved the question paper."

- A) The question paper was approved by the committee. B) The question paper is approved by the committee.  
C) The question paper has been approved by the committee. D) The question paper had approved by the committee.

18. Choose the correct passive form: "The office will issue the research summary."

- A) The research summary would be issued by the office. B) The research summary will issued by the office.  
C) The research summary will have issued by the office. D) The research summary will be issued by the office.

19. Select the correct indirect form: Sameer said, "I will complete the research summary."

- A) Sameer said that he will complete the research summary. B) Sameer told that the research summary would complete.  
C) Sameer said that I would complete the research summary. D) Sameer said that he would complete the research summary.

20. Select the correct indirect form: Tuba said, "I am checking the question paper."

- A) Tuba told that she was checking the question paper. B) Tuba said that I was checking the question paper.  
C) Tuba said that she is checking the question paper. D) Tuba said that she was checking the question paper.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L10: 7 candidates in a straight row - Questions 21-24**

7 candidates—Kashif, Faizan, Hina, Javeria, Esha, Imran, and Daniyal—sit in a straight row, all facing north. 1. Faizan is second from the left. 2. Imran is second from the right. 3. Kashif sits immediately left of Faizan. 4. Hina sits immediately right of Faizan. 5. Javeria occupies the central seat. 6. Esha is immediately right of Javeria. 7. Daniyal is immediately right of Imran.

21. Who occupies the fifth seat from the left?

- A) Esha B) Hina  
C) Imran D) Kashif

22. What is the position of Imran in the row?

- A) First from the left    B) Fifth from the left  
C) Sixth from the left    D) Third from the left

23. Who sits immediately to the left of Javeria?

- A) Hina    B) Imran  
C) Esha    D) Daniyal

24. How many people sit between Faizan and Imran?

- A) 4    B) 1  
C) 2    D) 3

**Analytical Set C10: 6 participants around a round table - Questions 25-28**

6 participants—Haris, Gul, Eman, Fahim, Danish, and Iqra—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Haris occupies the top seat. 2. Gul sits immediately clockwise of Haris. 3. Eman sits immediately clockwise of Gul. 4. Fahim sits directly opposite Haris. 5. Danish sits immediately clockwise of Fahim. 6. Iqra sits immediately clockwise of Danish.

25. Who sits immediately clockwise of Gul?

- A) Gul    B) Danish  
C) Eman    D) Iqra

26. Who sits directly opposite Haris?

- A) Danish    B) Gul  
C) Fahim    D) Haris

27. Who is second clockwise from Iqra?

- A) Gul    B) Iqra  
C) Danish    D) Haris

28. All participants face the centre. Who is immediately to the right of Fahim?

- A) Gul    B) Haris  
C) Danish    D) Eman

**Analytical Set S10: 6 meetings in fixed slots - Questions 29-32**

The following 6 meetings are assigned one per slot: Energy, Data, Budget, Grants, Faculty, and Campus. 1. Energy is scheduled in Monday. 2. Campus is scheduled in Saturday. 3. Data occurs immediately after Energy. 4. Grants occurs immediately after Budget. 5. Faculty is between Grants and Campus, consecutive with both.

29. On which slot is Budget scheduled?

- A) Thursday    B) Tuesday  
C) Wednesday    D) Monday

30. Which activity is scheduled in Friday?

- A) Grants    B) Data  
C) Energy    D) Faculty

31. Which activity occurs immediately before Grants?

- A) Campus    B) Energy  
C) Budget    D) Grants

32. How many complete slots lie between Data and Campus?

- A) 3    B) 1  
C) 0    D) 4

**Analytical Set D10: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the experiment begins, then the heater switches on. 2. If the heater switches on, then the sample does not warm. 3. If the sensor records data, then the sample warms. 4. If the safety lock engages, then the sensor records data. 5. If the technician presses reset, then the experiment begins.

33. If the technician presses reset, which statement is certain?

- A) The experiment does not begin    B) The safety lock engages  
C) The sensor records data    D) The sample does not warm

34. Given that the sample warms, what can be deduced about the last condition?

- A) The heater switches on    B) The technician does not press reset  
C) The sensor records data    D) The experiment begins

35. What must be true when the safety lock engages?

- A) The sample does not warm    B) The heater switches on  
C) The experiment begins    D) The heater does not switch on

36. Which two conditions cannot both hold?

- A) The technician presses reset and the experiment begins    B) The sensor records data and the safety lock engages  
C) The experiment begins and the heater switches on    D) The experiment begins and the sensor records data

**Analytical Set B10: The family of Feroz and Ghazala - Questions 37-40**

Feroz and Ghazala are married. Their children are Hasan, a son, and Inaya, a daughter. Hasan is married to Jalal; their children are Latif, a son, and Maira, a daughter. Inaya is married to Kiran; their child is Noman, a son.

37. How is Ghazala related to Maira?

- A) Paternal aunt    B) Maternal grandmother  
C) Maternal aunt    D) Paternal grandmother

38. What is Inaya's relation to Latif?

- A) Paternal aunt    B) Niece  
C) Maternal aunt    D) Sister

39. How is Noman related to Maira?

- A) Nephew    B) Cousin  
C) Sibling    D) Brother-in-law

40. How is Jalal related to Inaya?

- A) Cousin    B) Paternal aunt  
C) Mother-in-law    D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $67 + 5 \times 4 - 5$ .

- A) 82    B) 62  
C) 283    D) 87

42. Find  $\frac{1}{13} + \frac{1}{16}$  in simplest form.

- A)  $\frac{2}{29}$  B)  $\frac{29}{208}$   
C)  $\frac{3}{208}$  D)  $\frac{1}{104}$

43. What is 40% of 950?

- A)  $\frac{99}{10}$  B)  $\frac{95}{4}$   
C) 380 D) 570

44. A price of Rs. 1700 is increased by 5%. What is the new price?

- A) Rs. 85 B) Rs. 1705  
C) Rs. 1615 D) Rs. 1785

45. Rs. 350 is divided in the ratio 2:5. What is the larger share?

- A) 100 B) 175  
C) 7 D) 250

46. If 4 identical notebooks cost Rs. 560, what will 8 notebooks cost at the same rate?

- A) 1120 B) 568  
C) 4480 D) 700

47. Find the arithmetic mean of 95, 96, 97, 98, 99.

- A) 485 B) 97  
C) 96 D) 98

48. A student scores 80 in a 2-credit course and 79 in a 5-credit course. Find the weighted mean.

- A) 79.5 B) 277.5  
C) 79.29 D) 55.5

49. A vehicle travels 360 km at a constant speed of 90 km/h. How long does the journey take?

- A) 450 hours B) 270 hours  
C)  $\frac{1}{4}$  hours D) 4 hours

50. Worker A can complete a job in 34 days and Worker B in 67 days. Working together, how many days will they take?

- A)  $10\frac{1}{2}$  days B)  $10\frac{1}{2278}$  days  
C)  $\frac{2278}{33}$  days D)  $\frac{2278}{101}$  days

51. An item costs Rs. 1000 and is sold at a profit of 35%. Find the selling price.

- A) Rs. 1350 B) Rs. 350  
C) Rs. 650 D) Rs. 1035

52. Find the simple interest on Rs. 4000 at 6% per year for 4 years.

- A) Rs. 240 B) Rs. 960  
C) Rs. 160 D) Rs. 4960

53. Solve  $4x + 13 = 145$ .

- A) 132 B)  $\frac{132}{13}$   
C) 33 D) 34

54. What is the larger root of  $x^2 - 39x + 140 = 0$ ?

- A) 4 B) 39  
C) 140 D) 35

55. Find the 8th term of the arithmetic sequence with first term 63 and common difference 2.

- A) 79 B) 75  
C) 520 D) 77

56. If  $32^x = 1024$ , find x.

- A) 2 B) 32  
C) 1024 D) 3

57. Find the area of a rectangle of length 38 cm and width 5 cm.

- A)  $86 \text{ cm}^2$  B)  $190 \text{ cm}^2$   
C)  $43 \text{ cm}^2$  D)  $380 \text{ cm}^2$

58. Find the slope of the line through (30, 32) and (34, 40).

- A)  $\frac{1}{2}$  B) 8  
C) 2 D) 4

59. A bag contains 9 red and 6 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $\frac{2}{5}$  B)  $\frac{3}{2}$   
C)  $\frac{1}{15}$  D)  $\frac{3}{5}$

60. How many different pairs can be selected from 35 people?

- A) 1190 B) 37  
C) 35 D) 595

#### SECTION IV-A: PHYSICS | 10 QUESTIONS | Questions 61-70

61. A vehicle travels 102 m in 6 s at constant speed. What is its speed?

- A) 17 m/s B) 102 m/s  
C)  $\frac{6}{102} \text{ m/s}$  D) 19 m/s

62. An object's velocity changes from 6 m/s to 18 m/s in 4 s. What is its acceleration?

- A)  $4 \text{ m/s}^2$  B)  $12 \text{ m/s}^2$   
C)  $10 \text{ m/s}^2$  D)  $3 \text{ m/s}^2$

63. What force is required to accelerate a 7 kg mass at  $7 \text{ m/s}^2$ ?

- A) 56 N B) 24.5 N  
C) 1.00 N D) 49 N

64. Find the kinetic energy of a 10 kg object moving at 6 m/s.

- A) 360 J B) 186 J  
C) 180 J D) 60 J

65. What is the momentum of a 3 kg object moving at 8 m/s?

- A)  $24 \text{ kg}\cdot\text{m/s}$  B)  $192 \text{ kg}\cdot\text{m/s}$   
C)  $12 \text{ kg}\cdot\text{m/s}$  D)  $11 \text{ kg}\cdot\text{m/s}$

66. A sample has mass 48 kg and volume  $6 \text{ m}^3$ . What is its density?

- A)  $42 \text{ kg/m}^3$  B)  $8 \text{ kg/m}^3$   
C)  $288 \text{ kg/m}^3$  D)  $9 \text{ kg/m}^3$

67. A force of 300 N acts uniformly over an area of 3 m<sup>2</sup>. What pressure is produced?

- A) 103 Pa    B) 100 Pa  
C) 300 Pa    D) 900 Pa

68. An electrical device operates at 16 V and draws 3 A. What is its power?

- A) 51 W    B) 19 W  
C) 5.33 W    D) 48 W

69. A wave has frequency 10 Hz and wavelength 6 m. What is its speed?

- A) 1.67 m/s    B) 60 m/s  
C) 0.60 m/s    D) 16 m/s

70. Radioactive half-life is the time required for:

- A) the temperature to halve    B) all nuclei to decay  
C) the mass to double    D) half the unstable nuclei in a sample to decay

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $6x + 9 = 39$ .

- A) 6    B) 5  
C) 30    D) 4

72. What is the larger root of  $x^2 - 12x + 27 = 0$ ?

- A) 27    B) -9  
C) 9    D) 12

73. If  $\log_3 243 = x$ , find  $x$ .

- A) 3    B) 5  
C) 6    D) 243

74.  $y$  varies directly as  $x$ . If  $y = 24$  when  $x = 4$ , find  $y$  when  $x = 6$ .

- A) 30    B) 36  
C) 12    D) 26

75. Find the slope of the line through (4, 6) and (7, 18).

- A) 4    B) 13  
C) -4    D) 3

76. Find the midpoint of the segment joining (4, 5) and (10, 9).

- A) (7, 8)    B) (10, 9)  
C) (6, 8)    D) (7, 7)

77. Find the distance between (1, 3) and (13, 19).

- A) 20    B) 16  
C) 12    D) 400

78. Find the area of a triangle with base 11 cm and perpendicular height 6 cm.

- A) 66 cm<sup>2</sup>    B) 34 cm<sup>2</sup>  
C) 17 cm<sup>2</sup>    D) 33 cm<sup>2</sup>

79. How many different pairs can be selected from 9 people?

- A) 45    B) 72  
C) 36    D) 11

80. Find the determinant of the matrix  $\begin{bmatrix} 5 & 2 \\ 7 & 5 \end{bmatrix}$ .

- A) 10    B) 11  
C) 12    D) -11

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The component that performs arithmetic and logical operations is the:

- A) Monitor    B) Hard disk  
C) Input unit    D) ALU

82. RAM is best described as:

- A) permanent optical storage    B) volatile primary memory  
C) read-only firmware only    D) an input device

83. ROM is commonly used to store:

- A) keyboard signals    B) open application windows  
C) firmware that should persist without power    D) temporary user data only

84. A compiler generally translates:

- A) one instruction at a time during execution only    B) machine code into English  
C) data into hardware    D) an entire high-level program into machine code

85. An algorithm is:

- A) a network cable    B) a finite sequence of unambiguous steps for solving a problem  
C) an error message only    D) a computer brand

86. Pseudocode is used to:

- A) describe an algorithm in structured, language-independent form    B) store images  
C) replace all testing    D) encrypt a disk automatically

87. A syntax error occurs when:

- A) the program runs but gives the wrong result    B) a user forgets a password  
C) the computer loses power    D) programming-language rules are violated

88. A logic error causes a program to:

- A) run but produce an incorrect result    B) damage hardware necessarily  
C) have no variables    D) become an operating system

89. A variable is used to:

- A) define a monitor size    B) store a value that may change during program execution  
C) prevent all errors    D) draw a network cable

90. A function is useful because it:

- A) can contain no parameters    B) always runs before main memory  
C) is a hardware device    D) encapsulates a reusable block of code

**ANSWER KEY - ICS PHYSICS MODEL PAPER 10***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. D  | 3. B  | 4. D  | 5. C  | 6. D  | 7. D  | 8. C  | 9. C  | 10. B |
| 11. D | 12. B | 13. D | 14. D | 15. D | 16. C | 17. C | 18. D | 19. D | 20. D |
| 21. A | 22. C | 23. A | 24. D | 25. C | 26. C | 27. A | 28. D | 29. C | 30. D |
| 31. C | 32. A | 33. D | 34. B | 35. D | 36. D | 37. D | 38. A | 39. B | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. A | 62. D | 63. D | 64. C | 65. A | 66. B | 67. B | 68. D | 69. B | 70. D |
| 71. B | 72. C | 73. B | 74. B | 75. A | 76. D | 77. A | 78. D | 79. C | 80. B |
| 81. D | 82. B | 83. C | 84. D | 85. B | 86. A | 87. D | 88. A | 89. B | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | PHYSICS   | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|-----------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10 | ____ / 10   | ____ / 10        |



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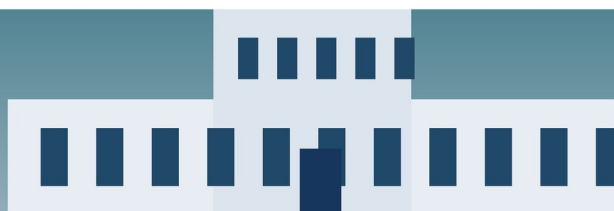
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## NTU ECAT - ICS-STATISTICS MODEL PAPERS

**Revised paper structure: English 20 | Analytical Reasoning 20 | Mathematics-Based Quantitative Reasoning 20 | Three group subjects 10 each | Total 90 MCQs | Time 120 minutes | Four options A-D**

**Ten complete model papers | 90 MCQs per paper | Four options A-D | Time: 2 Hours | Total Marks: 90**

**English 25 | Analytical Reasoning 10 | Quantitative Reasoning 20 | Statistics 15 | Mathematics 15 | Computer Science 15**

**Questions are varied across this model-paper group. Core concepts may recur with different wording, contexts, or numerical values to strengthen revision and prevent memorisation of a fixed sequence.**



**ICS-STATISTICS - MODEL PAPER 1**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 1

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) have    B) be  
C) is    D) were

2. At present, the students \_\_\_\_ for the test.

- A) were prepare    B) is preparing  
C) are preparing    D) have prepare

3. Pina \_\_\_\_ the test schedule already.

- A) had complete    B) have completed  
C) has completed    D) is completing since Monday

4. By the time the supervisor arrived, Qais \_\_\_\_ the safety checklist.

- A) has checked    B) had checked  
C) checks    D) was check

5. By next Friday, the team \_\_\_\_ the test schedule.

- A) will completed    B) has completed  
C) will have completed    D) had completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) be    B) were being  
C) are    D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) were    B) have  
C) are having    D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) has    B) have  
C) possess    D) were given by

9. There \_\_\_\_ several reasons for the delay.

- A) is    B) be  
C) are    D) was

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) will boil always    B) boils  
C) would have boiled    D) would boil

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) will play    B) would play  
C) would have played    D) played

12. If I knew the answer, I \_\_\_\_ Pina.

- A) told    B) would tell  
C) would have told    D) had told

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught    B) would have caught  
C) had caught    D) will catch

14. Choose the correct passive form: "The technician checks the test schedule."

- A) The test schedule was checked by the technician.    B) The test schedule is being checked by the technician.  
C) The test schedule will be checked by the technician.    D) The test schedule is checked by the technician.

15. Choose the correct passive form: "The technician is checking the safety checklist."

- A) The safety checklist has been checked by the technician.    B) The safety checklist is being checked by the technician.  
C) The safety checklist was being checked by the technician.    D) The safety checklist is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the test schedule."

- A) The test schedule is processed by the clerk.    B) The test schedule has processed by the clerk.  
C) The test schedule was processed by the clerk.    D) The test schedule was being processed by the clerk.

17. Choose the correct passive form: "The committee has approved the safety checklist."

- A) The safety checklist was approved by the committee.    B) The safety checklist has being approved by the committee.  
C) The safety checklist had approved by the committee.    D) The safety checklist has been approved by the committee.

18. Choose the correct passive form: "The office will issue the test schedule."

- A) The test schedule will issued by the office.    B) The test schedule will have issued by the office.  
C) The test schedule would be issued by the office.    D) The test schedule will be issued by the office.

19. Select the correct indirect form: Pina said, "I will complete the test schedule."

- A) Pina said that she will complete the test schedule.    B) Pina said that she would complete the test schedule.  
C) Pina said that she had complete the test schedule.    D) Pina said that I would complete the test schedule.

20. Select the correct indirect form: Qais said, "I am checking the safety checklist."

- A) Qais said that he is checking the safety checklist.    B) Qais said that he had checked the safety checklist.  
C) Qais said that he was checking the safety checklist.    D) Qais said that I was checking the safety checklist.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L1: Six students in one row - Questions 21-24**

Six students—Amina, Bilal, Camil, Danish, Eman, and Farah—sit in a straight row, all facing north. 1. Amina sits at the extreme left. 2. Farah sits at the extreme right. 3. Camil sits immediately to the right of Bilal. 4. Danish sits second to the right of Bilal. 5. Eman sits immediately to the left of Farah.

21. Who occupies the third seat from the left?

- A) Bilal    B) Camil  
C) Eman    D) Farah

22. Which pair sits next to each other in that left-to-right order?

- A) Camil and Eman    B) Bilal and Danish  
C) Amina and Camil    D) Danish and Eman

23. How many students sit between Bilal and Eman?

- A) Two    B) One  
C) None    D) Four

24. If Amina and Farah exchange seats, who will sit immediately to the left of Bilal?

- A) Amina    B) Eman  
C) Camil    D) Farah

**Analytical Set C1: Six people around a circular table - Questions 25-28**

Six people—Adeel, Bushra, Chetan, Dalia, Ehsan, and Farah—sit around a circular table facing the centre. Adeel's seat is taken as the top reference point.  
1. Bushra sits immediately clockwise from Adeel. 2. Dalia sits opposite Adeel. 3. Ehsan sits immediately clockwise from Dalia. 4. Chetan sits immediately clockwise from Bushra.

25. Who sits immediately anticlockwise from Dalia?

- A) Farah    B) Chetan  
C) Ehsan    D) Adeel

26. Which person sits opposite Bushra?

- A) Chetan    B) Ehsan  
C) Farah    D) Dalia

27. Who are Adeel's immediate neighbours?

- A) Bushra and Chetan    B) Dalia and Farah  
C) Ehsan and Farah    D) Bushra and Farah

28. If Chetan and Farah exchange seats, who will sit immediately anticlockwise from Adeel?

- A) Chetan    B) Dalia  
C) Ehsan    D) Farah

**Analytical Set S1: Six subjects across a week - Questions 29-32**

A student studies one subject each day from Monday to Saturday: Mathematics, Physics, Chemistry, English, Computer Science, and Biology. 1. Mathematics is studied on Monday. 2. Biology is studied on Saturday. 3. Physics is studied immediately after Mathematics. 4. English is studied immediately after Chemistry. 5. Computer Science is studied on Friday.

29. On which day is Chemistry studied?

- A) Monday    B) Tuesday  
C) Thursday    D) Wednesday

30. Which subject is studied immediately before Biology?

- A) English    B) Computer Science  
C) Mathematics    D) Chemistry

31. How many days occur between Physics and Computer Science?

- A) Four    B) Two  
C) None    D) Three

32. If English and Computer Science exchange days, what is studied on Thursday?

- A) Physics    B) Chemistry  
C) Computer Science    D) Biology

**Analytical Set D1: Symbolic implication chain - Questions 33-36**

Use the following rules: 1. If A is true, then B is true. 2. If B is true, then C is true. 3. If C is true, then D is true. 4. If D is false, then E is true. A conclusion is valid only when it must follow from the rules.

