

TIFR GS Science Education

Sample Paper – 3

Duration: 180 Minutes

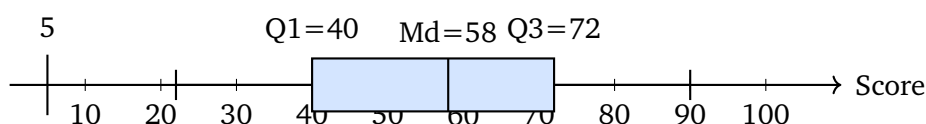
Maximum Marks: 100

Instructions

- This paper contains **80 Multiple Choice Questions** modelled on the **TIFR GS Science Education** (HBCSE PhD) entrance examination.
- You may attempt **any 50 questions** from this section. If more than 50 are attempted, the score will be normalized to 50 questions.
- Each correct answer earns **+2 marks**. There is **no negative marking**; unattempted and wrong answers earn 0.
- Distribution: Q1–25 (Quantitative Reasoning & Scientific Literacy) | Q26–40 (Social, Cognitive Sciences & Education) | Q41–50 (Biology) | Q51–60 (Chemistry) | Q61–70 (Mathematics) | Q71–80 (Physics).
- Only **one** option is correct per question. Read all options before marking.
- Syllabus: Quantitative reasoning, scientific literacy; science education research, learning theories, curriculum, assessment; Biology, Chemistry, Mathematics, Physics at CBSE Class XII level.
- Personal calculators, mobile phones, and electronic gadgets are strictly prohibited. Rough sheets are provided.

Part A: Quantitative Reasoning & Scientific Literacy (Q1–25)

Q1. The box plot below summarises the scores of 30 students on a science quiz.



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Based on this box plot, which statement is **correct**?

- (A) The median is equal to the mean of Q1 and Q3.
- (B) Approximately 75% of students scored below 40.
- (C) The interquartile range equals 18.
- (D) The value 5 is an outlier because it lies far below the lower whisker.

Q2. A chemist mixes 200 mL of a 30% salt solution with 300 mL of a 50% salt solution. What is the concentration of the resulting mixture?

- (A) 42%
- (B) 40%
- (C) 38%
- (D) 45%

Q3. Complete the analogy: **Microscope : Cell :: Telescope : ?**

- (A) Virus
- (B) Distant star
- (C) Atom
- (D) Bacterium

Q4. Read the following passage and answer the question.

“The emergence of antibiotic resistance is a classic example of evolution in action. When a population of bacteria is exposed to an antibiotic, most individuals are killed. However, a few individuals that carry a resistance mutation survive and reproduce. Over successive generations, the proportion of resistant individuals increases until the antibiotic becomes virtually ineffective. This process is accelerated when antibiotics are used unnecessarily, for example in treating viral infections.”

According to the passage, antibiotic resistance is **primarily driven by**:

- (A) Spontaneous mass mutation of all bacteria simultaneously.
- (B) The bacteria deliberately adapting to overcome the antibiotic.
- (C) Natural selection favouring pre-existing resistant variants.



(D) Antibiotic molecules triggering genetic changes in bacteria.

Q5. The frequency distribution of marks obtained by students is given below.

Marks	Frequency
10	4
20	7
30	12
40	9
50	3

What is the **mode** of this distribution?

(A) 20

(B) 25

(C) 40

(D) 30

Q6. Train A (length 120 m) travels at 72 km/h and Train B (length 80 m) travels in the *opposite* direction at 54 km/h. How long (in seconds) does it take for the two trains to completely pass each other?

(A) 8 s

(B) 10 s

(C) 12 s

(D) 6 s

Q7. For two events A and B , $P(A) = 0.5$, $P(B) = 0.4$, and $P(A \cap B) = 0.2$. What is $P(A \cup B)$?

(A) 0.9

(B) 0.7

(C) 0.6

(D) 0.8

Q8. Which of the following lengths is **larger**?



- (A) 10^6 nm
- (B) 10^{-3} m
- (C) Both are equal in length.
- (D) 10^6 nm is larger.

Q9. A survey of 100 students recorded gender and preferred subject. Use the table below.

