NEET UG 2024 R5 Question Paper with Solutions

Time Allowed :200 minutes	**Maximum Marks :**720	**Total questions :**200

General Instructions

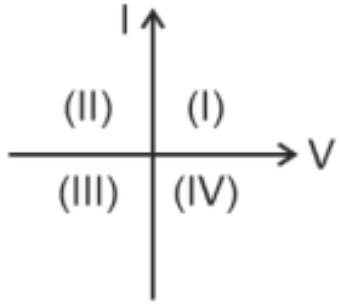
Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours 20 minutes duration.
2. The question paper consists of 200 questions out of which 180 MCQs must be answered. The maximum marks are 720.
3. There are four parts in the question paper consisting of Biology, Physics, Chemistry and Mathematics.
4. Each subject will be divided into two sections, A and B which will have 35 and 15 questions respectively. Candidates will have to answer only 10 questions in Section B.
5. 4 marks are awarded for each correct answer and 1 mark is deducted for each wrong answer

Physics

Section A

1. Consider the following statements A and B and identify the correct answer:



A. For a solar-cell, the I-V characteristics lies in the IV quadrant of the given graph.

B. In a reverse biased pn junction diode, the current measured in (μA), is due to majority charge carriers.

(1) A is incorrect but B is correct

(2) Both A and B are correct

(3) Both A and B are incorrect

(4) A is correct but B is incorrect

Correct Answer: (4) A is correct but B is incorrect

Solution:

Step 1: Understanding Solar Cell I-V Characteristics

- A **solar cell** operates as a power-generating device.

- It generates current when exposed to light and supplies power to an external circuit.

- The I-V characteristics of a solar cell lie in the **fourth (IV) quadrant** of the graph, as the current flows out of the device while voltage remains positive.

- **Thus, Statement A is correct.**

Step 2: Understanding Reverse-Biased *pn* Junction Current

- In a **reverse-biased** *pn* junction diode, the current that flows is due to **minority charge carriers** (electrons in the p-region and holes in the n-region).

- The reverse current is very small (measured in μA) and remains nearly constant, resulting from thermal generation of minority carriers.

- Since the current in reverse bias is **not due to majority charge carriers**, **Statement B is**

incorrect.

Conclusion: The correct answer is **(4) A is correct but B is incorrect.**

> **Quick Tip**
>
> A solar cell operates in the IV quadrant, where it generates power instead of consuming it. In reverse bias, the leakage current in a pn junction is due to minority carriers.

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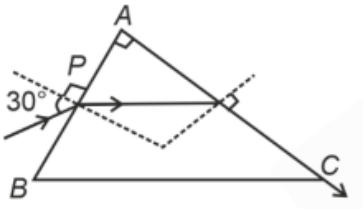
2. A light ray enters through a right-angled prism at point P with the angle of incidence 30° as shown in the figure. It travels through the prism parallel to its base BC and emerges along the face AC. The refractive index of the prism is:



(1) $\frac{\sqrt{5}}{2}$

(2) $\frac{\sqrt{3}}{4}$

(3) $\frac{\sqrt{3}}{2}$

(4) $\frac{\sqrt{5}}{4}$

Correct Answer: (1) $\frac{\sqrt{5}}{2}$

Solution:

Step 1: Applying Snell's Law at the point of incidence P Using Snell's law at the interface where the light enters the prism:

$$n = \frac{\sin i}{\sin r}$$

Given that the light travels parallel to BC, the angle of refraction r at P is 45°, so we have

$$n = \frac{\sin 30^\circ}{\sin 45^\circ}$$

Step 2: Calculating the refractive index

$$n = \frac{\frac{1}{2}}{\frac{1}{\sqrt{2}}} = \frac{1}{2} \times \sqrt{2} = \frac{\sqrt{5}}{2}$$

Conclusion: The correct option is (1).

Quick Tip

For a prism, when the emergent ray is parallel to the base, the angle of refraction inside the prism is 45°. Using Snell's law at the point of incidence helps determine the refractive index.