33. If A is true, which statement must also be true?

- A) D is true    B) C is false  
C) E is false    D) D is false

34. Suppose C is false. What must be true about B?

- A) Nothing can be known    B) B is false  
C) B may only be true    D) B is true

35. If D is false, which conclusion follows directly?

- A) B is true    B) A is true  
C) C is true    D) E is true

36. When B is true, which outcome is guaranteed?

- A) E is true    B) B is false  
C) A is true    D) D is true

**Analytical Set B1: Ahmed's family - Questions 37-40**

Ahmed and Sara are married. They have two children: Bilal, a son, and Hina, a daughter. Bilal is married to Nida, and their son is Owais. Hina is married to Kamran, and their daughter is Laiba.

37. How is Sara related to Owais?

- A) Mother-in-law    B) Paternal aunt  
C) Maternal aunt    D) Paternal grandmother

38. What is Kamran's relation to Bilal?

- A) Cousin    B) Son-in-law  
C) Maternal uncle    D) Brother-in-law

39. How is Laiba related to Bilal?

- A) Sister    B) Daughter  
C) Niece    D) Cousin

40. What is Nida's relation to Hina?

- A) Sister    B) Daughter-in-law  
C) Aunt    D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $69 + 6 \times 5 - 6$ .

- A) 93    B) 63  
C) 369    D) 99

42. Find  $\frac{11}{14} + \frac{14}{17}$  in simplest form.

- A)  $\frac{25}{31}$     B)  $\frac{383}{238}$   
C)  $-\frac{9}{238}$     D)  $\frac{25}{238}$

43. What is 45% of 975?

- A) 51/5    B) 65/3  
C) 1755/4    D) 2145/4

44. A price of Rs. 1740 is increased by 10%. What is the new price?

- A) Rs. 174    B) Rs. 1750  
C) Rs. 1566    D) Rs. 1914

45. Rs. 510 is divided in the ratio 3:7. What is the larger share?

- A) 153    B) 255  
C) 10    D) 357

46. If 5 identical notebooks cost Rs. 715, what will 10 notebooks cost at the same rate?

- A) 1430    B) 725  
C) 7150    D) 858

47. Find the arithmetic mean of 98, 100, 102, 104, 106.

- A) 510    B) 102  
C) 100    D) 104

48. A student scores 81 in a 3-credit course and 80 in a 6-credit course. Find the weighted mean.

- A) 80.5    B) 361.5  
C) 80.33    D) 40.17

49. A vehicle travels 460 km at a constant speed of 92 km/h. How long does the journey take?

- A) 552 hours    B) 368 hours  
C) 1/5 hours    D) 5 hours

50. Worker A can complete a job in 35 days and Worker B in 69 days. Working together, how many days will they take?

- A) 52 days    B) 104/2415 days  
C) 2415/34 days    D) 2415/104 days

51. An item costs Rs. 1020 and is sold at a profit of 40%. Find the selling price.

- A) Rs. 1428    B) Rs. 408  
C) Rs. 612    D) Rs. 1060

52. Find the simple interest on Rs. 4100 at 7% per year for 5 years.

- A) Rs. 287    B) Rs. 1435  
C) Rs. 205    D) Rs. 5535

53. Solve  $5x + 14 = 184$ .

- A) 170    B) 85/7  
C) 34    D) 35

54. What is the larger root of  $x^2 - 41x + 180 = 0$ ?

- A) 5    B) 41  
C) 180    D) 36

55. Find the 9th term of the arithmetic sequence with first term 65 and common difference 3.

- A) 92    B) 86  
C) 612    D) 89

56. If  $33^x = 35937$ , find x.

- A) 3    B) 33  
C) 35937    D) 4

57. Find the area of a triangle with base 41 cm and height 8 cm.

- A)  $328 \text{ cm}^2$     B)  $164 \text{ cm}^2$   
C)  $49 \text{ cm}^2$     D)  $82 \text{ cm}^2$

58. Find the midpoint of the segment joining (31, 33) and (37, 41).

- A) (6, 8)    B) (68, 74)  
C) (34, 37)    D) (3, 4)

59. A bag contains 10 red and 7 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A) 7/17    B) 10/7  
C) 1/17    D) 10/17

60. How many different pairs can be selected from 36 people?

- A) 1260    B) 38  
C) 36    D) 630

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 4, 6, 8, 10, 12.

- A) 6    B) 8  
C) 9    D) 40

62. A student scores 50 in a 2-credit course and 70 in a 3-credit course. Find the weighted mean.

- A) 310.00    B) 62.00  
C) 64.00    D) None of these

63. Find the median of 2, 5, 8, 11, 14.

- A) 8    B) 5  
C) 12    D) None of these

64. Find the mode of 3, 4, 3, 5, 3, 6.

- A) 4    B) None of these  
C) 3    D) 6

65. Find the range of 5, 8, 12, and 17.

- A) 13    B) 5  
C) 17    D) 12

66. A category has frequency 12 in a data set of 48 observations. What is its relative frequency?

- A) 4.00    B) 0.75  
C) 0.50    D) 0.25

67. If  $P(A) = 0.1$ , what is  $P(A^c)$ ?

- A) 0.8    B) 1.0  
C) 0.1    D) 0.9

68. An event has probability 0.2 in each of 100 independent trials. What is its expected frequency?

- A) None of these    B) 30  
C) 100    D) 20

69. A correlation coefficient close to +1 indicates:

- A) a strong positive linear relationship    B) that one variable causes the other  
C) no possible relationship    D) a strong negative linear relationship

70. Which sampling method gives every population member an equal known chance of selection?

- A) Snowball sampling    B) Convenience sampling  
C) Simple random sampling    D) Judgment sampling

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $2x + 10 = 24$ .

- A) 12    B) 14  
C) 6    D) 7

72. What is the larger root of  $x^2 - 11x + 28 = 0$ ?

- A) 4    B) 28  
C) -7    D) 7

73. If  $\log_5 25 = x$ , find  $x$ .

- A) 3    B) 2  
C) 25    D) 1

74.  $y$  varies directly as  $x$ . If  $y = 10$  when  $x = 5$ , find  $y$  when  $x = 7$ .

- A) 12    B) 70  
C) 14    D) 9

75. Find the midpoint of the segment joining (0, 2) and (6, 6).

- A) (6, 6)    B) (3, 4)  
C) (3, 5)    D) (6, 4)

76. Find the distance between (2, 0) and (5, 4).

- A) 6    B) 25  
C) 3    D) 5

77. Find the area of a triangle with base 12 cm and perpendicular height 7 cm.

- A)  $84 \text{ cm}^2$     B)  $38 \text{ cm}^2$   
C)  $42 \text{ cm}^2$     D)  $19 \text{ cm}^2$

78. How many different pairs can be selected from 10 people?

- A) 12    B) 45  
C) 90    D) 55

79. What is  $\sin 30^\circ$ ?

- A)  $\sqrt{2}/2$     B)  $\sqrt{3}/2$   
C)  $1/2$     D) 0

80. Find the determinant of the matrix  $\begin{bmatrix} 2 & 3 \\ 3 & 2 \end{bmatrix}$ .

- A) 4    B) -4  
C) -5    D) 5

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The decimal number 15 is represented in binary as:

- A)  $1110_2$     B)  $1010_2$   
C)  $1111_2$     D)  $1100_2$

82. An AND gate outputs 1 only when:

- A) inputs are different    B) all inputs are 0  
C) at least one input is 1    D) all inputs are 1

83. An OR gate outputs 1 when:

- A) all inputs are 0 only    B) at least one input is 1  
C) inputs are always equal    D) there is no power

84. A NOT gate:

- A) connects networks    B) reverses the input truth value  
C) sorts records    D) stores a byte

85. An IP address identifies:

- A) a database row only    B) a programming loop  
C) a keyboard key    D) a device or interface on an IP network

86. In a database table, a row is called a:

- A) record    B) data type  
C) field    D) form

87. In a database table, a column is called a:

- A) field    B) program loop  
C) report    D) tuple only in every context

88. A primary key should:

- A) be left blank in every row    B) contain duplicate values  
C) store images only    D) uniquely identify each record

89. Database normalization helps to:

- A) reduce redundancy and update anomalies    B) prevent queries  
C) convert tables into images    D) remove all keys

90. Phishing is an attempt to:

- A) repair hardware automatically    B) compress images losslessly  
C) improve processor speed    D) trick users into revealing sensitive information

**ANSWER KEY - ICS STATISTICS MODEL PAPER 1***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. C  | 2. C  | 3. C  | 4. B  | 5. C  | 6. D  | 7. D  | 8. A  | 9. C  | 10. B |
| 11. A | 12. B | 13. B | 14. D | 15. D | 16. C | 17. D | 18. D | 19. B | 20. C |
| 21. B | 22. D | 23. A | 24. D | 25. B | 26. B | 27. D | 28. A | 29. D | 30. B |
| 31. B | 32. C | 33. A | 34. B | 35. D | 36. D | 37. D | 38. D | 39. C | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. B | 63. A | 64. C | 65. D | 66. D | 67. D | 68. D | 69. A | 70. C |
| 71. D | 72. D | 73. B | 74. C | 75. B | 76. D | 77. C | 78. B | 79. C | 80. C |
| 81. C | 82. D | 83. B | 84. B | 85. D | 86. A | 87. A | 88. D | 89. A | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |

**ICS-STATISTICS - MODEL PAPER 2**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 2

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) were B) be  
C) is D) are

2. At present, the technicians \_\_\_\_ for the test.

- A) were prepare B) is preparing  
C) prepared D) are preparing

3. Shah \_\_\_\_ the design brief already.

- A) completed yesterday B) had complete  
C) has completed D) have completed

4. By the time the supervisor arrived, Talia \_\_\_\_ the library record.

- A) has checked B) will have checked  
C) had checked D) checks

5. By next Friday, the team \_\_\_\_ the design brief.

- A) had completed B) will completed  
C) has completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) be B) are  
C) is D) were being

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) were B) have  
C) are having D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having B) has  
C) were given by D) possess

9. There \_\_\_\_ several reasons for the delay.

- A) be B) are  
C) is D) has

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boils B) would boil  
C) boiled D) would have boiled

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) played B) had played  
C) would play D) will play

12. If I knew the answer, I \_\_\_\_ Shah.

- A) would have told B) will tell  
C) would tell D) told

13. If they had left earlier, they \_\_\_\_ the train.

- A) caught B) would catch  
C) will catch D) would have caught

14. Choose the correct passive form: "The technician checks the design brief."

- A) The design brief will be checked by the technician. B) The design brief is being checked by the technician.  
C) The design brief was checked by the technician. D) The design brief is checked by the technician.

15. Choose the correct passive form: "The technician is checking the library record."

- A) The library record is being checked by the technician. B) The library record is been checked by the technician.  
C) The library record has been checked by the technician. D) The library record was being checked by the technician.

16. Choose the correct passive form: "The clerk processed the design brief."

- A) The design brief was being processed by the clerk. B) The design brief will be processed by the clerk.  
C) The design brief is processed by the clerk. D) The design brief was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the library record."

- A) The library record has been approved by the committee. B) The library record was approved by the committee.  
C) The library record had approved by the committee. D) The library record is approved by the committee.

18. Choose the correct passive form: "The office will issue the design brief."

- A) The design brief will have issued by the office. B) The design brief would be issued by the office.  
C) The design brief will issued by the office. D) The design brief will be issued by the office.

19. Select the correct indirect form: Shah said, "I will complete the design brief."

- A) Shah told that the design brief would complete. B) Shah said that he would complete the design brief.  
C) Shah said that he will complete the design brief. D) Shah said that I would complete the design brief.

20. Select the correct indirect form: Talia said, "I am checking the library record."

- A) Talia told that she was checking the library record. B) Talia said that I was checking the library record.  
C) Talia said that she is checking the library record. D) Talia said that she was checking the library record.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L2: Seven candidates in a row - Questions 21-24**

Seven candidates—Haris, Iqra, Junaid, Kiran, Lubna, Moiz, and Nadia—sit in a row facing north. 1. Kiran occupies the middle seat. 2. Haris and Nadia sit at the two ends, with Haris on the left. 3. Iqra sits immediately to the left of Junaid. 4. Lubna sits immediately to the right of Kiran. 5. Moiz sits immediately to the left of Nadia.

21. Who sits second from the right end?

- A) Lubna B) Kiran  
C) Moiz D) Nadia

22. Which candidate sits exactly between Junaïd and Lubna?

- A) Haris B) Nadia  
C) Moiz D) Kiran

23. Which pair is NOT adjacent in the final arrangement?

- A) Iqra and Junaïd B) Junaïd and Lubna  
C) Moiz and Nadia D) Haris and Iqra

24. If Iqra and Lubna swap places, who will be immediately to the right of Kiran?

- A) Lubna B) Moiz  
C) Iqra D) Nadia

**Analytical Set C2: Eight officers in a circle - Questions 25-28**

Eight officers—Gohar, Hina, Imran, Javeria, Kamal, Laila, Musa, and Noreen—sit around a circular table facing the centre. Gohar is fixed at the top. 1. Hina sits immediately clockwise from Gohar. 2. Javeria sits third clockwise from Gohar. 3. Kamal sits immediately clockwise from Javeria. 4. Imran sits between Hina and Javeria. 5. Laila sits opposite Hina. 6. Musa sits immediately clockwise from Laila.

25. Who sits opposite Gohar?

- A) Noreen B) Laila  
C) Kamal D) Musa

26. Who is immediately anticlockwise from Noreen?

- A) Kamal B) Musa  
C) Gohar D) Hina

27. Which pair sits opposite each other?

- A) Imran and Musa B) Hina and Musa  
C) Javeria and Noreen D) Kamal and Laila

28. Starting at Javeria and moving clockwise, who is the third person reached?

- A) Musa B) Kamal  
C) Noreen D) Gohar

**Analytical Set S2: Five interviews - Questions 29-32**

Five applicants—Areeba, Bilal, Celine, Dawood, and Eman—are interviewed from Monday to Friday, one per day. 1. Celine is interviewed on Wednesday. 2. Areeba is interviewed on Monday. 3. Bilal is interviewed after Areeba but before Celine. 4. Dawood is interviewed immediately after Celine. 5. Eman is interviewed on Friday.

29. Who is interviewed on Tuesday?

- A) Eman B) Bilal  
C) Dawood D) Areeba

30. Whose interview is immediately before Eman's?

- A) Areeba B) No applicant  
C) Bilal D) Dawood

31. Which applicant is interviewed exactly two days after Bilal?

- A) Eman B) Areeba  
C) No applicant D) Dawood

32. If Wednesday is declared a holiday and all later interviews move one working day forward, on which day is Eman interviewed?

- A) Monday of the next week B) Saturday of the same week  
C) Tuesday of the next week D) Friday of the same week

**Analytical Set D2: Admission requirements - Questions 33-36**

Use these rules: 1. If a candidate qualifies (Q), the candidate passes Mathematics (M). 2. If a candidate qualifies (Q), the candidate passes the interview (I). 3. If the interview is passed (I), the documents are complete (D). 4. If the documents are complete (D), verification is approved (V).

33. A candidate qualifies. Which final result must occur?

- A) Verification is rejected B) Verification is approved  
C) Documents are incomplete D) The interview is failed

34. The documents are not complete. What must be concluded about the interview?

- A) The interview was repeated B) The interview was postponed  
C) The interview was passed D) The interview was not passed

35. A candidate did not pass Mathematics. Which conclusion is forced?

- A) The interview was passed B) The candidate qualified  
C) Verification was approved D) The candidate did not qualify

36. Verification is not approved. Which status is impossible under the rules?

- A) The candidate does not qualify B) The candidate qualifies  
C) The interview is not passed D) The candidate fails Mathematics

**Analytical Set B2: Farooq's family - Questions 37-40**

Farooq and Ayesha are married. Their children are Hamza, a son, and Iman, a daughter. Hamza is married to Zara; their daughters are Kiran and Mehak. Iman is married to Usman; their son is Danish.

37. How is Ayesha related to Danish?

- A) Paternal aunt B) Mother-in-law  
C) Paternal grandmother D) Maternal grandmother

38. What is Danish's relation to Hamza?

- A) Uncle B) Nephew  
C) Son D) Cousin

39. How is Zara related to Iman?

- A) Sister B) Niece  
C) Sister-in-law D) Cousin

40. What is Kiran's relation to Danish?

- A) Sister B) Cousin  
C) Niece D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $71 + 7 \times 6 - 7$ .

- A) 106 B) 64  
C) 461 D) 113

42. Find  $9/15 + 12/18$  in simplest form.

- A)  $7/11$  B)  $19/15$   
C)  $-1/15$  D)  $7/90$



43. What is 10% of 1000?

- A) 101/10 B) 900  
C) 100 D) 1000

44. A price of Rs. 1780 is increased by 15%. What is the new price?

- A) Rs. 267 B) Rs. 1795  
C) Rs. 1513 D) Rs. 2047

45. Rs. 468 is divided in the ratio 4:5. What is the larger share?

- A) 208 B) 234  
C) 9 D) 260

46. If 6 identical notebooks cost Rs. 876, what will 8 notebooks cost at the same rate?

- A) 1168 B) 884  
C) 7008 D) 1022

47. Find the arithmetic mean of 101, 104, 107, 110, 113.

- A) 535 B) 107  
C) 104 D) 110

48. A student scores 82 in a 4-credit course and 81 in a 3-credit course. Find the weighted mean.

- A) 81.5 B) 285.5  
C) 81.57 D) 47.58

49. A vehicle travels 188 km at a constant speed of 94 km/h. How long does the journey take?

- A) 282 hours B) 94 hours  
C) 1/2 hours D) 2 hours

50. Worker A can complete a job in 36 days and Worker B in 71 days. Working together, how many days will they take?

- A) 107/2 days B) 107/2556 days  
C) 2556/35 days D) 2556/107 days

51. An item costs Rs. 1040 and is sold at a profit of 5%. Find the selling price.

- A) Rs. 1092 B) Rs. 52  
C) Rs. 988 D) Rs. 1045

52. Find the simple interest on Rs. 4200 at 8% per year for 2 years.

- A) Rs. 336 B) Rs. 672  
C) Rs. 84 D) Rs. 4872

53. Solve  $6x + 15 = 225$ .

- A) 210 B) 14  
C) 35 D) 36

54. What is the larger root of  $x^2 - 43x + 222 = 0$ ?

- A) 6 B) 43  
C) 222 D) 37

55. Find the 10th term of the arithmetic sequence with first term 67 and common difference 4.

- A) 107 B) 99  
C) 710 D) 103

56. If  $34^x = 1336336$ , find  $x$ .

- A) 4 B) 34  
C) 1336336 D) 5

57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 231 cm.

- A) 167706 cm B) 1452 cm  
C) 726 cm D) 462 cm

58. Find the distance between (32, 33) and (35, 37).

- A) 7 B) 4  
C) 5 D) 25

59. A bag contains 3 red and 8 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A) 8/11 B) 3/8  
C) 1/11 D) 3/11

60. How many different pairs can be selected from 37 people?

- A) 1332 B) 39  
C) 37 D) 666

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 5, 7, 9, 11, 13.

- A) 45 B) 10  
C) 11 D) 9

62. A student scores 51 in a 3-credit course and 71 in a 4-credit course. Find the weighted mean.

- A) 437.00 B) 64.43  
C) 61.00 D) 62.43

63. Find the median of 3, 6, 9, 12, 15.

- A) None of these B) Cannot be determined  
C) 6 D) 9

64. Find the mode of 4, 5, 4, 6, 4, 7.

- A) None of these B) 7  
C) 5 D) 4

65. Find the range of 6, 9, 13, and 19.

- A) 12 B) 19  
C) 6 D) 13

66. For the population values 5, 11, and 17, find the population variance.

- A) 72 B) 6  
C) 36 D) 24

67. A category has frequency 13 in a data set of 52 observations. What is its relative frequency?

- A) 0.50 B) 4.00  
C) 0.20 D) 0.25



68. If  $P(A) = 0.2$ , what is  $P(A^c)$ ?

- A) 1.2   B) 0.9  
C) 0.2   D) 0.8

69. An event has probability 0.3 in each of 110 independent trials. What is its expected frequency?

- A) 23   B) 30  
C) 110   D) 33

70. In hypothesis testing, the hypothesis tested for possible rejection is called the:

- A) sample hypothesis   B) frequency hypothesis  
C) descriptive hypothesis   D) null hypothesis

### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $3x + 4 = 31$ .

- A) 27   B) 10  
C) 8   D) 9

72. What is the larger root of  $x^2 - 14x + 45 = 0$ ?

- A) 45   B) 5  
C) 14   D) 9

73. Find the 4th term of the geometric sequence with first term 2 and common ratio 3.

- A) 57   B) 54  
C) 162   D) 24

74.  $y$  varies directly as  $x$ . If  $y = 18$  when  $x = 6$ , find  $y$  when  $x = 8$ .