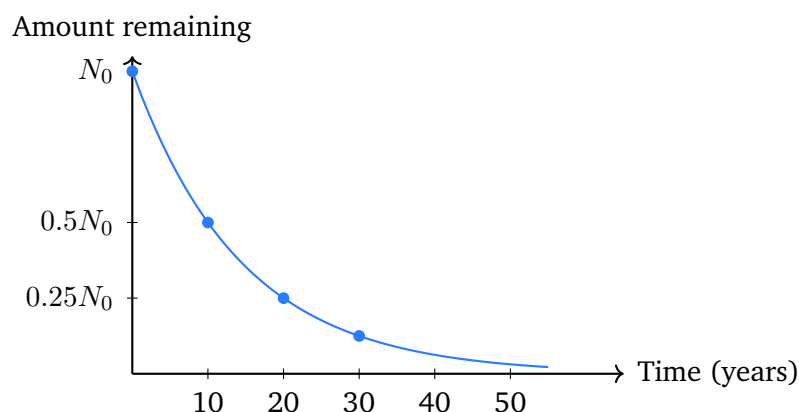
	Science	Arts	Total
Female	28	32	60
Male	30	10	40
Total	58	42	100

What percentage of **female** students preferred **Arts**?

- (A) 42%
 - (B) 50%
 - (C) 60%
 - (D) Approximately 53%
- Q10.** A researcher notices that cities with more hospitals have higher death rates. She concludes that hospitals cause death. Which concept best explains the flaw in her reasoning?
- (A) Confounding variable (population size drives both variables).
 - (B) Reverse causation.
 - (C) Sampling bias.
 - (D) Placebo effect.
- Q11.** A $3 \times 3 \times 3$ cube is made of 27 small unit cubes. One corner unit cube is removed. How many unit cubes remain?
- (A) 25
 - (B) 26
 - (C) 24
 - (D) 27



Q12. A radioactive substance has a half-life of 10 years. The graph below shows how the amount remaining changes with time.



Starting with N_0 atoms, how much remains after **30 years**?

- (A) $N_0/2$
 - (B) $N_0/4$
 - (C) $N_0/8$
 - (D) $N_0/16$
- Q13.** A histogram shows most data values concentrated near the higher end with a long tail stretching toward lower values. This distribution is best described as:
- (A) Symmetric (normal)
 - (B) Positively skewed (right-skewed)
 - (C) Bimodal
 - (D) Negatively skewed (left-skewed)
- Q14.** In a group of 60 students: 30 study Physics (P), 25 study Chemistry (C), 20 study Biology (B). Exactly 10 study all three. Exactly 5 study only Physics and Chemistry, 4 study only Chemistry and Biology, 6 study only Physics and Biology. How many students study **exactly two** subjects?
- (A) 15
 - (B) 10
 - (C) 20



(D) 25

Q15. A metal block has a mass of 540 g and a volume of 200 cm^3 . What is its density?

(A) 2.0 g/cm^3

(B) 2.7 g/cm^3

(C) 3.0 g/cm^3

(D) 1.8 g/cm^3

Q16. Consider the argument: *“If it rains, the ground is wet. The ground is not wet. Therefore, it did not rain.”* This argument is an example of:

(A) Modus ponens

(B) Affirming the consequent

(C) Modus tollens

(D) Denying the antecedent

Q17. The Interquartile Range (IQR) of a dataset is defined as $Q_3 - Q_1$. What does the IQR primarily measure?

(A) The range of all data values

(B) The average deviation from the mean

(C) The location of the median

(D) The spread of the middle 50% of data values

Q18. Ravi starts at point O, walks 5 km North, then 5 km East, then 5 km South. What is his final displacement from O?

(A) 5 km due East

(B) $5\sqrt{2}$ km North-East

(C) 5 km due North

(D) 10 km due North-East

Q19. Read the following passage and answer the question.



“Photosynthesis is the primary mechanism through which atmospheric carbon dioxide is fixed into organic matter. Forests, often called the “lungs of the Earth,” absorb billions of tonnes of CO_2 annually. Deforestation therefore contributes significantly to rising atmospheric CO_2 levels and global warming. Conversely, afforestation and reforestation are promoted as nature-based solutions to climate change.”