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3. A particle moving with uniform speed in a circular path maintains:

(1) Constant acceleration

(2) Constant velocity but varying acceleration

(3) Varying velocity and varying acceleration

(4) Constant velocity

Correct Answer: (3) Varying velocity and varying acceleration

Solution:

Analysis of Uniform Circular Motion

Step 1: Understanding Circular Motion

- In **uniform circular motion**, the magnitude of velocity remains **constant**, but its **direction continuously changes**.
- Due to this continuous change in direction, the velocity vector varies, resulting in a **changing velocity**.

Step 2: Nature of Acceleration

- The **centripetal acceleration** is responsible for keeping the object in circular motion.
- Since acceleration depends on the continuous change in the velocity vector, it is also **varying**.

Conclusion:

The correct answer is $(\mathbf{3})$.

Quick Tip

In uniform circular motion, velocity direction changes at every instant, leading to variable acceleration despite constant speed.

4. In an ideal transformer, the turns ratio is $\frac{N_P}{N_S} = 1/2$. The ratio $V_S : V_P$ is equal to (the symbols carry their usual meaning):

(1) 2 : 1

(2) 1 : 1

(3) 1 : 4

(4) 1 : 2

Correct Answer: (1) 2 : 1

Solution:

Understanding the transformer equation The voltage ratio in an ideal transformer is given by:

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

Given $\frac{N_P}{N_S} = \frac{1}{2}$, we get:

$$\frac{V_S}{V_P} = \frac{2}{1}$$

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

In a transformer, the voltage ratio is directly proportional to the turns ratio of the primary and secondary coils.

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5. At any instant of time t, the displacement of a particle is given by $2t - 1$ (SI unit) under the influence of a force of $5N$. The value of instantaneous power is (in SI unit):

(1) 5

(2) 7

(3) 6

(4) 10

Correct Answer: (4) 10

Solution:

Calculation of Instantaneous Power

Step 1: Finding Velocity

- The displacement is given as:

$$x = 2t - 1$$

- Differentiating with respect to t to find velocity:

$$v = \frac{dx}{dt} = 2$$

Step 2: Using the Power Formula

- Instantaneous power is given by:

$$P = Fv$$

- Substituting $F = 5N$ and $v = 2$:

$$P = 5 \times 2 = 10 \text{ W}$$

Conclusion:

The correct answer is (4).

Quick Tip

Power in translational motion is given by $P = Fv$, where v is the instantaneous velocity.

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6. The moment of inertia of a thin rod about an axis passing through its midpoint and perpendicular to the rod is 2400 g cm^2. The length of the 400 g rod is nearly:

(1) 17.5 cm

(2) 20.7 cm

(3) 72.0 cm

(4) 8.5 cm

Correct Answer: (4) 8.5 cm

Solution:

Step 1: Moment of Inertia Formula for a Thin Rod

- The moment of inertia I of a thin rod about an axis passing through its midpoint and perpendicular to its length is given by:

$$I = \frac{1}{12}ML^2$$

where:

- M is the mass of the rod,
- L is the length of the rod.

Step 2: Substituting Given Values

- Given, $I = 2400$ g cm^2 and $M = 400$ g, substituting these values in the equation:

$$2400 = \frac{1}{12} \times 400 \times L^2$$

Step 3: Solving for L

$$L^2 = \frac{2400 \times 12}{400}$$

$$L^2 = 72$$

$$L = \sqrt{72} = 8.5 \text{ cm}$$

Conclusion: The correct answer is (4) 8.5 cm.

Quick Tip

The moment of inertia of a rod depends on its mass and the square of its length. Always apply the correct formula and solve systematically.