- A) 20   B) 11  
C) 26   D) 24

75. Find the slope of the line through (2, 3) and (5, 9).

- A) 3   B) -2  
C) 7   D) 2

76. Find the midpoint of the segment joining (1, 3) and (7, 7).

- A) (4, 5)   B) (6, 4)  
C) (7, 7)   D) (4, 6)

77. Find the distance between (0, 1) and (6, 9).

- A) 11   B) 10  
C) 6   D) 8

78. Find the area of a triangle with base 13 cm and perpendicular height 8 cm.

- A)  $42 \text{ cm}^2$    B)  $26 \text{ cm}^2$   
C)  $104 \text{ cm}^2$    D)  $52 \text{ cm}^2$

79. How many different pairs can be selected from 11 people?

- A) 66   B) 11  
C) 55   D) 13

80. What is  $\cos 60^\circ$ ?

- A)  $\sqrt{2}/2$    B) 0  
C)  $\sqrt{3}/2$    D)  $1/2$

### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. Encryption converts readable data into:

- A) a compiler   B) a monitor signal  
C) a flowchart   D) ciphertext

82. A strong password should generally be:

- A) the user's name only   B) shared publicly  
C) the same for every account   D) long, unique and difficult to guess

83. Cloud computing provides resources:

- A) only through printers   B) without any servers  
C) over a network on demand   D) only from a local floppy disk

84. Machine learning enables systems to:

- A) avoid evaluation   B) guarantee perfect predictions  
C) improve performance from data   D) replace all hardware

85. Supervised learning uses:

- A) only random numbers   B) labelled training examples  
C) unlabelled data exclusively   D) no data

86. A black-box model is difficult to:

- A) represent numerically   B) execute on a computer  
C) store in memory   D) interpret internally

87. The purpose of testing software is to:

- A) find defects and verify expected behaviour   B) increase file size  
C) remove all documentation   D) replace users

88. The expression  $14 \% 3$  in C evaluates to:

- A) 1   B) 4  
C) 3   D) 2

89. In C,  $\&\&$  represents logical:

- A) assignment   B) AND  
C) division   D) OR

90. A for loop header normally contains:

- A) source, destination and protocol   B) input, output and storage  
C) table, row and field   D) initialization, condition and update

**ANSWER KEY - ICS STATISTICS MODEL PAPER 2***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. C  | 2. D  | 3. C  | 4. C  | 5. D  | 6. C  | 7. D  | 8. B  | 9. B  | 10. A |
| 11. D | 12. C | 13. D | 14. D | 15. A | 16. D | 17. A | 18. D | 19. B | 20. D |
| 21. C | 22. D | 23. B | 24. C | 25. C | 26. B | 27. A | 28. A | 29. B | 30. D |
| 31. D | 32. A | 33. B | 34. D | 35. D | 36. B | 37. D | 38. B | 39. C | 40. B |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. D | 63. D | 64. D | 65. D | 66. D | 67. D | 68. D | 69. D | 70. D |
| 71. D | 72. D | 73. B | 74. D | 75. D | 76. A | 77. B | 78. D | 79. C | 80. D |
| 81. D | 82. D | 83. C | 84. C | 85. B | 86. D | 87. A | 88. D | 89. B | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |

## ICS-STATISTICS - MODEL PAPER 3

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 3

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) is B) were  
C) have D) are

2. At present, the candidates \_\_\_\_ for the test.

- A) are preparing B) have prepare  
C) is preparing D) prepared

3. Cem \_\_\_\_ the computer program already.

- A) has completed B) had complete  
C) is completing since Monday D) completed yesterday

4. By the time the supervisor arrived, Dalia \_\_\_\_ the workshop plan.

- A) was check B) had checked  
C) checks D) has checked

5. By next Friday, the team \_\_\_\_ the computer program.

- A) would complete B) has completed  
C) will completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) be  
C) are D) were being

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) were B) are having  
C) has D) have

8. Each of the candidates \_\_\_\_ an admit card.

- A) has B) possess  
C) were given by D) are having

9. There \_\_\_\_ several reasons for the delay.

- A) has B) was  
C) is D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boiled B) would have boiled  
C) boils D) would boil

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would have played B) will play  
C) had played D) played

12. If I knew the answer, I \_\_\_\_ Cem.

- A) will tell B) would have told  
C) told D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) had caught B) would have caught  
C) caught D) will catch

14. Choose the correct passive form: "The technician checks the computer program."

- A) The computer program was checked by the technician. B) The computer program is being checked by the technician.  
C) The computer program is checked by the technician. D) The computer program has checked by the technician.

15. Choose the correct passive form: "The technician is checking the workshop plan."

- A) The workshop plan is checked by the technician. B) The workshop plan is been checked by the technician.  
C) The workshop plan is being checked by the technician. D) The workshop plan has been checked by the technician.

16. Choose the correct passive form: "The clerk processed the computer program."

- A) The computer program is processed by the clerk. B) The computer program has processed by the clerk.  
C) The computer program was being processed by the clerk. D) The computer program was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the workshop plan."

- A) The workshop plan has being approved by the committee. B) The workshop plan is approved by the committee.  
C) The workshop plan has been approved by the committee. D) The workshop plan had approved by the committee.

18. Choose the correct passive form: "The office will issue the computer program."

- A) The computer program is issued by the office. B) The computer program would be issued by the office.  
C) The computer program will be issued by the office. D) The computer program will issued by the office.

19. Select the correct indirect form: Cem said, "I will complete the computer program."

- A) Cem said that he will complete the computer program. B) Cem said that he had complete the computer program.  
C) Cem told that the computer program would complete. D) Cem said that he would complete the computer program.

20. Select the correct indirect form: Dalia said, "I am checking the workshop plan."

- A) Dalia said that she was checking the workshop plan. B) Dalia said that she is checking the workshop plan.  
C) Dalia said that she had checked the workshop plan. D) Dalia told that she was checking the workshop plan.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L3: Eight delegates in a row - Questions 21-24

Eight delegates—Omer, Pari, Qasim, Rabia, Salman, Tehmina, Usman, and Warda—sit in a row facing north. 1. Omer and Warda sit at the left and right ends respectively. 2. Pari sits immediately to the right of Omer. 3. Rabia sits immediately to the right of Qasim. 4. Salman sits immediately to the right of Rabia. 5. Tehmina sits immediately to the right of Salman. 6. Usman sits immediately to the left of Warda.

21. Who is fifth from the left?

- A) Tehmina B) Qasim  
C) Rabia D) Salman

22. How many delegates sit between Pari and Tehmina?

- A) One B) Four  
C) Three D) Two

23. Who sits immediately to the left of Usman?

- A) Salman B) Tehmina  
C) Warda D) Qasim

24. If Omer leaves and everyone to his right shifts one seat left, who becomes fourth from the left?

- A) Rabia B) Usman  
C) Salman D) Tehmina

**Analytical Set C3: Six students in a circle - Questions 25-28**

Six students—Owais, Parsa, Qasim, Rida, Saad, and Tania—sit around a circular table facing the centre. Owais is fixed at the top. 1. Qasim sits second clockwise from Owais. 2. Rida sits opposite Owais. 3. Saad sits immediately clockwise from Rida. 4. Parsa sits between Owais and Qasim on the clockwise side.

25. Who sits immediately clockwise from Qasim?

- A) Parsa B) Rida  
C) Saad D) Tania

26. Who sits opposite Parsa?

- A) Owais B) Rida  
C) Qasim D) Saad

27. Which two students are immediate neighbours of Tania?

- A) Rida and Saad B) Qasim and Rida  
C) Saad and Owais D) Parsa and Qasim

28. If everyone moves two seats clockwise, who occupies Owais's original seat?

- A) Saad B) Tania  
C) Qasim D) Rida

**Analytical Set S3: March calendar - Questions 29-32**

In a particular year, 1 March falls on a Tuesday. Use the ordinary seven-day weekly cycle for all four questions.

29. What day of the week is 8 March?

- A) Wednesday B) Friday  
C) Tuesday D) Thursday

30. On which weekday does 17 March fall?

- A) Friday B) Thursday  
C) Saturday D) Tuesday

31. Which weekday is 31 March?

- A) Saturday B) Sunday  
C) Wednesday D) Thursday

32. What day is 1 April?

- A) Monday B) Sunday  
C) Saturday D) Friday

**Analytical Set D3: Exclusive choice and implications - Questions 33-36**

Use these rules: 1. Exactly one of P and Q is true. 2. If P is true, R is true. 3. If Q is true, S is true. 4. If R is false, T is true.

33. If P is true, which statement must be false?

- A) R is true B) R may be true  
C) P is true D) Q is true

34. If S is false, which statement must be true?

- A) R is true B) P is false  
C) R is false D) T is false

35. Assume R is false. Which result must follow?

- A) P is true B) Q is false  
C) S is false D) S is true

36. If T is false, what follows necessarily?

- A) S is false B) R is true  
C) R is false D) Q is true

**Analytical Set B3: Rashid's family - Questions 37-40**

Rashid and Mariam are married. Their children are Sameer, a son, and Nadia, a daughter. Sameer is married to Huma; their children are Taimur, a son, and Rida, a daughter. Nadia is married to Asif; their son is Zain.

37. How is Mariam related to Rida?

- A) Paternal grandmother B) Great-grandmother  
C) Paternal aunt D) Maternal grandmother

38. What is Zain's relation to Sameer?

- A) Nephew B) Uncle  
C) Son D) Brother

39. How is Huma related to Nadia?

- A) Maternal aunt B) Sister-in-law  
C) Cousin D) Daughter-in-law

40. What is Taimur's relation to Zain?

- A) Nephew B) Uncle  
C) Cousin D) Brother-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $73 + 8 \times 7 - 8$ .

- A) 121 B) 65  
C) 559 D) 129

42. Find  $7/16 + 10/19$  in simplest form.

- A)  $17/35$  B)  $293/304$   
C)  $-27/304$  D)  $17/304$

43. What is 15% of 1025?

- A)  $52/5$  B)  $205/3$   
C)  $615/4$  D)  $3485/4$

44. A price of Rs. 1820 is increased by 20%. What is the new price?  
A) Rs. 364 B) Rs. 1840  
C) Rs. 1456 D) Rs. 2184
45. Rs. 636 is divided in the ratio 5:7. What is the larger share?  
A) 265 B) 318  
C) 12 D) 371
46. If 7 identical notebooks cost Rs. 1043, what will 10 notebooks cost at the same rate?  
A) 1490 B) 1053  
C) 10430 D) 1192
47. Find the arithmetic mean of 104, 108, 112, 116, 120.  
A) 560 B) 112  
C) 108 D) 116
48. A student scores 83 in a 2-credit course and 82 in a 4-credit course. Find the weighted mean.  
A) 82.5 B) 247  
C) 82.33 D) 61.75
49. A vehicle travels 288 km at a constant speed of 96 km/h. How long does the journey take?  
A) 384 hours B) 192 hours  
C) 1/3 hours D) 3 hours
50. Worker A can complete a job in 37 days and Worker B in 73 days. Working together, how many days will they take?  
A) 55 days B) 110/2701 days  
C) 2701/36 days D) 2701/110 days
51. An item costs Rs. 1060 and is sold at a profit of 10%. Find the selling price.  
A) Rs. 1166 B) Rs. 106  
C) Rs. 954 D) Rs. 1070
52. Find the simple interest on Rs. 4300 at 9% per year for 3 years.  
A) Rs. 387 B) Rs. 1161  
C) Rs. 129 D) Rs. 5461
53. Solve  $7x + 5 = 257$ .  
A) 252 B) 252/5  
C) 36 D) 37
54. What is the larger root of  $x^2 - 45x + 266 = 0$ ?  
A) 7 B) 45  
C) 266 D) 38
55. Find the 11th term of the arithmetic sequence with first term 69 and common difference 5.  
A) 124 B) 114  
C) 814 D) 119
56. If  $35^x = 1225$ , find x.  
A) 2 B) 35  
C) 1225 D) 3
57. Find the area of a rectangle of length 41 cm and width 8 cm.  
A) 98 cm<sup>2</sup> B) 328 cm<sup>2</sup>  
C) 49 cm<sup>2</sup> D) 656 cm<sup>2</sup>
58. Find the slope of the line through (33, 35) and (37, 43).  
A) 1/2 B) 8  
C) 2 D) 4
59. A bag contains 4 red and 9 blue balls. One ball is selected at random. What is P(red)?  
A) 9/13 B) 4/9  
C) 1/13 D) 4/13
60. How many different pairs can be selected from 38 people?  
A) 1406 B) 40  
C) 38 D) 703

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 6, 8, 10, 12, 14.  
A) 50 B) 11  
C) 8 D) 10
62. A student scores 52 in a 4-credit course and 72 in a 5-credit course. Find the weighted mean.  
A) 63.11 B) 568.00  
C) 65.11 D) 62.00
63. Find the median of 4, 7, 10, 13, 16.  
A) 12 B) 10  
C) 7 D) 13
64. Find the mode of 5, 6, 5, 7, 5, 8.  
A) 7 B) 6  
C) 5 D) None of these
65. Find the range of 7, 10, 14, and 21.  
A) 15 B) 13  
C) 21 D) 14
66. For the population values 3, 12, and 21, find the population variance.  
A) 162 B) 54  
C) 27 D) 9
67. A category has frequency 14 in a data set of 56 observations. What is its relative frequency?  
A) 0.75 B) 4.00  
C) 0.25 D) 0.50
68. If  $P(A) = 0.3$ , what is  $P(A^c)$ ?  
A) 1.3 B) 0.6  
C) 0.8 D) 0.7

69. An event has probability 0.4 in each of 120 independent trials. What is its expected frequency?

- A) 38 B) 40  
C) 48 D) 120

70. A correlation coefficient close to +1 indicates:

- A) a strong positive linear relationship B) a strong negative linear relationship  
C) that one variable causes the other D) no possible relationship

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $4x + 5 = 49$ .

- A) 10 B) 11  
C) 12 D) 44

72. What is the larger root of  $x^2 - 17x + 66 = 0$ ?

- A) 6 B) 66  
C) -11 D) 11

73. Find the 5th term of the geometric sequence with first term 3 and common ratio 2.

- A) 96 B) 48  
C) 30 D) 50

74.  $y$  varies directly as  $x$ . If  $y = 28$  when  $x = 7$ , find  $y$  when  $x = 9$ .

- A) 252 B) 37  
C) 13 D) 36

75. Find the midpoint of the segment joining (2, 4) and (8, 8).

- A) (4, 7) B) (5, 7)  
C) (8, 8) D) (5, 6)

76. Find the distance between (1, 2) and (10, 14).

- A) 12 B) 9  
C) 225 D) 15

77. Find the area of a triangle with base 14 cm and perpendicular height 9 cm.

- A)  $63 \text{ cm}^2$  B)  $63/2 \text{ cm}^2$   
C)  $23 \text{ cm}^2$  D)  $126 \text{ cm}^2$

78. How many different pairs can be selected from 12 people?

- A) 14 B) 12  
C) 66 D) 78

79. What is  $\tan 45^\circ$ ?

- A) 1 B)  $1/2$   
C) Undefined D)  $\sqrt{3}$

80. Find the determinant of the matrix  $\begin{bmatrix} 4 & 2 \\ 5 & 4 \end{bmatrix}$ .

- A) -6 B) 8  
C) 6 D) 7

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The component that performs arithmetic and logical operations is the:

- A) Control unit B) Monitor  
C) ALU D) Input unit

82. RAM is best described as:

- A) a network protocol B) permanent optical storage  
C) read-only firmware only D) volatile primary memory

83. ROM is commonly used to store:

- A) firmware that should persist without power B) temporary user data only  
C) internet addresses D) open application windows

84. A compiler generally translates:

- A) machine code into English B) one instruction at a time during execution only  
C) images into audio D) an entire high-level program into machine code

85. An algorithm is:

- A) an error message only B) a type of monitor  
C) a computer brand D) a finite sequence of unambiguous steps for solving a problem

86. Pseudocode is used to:

- A) compile a program directly B) replace all testing  
C) encrypt a disk automatically D) describe an algorithm in structured, language-independent form

87. A syntax error occurs when:

- A) a user forgets a password B) the computer loses power  
C) the program runs but gives the wrong result D) programming-language rules are violated

88. A logic error causes a program to:

- A) become an operating system B) damage hardware necessarily  
C) run but produce an incorrect result D) fail grammar checking before compilation only

89. A variable is used to:

- A) replace the CPU B) store a value that may change during program execution  
C) prevent all errors D) define a monitor size

90. A function is useful because it:

- A) encapsulates a reusable block of code B) is a hardware device  
C) always runs before main memory D) can contain no parameters

**ANSWER KEY - ICS STATISTICS MODEL PAPER 3***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. A  | 2. A  | 3. A  | 4. B  | 5. D  | 6. A  | 7. C  | 8. A  | 9. D  | 10. C |
| 11. B | 12. D | 13. B | 14. C | 15. C | 16. D | 17. C | 18. C | 19. D | 20. A |
| 21. D | 22. C | 23. B | 24. C | 25. B | 26. D | 27. C | 28. A | 29. C | 30. B |
| 31. D | 32. D | 33. D | 34. A | 35. D | 36. B | 37. A | 38. A | 39. B | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. A | 63. B | 64. C | 65. D | 66. B | 67. C | 68. D | 69. C | 70. A |
| 71. B | 72. D | 73. B | 74. D | 75. D | 76. D | 77. A | 78. C | 79. A | 80. C |
| 81. C | 82. D | 83. A | 84. D | 85. D | 86. D | 87. D | 88. C | 89. B | 90. A |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |

## ICS-STATISTICS - MODEL PAPER 4

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 4

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) were B) be  
C) is D) are

2. At present, the researchers \_\_\_\_ for the test.

- A) have prepare B) prepared  
C) are preparing D) were prepare

3. Bina \_\_\_\_ the experiment log already.

- A) completed yesterday B) have completed  
C) is completing since Monday D) has completed

4. By the time the supervisor arrived, Fiza \_\_\_\_ the report.

- A) will have checked B) was check  
C) had checked D) checks

5. By next Friday, the team \_\_\_\_ the experiment log.

- A) had completed B) would complete  
C) has completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) have B) is  
C) were being D) are

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) have B) do  
C) has D) are having

8. Each of the candidates \_\_\_\_ an admit card.

- A) has B) possess  
C) have D) are having

9. There \_\_\_\_ several reasons for the delay.

- A) was B) has  
C) is D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) will boil always  
C) would boil D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) will play B) had played  
C) would have played D) would play

12. If I knew the answer, I \_\_\_\_ Bina.

- A) had told B) told  
C) would have told D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) had caught B) would have caught  
C) will catch D) would catch

14. Choose the correct passive form: "The technician checks the experiment log."

- A) The experiment log was checked by the technician. B) The experiment log is being checked by the technician.  
C) The experiment log has checked by the technician. D) The experiment log is checked by the technician.

15. Choose the correct passive form: "The technician is checking the report."

- A) The report is been checked by the technician. B) The report has been checked by the technician.  
C) The report was being checked by the technician. D) The report is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the experiment log."

- A) The experiment log was being processed by the clerk. B) The experiment log was processed by the clerk.  
C) The experiment log will be processed by the clerk. D) The experiment log has processed by the clerk.

17. Choose the correct passive form: "The committee has approved the report."

- A) The report is approved by the committee. B) The report was approved by the committee.  
C) The report has being approved by the committee. D) The report has been approved by the committee.

18. Choose the correct passive form: "The office will issue the experiment log."

- A) The experiment log would be issued by the office. B) The experiment log will be issued by the office.  
C) The experiment log is issued by the office. D) The experiment log will issued by the office.

19. Select the correct indirect form: Bina said, "I will complete the experiment log."

- A) Bina told that the experiment log would complete. B) Bina said that she would complete the experiment log.  
C) Bina said that I would complete the experiment log. D) Bina said that she had complete the experiment log.

20. Select the correct indirect form: Fiza said, "I am checking the report."

- A) Fiza said that she was checking the report. B) Fiza said that I was checking the report.  
C) Fiza told that she was checking the report. D) Fiza said that she is checking the report.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L4: Six friends in a row - Questions 21-24

Six friends—Ali, Beenish, Chaman, Dua, Ehsan, and Fiza—stand in a line facing north. 1. Fiza is at the extreme right. 2. Ehsan is immediately to the left of Fiza. 3. Chaman is two places to the right of Ali. 4. Beenish sits immediately between Ali and Chaman. 5. Dua is immediately to the right of Chaman.