According to the passage, afforestation helps reduce climate change **primarily because**:

- (A) Trees release oxygen that neutralises CO_2 .
- (B) More trees increase the fixation of atmospheric CO_2 through photosynthesis.
- (C) Forests reduce wind speed and hence slow warming.
- (D) Trees reflect sunlight and lower surface temperature directly.

Q20. If $A : B = 2 : 3$ and $B : C = 4 : 5$, what is $A : C$?

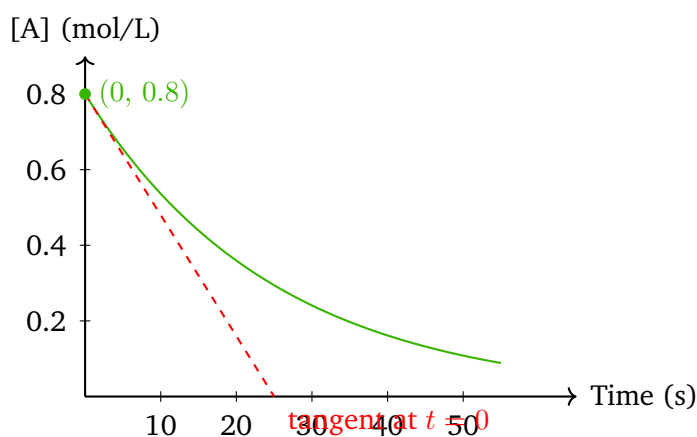
- (A) 4:5
- (B) 6:10
- (C) 8:15
- (D) 2:5

Q21. Find the sum of the first 20 terms of the arithmetic series 3, 7, 11, 15, ...

- (A) 760
- (B) 800
- (C) 820
- (D) 820

Q22. The graph below shows the concentration of reactant A as a function of time for a chemical reaction.





The **initial rate** of the reaction (at $t = 0$) is given by the magnitude of the slope of the tangent at $t = 0$. From the graph, the initial rate is approximately:

- (A) $0.032 \text{ mol L}^{-1}\text{s}^{-1}$
- (B) $0.020 \text{ mol L}^{-1}\text{s}^{-1}$
- (C) $0.016 \text{ mol L}^{-1}\text{s}^{-1}$
- (D) $0.040 \text{ mol L}^{-1}\text{s}^{-1}$

Q23. Identify the **false premise** in the following argument: “All scientists are geniuses. Riya is a scientist. Therefore, Riya is a genius.”

- (A) Riya is a scientist.
- (B) All scientists are geniuses.
- (C) Riya is a genius.
- (D) The conclusion is logically invalid.

Q24. For a fixed amount of gas at constant volume, which graph correctly represents the relationship between pressure (P) and absolute temperature (T)?

- (A) A hyperbola (P inversely proportional to T)
- (B) A parabola
- (C) A straight line through the origin ($P \propto T$)
- (D) An exponential curve

Q25. Read the following passage.



“Gregor Mendel conducted his famous experiments with pea plants between 1856 and 1863. He tracked seven traits, each controlled by genes on different chromosomes. He proposed two laws: the Law of Segregation states that the two alleles of a gene separate during gamete formation; the Law of Independent Assortment states that alleles of different genes are distributed independently during gamete formation. However, Morgan later showed that genes located on the same chromosome do not assort independently—they are linked.”

Which of the following correctly identifies a **limitation** of Mendel’s Law of Independent Assortment?

- (A) It applies to all genes regardless of chromosome location.
- (B) It fails when alleles fail to segregate.
- (C) It cannot explain dominance relationships.
- (D) It does not hold for genes located on the same chromosome (linked genes).

**Part B: Social & Cognitive Sciences
and Science Education (Q26–40)**

Q26. Lave and Wenger’s concept of “**situated learning**” emphasises that learning is best understood as:

- (A) A process of participation in communities of practice embedded in authentic contexts.
- (B) An internal cognitive restructuring that occurs independently of social context.
- (C) A linear transfer of knowledge from teacher to learner.
- (D) Memorisation of facts through repeated practice outside the workplace.

Q27. In the **Information Processing Model** of memory, which sequence correctly describes the flow of information?