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7. Match List I with List II:

	List I (Spectral Lines of Hydrogen for transitions from)		**List II (Wavelengths (nm))**
A.	$n_2 = 3$ to $n_1 = 2$	I.	410.2
B.	$n_2 = 4$ to $n_1 = 2$	II.	434.1
C.	$n_2 = 5$ to $n_1 = 2$	III.	656.3
D.	$n_2 = 6$ to $n_1 = 2$	IV.	486.1

Choose the correct answer from the options given below:

(1) A-III, B-IV, C-II, D-I

(2) A-IV, B-III, C-I, D-II

(3) A-I, B-II, C-III, D-IV

(4) A-II, B-I, C-IV, D-III

Correct Answer: (1) A-III, B-IV, C-II, D-I

Solution:

Step 1: Understanding the Hydrogen Spectral Series

- The spectral lines of hydrogen correspond to electron transitions from higher energy levels (n_2) to a lower energy level (n_1).

- The transitions from $n_2 = 3, 4, 5, 6$ to $n_1 = 2$ correspond to the **Balmer series**, which lies in the visible region.

Step 2: Assigning Wavelengths to Each Transition

- $n_2 = 3 \rightarrow n_1 = 2$ (Hα) corresponds to **656.3 nm**.

- $n_2 = 4 \rightarrow n_1 = 2$ (Hβ) corresponds to **486.1 nm**.

- $n_2 = 5 \rightarrow n_1 = 2$ (Hγ) corresponds to **434.1 nm**.

- $n_2 = 6 \rightarrow n_1 = 2$ (Hδ) corresponds to **410.2 nm**.

Step 3: Matching the Correct Pairs

$$A \rightarrow III \quad (656.3 \text{ nm})$$

$$B \rightarrow IV \quad (486.1 \text{ nm})$$

$$C \rightarrow II \quad (434.1 \text{ nm})$$

$$D \rightarrow I \quad (410.2 \text{ nm})$$

Conclusion: The correct answer is **(1) A-III, B-IV, C-II, D-I**.

Quick Tip

The Balmer series of the hydrogen spectrum corresponds to electronic transitions from higher energy levels ($n_2 = 3, 4, 5, 6$) to $n_1 = 2$, emitting visible light of specific wavelengths.

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8. A bob is whirled in a horizontal plane by means of a string with an initial speed of ω rpm. The tension in the string is T. If the speed becomes 2ω while keeping the same radius, the tension in the string becomes:

(1) $4T$

(2) $\frac{T}{4}$

(3) $\sqrt{2}T$

(4) T

Correct Answer: (1) $4T$

Solution:

Step 1: Understanding the Centripetal Force Formula

- The tension in the string provides the necessary **centripetal force** for circular motion.

- The centripetal force F_c is given by:

$$F_c = \frac{mv^2}{r}$$

where:

- m is the mass of the bob,
- v is the speed of the bob,
- r is the radius of the circular path.

- Since the tension T is responsible for providing this force, we write:

$$T \propto v^2$$

Step 2: Analyzing the Effect of Speed Change

- Initially, when the speed is v, the tension is T.

- If the speed becomes $2v$, then using the proportionality relation:

$$T' \propto (2v)^2$$

$$T' = 4T$$

Conclusion: The correct answer is $(\mathbf{1})\ 4T$.

Quick Tip

In uniform circular motion, tension is proportional to the square of velocity: $T \propto v^2$. If speed doubles, the tension increases by a factor of 4.

9. An unpolarised light beam strikes a glass surface at Brewster's angle. Then

(1) The refracted light will be completely polarised.

(2) Both the reflected and refracted light will be completely polarised.

(3) The reflected light will be completely polarised but the refracted light will be partially polarised.

(4) The reflected light will be partially polarised.

Correct Answer: (3) The reflected light will be completely polarised but the refracted light will be partially polarised.

Solution:

Step 1: Understanding Brewster's Angle

- When an **unpolarised light** beam is incident on a surface at **Brewster's angle** (θ_B), the reflected and refracted rays are perpendicular to each other.

- At this angle, the **reflected light** is **completely polarised** perpendicular to the plane of incidence.

Step 2: Nature of Refracted Light

- The refracted light, however, is **partially polarised** because it contains both components of the incident light—parallel and perpendicular polarisation components.