21. Who stands at the extreme left?

- A) Chaman B) Ehsan  
C) Dua D) Ali



22. Which person is third from the right?

- A) Ali B) Dua  
C) Beenish D) Ehsan

23. Who is positioned between Beenish and Dua?

- A) Chaman B) Ali  
C) Ehsan D) No one

24. If the row is viewed from the north side, who appears second from the left to the observer?

- A) Fiza B) Beenish  
C) Dua D) Ehsan

**Analytical Set C4: Eight friends around a table - Questions 25-28**

Eight friends—Umar, Vaneeza, Wasif, Xara, Yasir, Zara, Adil, and Bushra—sit around a circular table facing the centre. Umar is fixed at the top. 1. Yasir sits opposite Umar. 2. Vaneeza sits immediately clockwise from Umar. 3. Wasif sits immediately clockwise from Vaneeza. 4. Xara sits immediately anticlockwise from Yasir. 5. Zara sits immediately clockwise from Yasir. 6. Adil sits immediately clockwise from Zara.

25. Who sits immediately anticlockwise from Bushra?

- A) Umar B) Yasir  
C) Adil D) Zara

26. Which friend sits opposite Wasif?

- A) Bushra B) Xara  
C) Zara D) Adil

27. How many people sit between Vaneeza and Yasir along the shorter route?

- A) Four B) Two  
C) None D) One

28. If Umar and Yasir swap seats, who will be immediately clockwise from Umar?

- A) Vaneeza B) Xara  
C) Bushra D) Zara

**Analytical Set S4: Seven-day workshop plan - Questions 29-32**

A seven-day workshop runs from Monday to Sunday. One session is held each day: Logic, English, Mathematics, Physics, Chemistry, Computer, and Review. 1. Logic is on Monday. 2. Review is on Sunday. 3. English is immediately after Logic. 4. Physics is immediately after Mathematics. 5. Chemistry is on Friday. 6. Computer is immediately before Review.

29. On which day is Mathematics scheduled?

- A) Saturday B) Friday  
C) Thursday D) Wednesday

30. Which session is held on Saturday?

- A) Computer B) Chemistry  
C) Review D) English

31. How many sessions occur between English and Chemistry?

- A) Three B) Two  
C) One D) None

32. If Mathematics is cancelled and Physics moves one day earlier, what session remains on Thursday?

- A) Review B) No session  
C) Physics D) Computer

**Analytical Set D4: Library security system - Questions 33-36**

Use these rules: 1. If the library is open (L), the guard is present (G). 2. If the guard is present (G), the cameras are on (C). 3. If the power fails (P), the cameras are off. 4. If the cameras are on (C), the alarm is active (A).

33. The library is open. Which condition must be present?

- A) The guard is absent B) The library is closed  
C) The alarm is active D) The power has failed

34. If the alarm is not active, what must be true about the library?

- A) The library is open B) The guard is present  
C) The power is normal D) The library is not open

35. The power fails. Which statement is forced if all rules remain consistent?

- A) The library is open B) The guard is present  
C) The library is not open D) The alarm is active

36. The guard is present and the power has not failed. What follows from the rules?

- A) The alarm is active B) The cameras are off  
C) The library is open D) The guard is absent

**Analytical Set B4: Akbar's family - Questions 37-40**

Akbar and Bushra are married. They have three children: Danish, a son; Esha, a daughter; and Faraz, a son. Danish is married to Gohar, and their daughter is Hira. Esha is married to Imran, and their son is Junaid. Faraz is unmarried.

37. How is Hira related to Faraz?

- A) Sister B) Daughter  
C) Niece D) Aunt

38. What is Junaid's relation to Bushra?

- A) Nephew B) Grandson  
C) Son D) Brother

39. How is Imran related to Danish?

- A) Brother-in-law B) Cousin  
C) Paternal uncle D) Maternal uncle

40. What is Gohar's relation to Esha?

- A) Aunt B) Sister-in-law  
C) Cousin D) Niece

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $75 + 9 \times 8 - 9$ .

- A) 138 B) 66  
C) 663 D) 147

42. Find  $5/17 + 8/20$  in simplest form.

- A)  $13/37$  B)  $59/85$   
C)  $-9/85$  D)  $13/340$

43. What is 20% of 1050?

- A) 107/10    B) 105/2  
C) 210    D) 840

44. A price of Rs. 1860 is increased by 25%. What is the new price?

- A) Rs. 465    B) Rs. 1885  
C) Rs. 1395    D) Rs. 2325

45. Rs. 810 is divided in the ratio 6:9. What is the larger share?

- A) 324    B) 405  
C) 15    D) 486

46. If 8 identical notebooks cost Rs. 1216, what will 12 notebooks cost at the same rate?

- A) 1824    B) 1228  
C) 14592    D) 1368

47. Find the arithmetic mean of 107, 112, 117, 122, 127.

- A) 585    B) 117  
C) 112    D) 122

48. A student scores 84 in a 3-credit course and 83 in a 5-credit course. Find the weighted mean.

- A) 83.5    B) 333.5  
C) 83.38    D) 44.47

49. A vehicle travels 392 km at a constant speed of 98 km/h. How long does the journey take?

- A) 490 hours    B) 294 hours  
C) 1/4 hours    D) 4 hours

50. Worker A can complete a job in 38 days and Worker B in 75 days. Working together, how many days will they take?

- A) 113/2 days    B) 113/2850 days  
C) 2850/37 days    D) 2850/113 days

51. An item costs Rs. 1080 and is sold at a profit of 15%. Find the selling price.

- A) Rs. 1242    B) Rs. 162  
C) Rs. 918    D) Rs. 1095

52. Find the simple interest on Rs. 4400 at 10% per year for 4 years.

- A) Rs. 440    B) Rs. 1760  
C) Rs. 176    D) Rs. 6160

53. Solve  $8x + 6 = 302$ .

- A) 296    B) 148/3  
C) 37    D) 38

54. What is the larger root of  $x^2 - 47x + 312 = 0$ ?

- A) 8    B) 47  
C) 312    D) 39

55. Find the 12th term of the arithmetic sequence with first term 71 and common difference 6.

- A) 143    B) 131  
C) 924    D) 137

56. If  $36^x = 46656$ , find  $x$ .

- A) 3    B) 36  
C) 46656    D) 4

57. Find the area of a triangle with base 44 cm and height 11 cm.

- A)  $484 \text{ cm}^2$     B)  $242 \text{ cm}^2$   
C)  $55 \text{ cm}^2$     D)  $121 \text{ cm}^2$

58. Find the midpoint of the segment joining (34, 36) and (40, 44).

- A) (6, 8)    B) (74, 80)  
C) (37, 40)    D) (3, 4)

59. A bag contains 5 red and 10 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $2/3$     B)  $1/2$   
C)  $1/15$     D)  $1/3$

60. How many different pairs can be selected from 39 people?

- A) 1482    B) 41  
C) 39    D) 741

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 7, 9, 11, 13, 15.

- A) 12    B) 11  
C) 55    D) 9

62. A student scores 53 in a 2-credit course and 73 in a 3-credit course. Find the weighted mean.

- A) 325.00    B) 67.00  
C) 65.00    D) 63.00

63. Find the median of 5, 8, 11, 14, 17.

- A) 8    B) 12  
C) None of these    D) 11

64. Find the mode of 6, 7, 6, 8, 6, 9.

- A) 6    B) None of these  
C) 8    D) 7

65. Find the range of 8, 11, 15, and 23.

- A) 15    B) 16  
C) 8    D) 23

66. A category has frequency 15 in a data set of 60 observations. What is its relative frequency?

- A) 0.75    B) 0.50  
C) 0.25    D) 4.00

67. If  $P(A) = 0.4$ , what is  $P(A^c)$ ?

- A) 0.5    B) 0.7  
C) 0.4    D) 0.6

68. An event has probability 0.5 in each of 130 independent trials. What is its expected frequency?

- A) 55 B) 75  
C) 50 D) 65

69. A correlation coefficient close to +1 indicates:

- A) that one variable causes the other B) no possible relationship  
C) a strong negative linear relationship D) a strong positive linear relationship

70. Which sampling method gives every population member an equal known chance of selection?

- A) Snowball sampling B) Convenience sampling  
C) Judgment sampling D) Simple random sampling

### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $5x + 6 = 26$ .

- A) 20 B) 3  
C) 5 D) 4

72. What is the larger root of  $x^2 - 20x + 91 = 0$ ?

- A) 7 B) 91  
C) 13 D) 20

73. Find the 6th term of the geometric sequence with first term 4 and common ratio 3.

- A) 2916 B) 969  
C) 972 D) 975

74. Find the slope of the line through (4, 5) and (7, 17).

- A) 3 B)  $\frac{1}{4}$   
C) 13 D) 4

75. Find the midpoint of the segment joining (3, 5) and (9, 9).

- A) (5, 8) B) (6, 8)  
C) (6, 7) D) (9, 9)

76. Find the distance between (2, 3) and (14, 19).

- A) 400 B) 21  
C) 12 D) 20

77. Find the area of a triangle with base 15 cm and perpendicular height 10 cm.

- A)  $150 \text{ cm}^2$  B)  $75/2 \text{ cm}^2$   
C)  $50 \text{ cm}^2$  D)  $75 \text{ cm}^2$

78. How many different pairs can be selected from 13 people?

- A) 15 B) 78  
C) 13 D) 91

79. What is  $\sin 90^\circ$ ?

- A) 0 B)  $\frac{1}{2}$   
C) 1 D)  $\frac{\sqrt{2}}{2}$

80. Find the determinant of the matrix  $\begin{bmatrix} 5 & 3 \\ 6 & 5 \end{bmatrix}$ .

- A) 8 B) 10  
C) -7 D) 7

### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The decimal number 15 is represented in binary as:

- A)  $1111_2$  B)  $1001_2$   
C)  $1010_2$  D)  $1100_2$

82. An AND gate outputs 1 only when:

- A) there is no input B) all inputs are 1  
C) inputs are different D) at least one input is 1

83. An OR gate outputs 1 when:

- A) all inputs are 0 only B) exactly two inputs are 0  
C) inputs are always equal D) at least one input is 1

84. A NOT gate:

- A) sorts records B) reverses the input truth value  
C) stores a byte D) connects networks

85. An IP address identifies:

- A) a programming loop B) a file extension  
C) a device or interface on an IP network D) a database row only

86. In a database table, a row is called a:

- A) record B) form  
C) data type D) field

87. In a database table, a column is called a:

- A) field B) report  
C) program loop D) record

88. A primary key should:

- A) contain duplicate values B) be left blank in every row  
C) uniquely identify each record D) always be a person's name

89. Database normalization helps to:

- A) remove all keys B) prevent queries  
C) reduce redundancy and update anomalies D) convert tables into images

90. Phishing is an attempt to:

- A) create a backup B) improve processor speed  
C) repair hardware automatically D) trick users into revealing sensitive information

**ANSWER KEY - ICS STATISTICS MODEL PAPER 4***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. C  | 2. C  | 3. D  | 4. C  | 5. D  | 6. B  | 7. C  | 8. A  | 9. D  | 10. D |
| 11. A | 12. D | 13. B | 14. D | 15. D | 16. B | 17. D | 18. B | 19. B | 20. A |
| 21. D | 22. B | 23. A | 24. D | 25. C | 26. D | 27. B | 28. D | 29. D | 30. A |
| 31. B | 32. B | 33. C | 34. D | 35. C | 36. A | 37. C | 38. B | 39. A | 40. B |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. C | 63. D | 64. A | 65. A | 66. C | 67. D | 68. D | 69. D | 70. D |
| 71. D | 72. C | 73. C | 74. D | 75. C | 76. D | 77. D | 78. B | 79. C | 80. D |
| 81. A | 82. B | 83. D | 84. B | 85. C | 86. A | 87. A | 88. C | 89. C | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |

**ICS-STATISTICS - MODEL PAPER 5**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 5

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) are B) is  
C) were D) be

2. At present, the workers \_\_\_\_ for the test.

- A) are preparing B) is preparing  
C) were prepare D) prepared

3. Ayesha \_\_\_\_ the attendance sheet already.

- A) has completed B) is completing since Monday  
C) completed yesterday D) had complete

4. By the time the supervisor arrived, Hamza \_\_\_\_ the assignment.

- A) will have checked B) checks  
C) was check D) had checked

5. By next Friday, the team \_\_\_\_ the attendance sheet.

- A) had completed B) has completed  
C) will completed D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) were being B) have  
C) is D) be

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) were B) do  
C) has D) have

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having B) have  
C) possess D) has

9. There \_\_\_\_ several reasons for the delay.

- A) has B) are  
C) be D) was

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) will boil always B) would boil  
C) would have boiled D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would have played B) had played  
C) would play D) will play

12. If I knew the answer, I \_\_\_\_ Ayesha.

- A) told B) will tell  
C) had told D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) would catch B) caught  
C) would have caught D) will catch

14. Choose the correct passive form: "The technician checks the attendance sheet."

- A) The attendance sheet is checked by the technician. B) The attendance sheet will be checked by the technician.  
C) The attendance sheet has checked by the technician. D) The attendance sheet was checked by the technician.

15. Choose the correct passive form: "The technician is checking the assignment."

- A) The assignment was being checked by the technician. B) The assignment is checked by the technician.  
C) The assignment is being checked by the technician. D) The assignment is been checked by the technician.

16. Choose the correct passive form: "The clerk processed the attendance sheet."

- A) The attendance sheet was processed by the clerk. B) The attendance sheet is processed by the clerk.  
C) The attendance sheet has processed by the clerk. D) The attendance sheet will be processed by the clerk.

17. Choose the correct passive form: "The committee has approved the assignment."

- A) The assignment has being approved by the committee. B) The assignment had approved by the committee.  
C) The assignment is approved by the committee. D) The assignment has been approved by the committee.

18. Choose the correct passive form: "The office will issue the attendance sheet."

- A) The attendance sheet will issued by the office. B) The attendance sheet will be issued by the office.  
C) The attendance sheet will have issued by the office. D) The attendance sheet is issued by the office.

19. Select the correct indirect form: Ayesha said, "I will complete the attendance sheet."

- A) Ayesha told that the attendance sheet would complete. B) Ayesha said that she will complete the attendance sheet.  
C) Ayesha said that she would complete the attendance sheet. D) Ayesha said that she had complete the attendance sheet.

20. Select the correct indirect form: Hamza said, "I am checking the assignment."

- A) Hamza said that I was checking the assignment. B) Hamza said that he was checking the assignment.  
C) Hamza said that he had checked the assignment. D) Hamza told that he was checking the assignment.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L5: Seven students in a row - Questions 21-24**

Seven students—Gul, Hamza, Inaya, Jawad, Komal, Laiba, and Mustafa—sit in a row facing north. 1. Jawad sits in the middle. 2. Gul sits third to the left of Jawad. 3. Mustafa sits third to the right of Jawad. 4. Hamza sits immediately to the left of Inaya. 5. Komal sits immediately to the right of Jawad. 6. Laiba sits immediately to the right of Komal.

21. Which student is seated in position three when counted from the left?

- A) Hamza B) Jawad  
C) Komal D) Inaya

22. Which student sits two places to the right of Inaya?

- A) Hamza B) Komal  
C) Jawad D) Laiba

23. How many people are seated between Gul and Jawad?

- A) Two B) One  
C) None D) Three

24. If Jawad moves to Mustafa's seat and everyone between them shifts one place left, who will sit in the middle?

- A) Komal B) Mustafa  
C) Jawad D) Inaya

**Analytical Set C5: Six participants around a round table - Questions 25-28**

Six participants—Cyrus, Daniyal, Esha, Faizan, Ghazal, and Hammad—sit around a round table facing the centre. Cyrus is fixed at the top. 1. Faizan sits opposite Cyrus. 2. Daniyal sits immediately clockwise from Cyrus. 3. Esha sits between Daniyal and Faizan on the clockwise side. 4. Ghazal sits immediately clockwise from Faizan.

25. Who sits immediately anticlockwise from Cyrus?

- A) Esha B) Daniyal  
C) Ghazal D) Hammad

26. Who is opposite Esha?

- A) Daniyal B) Hammad  
C) Faizan D) Cyrus

27. Which pair forms Faizan's immediate neighbours?

- A) Ghazal and Hammad B) Esha and Ghazal  
C) Daniyal and Esha D) Cyrus and Ghazal

28. After a one-seat anticlockwise rotation by everyone, who takes Daniyal's original position?

- A) Ghazal B) Hammad  
C) Esha D) Faizan

**Analytical Set S5: Six class periods - Questions 29-32**

Six lessons—Accounting, Biology, Chemistry, Drawing, English, and French—are placed in periods 1 to 6. 1. Accounting is in period 1. 2. French is in period 6. 3. Biology is immediately before Chemistry. 4. English is immediately after Drawing. 5. Chemistry is earlier than Drawing.

29. Which lesson is in period 3?

- A) Chemistry B) French  
C) Drawing D) English

30. What lesson immediately follows Drawing?

- A) Accounting B) French  
C) Chemistry D) English

31. How many periods separate Biology and English?

- A) Three B) None  
C) One D) Two

32. If the Biology-Chemistry pair swaps places with the Drawing-English pair, which lesson will be in period 2?

- A) Accounting B) Chemistry  
C) English D) Drawing

**Analytical Set D5: Train and meeting chain - Questions 33-36**

Use these rules: 1. If the train is late (T), the meeting is delayed (M). 2. If the meeting is delayed (M), the manager calls (C). 3. If the manager calls (C), the staff wait (W). 4. If the staff do not wait, the report is sent (R).

33. The train is late. Which result must eventually occur?

- A) The report is not sent B) The staff leave immediately  
C) The staff wait D) The manager does not call

34. The manager does not call. What must be true about the train?

- A) The train is late B) The meeting is delayed  
C) The report is not sent D) The train is not late

35. If the staff do not wait, which conclusion follows directly?

- A) The train is late B) The meeting is delayed  
C) The report is withheld D) The report is sent

36. The report is not sent. What must be true?

- A) The staff do not wait B) The train is late  
C) The meeting is delayed D) The staff wait

**Analytical Set B5: Khalid's family - Questions 37-40**

Khalid and Salma are married. Their daughter Lubna is married to Noman and has two children, Omer and Pari. Their son Majid is married to Qurat and has one son, Raza.

37. What is Omer's relation to Majid?

- A) Brother B) Uncle  
C) Cousin D) Nephew

38. How is Salma related to Pari?

- A) Mother-in-law B) Maternal aunt  
C) Paternal grandmother D) Maternal grandmother

39. What is Raza's relation to Pari?

- A) Uncle B) Brother  
C) Nephew D) Cousin

40. How is Qurat related to Lubna?

- A) Sister-in-law B) Maternal aunt  
C) Daughter-in-law D) Sister

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $77 + 3 \times 4 - 10$ .

- A) 79 B) 59  
C) 310 D) 82

42. Find  $\frac{1}{11} + \frac{6}{21}$  in simplest form.

- A)  $\frac{7}{32}$  B)  $\frac{29}{77}$   
C)  $-\frac{15}{77}$  D)  $\frac{1}{33}$

43. What is 25% of 1075?

- A) 11    B) 43  
C) 1075/4    D) 3225/4

44. A price of Rs. 1900 is increased by 30%. What is the new price?

- A) Rs. 570    B) Rs. 1930  
C) Rs. 1330    D) Rs. 2470

45. Rs. 440 is divided in the ratio 2:6. What is the larger share?

- A) 110    B) 220  
C) 8    D) 330

46. If 4 identical notebooks cost Rs. 620, what will 9 notebooks cost at the same rate?

- A) 1395    B) 629  
C) 5580    D) 775

47. Find the arithmetic mean of 110, 116, 122, 128, 134.

- A) 610    B) 122  
C) 116    D) 128

48. A student scores 85 in a 4-credit course and 84 in a 6-credit course. Find the weighted mean.

- A) 84.5    B) 422  
C) 84.4    D) 35.17

49. A vehicle travels 500 km at a constant speed of 100 km/h. How long does the journey take?

- A) 600 hours    B) 400 hours  
C) 1/5 hours    D) 5 hours

50. Worker A can complete a job in 39 days and Worker B in 77 days. Working together, how many days will they take?

- A) 58 days    B) 116/3003 days  
C) 3003/38 days    D) 3003/116 days

51. An item costs Rs. 1100 and is sold at a profit of 20%. Find the selling price.

- A) Rs. 1320    B) Rs. 220  
C) Rs. 880    D) Rs. 1120

52. Find the simple interest on Rs. 4500 at 4% per year for 5 years.

- A) Rs. 180    B) Rs. 900  
C) Rs. 225    D) Rs. 5400

53. Solve  $2x + 7 = 83$ .

- A) 76    B) 76/7  
C) 38    D) 39

54. What is the larger root of  $x^2 - 42x + 80 = 0$ ?

- A) 2    B) 42  
C) 80    D) 40

55. Find the 13th term of the arithmetic sequence with first term 73 and common difference 2.

- A) 99    B) 95  
C) 975    D) 97

56. If  $37^x = 1874161$ , find x.

- A) 4    B) 37  
C) 1874161    D) 5

57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 252 cm.