- (A) Long-term memory → Working memory → Sensory register
- (B) Sensory register → Working memory → Long-term memory



(C) Working memory → Sensory register → Long-term memory

(D) Sensory register → Long-term memory → Working memory

Q28. Jerome Bruner advocated **discovery learning**. Which of the following is a key advantage of discovery learning over expository (direct instruction) teaching?

(A) It is faster and covers more content in the same time.

(B) It is more suitable for absolute beginners with no prior knowledge.

(C) It fosters intrinsic motivation and deeper conceptual understanding through active inquiry.

(D) It reduces the cognitive load on learners by providing clear explanations.

Q29. In Biggs and Collis's **SOLO Taxonomy**, the *relational* level of understanding means that the learner:

(A) Can recall isolated facts without connecting them.

(B) Provides one relevant piece of information.

(C) Lists several ideas but without integration.

(D) Integrates several ideas into a coherent whole and understands their relationships.

Q30. Research in science education consistently shows that many students hold the misconception that **heavier objects fall faster than lighter ones**. This misconception is best attributed to:

(A) Everyday experience where air resistance causes heavier objects to appear to fall faster in real-life conditions.

(B) Poor teaching of Newton's laws at the primary level.

(C) Reading popular-science books that contain errors.

(D) Misinterpretation of Archimedes' principle.

Q31. A teacher administers a short quiz **before beginning** a new unit on chemical bonding to identify students' existing knowledge and misconceptions. This assessment is best described as:



- (A) Summative assessment
- (B) Diagnostic assessment
- (C) Norm-referenced assessment
- (D) Criterion-referenced assessment

Q32. A science teacher asks: “*Why do you think plants in the desert have fewer and smaller leaves? What principle explains this?*” This type of teacher questioning is best categorised in Bloom’s taxonomy as:

- (A) Knowledge (remembering)
- (B) Comprehension (understanding)
- (C) Analysis and evaluation
- (D) Application

Q33. Advocates of incorporating **indigenous knowledge** in science education argue that it:

- (A) Should replace the Western scientific canon in all schools.
- (B) Has no empirical basis and should not be included in science classrooms.
- (C) Can only be taught as cultural history, not as scientific knowledge.
- (D) Can enrich science learning by providing culturally relevant contexts and valuing diverse epistemologies.

Q34. Which of the following is the **primary benefit** of integrating science and mathematics in an interdisciplinary curriculum?

- (A) Students see the natural connections between disciplines and develop coherent understanding of quantitative science.
- (B) It reduces the total teaching time by combining two subjects into one period.
- (C) Mathematics becomes easier because students apply it only to familiar science contexts.
- (D) It eliminates the need for separate laboratory work in science.



- Q35. Representational competence** in science education refers to the ability to:
- (A) Reproduce diagrams and graphs from textbooks accurately from memory.
 - (B) Interpret, create, and translate between multiple representations (graphs, models, equations, images) of scientific phenomena.
 - (C) Represent the school in inter-school science competitions.
 - (D) Follow standard laboratory protocols correctly.
- Q36.** Analogical reasoning is widely used in science teaching (e.g., comparing electric current to water flow). A key **limitation** of using analogies in science instruction is:
- (A) Analogies are too abstract for most students to comprehend.
 - (B) Analogies work only for physics topics, not for biology or chemistry.
 - (C) Analogies can create new misconceptions if students over-extend the mapping beyond its valid domain.
 - (D) Analogies replace the need for experimentation and observation.
- Q37.** In Toulmin's model of argumentation, the component that explains **why** the evidence supports the claim is called the:
- (A) Claim
 - (B) Data (Evidence)
 - (C) Rebuttal
 - (D) Warrant
- Q38.** The **flipped classroom** model is characterised by:
- (A) Students reviewing instructional content (video/reading) at home and using class time for active problem-solving and discussion.
 - (B) Teachers assigning all textbook exercises as homework while class time is used for lectures.
 - (C) Students teaching each other in rotating roles with no teacher intervention.



- (D) Conducting laboratory work at home and writing theoretical notes in class.

Q39. Which of the following best describes a unique **affordance** of computer simulations in science education compared to traditional laboratory experiments?