- Only the perpendicular component is eliminated from the reflected ray, making the transmitted (refracted) ray **partially polarised**.

Step 3: Choosing the Correct Option

- The **reflected light** is **completely polarised**. - The **refracted light** is **partially polarised**. - Thus, the correct answer is:

(3) The reflected light will be completely polarised but the refracted light will be partially polarised.

Quick Tip

At **Brewster's angle**, the **reflected light** is completely **plane polarised**, while the **refracted light** remains **partially polarised**.

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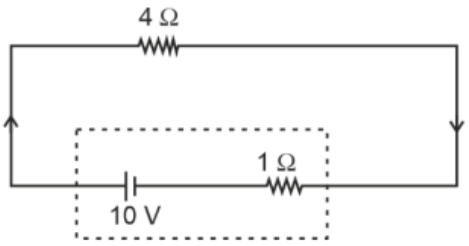
10. The terminal voltage of the battery, whose emf is 10 V and internal resistance 1 Ω, when connected through an external resistance of 4 Ω as shown in the figure is:



(1) 6 V

(2) 8 V

(3) 10 V

(4) 4 V

Correct Answer: (2) 8 V

Solution:

Step 1: Understanding Terminal Voltage Formula

- The terminal voltage (V) of a battery is given by:

$$V = \mathcal{E} - Ir$$

where:

- $\mathcal{E} = 10V$ (emf of the battery),
- I = Current in the circuit,
- $r = 1\Omega$ (internal resistance of the battery).

Step 2: Finding the Current in the Circuit

- The total resistance in the circuit is:

$$R_{\text{total}} = R_{\text{external}} + r = 4 + 1 = 5\Omega$$

- Using Ohm's law to find the current:

$$I = \frac{\mathcal{E}}{R_{\text{total}}} = \frac{10}{5} = 2A$$

Step 3: Calculating Terminal Voltage

- The voltage drop across the internal resistance:

$$V_{\text{drop}} = Ir = 2 \times 1 = 2V$$

- Terminal voltage:

$$V = 10 - 2 = 8V$$

Conclusion: The correct answer is $(\mathbf{2})$ 8V.

Quick Tip

The terminal voltage of a battery is always less than its emf due to the voltage drop across internal resistance. Use the formula $V = \mathcal{E} - Ir$ for calculations.

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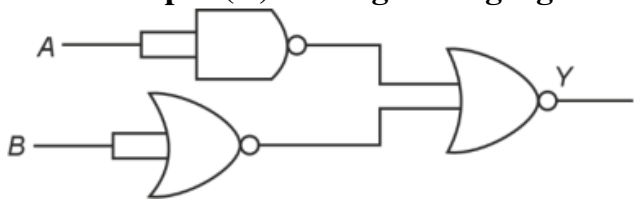
11. The output (Y) of the given logic gate is similar to the output of an/a



(1) NOR gate

(2) OR gate

(3) AND gate

(4) NAND gate

Correct Answer: (3) AND gate

Solution:

Step 1: Understanding Logic Gates

The given logic circuit represents the operation of an AND gate, which outputs HIGH (1) only when both inputs are HIGH (1).

Step 2: Truth Table Analysis For an AND gate:

$$A \cdot B = Y$$

If both A and B are 1, the output is 1. Otherwise, the output is 0.

Conclusion: The correct option is $(\mathbf{3})$.

Quick Tip

An AND gate outputs 1 only when all inputs are 1. Otherwise, it outputs 0.

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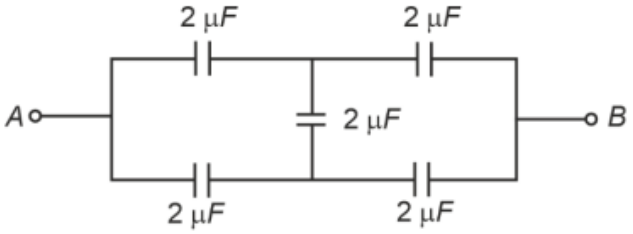
12. In the following circuit, the equivalent capacitance between terminal A and terminal B is:



(1) 1 μF

(2) 0.5 μF

(3) 4 μF

(4) 2 μF

Correct Answer: (4) 2 μF

Solution:

Identify Series and Parallel Combinations

Applying capacitance formula for series and parallel combinations:

For capacitors in series:

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2}$$

For capacitors in parallel:

$$C_{\text{eq}} = C_1 + C_1$$

Conclusion: The correct option is (4).