- A) 199584 cm    B) 1584 cm  
C) 792 cm    D) 504 cm

58. Find the distance between (35, 36) and (38, 40).

- A) 7    B) 4  
C) 5    D) 25

59. A bag contains 6 red and 4 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A) 2/5    B) 3/2  
C) 1/10    D) 3/5

60. How many different pairs can be selected from 40 people?

- A) 1560    B) 42  
C) 40    D) 780

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 8, 10, 12, 14, 16.

- A) 10    B) 60  
C) 13    D) 12

62. A student scores 54 in a 3-credit course and 74 in a 4-credit course. Find the weighted mean.

- A) 458.00    B) 65.43  
C) 64.00    D) 67.43

63. Find the median of 6, 9, 12, 15, 18.

- A) 9    B) 12  
C) 15    D) Cannot be determined

64. Find the mode of 7, 8, 7, 9, 7, 10.

- A) 10    B) 7  
C) 9    D) 8

65. Find the range of 9, 12, 16, and 25.

- A) 16    B) 9  
C) 25    D) 17

66. For the population values 8, 14, and 20, find the population variance.

- A) 72    B) 12  
C) 6    D) 24

67. A category has frequency 16 in a data set of 64 observations. What is its relative frequency?

- A) 0.20    B) 0.50  
C) 4.00    D) 0.25



68. If  $P(A) = 0.1$ , what is  $P(A^c)$ ?

- A) 1.1   B) 0.1  
C) 0.8   D) 0.9

69. An event has probability 0.6 in each of 140 independent trials. What is its expected frequency?

- A) 140   B) 60  
C) 84   D) 94

70. In hypothesis testing, the hypothesis tested for possible rejection is called the:

- A) frequency hypothesis   B) descriptive hypothesis  
C) null hypothesis   D) sample hypothesis

### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $6x + 7 = 43$ .

- A) 36   B) 6  
C) 5   D) 7

72. What is the larger root of  $x^2 - 7x + 10 = 0$ ?

- A) -5   B) 5  
C) 10   D) 2

73.  $y$  varies directly as  $x$ . If  $y = 18$  when  $x = 3$ , find  $y$  when  $x = 5$ .

- A) 30   B) 11  
C) 23   D) 90

74. Find the midpoint of the segment joining (4, 2) and (10, 6).

- A) (6, 5)   B) (6, 4)  
C) (7, 5)   D) (7, 4)

75. Find the distance between (0, 0) and (3, 4).

- A) 25   B) 3  
C) 6   D) 5

76. Find the area of a triangle with base 8 cm and perpendicular height 5 cm.

- A)  $20 \text{ cm}^2$    B)  $26 \text{ cm}^2$   
C)  $13 \text{ cm}^2$    D)  $40 \text{ cm}^2$

77. A bag contains 3 red and 10 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $1/13$    B)  $3/10$   
C)  $3/13$    D)  $13/3$

78. How many different pairs can be selected from 6 people?

- A) 21   B) 30  
C) 8   D) 15

79. What is  $\sin 30^\circ$ ?

- A) 0   B)  $\sqrt{2}/2$   
C)  $1/2$    D) 1

80. Find the determinant of the matrix  $\begin{bmatrix} 2 & 1 \\ 7 & 2 \end{bmatrix}$ .

- A) -3   B) 4  
C) -2   D) 11

### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. Encryption converts readable data into:

- A) a monitor signal   B) a compiler  
C) a flowchart   D) ciphertext

82. A strong password should generally be:

- A) shared publicly   B) the user's name only  
C) long, unique and difficult to guess   D) the same for every account

83. Cloud computing provides resources:

- A) only through printers   B) only from a local floppy disk  
C) inside a keyboard   D) over a network on demand

84. Machine learning enables systems to:

- A) replace all hardware   B) avoid evaluation  
C) guarantee perfect predictions   D) improve performance from data

85. Supervised learning uses:

- A) labelled training examples   B) only random numbers  
C) hardware instructions   D) no data

86. A black-box model is difficult to:

- A) store in memory   B) represent numerically  
C) train with data   D) interpret internally

87. The purpose of testing software is to:

- A) replace users   B) remove all documentation  
C) guarantee no future changes   D) find defects and verify expected behaviour

88. The expression  $14 \% 3$  in C evaluates to:

- A) 1   B) 2  
C) 4.67   D) 4

89. In C,  $\&\&$  represents logical:

- A) assignment   B) AND  
C) division   D) OR

90. A for loop header normally contains:

- A) table, row and field   B) class, object and method  
C) input, output and storage   D) initialization, condition and update



**ANSWER KEY - ICS STATISTICS MODEL PAPER 5***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. A  | 3. A  | 4. D  | 5. D  | 6. C  | 7. C  | 8. D  | 9. B  | 10. D |
| 11. D | 12. D | 13. C | 14. A | 15. C | 16. A | 17. D | 18. B | 19. C | 20. B |
| 21. D | 22. B | 23. A | 24. A | 25. D | 26. B | 27. B | 28. C | 29. A | 30. D |
| 31. D | 32. D | 33. C | 34. D | 35. D | 36. D | 37. D | 38. D | 39. D | 40. A |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. B | 63. B | 64. B | 65. A | 66. D | 67. D | 68. D | 69. C | 70. C |
| 71. B | 72. B | 73. A | 74. D | 75. D | 76. A | 77. C | 78. D | 79. C | 80. A |
| 81. D | 82. C | 83. D | 84. D | 85. A | 86. D | 87. D | 88. B | 89. B | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |

**ICS-STATISTICS - MODEL PAPER 6**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 6

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) were B) is  
C) be D) are

2. At present, the students \_\_\_\_ for the test.

- A) prepared B) are preparing  
C) have prepare D) were prepare

3. Ali \_\_\_\_ the data table already.

- A) is completing since Monday B) has completed  
C) completed yesterday D) had complete

4. By the time the supervisor arrived, Hira \_\_\_\_ the project.

- A) has checked B) checks  
C) had checked D) will have checked

5. By next Friday, the team \_\_\_\_ the data table.

- A) will completed B) has completed  
C) would complete D) will have completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) were being  
C) are D) have

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) do  
C) has D) have

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having B) were given by  
C) has D) possess

9. There \_\_\_\_ several reasons for the delay.

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C) be D) was

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boils B) would boil  
C) boiled D) would have boiled

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play B) will play  
C) had played D) played

12. If I knew the answer, I \_\_\_\_ Ali.

- A) had told B) told  
C) will tell D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) will catch B) caught  
C) would catch D) would have caught

14. Choose the correct passive form: "The technician checks the data table."

- A) The data table was checked by the technician. B) The data table has checked by the technician.  
C) The data table is being checked by the technician. D) The data table is checked by the technician.

15. Choose the correct passive form: "The technician is checking the project."

- A) The project has been checked by the technician. B) The project was being checked by the technician.  
C) The project is been checked by the technician. D) The project is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the data table."

- A) The data table was processed by the clerk. B) The data table is processed by the clerk.  
C) The data table was being processed by the clerk. D) The data table will be processed by the clerk.

17. Choose the correct passive form: "The committee has approved the project."

- A) The project has been approved by the committee. B) The project had approved by the committee.  
C) The project was approved by the committee. D) The project is approved by the committee.

18. Choose the correct passive form: "The office will issue the data table."

- A) The data table will be issued by the office. B) The data table would be issued by the office.  
C) The data table will issued by the office. D) The data table will have issued by the office.

19. Select the correct indirect form: Ali said, "I will complete the data table."

- A) Ali told that the data table would complete. B) Ali said that he had complete the data table.  
C) Ali said that I would complete the data table. D) Ali said that he would complete the data table.

20. Select the correct indirect form: Hira said, "I am checking the project."

- A) Hira said that she was checking the project. B) Hira said that she had checked the project.  
C) Hira said that she is checking the project. D) Hira said that I was checking the project.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L6: 6 candidates in a straight row - Questions 21-24**

6 candidates—Cyrus, Bushra, Adeel, Dua, Fahad, and Ghazal—sit in a straight row, all facing north. 1. Cyrus occupies the extreme left seat. 2. Ghazal sits at the extreme right. 3. Bushra is immediately to the right of Cyrus. 4. Dua sits immediately to the right of Adeel. 5. Fahad sits between Dua and Ghazal, adjacent to both.

21. Which pair occupies the two end seats?

- A) Bushra and Ghazal B) Cyrus and Ghazal  
C) Cyrus and Fahad D) Dua and Fahad

22. Who sits second to the right of Bushra?

- A) Adeel B) Cyrus  
C) Ghazal D) Dua

23. Which statement is consistent with the completed arrangement?

- A) Adeel sits at an end B) Dua sits second from the left  
C) Bushra sits immediately left of Cyrus D) Fahad sits immediately left of Ghazal

24. If everyone now faces south without changing seats, who is immediately to the left of Dua?

- A) Bushra B) Fahad  
C) Cyrus D) Ghazal

**Analytical Set C6: 6 participants around a round table - Questions 25-28**

6 participants—Cem, Dalia, Aariz, Bina, Fiza, and Ehsan—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Cem occupies the top seat. 2. Dalia sits immediately clockwise of Cem. 3. Aariz sits immediately clockwise of Dalia. 4. Bina sits directly opposite Cem. 5. Fiza sits immediately clockwise of Bina. 6. Ehsan sits immediately clockwise of Fiza.

25. Which pair are the immediate neighbours of Cem?

- A) Aariz and Ehsan B) Ehsan and Dalia  
C) Dalia and Bina D) Cem and Aariz

26. Identify the participant opposite Aariz.

- A) Ehsan B) Dalia  
C) Bina D) Fiza

27. Who sits between Cem and Aariz on the shorter arc?

- A) Dalia B) Fiza  
C) Aariz D) Bina

28. If everyone turns to face outward, who is immediately to the left of Fiza?

- A) Dalia B) Aariz  
C) Bina D) Ehsan

**Analytical Set S6: 6 subjects in fixed slots - Questions 29-32**

The following 6 subjects are assigned one per slot: Drawing, English, Physics, Algebra, Chemistry, and Biology. 1. Drawing is scheduled in Monday. 2. Biology is scheduled in Saturday. 3. English occurs immediately after Drawing. 4. Algebra occurs immediately after Physics. 5. Chemistry is between Algebra and Biology, consecutive with both.

29. What is the first scheduled activity?

- A) Biology B) Algebra  
C) Chemistry D) Drawing

30. When does Chemistry take place?

- A) Wednesday B) Thursday  
C) Monday D) Friday

31. Which pair occurs in two consecutive slots in the stated order?

- A) Drawing followed by Biology B) Physics followed by Algebra  
C) Drawing followed by Physics D) English followed by Chemistry

32. If English and Chemistry exchange slots, which activity occupies Tuesday?

- A) Drawing B) Physics  
C) Algebra D) Chemistry

**Analytical Set D6: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the proposal is funded, then the audit begins. 2. If the audit begins, then the report is drafted. 3. If the report is drafted, then the board meets. 4. If a security hold is imposed, then the report is not drafted. 5. If an alert is issued, then a security hold is imposed.

33. If the proposal is funded, which outcome must eventually follow?

- A) A security hold is imposed B) The audit does not begin  
C) The report is not drafted D) The board meets

34. Suppose the board does not meet. Which conclusion is unavoidable?

- A) The report is drafted B) The audit begins  
C) The proposal is not funded D) A security hold is imposed

35. If an alert is issued, what must be true about the second condition?

- A) The audit begins B) The report is drafted  
C) The board meets D) The audit does not begin

36. Which pair cannot both be true under the stated rules?

- A) The proposal is funded and the audit begins B) A security hold is imposed and an alert is issued  
C) The proposal is funded and a security hold is imposed D) The audit begins and the board meets

**Analytical Set B6: The family of Rauf and Shazia - Questions 37-40**

Rauf and Shazia are married. Their children are Adnan, a son, and Bina, a daughter. Adnan is married to Naila; their children are Iqra, a son, and Junaid, a daughter. Bina is married to Hamid; their child is Komal, a son.

37. How is Shazia related to Junaid?

- A) Mother-in-law B) Maternal aunt  
C) Maternal grandmother D) Paternal grandmother

38. What is Bina's relation to Iqra?

- A) Maternal aunt B) Sister-in-law  
C) Sister D) Paternal aunt

39. How is Komal related to Junaid?

- A) Uncle B) Brother-in-law  
C) Cousin D) Sibling

40. How is Naila related to Bina?

- A) Maternal aunt B) Paternal aunt  
C) Mother-in-law D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $79 + 4 \times 5 - 2$ .

- A) 97 B) 91  
C) 413 D) 101

42. Find  $7/12 + 1/13$  in simplest form.

- A)  $8/25$  B)  $103/156$   
C)  $79/156$  D)  $2/39$

43. What is 30% of 1100?

- A)  $113/10$  B)  $110/3$   
C) 330 D) 770

44. A price of Rs. 1940 is increased by 5%. What is the new price?

- A) Rs. 97 B) Rs. 1945  
C) Rs. 1843 D) Rs. 2037

45. Rs. 392 is divided in the ratio 3:4. What is the larger share?

- A) 168 B) 196  
C) 7 D) 224

46. If 5 identical notebooks cost Rs. 790, what will 7 notebooks cost at the same rate?

- A) 1106 B) 797  
C) 5530 D) 948

47. Find the arithmetic mean of 113, 114, 115, 116, 117.

- A) 575 B) 115  
C) 114 D) 116

48. A student scores 86 in a 2-credit course and 85 in a 3-credit course. Find the weighted mean.

- A) 85.5 B) 213.5  
C) 85.4 D) 71.17

49. A vehicle travels 204 km at a constant speed of 102 km/h. How long does the journey take?

- A) 306 hours B) 102 hours  
C)  $1/2$  hours D) 2 hours

50. Worker A can complete a job in 40 days and Worker B in 79 days. Working together, how many days will they take?

- A)  $119/2$  days B)  $119/3160$  days  
C)  $3160/39$  days D)  $3160/119$  days

51. An item costs Rs. 1120 and is sold at a profit of 25%. Find the selling price.

- A) Rs. 1400 B) Rs. 280  
C) Rs. 840 D) Rs. 1145

52. Find the simple interest on Rs. 4600 at 5% per year for 2 years.

- A) Rs. 230 B) Rs. 460  
C) Rs. 92 D) Rs. 5060

53. Solve  $3x + 8 = 125$ .

- A) 117 B)  $117/8$   
C) 39 D) 40

54. What is the larger root of  $x^2 - 44x + 123 = 0$ ?

- A) 3 B) 44  
C) 123 D) 41

55. Find the 14th term of the arithmetic sequence with first term 75 and common difference 3.

- A) 117 B) 111  
C) 1092 D) 114

56. If  $38^x = 1444$ , find x.

- A) 2 B) 38  
C) 1444 D) 3

57. Find the area of a rectangle of length 44 cm and width 4 cm.

- A)  $96 \text{ cm}^2$  B)  $176 \text{ cm}^2$   
C)  $48 \text{ cm}^2$  D)  $352 \text{ cm}^2$

58. Find the slope of the line through (36, 38) and (40, 46).

- A)  $1/2$  B) 8  
C) 2 D) 4

59. A bag contains 7 red and 5 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $5/12$  B)  $7/5$   
C)  $1/12$  D)  $7/12$

60. How many different pairs can be selected from 41 people?

- A) 1640 B) 43  
C) 41 D) 820

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 9, 11, 13, 15, 17.

- A) 13 B) 14  
C) 65 D) 15

62. A student scores 55 in a 4-credit course and 75 in a 5-credit course. Find the weighted mean.

- A) 68.11 B) 66.11  
C) 65.00 D) 64.11

63. Find the median of 2, 5, 8, 11, 14.

- A) 12 B) 8  
C) 5 D) 11

64. Find the mode of 8, 9, 8, 10, 8, 11.

- A) 8 B) 10  
C) 11 D) 9

65. Find the range of 10, 13, 17, and 22.

- A) 12 B) 10  
C) 11 D) 13

66. For the population values 6, 15, and 24, find the population variance.

- A) 9 B) 162  
C) 27 D) 54

67. A category has frequency 17 in a data set of 68 observations. What is its relative frequency?

- A) 0.25   B) 0.20  
C) 0.50   D) 4.00

68. If  $P(A) = 0.2$ , what is  $P(A^c)$ ?

- A) 0.8   B) 0.7  
C) 0.2   D) 1.2

69. An event has probability 0.2 in each of 100 independent trials. What is its expected frequency?

- A) 100   B) 30  
C) 10   D) 20

70. A correlation coefficient close to +1 indicates:

- A) a strong positive linear relationship   B) no possible relationship  
C) a strong negative linear relationship   D) that one variable causes the other

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $2x + 8 = 24$ .

- A) 7   B) 8  
C) 9   D) 16

72. What is the larger root of  $x^2 - 10x + 21 = 0$ ?

- A) 7   B) 21  
C) 10   D) 3

73.  $y$  varies directly as  $x$ . If  $y = 8$  when  $x = 4$ , find  $y$  when  $x = 6$ .

- A) 48   B) 12  
C) 14   D) 8

74. Find the slope of the line through (2, 2) and (5, 8).

- A) 2   B)  $\frac{1}{2}$   
C) 7   D) 3

75. Find the midpoint of the segment joining (0, 3) and (6, 7).

- A) (6, 4)   B) (3, 5)  
C) (2, 6)   D) (3, 6)

76. Find the distance between (1, 1) and (7, 9).

- A) 11   B) 6  
C) 100   D) 10

77. Find the area of a triangle with base 9 cm and perpendicular height 6 cm.

- A)  $54 \text{ cm}^2$    B)  $15 \text{ cm}^2$   
C)  $27/2 \text{ cm}^2$    D)  $27 \text{ cm}^2$

78. How many different pairs can be selected from 7 people?

- A) 9   B) 7  
C) 42   D) 21

79. What is  $\cos 60^\circ$ ?

- A)  $\sqrt{2}/2$    B)  $1/2$   
C)  $\sqrt{3}/2$    D) 0

80. Find the determinant of the matrix  $\begin{bmatrix} 3 & 2 \\ 3 & 3 \end{bmatrix}$ .

- A) 15   B) -3  
C) 4   D) 3

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The component that performs arithmetic and logical operations is the:

- A) Input unit   B) ALU  
C) Control unit   D) Hard disk

82. RAM is best described as:

- A) a network protocol   B) volatile primary memory  
C) permanent optical storage   D) an input device

83. ROM is commonly used to store:

- A) open application windows   B) keyboard signals  
C) firmware that should persist without power   D) temporary user data only

84. A compiler generally translates:

- A) machine code into English   B) an entire high-level program into machine code  
C) images into audio   D) data into hardware

85. An algorithm is:

- A) a network cable   B) a finite sequence of unambiguous steps for solving a problem  
C) an error message only   D) a computer brand

86. Pseudocode is used to:

- A) describe an algorithm in structured, language-independent form   B) encrypt a disk automatically  
C) compile a program directly   D) replace all testing

87. A syntax error occurs when:

- A) a user forgets a password   B) data are duplicated in a table  
C) the program runs but gives the wrong result   D) programming-language rules are violated

88. A logic error causes a program to:

- A) run but produce an incorrect result   B) have no variables  
C) become an operating system   D) fail grammar checking before compilation only

89. A variable is used to:

- A) store a value that may change during program execution   B) prevent all errors  
C) replace the CPU   D) draw a network cable

90. A function is useful because it:

- A) replaces all variables   B) always runs before main memory  
C) can contain no parameters   D) encapsulates a reusable block of code

**ANSWER KEY - ICS STATISTICS MODEL PAPER 6***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. B  | 3. B  | 4. C  | 5. D  | 6. A  | 7. C  | 8. C  | 9. A  | 10. A |
| 11. B | 12. D | 13. D | 14. D | 15. D | 16. A | 17. A | 18. A | 19. D | 20. A |
| 21. B | 22. D | 23. D | 24. B | 25. B | 26. A | 27. A | 28. C | 29. D | 30. D |
| 31. B | 32. D | 33. D | 34. C | 35. D | 36. C | 37. D | 38. D | 39. C | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. A | 62. B | 63. B | 64. A | 65. A | 66. D | 67. A | 68. A | 69. D | 70. A |
| 71. B | 72. A | 73. B | 74. A | 75. B | 76. D | 77. D | 78. D | 79. B | 80. D |
| 81. B | 82. B | 83. C | 84. B | 85. B | 86. A | 87. D | 88. A | 89. A | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |

## ICS-STATISTICS - MODEL PAPER 7

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 7

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) have B) is  
C) were D) be

2. At present, the technicians \_\_\_\_ for the test.

- A) prepared B) is preparing  
C) have prepare D) are preparing

3. Sara \_\_\_\_ the question paper already.

- A) have completed B) had complete  
C) has completed D) is completing since Monday

4. By the time the supervisor arrived, Ahmed \_\_\_\_ the application.

- A) checks B) had checked  
C) was check D) will have checked

5. By next Friday, the team \_\_\_\_ the question paper.

- A) will completed B) has completed  
C) will have completed D) would complete

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) be  
C) have D) were being

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) were B) have  
C) are having D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having B) were given by  
C) has D) possess

9. There \_\_\_\_ several reasons for the delay.

- A) has B) are  
C) be D) is

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) would have boiled B) boiled  
C) would boil D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would have played B) will play  
C) played D) had played

12. If I knew the answer, I \_\_\_\_ Sara.

- A) had told B) would have told  
C) will tell D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) would catch B) caught  
C) had caught D) would have caught

14. Choose the correct passive form: "The technician checks the question paper."

- A) The question paper is checked by the technician. B) The question paper will be checked by the technician.  
C) The question paper has checked by the technician. D) The question paper is being checked by the technician.