- (A) Simulations provide hands-on psychomotor skill development that lab experiments do not.
- (B) Simulations allow students to manipulate variables and observe phenomena that are impossible, dangerous, or impractical in a real lab (e.g., atomic-scale processes).
- (C) Simulations are cheaper than all laboratory equipment in every situation.
- (D) Simulations provide real measurement data with genuine experimental error.

Q40. Self-regulated learning (SRL) involves learners actively controlling their own cognition. Which of the following is a **metacognitive strategy** that supports SRL?

- (A) Reading the textbook chapter from beginning to end without pausing.
- (B) Copying notes from the board during class.
- (C) Monitoring one's own understanding during study and adjusting strategies when comprehension fails.
- (D) Completing all assigned homework questions before any revision.

Part C: Biology — CBSE Class XII Level (Q41–50)

Q41. During **protein synthesis** (translation), which type of RNA is responsible for carrying specific amino acids to the ribosome?

- (A) mRNA (messenger RNA)
- (B) rRNA (ribosomal RNA)
- (C) hnRNA (heterogeneous nuclear RNA)



(D) tRNA (transfer RNA)

Q42. In enzyme kinetics, when a **competitive inhibitor** is added to a reaction mixture (with excess substrate available to overcome inhibition), what happens to $V_{\max}$?

(A) $V_{\max}$ remains unchanged; only K_m increases.

(B) $V_{\max}$ decreases; K_m remains unchanged.

(C) Both $V_{\max}$ and K_m decrease.

(D) $V_{\max}$ increases to compensate for inhibition.

Q43. Which of the following factors **increases** the rate of transpiration in plants? The diagram below shows a cross-section of a stoma.



(A) High atmospheric humidity

(B) High wind speed and low humidity

(C) Stomatal closure triggered by abscisic acid (ABA)

(D) Low temperature

Q44. The **Hardy-Weinberg equilibrium** describes a population in which allele frequencies remain constant from generation to generation. Which set of conditions is required for this equilibrium?

(A) Small population, random mating, no migration, no mutation

(B) Large population, non-random mating, no natural selection, no mutation

(C) Large population, random mating, no mutation, no migration, no natural selection

(D) Small population, random mating, mutation allowed, no migration

Q45. **Apomixis** in plants refers to:



- (A) Sexual reproduction requiring both male and female gametes.
- (B) Vegetative propagation through stem cuttings only.
- (C) Fertilisation of the egg by a pollen tube without pollination.
- (D) Production of seeds without fertilisation (asexual seed formation).

Q46. ELISA (Enzyme-Linked Immunosorbent Assay) detects a target molecule based on the principle of:

- (A) Specific antigen-antibody binding coupled to an enzyme-mediated colorimetric or fluorescent signal.
- (B) Separation of molecules by size using gel electrophoresis.
- (C) Amplification of target DNA by polymerase chain reaction.
- (D) Hybridisation of complementary nucleic acid strands.

Q47. In the human kidney, the majority of water and useful solutes are reabsorbed in which structure?

- (A) Glomerulus
- (B) Proximal convoluted tubule (PCT)
- (C) Collecting duct
- (D) Loop of Henle (descending limb only)

Q48. In a food web, a **keystone species** is one whose removal causes disproportionately large changes. If a keystone predator is removed, the most likely consequence is:

- (A) Increase in biodiversity due to the removal of a dominant predator.
- (B) No significant change since other species compensate immediately.
- (C) Overpopulation of prey species, leading to overgrazing and reduction of species diversity.
- (D) Rapid evolution of new predator species to fill the niche.

Q49. The **centromere** of a chromosome is:

- (A) The region where DNA replication begins.



- (B) The repetitive DNA sequences at the ends of chromosomes that protect them from degradation.
- (C) The region that codes for ribosomal RNA genes.
- (D) The constricted region that holds sister chromatids together and serves as the attachment site for spindle fibres during cell division.

Q50. In forensic science, the **Polymerase Chain Reaction (PCR)** is used primarily to:

- (A) Amplify minute quantities of DNA from crime-scene samples for subsequent analysis and identification.
- (B) Sequence the entire genome of a suspect within hours.
- (C) Synthesise protein antigens for serological testing.
- (D) Separate DNA fragments by charge and size using an electric field.