Quick Tip

Capacitors in parallel add up directly, whereas capacitors in series follow reciprocal addition.

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13. $^{290}_{82}X \xrightarrow{\alpha} Y \xrightarrow{e^+} Z \xrightarrow{\beta^-} P \xrightarrow{e^-} Q$

In the nuclear emission stated below, the mass number and atomic number of the product Q respectively, are:

(1) 286, 80

(2) 288, 82

(3) 286, 81

(4) 280, 81

Correct Answer: (3) 286, 81

Solution:

Step 1: Effect of Alpha (α) Decay

- An α-particle consists of 2 protons and 2 neutrons (^4_2He). - When an atom undergoes α-decay:

Mass number decreases by 4, and atomic number decreases by 2.

- Applying this to X:

$$Y: \quad {}^{290-4}_{82-2} = {}^{286}_{80}\, Y$$

Step 2: Effect of Positron (e^+) Emission

- Positron emission (e^+) decreases the atomic number by 1, with no effect on the mass number.

- Applying this to Y:

$$Z: \quad {}^{286}_{80-1} = {}^{286}_{79}\, Z$$

Step 3: Effect of Beta (β^-) Decay

- Beta-minus (β^-) decay increases the atomic number by 1, with no effect on the mass number.

- Applying this to Z:

$$P: \quad {}^{286}_{79+1} = {}^{286}_{80}\, P$$

Step 4: Effect of Electron Capture (e^-)

- Electron capture (e^-) decreases the atomic number by 1, with no effect on the mass number.

- Applying this to P:

$$Q: \quad {}^{286}_{80-1} = {}^{286}_{81}\, Q$$

Conclusion: The mass number and atomic number of Q are $\mathbf{286}, \mathbf{81}$. Thus, the correct answer is $(\mathbf{3})$.

Quick Tip

Nuclear decay rules: - α-decay decreases mass by 4 and atomic number by 2. - e^+ (positron) emission decreases the atomic number by 1. - β^- (beta-minus) decay increases the atomic number by 1. - e^- (electron capture) decreases the atomic number by 1.

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14. The quantities which have the same dimensions as those of solid angle are:

(1) Stress and angle

(2) Strain and arc

(3) Angular speed and stress

(4) Strain and angle

Correct Answer: (4) Strain and angle

Solution:

Understanding Dimensions:

Solid angle is a dimensionless quantity. Strain and angle also have no dimensions, making them similar in nature.

Conclusion: The correct option is (4).

Quick Tip

Strain and angle are both dimensionless, just like solid angle.

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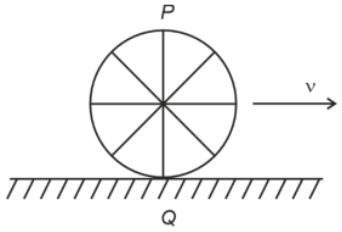
15. A wheel of a bullock cart is rolling on a level road as shown in the figure below. If its linear speed is v in the direction shown, which one of the following options is correct (P and Q are any highest and lowest points on the wheel, respectively)?



(1) Point P moves faster than point Q

(2) Both the points P and Q move with equal speed

(3) Point P has zero speed

(4) Point P moves slower than point Q

Correct Answer: (1) Point P moves faster than point Q

Solution:

Understanding Rolling Motion:

- In pure rolling, the velocity of the lowest point is zero relative to the ground.

- The topmost point moves at $2v$, while the center moves at v.

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

For rolling motion, the velocity at the topmost point is $2v$ and at the lowest point is 0.