15. Choose the correct passive form: "The technician is checking the application."

- A) The application is been checked by the technician. B) The application has been checked by the technician.  
C) The application is checked by the technician. D) The application is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the question paper."

- A) The question paper was processed by the clerk. B) The question paper has processed by the clerk.  
C) The question paper will be processed by the clerk. D) The question paper was being processed by the clerk.

17. Choose the correct passive form: "The committee has approved the application."

- A) The application is approved by the committee. B) The application has been approved by the committee.  
C) The application was approved by the committee. D) The application has being approved by the committee.

18. Choose the correct passive form: "The office will issue the question paper."

- A) The question paper would be issued by the office. B) The question paper will have issued by the office.  
C) The question paper will be issued by the office. D) The question paper is issued by the office.

19. Select the correct indirect form: Sara said, "I will complete the question paper."

- A) Sara said that she will complete the question paper. B) Sara told that the question paper would complete.  
C) Sara said that she had complete the question paper. D) Sara said that she would complete the question paper.

20. Select the correct indirect form: Ahmed said, "I am checking the application."

- A) Ahmed said that he had checked the application. B) Ahmed said that he was checking the application.  
C) Ahmed told that he was checking the application. D) Ahmed said that I was checking the application.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L7: 7 candidates in a straight row - Questions 21-24

7 candidates—Laiba, Noreen, Iqra, Muneeb, Jibran, Hammad, and Komal—sit in a straight row, all facing north. 1. Noreen is second from the left. 2. Hammad is second from the right. 3. Laiba sits immediately left of Noreen. 4. Iqra sits immediately right of Noreen. 5. Muneeb occupies the central seat. 6. Jibran is immediately right of Muneeb. 7. Komal is immediately right of Hammad.

21. Who is in the left-middle seat of this row?

- A) Laiba B) Komal  
C) Iqra D) Hammad

22. Who sits exactly between Noreen and Muneeb?

- A) Laiba B) Iqra  
C) Jibran D) Hammad

23. Who is third from the right end?

- A) Hammad B) Noreen  
C) Muneeb D) Jibran

24. If Noreen and Hammad exchange seats, who occupies seat 2 from the left?

- A) Noreen B) Hammad  
C) Komal D) Muneeb

**Analytical Set C7: 8 participants around a round table - Questions 25-28**

8 participants—Irtaza, Laila, Hiba, Mahir, Joya, Nida, Gibran, and Kashan—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Irtaza sits at the top. 2. Kashan is immediately anticlockwise from Irtaza. 3. Gibran is immediately anticlockwise from Kashan. 4. Joya is opposite Irtaza. 5. Mahir is immediately anticlockwise from Joya. 6. Hiba is immediately anticlockwise from Mahir. 7. Laila sits between Irtaza and Hiba, adjacent to both. 8. Nida is immediately clockwise from Joya.

25. Who occupies the bottom seat, directly across from the top seat?

- A) Laila B) Irtaza  
C) Hiba D) Joya

26. Who is second anticlockwise from Irtaza?

- A) Nida B) Joya  
C) Hiba D) Gibran

27. Which pair sits in consecutive clockwise seats?

- A) Mahir and Kashan B) Irtaza and Nida  
C) Irtaza and Mahir D) Hiba and Mahir

28. If Laila exchanges seats with the person opposite, who then sits immediately clockwise of Irtaza?

- A) Irtaza B) Gibran  
C) Mahir D) Nida

**Analytical Set S7: 7 sessions in fixed slots - Questions 29-32**

The following 7 sessions are assigned one per slot: Audit, Guidance, Design, Briefing, Coding, Finance, and Evaluation. 1. Briefing is scheduled in the middle slot, Thursday. 2. Audit opens the schedule. 3. Evaluation closes the schedule. 4. Guidance immediately follows Audit. 5. Design immediately precedes Briefing. 6. Coding immediately follows Briefing. 7. Finance immediately precedes Evaluation.

29. Which activity is assigned to Thursday?

- A) Design B) Briefing  
C) Finance D) Evaluation

30. What comes immediately after Design?

- A) Coding B) Evaluation  
C) Guidance D) Briefing

31. Which pair occupies the first and last slots respectively?

- A) Guidance and Design B) Design and Finance  
C) Guidance and Coding D) Audit and Evaluation

32. If Guidance is postponed by two slots and intervening activities shift earlier, what occupies Wednesday?

- A) Guidance B) Audit  
C) Briefing D) Design

**Analytical Set D7: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the student qualifies, then the interview is scheduled. 2. If the student qualifies, then the documents are verified. 3. If the interview is scheduled, then the fee voucher is issued. 4. If the documents are verified, then the admission file opens. 5. If the fee voucher is issued, then the final list includes the student.

33. When the student qualifies, which later result is guaranteed?

- A) The final list includes the student B) The fee voucher is not issued  
C) The documents are not verified D) The interview is not scheduled

34. If the admission file does not open, what must be concluded?

- A) The student does not qualify B) The interview is scheduled  
C) The student qualifies D) The documents are verified

35. Given that the fee voucher is not issued, which earlier condition must be false?

- A) The documents are verified B) The admission file opens  
C) The student qualifies D) The interview is not scheduled

36. If the student qualifies, which pair must both be true?

- A) The fee voucher is issued and the admission file does not open B) The interview is scheduled and the documents are not verified  
C) The fee voucher is not issued and the final list includes the student D) The fee voucher is issued and the admission file opens

**Analytical Set B7: The family of Tariq and Uzma - Questions 37-40**

Tariq and Uzma are married. Their children are Bilal, a son, and Celia, a daughter. Bilal is married to Dua; their children are Gul, a son, and Haris, a daughter. Celia is married to Fahad; their child is Ilma, a son.

37. How is Uzma related to Haris?

- A) Paternal aunt B) Paternal grandmother  
C) Maternal aunt D) Maternal grandmother

38. What is Celia's relation to Gul?

- A) Maternal aunt B) Niece  
C) Paternal aunt D) Sister-in-law

39. How is Ilma related to Haris?

- A) Uncle B) Nephew  
C) Brother-in-law D) Cousin

40. How is Dua related to Celia?

- A) Mother-in-law B) Paternal aunt  
C) Sister-in-law D) Maternal aunt

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $81 + 5 \times 6 - 3$ .

- A) 108 B) 96  
C) 513 D) 113



42. Find  $\frac{3}{13} + \frac{8}{14}$  in simplest form.

- A)  $\frac{11}{27}$  B)  $\frac{73}{91}$   
C)  $-\frac{31}{91}$  D)  $\frac{11}{182}$

43. What is 35% of 1125?

- A)  $\frac{58}{5}$  B)  $\frac{225}{7}$   
C)  $\frac{1575}{4}$  D)  $\frac{2925}{4}$

44. A price of Rs. 1980 is increased by 10%. What is the new price?

- A) Rs. 198 B) Rs. 1990  
C) Rs. 1782 D) Rs. 2178

45. Rs. 570 is divided in the ratio 4:6. What is the larger share?

- A) 228 B) 285  
C) 10 D) 342

46. If 6 identical notebooks cost Rs. 966, what will 9 notebooks cost at the same rate?

- A) 1449 B) 975  
C) 8694 D) 1127

47. Find the arithmetic mean of 116, 118, 120, 122, 124.

- A) 600 B) 120  
C) 118 D) 122

48. A student scores 87 in a 3-credit course and 86 in a 4-credit course. Find the weighted mean.

- A) 86.5 B) 302.5  
C) 86.43 D) 50.42

49. A vehicle travels 312 km at a constant speed of 104 km/h. How long does the journey take?

- A) 416 hours B) 208 hours  
C)  $\frac{1}{3}$  hours D) 3 hours

50. Worker A can complete a job in 41 days and Worker B in 81 days. Working together, how many days will they take?

- A) 61 days B)  $\frac{122 \times 3321}{\text{days}}$   
C)  $\frac{3321 \times 40}{\text{days}}$  D)  $\frac{3321 \times 122}{\text{days}}$

51. An item costs Rs. 1140 and is sold at a profit of 30%. Find the selling price.

- A) Rs. 1482 B) Rs. 342  
C) Rs. 798 D) Rs. 1170

52. Find the simple interest on Rs. 4700 at 6% per year for 3 years.

- A) Rs. 282 B) Rs. 846  
C) Rs. 141 D) Rs. 5546

53. Solve  $4x + 9 = 169$ .

- A) 160 B)  $\frac{160}{9}$   
C) 40 D) 41

54. What is the larger root of  $x^2 - 46x + 168 = 0$ ?

- A) 4 B) 46  
C) 168 D) 42

55. Find the 15th term of the arithmetic sequence with first term 77 and common difference 4.

- A) 137 B) 129  
C) 1215 D) 133

56. If  $39^x = 59319$ , find x.

- A) 3 B) 39  
C) 59319 D) 4

57. Find the area of a triangle with base 47 cm and height 5 cm.

- A)  $235 \text{ cm}^2$  B)  $\frac{235}{2} \text{ cm}^2$   
C)  $52 \text{ cm}^2$  D)  $\frac{235}{4} \text{ cm}^2$

58. Find the midpoint of the segment joining (37, 39) and (43, 47).

- A) (6, 8) B) (80, 86)  
C) (40, 43) D) (3, 4)

59. A bag contains 8 red and 6 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $\frac{3}{7}$  B)  $\frac{4}{3}$   
C)  $\frac{1}{14}$  D)  $\frac{4}{7}$

60. How many different pairs can be selected from 42 people?

- A) 1722 B) 44  
C) 42 D) 861

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 10, 12, 14, 16, 18.

- A) 15 B) 12  
C) 70 D) 14

62. A student scores 56 in a 2-credit course and 76 in a 3-credit course. Find the weighted mean.

- A) 66.00 B) 70.00  
C) 340.00 D) 68.00

63. Find the median of 3, 6, 9, 12, 15.

- A) 9 B) 6  
C) None of these D) 12

64. Find the mode of 9, 10, 9, 11, 9, 12.

- A) 11 B) 12  
C) 10 D) 9

65. Find the range of 11, 14, 18, and 24.

- A) 12 B) 13  
C) 11 D) 24

66. A category has frequency 18 in a data set of 72 observations. What is its relative frequency?

- A) 0.50 B) 0.75  
C) 0.20 D) 0.25

67. If  $P(A) = 0.3$ , what is  $P(A^c)$ ?

- A) 0.6    B) 0.7  
C) 1.3    D) 0.3

68. An event has probability 0.3 in each of 110 independent trials. What is its expected frequency?

- A) 110    B) 30  
C) 43    D) 33

69. A correlation coefficient close to +1 indicates:

- A) a strong negative linear relationship    B) that the variables have equal means  
C) that one variable causes the other    D) a strong positive linear relationship

70. Which sampling method gives every population member an equal known chance of selection?

- A) Judgment sampling    B) Convenience sampling  
C) Quota sampling    D) Simple random sampling

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $3x + 9 = 39$ .

- A) 13    B) 30  
C) 11    D) 10

72. What is the larger root of  $x^2 - 13x + 36 = 0$ ?

- A) 9    B) 13  
C) -9    D) 36

73. Find the 6th term of the geometric sequence with first term 4 and common ratio 2.

- A) 128    B) 256  
C) 126    D) 130

74.  $y$  varies directly as  $x$ . If  $y = 15$  when  $x = 5$ , find  $y$  when  $x = 7$ .

- A) 10    B) 21  
C) 105    D) 17

75. Find the midpoint of the segment joining (1, 4) and (7, 8).

- A) (6, 4)    B) (7, 8)  
C) (4, 7)    D) (4, 6)

76. Find the distance between (2, 2) and (11, 14).

- A) 16    B) 9  
C) 15    D) 225

77. Find the area of a triangle with base 10 cm and perpendicular height 7 cm.

- A)  $17 \text{ cm}^2$     B)  $35/2 \text{ cm}^2$   
C)  $70 \text{ cm}^2$     D)  $35 \text{ cm}^2$

78. How many different pairs can be selected from 8 people?

- A) 56    B) 10  
C) 8    D) 28

79. What is  $\tan 45^\circ$ ?

- A)  $1/2$     B)  $\sqrt{3}$   
C) 0    D) 1

80. Find the determinant of the matrix  $\begin{bmatrix} 4 & 3 \\ 4 & 4 \end{bmatrix}$ .

- A) 5    B) 4  
C) 8    D) -4

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The decimal number 15 is represented in binary as:

- A)  $1100_2$     B)  $1111_2$   
C)  $1001_2$     D)  $1110_2$

82. An AND gate outputs 1 only when:

- A) at least one input is 1    B) inputs are different  
C) there is no input    D) all inputs are 1

83. An OR gate outputs 1 when:

- A) inputs are always equal    B) all inputs are 0 only  
C) there is no power    D) at least one input is 1

84. A NOT gate:

- A) reverses the input truth value    B) sorts records  
C) adds two inputs    D) connects networks

85. An IP address identifies:

- A) a device or interface on an IP network    B) a programming loop  
C) a database row only    D) a file extension

86. In a database table, a row is called a:

- A) form    B) record  
C) query    D) data type

87. In a database table, a column is called a:

- A) program loop    B) record  
C) tuple only in every context    D) field

88. A primary key should:

- A) uniquely identify each record    B) always be a person's name  
C) store images only    D) contain duplicate values

89. Database normalization helps to:

- A) convert tables into images    B) remove all keys  
C) prevent queries    D) reduce redundancy and update anomalies

90. Phishing is an attempt to:

- A) create a backup    B) improve processor speed  
C) compress images losslessly    D) trick users into revealing sensitive information

**ANSWER KEY - ICS STATISTICS MODEL PAPER 7***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. D  | 3. C  | 4. B  | 5. C  | 6. A  | 7. D  | 8. C  | 9. B  | 10. D |
| 11. B | 12. D | 13. D | 14. A | 15. D | 16. A | 17. B | 18. C | 19. D | 20. B |
| 21. C | 22. B | 23. D | 24. B | 25. D | 26. D | 27. D | 28. D | 29. B | 30. D |
| 31. D | 32. C | 33. A | 34. A | 35. D | 36. D | 37. B | 38. C | 39. D | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. D | 62. D | 63. A | 64. D | 65. B | 66. D | 67. B | 68. D | 69. D | 70. D |
| 71. D | 72. A | 73. A | 74. B | 75. D | 76. C | 77. D | 78. D | 79. D | 80. B |
| 81. B | 82. D | 83. D | 84. A | 85. A | 86. B | 87. D | 88. A | 89. D | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |

## ICS-STATISTICS - MODEL PAPER 8

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 8

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) be B) are  
C) have D) is

2. At present, the candidates \_\_\_\_ for the test.

- A) prepared B) were prepare  
C) is preparing D) are preparing

3. Bilal \_\_\_\_ the safety checklist already.

- A) is completing since Monday B) have completed  
C) has completed D) completed yesterday

4. By the time the supervisor arrived, Fatima \_\_\_\_ the laboratory record.

- A) will have checked B) checks  
C) has checked D) had checked

5. By next Friday, the team \_\_\_\_ the safety checklist.

- A) had completed B) will have completed  
C) has completed D) will completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) are B) have  
C) were being D) is

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) are having B) do  
C) have D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) has B) have  
C) possess D) were given by

9. There \_\_\_\_ several reasons for the delay.

- A) has B) be  
C) are D) is

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boils B) will boil always  
C) boiled D) would boil

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would play B) would have played  
C) had played D) will play

12. If I knew the answer, I \_\_\_\_ Bilal.

- A) had told B) will tell  
C) told D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) would have caught B) would catch  
C) will catch D) caught

14. Choose the correct passive form: "The technician checks the safety checklist."

- A) The safety checklist was checked by the technician. B) The safety checklist will be checked by the technician.  
C) The safety checklist is checked by the technician. D) The safety checklist is being checked by the technician.

15. Choose the correct passive form: "The technician is checking the laboratory record."

- A) The laboratory record is checked by the technician. B) The laboratory record is being checked by the technician.  
C) The laboratory record has been checked by the technician. D) The laboratory record was being checked by the technician.

16. Choose the correct passive form: "The clerk processed the safety checklist."

- A) The safety checklist was processed by the clerk. B) The safety checklist will be processed by the clerk.  
C) The safety checklist was being processed by the clerk. D) The safety checklist has been processed by the clerk.

17. Choose the correct passive form: "The committee has approved the laboratory record."

- A) The laboratory record was approved by the committee. B) The laboratory record is approved by the committee.  
C) The laboratory record had approved by the committee. D) The laboratory record has been approved by the committee.

18. Choose the correct passive form: "The office will issue the safety checklist."

- A) The safety checklist would be issued by the office. B) The safety checklist will have issued by the office.  
C) The safety checklist will issued by the office. D) The safety checklist will be issued by the office.

19. Select the correct indirect form: Bilal said, "I will complete the safety checklist."

- A) Bilal said that I would complete the safety checklist. B) Bilal told that the safety checklist would complete.  
C) Bilal said that he will complete the safety checklist. D) Bilal said that he would complete the safety checklist.

20. Select the correct indirect form: Fatima said, "I am checking the laboratory record."

- A) Fatima said that she had checked the laboratory record. B) Fatima told that she was checking the laboratory record.  
C) Fatima said that I was checking the laboratory record. D) Fatima said that she was checking the laboratory record.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L8: 8 candidates in a straight row - Questions 21-24

8 candidates—Parveen, Vania, Umar, Tania, Owais, Qadir, Saad, and Rida—sit in a straight row, all facing north. 1. Parveen is at the extreme left. 2. Rida is at the extreme right. 3. Umar occupies the third seat. 4. Vania sits immediately left of Umar. 5. Tania sits immediately right of Umar. 6. Qadir is third from the right. 7. Owais is immediately left of Qadir. 8. Saad is immediately right of Qadir.

21. Which pair is seated next to each other?

- A) Parveen and Umar B) Parveen and Qadir  
C) Umar and Tania D) Umar and Rida

22. Who is farthest from Parveen?

- A) Owais B) Qadir  
C) Saad D) Rida

23. How many seats lie strictly between Umar and Rida?

- A) 4 B) 1  
C) 2 D) 0

24. If Rida moves to the left end and everyone else shifts one seat right, who becomes fourth from the left?

- A) Umar B) Rida  
C) Saad D) Parveen

**Analytical Set C8: 6 participants around a round table - Questions 25-28**

6 participants—Rania, Qais, Shah, Pina, Talia, and Omar—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Rania occupies the top seat. 2. Qais sits immediately clockwise of Rania. 3. Shah sits immediately clockwise of Qais. 4. Pina sits directly opposite Rania. 5. Talia sits immediately clockwise of Pina. 6. Omar sits immediately clockwise of Talia.

25. Who is the clockwise neighbour of Talia?

- A) Shah B) Rania  
C) Talia D) Omar

26. Which person is separated from Pina by exactly half the circle?

- A) Rania B) Talia  
C) Qais D) Pina

27. With everyone facing inward, who is on the immediate right of Qais?

- A) Rania B) Omar  
C) Shah D) Pina

28. If the clockwise order is reversed while the top person remains fixed, who becomes third clockwise from the top?

- A) Rania B) Talia  
C) Shah D) Qais

**Analytical Set S8: 6 presentations in fixed slots - Questions 29-32**

The following 6 presentations are assigned one per slot: Karachi, Peshawar, Multan, Lahore, Rawalpindi, and Quetta. 1. Karachi is scheduled in 8:00 a.m.. 2. Quetta is scheduled in 1:00 p.m.. 3. Peshawar occurs immediately after Karachi. 4. Lahore occurs immediately after Multan. 5. Rawalpindi is between Lahore and Quetta, consecutive with both.

29. Identify the slot assigned to Peshawar.

- A) 10:00 a.m. B) 9:00 a.m.  
C) 11:00 a.m. D) 12:00 noon

30. Which activity closes the schedule?

- A) Multan B) Quetta  
C) Lahore D) Rawalpindi

31. Which activity falls between Peshawar and Lahore?

- A) Peshawar B) Lahore  
C) Karachi D) Multan

32. If the final three activities are conducted in reverse order, which activity becomes second-last?

- A) Rawalpindi B) Lahore  
C) Peshawar D) Multan

**Analytical Set D8: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the server starts, then the network connects. 2. If the network connects, then the server starts. 3. If the network connects, then the database loads. 4. If the database loads, then the dashboard does not appear. 5. If maintenance mode is active, then the dashboard appears. 6. If the warning lamp glows, then maintenance mode is active.