Part D: Chemistry — CBSE
Class XII Level (Q51–60)

Q51. Henry's law states that the solubility of a gas in a liquid is:

- (A) Inversely proportional to the partial pressure of the gas above the solution.
- (B) Directly proportional to the partial pressure of the gas above the solution at constant temperature.
- (C) Independent of temperature and pressure.
- (D) Directly proportional to the temperature at constant pressure.

Q52. Faraday's **first law** of electrolysis states that the mass of substance deposited at an electrode is:

- (A) Inversely proportional to the quantity of charge passed.
- (B) Independent of the equivalent mass of the substance.
- (C) Directly proportional to the quantity of electricity (charge) passed through the electrolyte.
- (D) Equal to one mole per Faraday regardless of the ion charge.



- Q53.** The Arrhenius equation is $k = Ae^{-E_a/RT}$. According to this equation, increasing temperature **increases** the rate constant k because:
- (A) The activation energy E_a decreases with temperature.
 - (B) The pre-exponential factor A increases with temperature.
 - (C) Increasing T decreases the exponent in magnitude, reducing $e^{-E_a/RT}$.
 - (D) The fraction of molecules with energy $\geq E_a$ increases, raising k exponentially.
- Q54.** The **Born-Haber cycle** is used to calculate or verify which energy term for ionic crystals?
- (A) Lattice enthalpy (lattice energy)
 - (B) Bond dissociation enthalpy
 - (C) Enthalpy of combustion
 - (D) Enthalpy of solution
- Q55.** The **Reimer-Tiemann reaction** involves the treatment of phenol with chloroform in the presence of aqueous NaOH. The **major product** is:
- (A) Benzoic acid
 - (B) Salicylaldehyde (2-hydroxybenzaldehyde)
 - (C) Phenyl chloride
 - (D) Catechol (1,2-dihydroxybenzene)
- Q56.** EDTA (ethylenediaminetetraacetic acid) acts as a **hexadentate ligand** (chelating agent). In which of the following contexts is EDTA most commonly used?
- (A) As a reducing agent in redox titrations.
 - (B) As a precipitating agent for metal ions.
 - (C) In complexometric titrations to determine the concentration of metal ions such as Ca^{2+} and Mg^{2+} in water hardness analysis.
 - (D) As a pH indicator in acid-base titrations.



- Q57.** The **lanthanide contraction** refers to the gradual decrease in atomic and ionic radii across the lanthanide series. The primary cause is:
- (A) Increasing nuclear charge with poor shielding by outer d electrons.
 - (B) Decreasing number of protons across the series.
 - (C) Increasing number of valence electrons that repel each other.
 - (D) Increasing nuclear charge with poor shielding by $4f$ electrons (which have poor shielding ability).
- Q58.** The **Cannizzaro reaction** is a disproportionation reaction. Which class of aldehydes undergoes this reaction?
- (A) Aldehydes having **no** α -hydrogen atoms (e.g., formaldehyde, benzaldehyde).
 - (B) Aldehydes with one or more α -hydrogen atoms.
 - (C) Ketones only, not aldehydes.
 - (D) All aldehydes regardless of α -hydrogen presence.
- Q59.** Enzymes are classified into six major classes. Which class of enzymes catalyses the **hydrolysis of peptide bonds**?
- (A) Transferases
 - (B) Hydrolases
 - (C) Lyases
 - (D) Oxidoreductases
- Q60.** In osmosis across a semipermeable membrane, water moves:
- (A) From a region of higher solute concentration to lower solute concentration.
 - (B) From a region of lower water potential to higher water potential.
 - (C) From a region of higher water potential (lower solute concentration) to lower water potential (higher solute concentration).
 - (D) In a direction determined by applied pressure only.



Part E: Mathematics — CBSE
Class XII Level (Q61–70)

- Q61.** Consider the function $f : \mathbb{R} \rightarrow \mathbb{R}$ defined by $f(x) = x^2$. Which of the following statements is **correct**?
- (A) f is both one-to-one (injective) and onto (surjective).
(B) f is onto but not one-to-one.
(C) f is one-to-one but not onto.
(D) f is neither one-to-one nor onto (as a function from $\mathbb{R}$ to $\mathbb{R}$).
- Q62.** Evaluate $\int \sin^2 x \, dx$.
- (A) $\frac{x}{2} - \frac{\sin 2x}{4} + C$
(B) $-\cos^2 x + C$
(C) $\frac{\sin 2x}{4} + C$
(D) $\frac{x}{2} + \frac{\sin 2x}{4} + C$
- Q63.** Events H_1 and H_2 partition the sample space with $P(H_1) = 0.6$, $P(H_2) = 0.4$. Given $P(B|H_1) = 0.3$ and $P(B|H_2) = 0.5$, find $P(B)$ using the Total Probability Theorem.
- (A) 0.30
(B) 0.38
(C) 0.45
(D) 0.50
- Q64.** The **scalar triple product** $\vec{a} \cdot (\vec{b} \times \vec{c})$ of three vectors represents:
- (A) The area of the triangle formed by the three vectors.
(B) The dot product of $\vec{a}$ and $\vec{b}$.
(C) The volume of the parallelepiped formed by the three vectors as adjacent edges.
(D) The magnitude of the cross product of $\vec{a}$ and $\vec{b}$.



Q65. The integrating factor for the first-order linear ODE $\frac{dy}{dx} + P(x)y = Q(x)$ is:

(A) $e^{-\int P dx}$

(B) $e^{\int Q dx}$

(C) $\int P dx$

(D) $e^{\int P dx}$

Q66. Lagrange's Mean Value Theorem (MVT) states: if f is continuous on $[a, b]$ and differentiable on (a, b) , then there exists $c \in (a, b)$ such that:

(A) $f'(c) = \frac{f(b) - f(a)}{b - a}$

(B) $f'(c) = f(b) - f(a)$

(C) $f(c) = \frac{f(a) + f(b)}{2}$

(D) $f''(c) = 0$

Q67. For an invertible square matrix A , the **adjoint** ($\text{adj } A$) is used to find the inverse. The correct formula is:

(A) $A^{-1} = \text{adj } A$

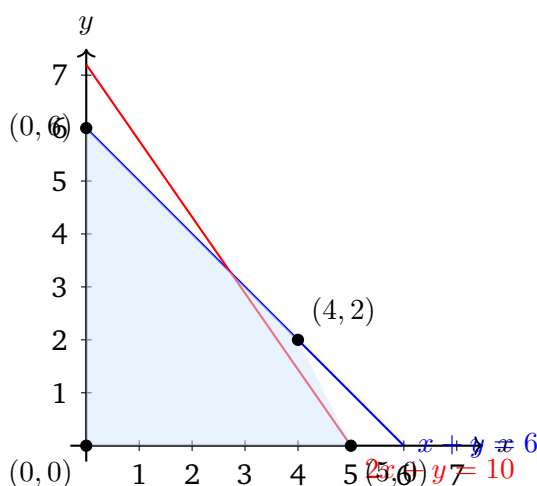
(B) $A^{-1} = \frac{1}{|A|} \text{adj } A$

(C) $A^{-1} = |A| \text{adj } A$

(D) $A^{-1} = \frac{\text{adj } A}{|A|^2}$

Q68. A linear programming problem has the constraints: $x \geq 0$, $y \geq 0$, $x + y \leq 6$, $2x + y \leq 10$. The feasible region is shown below.





The corner point of the feasible region where both constraint lines intersect is:

- (A) (3, 3)
- (B) (5, 2)
- (C) (4, 2)
- (D) (2, 4)

Q69. What is the principal value of $\arctan(1) + \arctan(-1)$?

- (A) $\frac{\pi}{2}$
- (B) π
- (C) $\frac{\pi}{4}$
- (D) 0

Q70. A function $f : A \rightarrow B$ is called **surjective (onto)** if and only if:

- (A) Every element of B has at least one pre-image in A (i.e., $f(A) = B$).
- (B) Every element of A maps to a distinct element of B .
- (C) $|A| = |B|$.
- (D) f has an inverse function.