33. If the server starts, which statement must be true?

- A) The warning lamp glows B) The network does not connect  
C) The dashboard does not appear D) Maintenance mode is active

34. Assume the dashboard appears. Which condition must fail?

- A) The server does not start B) The server starts  
C) Maintenance mode is active D) The network connects

35. What follows necessarily when the warning lamp glows?

- A) The dashboard appears B) The database loads  
C) The dashboard does not appear D) The server starts

36. Which pair is logically incompatible?

- A) The server starts and the network connects B) The server starts and the database loads  
C) The network connects and maintenance mode is active D) The dashboard appears and maintenance mode is active

**Analytical Set B8: The family of Waseem and Yasmeen - Questions 37-40**

Waseem and Yasmeen are married. Their children are Kamran, a son, and Laraib, a daughter. Kamran is married to Maha; their children are Omaira, a son, and Parsa, a daughter. Laraib is married to Nabeel; their child is Qadir, a son.

37. How is Yasmeen related to Parsa?

- A) Paternal grandmother B) Mother-in-law  
C) Paternal aunt D) Maternal aunt

38. What is Laraib's relation to Omaira?

- A) Niece B) Paternal aunt  
C) Sister-in-law D) Sister

39. How is Qadir related to Parsa?

- A) Cousin B) Brother-in-law  
C) Sibling D) Uncle

40. How is Maha related to Laraib?

- A) Maternal aunt B) Paternal aunt  
C) Sister-in-law D) Cousin

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $83 + 6 \times 7 - 4$ .

- A) 121 B) 101  
C) 619 D) 127

42. Find  $12/14 + 3/15$  in simplest form.  
A) 15/29 B) 37/35  
C) 23/35 D) 1/14
43. What is 40% of 1150?  
A) 119/10 B) 115/4  
C) 460 D) 690
44. A price of Rs. 2020 is increased by 15%. What is the new price?  
A) Rs. 303 B) Rs. 2035  
C) Rs. 1717 D) Rs. 2323
45. Rs. 754 is divided in the ratio 5:8. What is the larger share?  
A) 290 B) 377  
C) 13 D) 464
46. If 7 identical notebooks cost Rs. 1148, what will 11 notebooks cost at the same rate?  
A) 1804 B) 1159  
C) 12628 D) 1312
47. Find the arithmetic mean of 119, 122, 125, 128, 131.  
A) 625 B) 125  
C) 122 D) 128
48. A student scores 88 in a 4-credit course and 87 in a 5-credit course. Find the weighted mean.  
A) 87.5 B) 393.5  
C) 87.44 D) 39.35
49. A vehicle travels 424 km at a constant speed of 106 km/h. How long does the journey take?  
A) 530 hours B) 318 hours  
C) 1/4 hours D) 4 hours
50. Worker A can complete a job in 42 days and Worker B in 83 days. Working together, how many days will they take?  
A) 125/2 days B) 125/3486 days  
C) 3486/41 days D) 3486/125 days
51. An item costs Rs. 1160 and is sold at a profit of 35%. Find the selling price.  
A) Rs. 1566 B) Rs. 406  
C) Rs. 754 D) Rs. 1195
52. Find the simple interest on Rs. 4800 at 7% per year for 4 years.  
A) Rs. 336 B) Rs. 1344  
C) Rs. 192 D) Rs. 6144
53. Solve  $5x + 10 = 215$ .  
A) 205 B) 41/2  
C) 41 D) 42
54. What is the larger root of  $x^2 - 48x + 215 = 0$ ?  
A) 5 B) 48  
C) 215 D) 43
55. Find the 16th term of the arithmetic sequence with first term 79 and common difference 5.  
A) 159 B) 149  
C) 1344 D) 154
56. If  $40^x = 2560000$ , find x.  
A) 4 B) 40  
C) 2560000 D) 5
57. Using  $\pi = 22/7$ , find the circumference of a circle of radius 273 cm.  
A) 234234 cm B) 1716 cm  
C) 858 cm D) 546 cm
58. Find the distance between (38, 39) and (41, 43).  
A) 7 B) 4  
C) 5 D) 25
59. A bag contains 9 red and 7 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?  
A) 7/16 B) 9/7  
C) 1/16 D) 9/16
60. How many different pairs can be selected from 43 people?  
A) 1806 B) 45  
C) 43 D) 903

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 11, 13, 15, 17, 19.  
A) 13 B) 15  
C) 75 D) 17
62. A student scores 57 in a 3-credit course and 77 in a 4-credit course. Find the weighted mean.  
A) 68.43 B) 479.00  
C) 66.43 D) 70.43
63. Find the median of 4, 7, 10, 13, 16.  
A) 7 B) None of these  
C) 10 D) 12
64. Find the mode of 3, 4, 3, 5, 3, 6.  
A) 5 B) 4  
C) None of these D) 3
65. Find the range of 12, 15, 19, and 26.  
A) 14 B) 12  
C) 15 D) 13
66. For the population values 11, 17, and 23, find the population variance.  
A) 6 B) 72  
C) 12 D) 24

67. A category has frequency 19 in a data set of 76 observations. What is its relative frequency?

- A) 0.75 B) 0.20  
C) 4.00 D) 0.25

68. If  $P(A) = 0.4$ , what is  $P(A^c)$ ?

- A) 0.6 B) 1.4  
C) 0.4 D) 0.5

69. An event has probability 0.4 in each of 120 independent trials. What is its expected frequency?

- A) 120 B) 40  
C) 58 D) 48

70. In hypothesis testing, the hypothesis tested for possible rejection is called the:

- A) survey hypothesis B) sample hypothesis  
C) null hypothesis D) descriptive hypothesis

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $4x + 10 = 22$ .

- A) 4 B)  $11/2$   
C) 2 D) 3

72. What is the larger root of  $x^2 - 16x + 55 = 0$ ?

- A) -11 B) 16  
C) 5 D) 11

73. If  $\log_2 32 = x$ , find  $x$ .

- A) 2 B) 6  
C) 4 D) 5

74. Find the slope of the line through (4, 4) and (7, 16).

- A) 4 B)  $1/4$   
C) 3 D) 13

75. Find the midpoint of the segment joining (2, 5) and (8, 9).

- A) (5, 7) B) (5, 8)  
C) (4, 8) D) (8, 9)

76. Find the distance between (0, 3) and (12, 19).

- A) 21 B) 20  
C) 12 D) 400

77. Find the area of a triangle with base 11 cm and perpendicular height 8 cm.

- A)  $44 \text{ cm}^2$  B)  $38 \text{ cm}^2$   
C)  $22 \text{ cm}^2$  D)  $19 \text{ cm}^2$

78. How many different pairs can be selected from 9 people?

- A) 72 B) 9  
C) 11 D) 36

79. What is  $\sin 90^\circ$ ?

- A) Undefined B)  $1/2$   
C) 1 D) 0

80. Find the determinant of the matrix  $\begin{bmatrix} 5 & 1 \\ 5 & 5 \end{bmatrix}$ .

- A) 21 B) 20  
C) 10 D) -20

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. Encryption converts readable data into:

- A) a flowchart B) a database key only  
C) a monitor signal D) ciphertext

82. A strong password should generally be:

- A) the same for every account B) shared publicly  
C) long, unique and difficult to guess D) the user's name only

83. Cloud computing provides resources:

- A) inside a keyboard B) only through printers  
C) without any servers D) over a network on demand

84. Machine learning enables systems to:

- A) avoid evaluation B) replace all hardware  
C) improve performance from data D) operate without algorithms or data

85. Supervised learning uses:

- A) no data B) labelled training examples  
C) only random numbers D) unlabelled data exclusively

86. A black-box model is difficult to:

- A) interpret internally B) execute on a computer  
C) represent numerically D) store in memory

87. The purpose of testing software is to:

- A) find defects and verify expected behaviour B) replace users  
C) remove all documentation D) increase file size

88. The expression  $14 \% 3$  in C evaluates to:

- A) 3 B) 2  
C) 4.67 D) 4

89. In C,  $\&\&$  represents logical:

- A) OR B) assignment  
C) NOT D) AND

90. A for loop header normally contains:

- A) class, object and method B) initialization, condition and update  
C) table, row and field D) input, output and storage

**ANSWER KEY - ICS STATISTICS MODEL PAPER 8***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. D  | 3. C  | 4. D  | 5. B  | 6. D  | 7. D  | 8. A  | 9. C  | 10. A |
| 11. D | 12. D | 13. A | 14. C | 15. B | 16. A | 17. D | 18. D | 19. D | 20. D |
| 21. C | 22. D | 23. A | 24. A | 25. D | 26. A | 27. A | 28. B | 29. B | 30. B |
| 31. D | 32. A | 33. C | 34. A | 35. A | 36. C | 37. A | 38. B | 39. A | 40. C |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. B | 62. A | 63. C | 64. D | 65. A | 66. D | 67. D | 68. A | 69. D | 70. C |
| 71. D | 72. D | 73. D | 74. A | 75. A | 76. B | 77. A | 78. D | 79. C | 80. B |
| 81. D | 82. C | 83. D | 84. C | 85. B | 86. A | 87. A | 88. B | 89. D | 90. B |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |



## ICS-STATISTICS - MODEL PAPER 9

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 9

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

## SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20

1. The list of required documents \_\_\_\_ on the desk.

- A) be B) is  
C) are D) have

2. At present, the researchers \_\_\_\_ for the test.

- A) are preparing B) prepared  
C) were prepare D) have prepare

3. Iqra \_\_\_\_ the library record already.

- A) is completing since Monday B) completed yesterday  
C) have completed D) has completed

4. By the time the supervisor arrived, Junaid \_\_\_\_ the presentation.

- A) checks B) will have checked  
C) had checked D) has checked

5. By next Friday, the team \_\_\_\_ the library record.

- A) will completed B) will have completed  
C) would complete D) has completed

6. The quality of the samples \_\_\_\_ satisfactory.

- A) were being B) be  
C) is D) are

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) have B) has  
C) do D) were

8. Each of the candidates \_\_\_\_ an admit card.

- A) were given by B) possess  
C) has D) have

9. There \_\_\_\_ several reasons for the delay.

- A) was B) has  
C) be D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) will boil always B) boiled  
C) would boil D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) played B) would have played  
C) would play D) will play

12. If I knew the answer, I \_\_\_\_ Iqra.

- A) would have told B) had told  
C) will tell D) would tell

13. If they had left earlier, they \_\_\_\_ the train.

- A) would catch B) will catch  
C) had caught D) would have caught

14. Choose the correct passive form: "The technician checks the library record."

- A) The library record is being checked by the technician. B) The library record will be checked by the technician.  
C) The library record has checked by the technician. D) The library record is checked by the technician.

15. Choose the correct passive form: "The technician is checking the presentation."

- A) The presentation is been checked by the technician. B) The presentation has been checked by the technician.  
C) The presentation was being checked by the technician. D) The presentation is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the library record."

- A) The library record has processed by the clerk. B) The library record is processed by the clerk.  
C) The library record was being processed by the clerk. D) The library record was processed by the clerk.

17. Choose the correct passive form: "The committee has approved the presentation."

- A) The presentation has been approved by the committee. B) The presentation has being approved by the committee.  
C) The presentation is approved by the committee. D) The presentation was approved by the committee.

18. Choose the correct passive form: "The office will issue the library record."

- A) The library record will be issued by the office. B) The library record will have issued by the office.  
C) The library record will issued by the office. D) The library record would be issued by the office.

19. Select the correct indirect form: Iqra said, "I will complete the library record."

- A) Iqra said that I would complete the library record. B) Iqra said that she had complete the library record.  
C) Iqra told that the library record would complete. D) Iqra said that she would complete the library record.

20. Select the correct indirect form: Junaid said, "I am checking the presentation."

- A) Junaid said that he is checking the presentation. B) Junaid said that he had checked the presentation.  
C) Junaid told that he was checking the presentation. D) Junaid said that he was checking the presentation.

## SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40

Analytical Set L9: 6 candidates in a straight row - Questions 21-24

6 candidates—Basit, Zain, Celia, Waleed, Areeba, and Yusra—sit in a straight row, all facing north. 1. Basit occupies the extreme left seat. 2. Yusra sits at the extreme right. 3. Zain is immediately to the right of Basit. 4. Waleed sits immediately to the right of Celia. 5. Areeba sits between Waleed and Yusra, adjacent to both.

21. Identify the person sitting in seat 5.

- A) Celia B) Areeba  
C) Basit D) Yusra

22. Who is the immediate left neighbour of Areeba?

- A) Yusra B) Celia  
C) Areeba D) Waleed

23. Which pair is NOT seated adjacently?

- A) Zain and Celia B) Basit and Zain  
C) Waleed and Areeba D) Basit and Celia

24. If the entire row is viewed from the opposite end, who appears third from the left?

- A) Yusra B) Waleed  
C) Basit D) Celia

**Analytical Set C9: 8 participants around a round table - Questions 25-28**

8 participants—Vania, Waseem, Adil, Zainab, Ubaid, Yara, Cyrus, and Bisma—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Vania sits at the top. 2. Bisma is immediately anticlockwise from Vania. 3. Cyrus is immediately anticlockwise from Bisma. 4. Ubaid is opposite Vania. 5. Zainab is immediately anticlockwise from Ubaid. 6. Adil is immediately anticlockwise from Zainab. 7. Waseem sits between Vania and Adil, adjacent to both. 8. Yara is immediately clockwise from Ubaid.

25. Who sits one place clockwise from Vania?

- A) Adil B) Bisma  
C) Waseem D) Cyrus

26. For Set C9, which pair sits opposite each other?

- A) Zainab and Cyrus B) Adil and Cyrus  
C) Waseem and Bisma D) Ubaid and Bisma

27. Who sits immediately clockwise of Bisma, crossing the top position?

- A) Bisma B) Yara  
C) Vania D) Cyrus

28. If all participants face outward, who is immediately to the right of Adil?

- A) Zainab B) Cyrus  
C) Bisma D) Yara

**Analytical Set S9: 7 classes in fixed slots - Questions 29-32**

The following 7 classes are assigned one per slot: Physics, Calculus, Aptitude, Writing, Logic, Grammar, and Vocabulary. 1. Writing is scheduled in the middle slot, Period 4. 2. Physics opens the schedule. 3. Vocabulary closes the schedule. 4. Calculus immediately follows Physics. 5. Aptitude immediately precedes Writing. 6. Logic immediately follows Writing. 7. Grammar immediately precedes Vocabulary.

29. What is scheduled during Period 5?

- A) Writing B) Aptitude  
C) Logic D) Physics

30. Which activity directly precedes Logic?

- A) Physics B) Grammar  
C) Aptitude D) Writing

31. How many activities are scheduled between Physics and Writing?

- A) 3 B) 2  
C) 0 D) 1

32. If the opening activity is shifted to the end and all others move one slot earlier, which activity is last?

- A) Calculus B) Grammar  
C) Physics D) Vocabulary

**Analytical Set D9: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the train departs, then the signal turns green. 2. If the crossing closes, then the signal turns green. 3. If the signal turns green, then the platform announcement plays. 4. If the platform announcement does not play, then an obstruction is detected. 5. If an obstruction is detected, then the alarm sounds.

33. Which result is forced if the train departs?

- A) The signal does not turn green B) An obstruction is detected  
C) The alarm sounds D) The platform announcement plays

34. If the platform announcement does not play, which pair of statements must both be true?

- A) The train does not depart and the crossing does not close B) The train departs and the crossing closes  
C) The crossing closes and the alarm sounds D) The signal turns green and an obstruction is detected

35. If the signal does not turn green, which conclusion follows immediately?

- A) An obstruction is detected B) The train does not depart  
C) The platform announcement plays D) The crossing closes

36. Suppose an obstruction is detected. What must occur next in the implication chain?

- A) The signal turns green B) The platform announcement plays  
C) The crossing closes D) The alarm sounds

**Analytical Set B9: The family of Zubair and Afsheen - Questions 37-40**

Zubair and Afsheen are married. Their children are Rameez, a son, and Sonia, a daughter. Rameez is married to Tuba; their children are Vania, a son, and Wajid, a daughter. Sonia is married to Usman; their child is Yumna, a son.

37. How is Afsheen related to Wajid?

- A) Paternal aunt B) Mother-in-law  
C) Maternal aunt D) Paternal grandmother

38. What is Sonia's relation to Vania?

- A) Niece B) Maternal aunt  
C) Sister-in-law D) Paternal aunt

39. How is Yumna related to Wajid?

- A) Sibling B) Uncle  
C) Brother-in-law D) Cousin

40. How is Tuba related to Sonia?

- A) Paternal aunt B) Cousin  
C) Maternal aunt D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $85 + 7 \times 8 - 5$ .

- A) 136 B) 106  
C) 731 D) 143

42. Find  $9/15 + 13/16$  in simplest form.  
A)  $22/31$  B)  $113/80$   
C)  $-17/80$  D)  $11/120$
43. What is 45% of 1175?  
A)  $61/5$  B)  $235/9$   
C)  $2115/4$  D)  $2585/4$
44. A price of Rs. 2060 is increased by 20%. What is the new price?  
A) Rs. 412 B) Rs. 2080  
C) Rs. 1648 D) Rs. 2472
45. Rs. 944 is divided in the ratio 6:10. What is the larger share?  
A) 354 B) 472  
C) 16 D) 590
46. If 8 identical notebooks cost Rs. 1336, what will 13 notebooks cost at the same rate?  
A) 2171 B) 1349  
C) 17368 D) 1503
47. Find the arithmetic mean of 122, 126, 130, 134, 138.  
A) 650 B) 130  
C) 126 D) 134
48. A student scores 89 in a 2-credit course and 88 in a 6-credit course. Find the weighted mean.  
A) 88.5 B) 353  
C) 88.25 D) 58.83
49. A vehicle travels 540 km at a constant speed of 108 km/h. How long does the journey take?  
A) 648 hours B) 432 hours  
C)  $1/5$  hours D) 5 hours
50. Worker A can complete a job in 43 days and Worker B in 85 days. Working together, how many days will they take?  
A) 64 days B)  $128/3655$  days  
C)  $3655/42$  days D)  $3655/128$  days
51. An item costs Rs. 1180 and is sold at a profit of 40%. Find the selling price.  
A) Rs. 1652 B) Rs. 472  
C) Rs. 708 D) Rs. 1220
52. Find the simple interest on Rs. 4900 at 8% per year for 5 years.  
A) Rs. 392 B) Rs. 1960  
C) Rs. 245 D) Rs. 6860
53. Solve  $6x + 11 = 263$ .  
A) 252 B)  $252/11$   
C) 42 D) 43
54. What is the larger root of  $x^2 - 50x + 264 = 0$ ?  
A) 6 B) 50  
C) 264 D) 44
55. Find the 17th term of the arithmetic sequence with first term 81 and common difference 6.  
A) 183 B) 171  
C) 1479 D) 177
56. If  $41^x = 1681$ , find x.  
A) 2 B) 41  
C) 1681 D) 3
57. Find the area of a rectangle of length 47 cm and width 7 cm.  
A)  $108 \text{ cm}^2$  B)  $329 \text{ cm}^2$   
C)  $54 \text{ cm}^2$  D)  $658 \text{ cm}^2$
58. Find the slope of the line through (39, 41) and (43, 49).  
A)  $1/2$  B) 8  
C) 2 D) 4
59. A bag contains 10 red and 8 blue balls. One ball is selected at random. What is P(red)?  
A)  $4/9$  B)  $5/4$   
C)  $1/18$  D)  $5/9$
60. How many different pairs can be selected from 44 people?  
A) 1892 B) 46  
C) 44 D) 946

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 12, 14, 16, 18, 20.  
A) 18 B) 17  
C) 16 D) 80
62. A student scores 58 in a 4-credit course and 78 in a 5-credit course. Find the weighted mean.  
A) 71.11 B) 68.00  
C) 69.11 D) 67.11
63. Find the median of 5, 8, 11, 14, 17.  
A) None of these B) 8  
C) 14 D) 11
64. Find the mode of 4, 5, 4, 6, 4, 7.  
A) 7 B) 4  
C) None of these D) 5
65. Find the range of 5, 8, 12, and 20.  
A) 5 B) 15  
C) 20 D) 14
66. For the population values 9, 18, and 27, find the population variance.  
A) 9 B) 27  
C) 81 D) 54

67. A category has frequency 20 in a data set of 80 observations. What is its relative frequency?

- A) 0.50 B) 4.00  
C) 0.20 D) 0.25

68. If  $P(A) = 0.1$ , what is  $P(A^c)$ ?

- A) 1.1 B) 1.0  
C) 0.1 D) 0.9

69. An event has probability 0.5 in each of 130 independent trials. What is its expected frequency?

- A) 75 B) 130  
C) 55 D) 65

70. A correlation coefficient close to +1 indicates:

- A) that the variables have equal means B) no possible relationship  
C) that one variable causes the other D) a strong positive linear relationship

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $5x + 4 = 29$ .