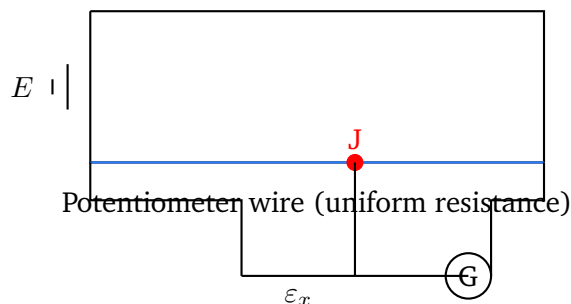
Part F: Physics — CBSE Class XII Level (Q71–80)

Q71. According to Gauss's law, the total electric flux through a closed surface is:



- (A) Proportional to the total charge outside the surface.
- (B) $\frac{Q_{\text{enc}}}{\epsilon_0}$, where Q_{enc} is the total charge enclosed by the surface.
- (C) Always zero for any closed surface.
- (D) Dependent on the shape and size of the closed surface for a given charge.

Q72. The diagram below shows a basic **potentiometer** circuit.



A key advantage of a potentiometer over a voltmeter for measuring EMF is:

- (A) A potentiometer has a very low internal resistance, whereas a voltmeter has high resistance.
- (B) A potentiometer is digital while a voltmeter is analog.
- (C) At the null (balance) point, no current is drawn from the cell being measured, so the potentiometer measures true EMF.
- (D) A potentiometer can measure both DC and AC voltages accurately.

Q73. Mutual inductance (M) between two coils is defined as the ratio of the EMF induced in one coil to the rate of change of current in the other. The SI unit of mutual inductance is:

- (A) Farad (F)
- (B) Ohm (Ω)
- (C) Weber (Wb)
- (D) Henry (H)

Q74. When white light passes through a glass prism, it disperses into a spectrum of colours. The **primary cause** of dispersion is:



- (A) Different wavelengths of light travel at different speeds in glass (different refractive indices), causing different angles of refraction.
- (B) Different colours have different amplitudes and are thus bent differently.
- (C) Total internal reflection occurs at different angles for different colours.
- (D) Diffraction at the glass surface separates different wavelengths.

Q75. The **Compton effect** (scattering of X-rays by electrons) provides direct evidence for:

- (A) The wave nature of matter (de Broglie hypothesis).
- (B) The particle nature (momentum) of photons.
- (C) The wave nature of X-rays through interference.
- (D) Quantisation of electron energy levels in atoms.

Q76. In nuclear **fission**, a heavy nucleus splits into lighter fragments releasing energy. This is energetically possible because:

- (A) Heavy nuclei have very low binding energy per nucleon, and so do their fragments.
- (B) Fission always releases exactly 200 MeV per event regardless of the nucleus.
- (C) The binding energy per nucleon of the fission fragments is **higher** than that of the original heavy nucleus, releasing energy as mass defect.
- (D) The total number of nucleons increases during fission, releasing energy.

Q77. A Zener diode is used as a **voltage regulator**. It operates in:

- (A) Forward bias, where it acts like an ordinary diode.
- (B) Both forward and reverse bias alternately.
- (C) Forward bias with a very large current.
- (D) Reverse bias, maintaining a nearly constant voltage (Zener voltage) across it despite changes in input voltage or load.



- Q78.** In an AC circuit, the power factor is 1 (unity). This condition occurs when:
- (A) The circuit is purely resistive (or at resonance, where $X_L = X_C$).
 - (B) The circuit contains only a capacitor.
 - (C) The circuit contains only an inductor.
 - (D) The impedance equals the reactance.
- Q79.** In a **cyclotron**, a charged particle moves in a magnetic field. Which of the following quantities remains **constant** during the circular motion of the particle?
- (A) The kinetic energy of the particle.
 - (B) The time period (or frequency) of revolution, independent of the particle's speed (for non-relativistic particles).
 - (C) The radius of the circular orbit.
 - (D) The angular momentum of the particle.
- Q80.** For a parallel plate capacitor with plate area A , plate separation d , and dielectric constant κ , the capacitance $C = \kappa\epsilon_0 A/d$. If the plate **area is doubled** while d and κ are kept constant, what happens to C ?
- (A) C is halved.
 - (B) C remains unchanged.
 - (C) C is doubled.
 - (D) C is quadrupled.