- A) 6 B) 25  
C) 5 D) 29/5

72. What is the larger root of  $x^2 - 15x + 54 = 0$ ?

- A) -9 B) 54  
C) 15 D) 9

73. Find the 5th term of the geometric sequence with first term 3 and common ratio 2.

- A) 48 B) 50  
C) 46 D) 96

74.  $y$  varies directly as  $x$ . If  $y = 35$  when  $x = 7$ , find  $y$  when  $x = 9$ .

- A) 44 B) 315  
C) 37 D) 45

75. Find the distance between (1, 0) and (4, 4).

- A) 25 B) 4  
C) 6 D) 5

76. Find the area of a triangle with base 12 cm and perpendicular height 9 cm.

- A) 27 cm<sup>2</sup> B) 21 cm<sup>2</sup>  
C) 42 cm<sup>2</sup> D) 54 cm<sup>2</sup>

77. A bag contains 7 red and 4 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A) 1/11 B) 7/11  
C) 4/11 D) 11/7

78. How many different pairs can be selected from 10 people?

- A) 45 B) 12  
C) 90 D) 55

79. What is  $\sin 30^\circ$ ?

- A)  $\sqrt{2}/2$  B) 0  
C) 1/2 D) 1

80. Find the determinant of the matrix  $\begin{bmatrix} 2 & 2 \\ 6 & 2 \end{bmatrix}$ .

- A) 4 B) -8  
C) -7 D) 8

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The component that performs arithmetic and logical operations is the:

- A) ALU B) Input unit  
C) Control unit D) Hard disk

82. RAM is best described as:

- A) an input device B) read-only firmware only  
C) a network protocol D) volatile primary memory

83. ROM is commonly used to store:

- A) internet addresses B) keyboard signals  
C) open application windows D) firmware that should persist without power

84. A compiler generally translates:

- A) an entire high-level program into machine code B) machine code into English  
C) images into audio D) one instruction at a time during execution only

85. An algorithm is:

- A) a computer brand B) an error message only  
C) a type of monitor D) a finite sequence of unambiguous steps for solving a problem

86. Pseudocode is used to:

- A) replace all testing B) encrypt a disk automatically  
C) compile a program directly D) describe an algorithm in structured, language-independent form

87. A syntax error occurs when:

- A) the program runs but gives the wrong result B) a user forgets a password  
C) data are duplicated in a table D) programming-language rules are violated

88. A logic error causes a program to:

- A) become an operating system B) fail grammar checking before compilation only  
C) run but produce an incorrect result D) damage hardware necessarily

89. A variable is used to:

- A) replace the CPU B) prevent all errors  
C) define a monitor size D) store a value that may change during program execution

90. A function is useful because it:

- A) can contain no parameters B) replaces all variables  
C) always runs before main memory D) encapsulates a reusable block of code

**ANSWER KEY - ICS STATISTICS MODEL PAPER 9***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. A  | 3. D  | 4. C  | 5. B  | 6. C  | 7. B  | 8. C  | 9. D  | 10. D |
| 11. D | 12. D | 13. D | 14. D | 15. D | 16. D | 17. A | 18. A | 19. D | 20. D |
| 21. B | 22. D | 23. D | 24. B | 25. C | 26. B | 27. C | 28. A | 29. C | 30. D |
| 31. B | 32. C | 33. D | 34. A | 35. B | 36. D | 37. D | 38. D | 39. D | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. C | 63. D | 64. B | 65. B | 66. D | 67. D | 68. D | 69. D | 70. D |
| 71. C | 72. D | 73. A | 74. D | 75. D | 76. D | 77. B | 78. A | 79. C | 80. B |
| 81. A | 82. D | 83. D | 84. A | 85. D | 86. D | 87. D | 88. C | 89. D | 90. D |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |

**ICS-STATISTICS - MODEL PAPER 10**

Candidate Name: \_\_\_\_\_

Roll No.: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_ / 90

Paper: ICS-Statistics 10

Questions: 90

Time: 2 Hours

Marks: 90

Instructions: Attempt all questions. Select one best answer (A-D). Each question carries one mark. No negative marking. Use rough work where required. Section II contains five shared-clue analytical sets. Section III contains Mathematics-Based Quantitative Reasoning.

**SECTION I: ENGLISH | 20 QUESTIONS | Questions 1-20**

1. The list of required documents \_\_\_\_ on the desk.

- A) are B) have  
C) be D) is

2. At present, the workers \_\_\_\_ for the test.

- A) prepared B) are preparing  
C) were prepare D) have prepare

3. Omer \_\_\_\_ the workshop plan already.

- A) has completed B) have completed  
C) completed yesterday D) had complete

4. By the time the supervisor arrived, Pari \_\_\_\_ the survey form.

- A) had checked B) has checked  
C) was check D) checks

5. By next Friday, the team \_\_\_\_ the workshop plan.

- A) has completed B) will completed  
C) will have completed D) would complete

6. The quality of the samples \_\_\_\_ satisfactory.

- A) is B) are  
C) have D) be

7. Either the assistants or the supervisor \_\_\_\_ the key.

- A) do B) are having  
C) have D) has

8. Each of the candidates \_\_\_\_ an admit card.

- A) are having B) has  
C) possess D) have

9. There \_\_\_\_ several reasons for the delay.

- A) has B) was  
C) is D) are

10. If water reaches 100°C at standard atmospheric pressure, it \_\_\_\_.

- A) boiled B) would boil  
C) would have boiled D) boils

11. If the weather improves tomorrow, we \_\_\_\_ the match.

- A) would have played B) had played  
C) would play D) will play

12. If I knew the answer, I \_\_\_\_ Omer.

- A) would tell B) had told  
C) told D) would have told

13. If they had left earlier, they \_\_\_\_ the train.

- A) will catch B) would catch  
C) would have caught D) caught

14. Choose the correct passive form: "The technician checks the workshop plan."

- A) The workshop plan has checked by the technician. B) The workshop plan was checked by the technician.  
C) The workshop plan will be checked by the technician. D) The workshop plan is checked by the technician.

15. Choose the correct passive form: "The technician is checking the survey form."

- A) The survey form was being checked by the technician. B) The survey form has been checked by the technician.  
C) The survey form is checked by the technician. D) The survey form is being checked by the technician.

16. Choose the correct passive form: "The clerk processed the workshop plan."

- A) The workshop plan will be processed by the clerk. B) The workshop plan has processed by the clerk.  
C) The workshop plan was processed by the clerk. D) The workshop plan is processed by the clerk.

17. Choose the correct passive form: "The committee has approved the survey form."

- A) The survey form has been approved by the committee. B) The survey form was approved by the committee.  
C) The survey form is approved by the committee. D) The survey form has being approved by the committee.

18. Choose the correct passive form: "The office will issue the workshop plan."

- A) The workshop plan will be issued by the office. B) The workshop plan will have issued by the office.  
C) The workshop plan would be issued by the office. D) The workshop plan will issued by the office.

19. Select the correct indirect form: Omer said, "I will complete the workshop plan."

- A) Omer said that he had complete the workshop plan. B) Omer said that I would complete the workshop plan.  
C) Omer said that he will complete the workshop plan. D) Omer said that he would complete the workshop plan.

20. Select the correct indirect form: Pari said, "I am checking the survey form."

- A) Pari said that she was checking the survey form. B) Pari said that she is checking the survey form.  
C) Pari told that she was checking the survey form. D) Pari said that I was checking the survey form.

**SECTION II: ANALYTICAL REASONING | 20 QUESTIONS | Questions 21-40****Analytical Set L10: 7 candidates in a straight row - Questions 21-24**

7 candidates—Kashif, Faizan, Hina, Javeria, Esha, Imran, and Daniyal—sit in a straight row, all facing north. 1. Faizan is second from the left. 2. Imran is second from the right. 3. Kashif sits immediately left of Faizan. 4. Hina sits immediately right of Faizan. 5. Javeria occupies the central seat. 6. Esha is immediately right of Javeria. 7. Daniyal is immediately right of Imran.

21. Who occupies the fifth seat from the left?

- A) Esha B) Hina  
C) Imran D) Kashif

22. What is the position of Imran in the row?

- A) First from the left    B) Fifth from the left  
C) Sixth from the left    D) Third from the left

23. Who sits immediately to the left of Javeria?

- A) Hina    B) Imran  
C) Esha    D) Daniyal

24. How many people sit between Faizan and Imran?

- A) 4    B) 1  
C) 2    D) 3

**Analytical Set C10: 6 participants around a round table - Questions 25-28**

6 participants—Haris, Gul, Eman, Fahim, Danish, and Iqra—sit equally spaced around a circular table, all facing the centre. Clockwise and anticlockwise are viewed from above. 1. Haris occupies the top seat. 2. Gul sits immediately clockwise of Haris. 3. Eman sits immediately clockwise of Gul. 4. Fahim sits directly opposite Haris. 5. Danish sits immediately clockwise of Fahim. 6. Iqra sits immediately clockwise of Danish.

25. Who sits immediately clockwise of Gul?

- A) Gul    B) Danish  
C) Eman    D) Iqra

26. Who sits directly opposite Haris?

- A) Danish    B) Gul  
C) Fahim    D) Haris

27. Who is second clockwise from Iqra?

- A) Gul    B) Iqra  
C) Danish    D) Haris

28. All participants face the centre. Who is immediately to the right of Fahim?

- A) Gul    B) Haris  
C) Danish    D) Eman

**Analytical Set S10: 6 meetings in fixed slots - Questions 29-32**

The following 6 meetings are assigned one per slot: Energy, Data, Budget, Grants, Faculty, and Campus. 1. Energy is scheduled in Monday. 2. Campus is scheduled in Saturday. 3. Data occurs immediately after Energy. 4. Grants occurs immediately after Budget. 5. Faculty is between Grants and Campus, consecutive with both.

29. On which slot is Budget scheduled?

- A) Thursday    B) Tuesday  
C) Wednesday    D) Monday

30. Which activity is scheduled in Friday?

- A) Grants    B) Data  
C) Energy    D) Faculty

31. Which activity occurs immediately before Grants?

- A) Campus    B) Energy  
C) Budget    D) Grants

32. How many complete slots lie between Data and Campus?

- A) 3    B) 1  
C) 0    D) 4

**Analytical Set D10: Conditional implication system - Questions 33-36**

Use only the following rules. A conditional statement may be chained forward, and its contrapositive may be used; do not assume the converse. 1. If the experiment begins, then the heater switches on. 2. If the heater switches on, then the sample does not warm. 3. If the sensor records data, then the sample warms. 4. If the safety lock engages, then the sensor records data. 5. If the technician presses reset, then the experiment begins.

33. If the technician presses reset, which statement is certain?

- A) The experiment does not begin    B) The safety lock engages  
C) The sensor records data    D) The sample does not warm

34. Given that the sample warms, what can be deduced about the last condition?

- A) The heater switches on    B) The technician does not press reset  
C) The sensor records data    D) The experiment begins

35. What must be true when the safety lock engages?

- A) The sample does not warm    B) The heater switches on  
C) The experiment begins    D) The heater does not switch on

36. Which two conditions cannot both hold?

- A) The technician presses reset and the experiment begins    B) The sensor records data and the safety lock engages  
C) The experiment begins and the heater switches on    D) The experiment begins and the sensor records data

**Analytical Set B10: The family of Feroz and Ghazala - Questions 37-40**

Feroz and Ghazala are married. Their children are Hasan, a son, and Inaya, a daughter. Hasan is married to Jalal; their children are Latif, a son, and Maira, a daughter. Inaya is married to Kiran; their child is Noman, a son.

37. How is Ghazala related to Maira?

- A) Paternal aunt    B) Maternal grandmother  
C) Maternal aunt    D) Paternal grandmother

38. What is Inaya's relation to Latif?

- A) Paternal aunt    B) Niece  
C) Maternal aunt    D) Sister

39. How is Noman related to Maira?

- A) Nephew    B) Cousin  
C) Sibling    D) Brother-in-law

40. How is Jalal related to Inaya?

- A) Cousin    B) Paternal aunt  
C) Mother-in-law    D) Sister-in-law

### SECTION III: MATHEMATICS-BASED QUANTITATIVE REASONING | 20 QUESTIONS | Questions 41-60

41. Evaluate  $87 + 8 \times 4 - 6$ .

- A) 113    B) 71  
C) 374    D) 121



42. Find  $6/16 + 9/17$  in simplest form.

- A)  $5/11$  B)  $123/136$   
C)  $-21/136$  D)  $15/272$

43. What is 10% of 1200?

- A)  $121/10$  B) 1080  
C) 120 D) 1200

44. A price of Rs. 2100 is increased by 25%. What is the new price?

- A) Rs. 525 B) Rs. 2125  
C) Rs. 1575 D) Rs. 2625

45. Rs. 300 is divided in the ratio 2:3. What is the larger share?

- A) 120 B) 150  
C) 5 D) 180

46. If 4 identical notebooks cost Rs. 680, what will 6 notebooks cost at the same rate?

- A) 1020 B) 686  
C) 4080 D) 850

47. Find the arithmetic mean of 125, 130, 135, 140, 145.

- A) 675 B) 135  
C) 130 D) 140

48. A student scores 90 in a 3-credit course and 89 in a 3-credit course. Find the weighted mean.

- A) 268.5 B) 59.67  
C) 89.5 D) 90

49. A vehicle travels 220 km at a constant speed of 110 km/h. How long does the journey take?

- A) 330 hours B) 110 hours  
C)  $1/2$  hours D) 2 hours

50. Worker A can complete a job in 44 days and Worker B in 87 days. Working together, how many days will they take?

- A)  $131/2$  days B)  $131/3828$  days  
C)  $3828/43$  days D)  $3828/131$  days

51. An item costs Rs. 1200 and is sold at a profit of 5%. Find the selling price.

- A) Rs. 1260 B) Rs. 60  
C) Rs. 1140 D) Rs. 1205

52. Find the simple interest on Rs. 5000 at 9% per year for 2 years.

- A) Rs. 450 B) Rs. 900  
C) Rs. 100 D) Rs. 5900

53. Solve  $7x + 12 = 313$ .

- A) 301 B)  $301/12$   
C) 43 D) 44

54. What is the larger root of  $x^2 - 52x + 315 = 0$ ?

- A) 7 B) 52  
C) 315 D) 45

55. Find the 8th term of the arithmetic sequence with first term 83 and common difference 2.

- A) 99 B) 95  
C) 680 D) 97

56. If  $42^x = 74088$ , find x.

- A) 3 B) 42  
C) 74088 D) 4

57. Find the area of a triangle with base 50 cm and height 8 cm.

- A)  $400 \text{ cm}^2$  B)  $200 \text{ cm}^2$   
C)  $58 \text{ cm}^2$  D)  $100 \text{ cm}^2$

58. Find the midpoint of the segment joining (40, 42) and (46, 50).

- A) (6, 8) B) (86, 92)  
C) (43, 46) D) (3, 4)

59. A bag contains 3 red and 9 blue balls. One ball is selected at random. What is  $P(\text{red})$ ?

- A)  $3/4$  B)  $1/3$   
C)  $1/12$  D)  $1/4$

60. How many different pairs can be selected from 45 people?

- A) 1980 B) 47  
C) 45 D) 990

#### SECTION IV-A: STATISTICS | 10 QUESTIONS | Questions 61-70

61. Find the arithmetic mean of 13, 15, 17, 19, 21.

- A) 19 B) 85  
C) 17 D) 18

62. A student scores 59 in a 2-credit course and 79 in a 3-credit course. Find the weighted mean.

- A) None of these B) 73.00  
C) 71.00 D) 355.00

63. Find the median of 6, 9, 12, 15, 18.

- A) 12 B) None of these  
C) 9 D) Cannot be determined

64. Find the mode of 5, 6, 5, 7, 5, 8.

- A) 6 B) None of these  
C) 8 D) 5

65. Find the range of 6, 9, 13, and 22.

- A) 15 B) 22  
C) 6 D) 16

66. A category has frequency 21 in a data set of 84 observations. What is its relative frequency?

- A) 0.50 B) 0.75  
C) 4.00 D) 0.25



67. If  $P(A) = 0.2$ , what is  $P(A^c)$ ?

- A) 1.2    B) 0.8  
C) 0.2    D) 0.7

68. An event has probability 0.6 in each of 140 independent trials. What is its expected frequency?

- A) 84    B) 60  
C) 140    D) 94

69. A correlation coefficient close to +1 indicates:

- A) a strong positive linear relationship    B) a strong negative linear relationship  
C) that the variables have equal means    D) no possible relationship

70. Which sampling method gives every population member an equal known chance of selection?

- A) Convenience sampling    B) Snowball sampling  
C) Quota sampling    D) Simple random sampling

#### SECTION IV-B: MATHEMATICS | 10 QUESTIONS | Questions 71-80

71. Solve  $6x + 5 = 47$ .

- A) 47/6    B) 8  
C) 7    D) 42

72. What is the larger root of  $x^2 - 18x + 77 = 0$ ?

- A) 7    B) -11  
C) 77    D) 11

73. If  $\log_5 125 = x$ , find  $x$ .

- A) 5    B) 125  
C) 4    D) 3

74.  $y$  varies directly as  $x$ . If  $y = 48$  when  $x = 8$ , find  $y$  when  $x = 10$ .

- A) 58    B) 50  
C) 16    D) 60

75. Find the slope of the line through (2, 6) and (5, 12).

- A)  $1/2$     B) -2  
C) 2    D) 3

76. Find the midpoint of the segment joining (4, 3) and (10, 7).

- A) (6, 6)    B) (7, 6)  
C) (7, 5)    D) (10, 7)

77. Find the distance between (2, 1) and (8, 9).

- A) 8    B) 11  
C) 100    D) 10

78. Find the area of a triangle with base 13 cm and perpendicular height 10 cm.

- A)  $23 \text{ cm}^2$     B)  $130 \text{ cm}^2$   
C)  $65 \text{ cm}^2$     D)  $65/2 \text{ cm}^2$

79. How many different pairs can be selected from 11 people?

- A) 13    B) 55  
C) 11    D) 66

80. Find the determinant of the matrix  $\begin{bmatrix} 3 & 3 \\ 7 & 3 \end{bmatrix}$ .

- A) 6    B) -11  
C) 30    D) -12

#### SECTION IV-C: COMPUTER SCIENCE | 10 QUESTIONS | Questions 81-90

81. The decimal number 15 is represented in binary as:

- A)  $1010_2$     B)  $1100_2$   
C)  $1001_2$     D)  $1111_2$

82. An AND gate outputs 1 only when:

- A) inputs are different    B) there is no input  
C) at least one input is 1    D) all inputs are 1

83. An OR gate outputs 1 when:

- A) exactly two inputs are 0    B) inputs are always equal  
C) at least one input is 1    D) there is no power

84. A NOT gate:

- A) reverses the input truth value    B) adds two inputs  
C) stores a byte    D) connects networks

85. An IP address identifies:

- A) a file extension    B) a device or interface on an IP network  
C) a programming loop    D) a keyboard key

86. In a database table, a row is called a:

- A) field    B) data type  
C) record    D) form

87. In a database table, a column is called a:

- A) field    B) tuple only in every context  
C) program loop    D) report

88. A primary key should:

- A) contain duplicate values    B) uniquely identify each record  
C) always be a person's name    D) be left blank in every row

89. Database normalization helps to:

- A) prevent queries    B) remove all keys  
C) reduce redundancy and update anomalies    D) increase duplicate data

90. Phishing is an attempt to:

- A) compress images losslessly    B) trick users into revealing sensitive information  
C) repair hardware automatically    D) create a backup

**ANSWER KEY - ICS STATISTICS MODEL PAPER 10***Check the key only after completing the full paper under timed conditions.*

|       |       |       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1. D  | 2. B  | 3. A  | 4. A  | 5. C  | 6. A  | 7. D  | 8. B  | 9. D  | 10. D |
| 11. D | 12. A | 13. C | 14. D | 15. D | 16. C | 17. A | 18. A | 19. D | 20. A |
| 21. A | 22. C | 23. A | 24. D | 25. C | 26. C | 27. A | 28. D | 29. C | 30. D |
| 31. C | 32. A | 33. D | 34. B | 35. D | 36. D | 37. D | 38. A | 39. B | 40. D |
| 41. A | 42. B | 43. C | 44. D | 45. D | 46. A | 47. B | 48. C | 49. D | 50. D |
| 51. A | 52. B | 53. C | 54. D | 55. D | 56. A | 57. B | 58. C | 59. D | 60. D |
| 61. C | 62. C | 63. A | 64. D | 65. D | 66. D | 67. B | 68. A | 69. A | 70. D |
| 71. C | 72. D | 73. D | 74. D | 75. C | 76. C | 77. D | 78. C | 79. B | 80. D |
| 81. D | 82. D | 83. C | 84. A | 85. B | 86. C | 87. A | 88. B | 89. C | 90. B |

**Section-wise Score Record**

| English   | Analytical | Math-Based QR | STATISTICS | MATHEMATICS | COMPUTER SCIENCE |
|-----------|------------|---------------|------------|-------------|------------------|
| ____ / 20 | ____ / 20  | ____ / 20     | ____ / 10  | ____ / 10   | ____ / 10        |