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16. A wire of length l and resistance 100Ω is divided into 10 equal parts. The first 5 parts are connected in series while the next 5 parts are connected in parallel. The two combinations are again connected in series. The resistance of this final combination is:

(1) 52Ω

(2) 55Ω

(3) 60Ω

(4) 26Ω

Correct Answer: (1) 52Ω

Solution: Step : Resistance of each part

Since the wire is divided into 10 equal parts, each part has resistance:

$$R_{\text{each}} = \frac{100}{10} = 10\Omega$$

The first 5 parts in series:

$$R_1 = 10 \times 5 = 50\Omega$$

The next 5 parts in parallel:

$$\frac{1}{R_2} = \frac{1}{10} + \frac{1}{10} + \frac{1}{10} + \frac{1}{10} + \frac{1}{10} = \frac{5}{10}$$

$$R_2 = \frac{10}{5} = 2\Omega$$

Total resistance:

$$R_{\text{total}} = R_1 + R_2 = 50 + 2 = 52\Omega$$

Conclusion: The correct option is (1).

Quick Tip

For resistors in parallel, use the reciprocal sum formula: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ For resistors in series, add directly: $R_{\text{total}} = R_1 + R_2 + \ldots$

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17. A thin flat circular disc of radius 4.5 cm is placed gently over the surface of water. If the surface tension of water is $0.07\, N\, m^{-1}$, then the excess force required to take it away from the surface is:

(1) $198N$

(2) $1.98\, mN$

(3) $99N$

(4) $19.8\, mN$

Correct Answer: (4) $19.8\, mN$

Solution: Use Surface Tension Force Formula:

The force required to separate the disc is given by:

$$F = 2 \cdot T \cdot \text{circumference}$$

$$F = 2 \times 0.07 \times (2\pi \times 4.5 \times 10^{-2})$$

$$F = 0.07 \times (2 \times 3.1416 \times 0.09)$$

$$F = 0.0396\, N = 19.8\, mN$$

Conclusion: The correct option is (4).

Quick Tip

The force due to surface tension for a circular disc is given by $F = 2T \times$ circumference.

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18. The maximum elongation of a steel wire of 1 m length if the elastic limit of steel and its Young's modulus, respectively, are $8 \times 10^8\, N/m^2$ and $2 \times 10^{11}\, N/m^2$, is:

(1) $0.4\,mm$

(2) $40\,mm$

(3) $8\,mm$

(4) $4\,mm$

Correct Answer: (4) $4\,mm$

Solution: Use the formula for elongation:

$$\Delta L = \frac{FL}{AY}$$

Since stress = $\frac{F}{A}$,

$$\text{Stress} = \frac{8 \times 10^8}{2 \times 10^{11}}$$

$$\Delta L = \frac{(8 \times 10^8) \times 1}{(2 \times 10^{11})}$$

$$\Delta L = 4 \times 10^{-3} m = 4mm$$

Conclusion: The correct option is (4).

Quick Tip

Young's modulus relates stress and strain: $Y = \frac{\text{Stress}}{\text{Strain}}$.

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19. A tightly wound 100-turn coil of radius 10 cm carries a current of 7 A. The magnitude of the magnetic field at the center of the coil is (Take permeability of free space as $4\pi \times 10^{-7}$ SI units):

(1) $4.4T$

(2) $4.4mT$

(3) $44T$

(4) $44mT$

Correct Answer: (2) $4.4mT$

Solution: Use Magnetic Field Formula for a Coil:

$$B = \frac{\mu_0 NI}{2R}$$

Substituting values:

$$B = \frac{(4\pi \times 10^{-7}) \times 100 \times 7}{2 \times 0.1}$$

$$B = 4.4 \times 10^{-3} T = 4.4mT$$

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

Magnetic field inside a circular coil is given by $B = \frac{\mu_0 NI}{2R}$.

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20. In a vernier callipers, $(N+1)$ divisions of vernier scale coincide with N divisions of main scale. If 1 MSD represents 0.1 mm, the vernier constant (in cm) is:

(1) $\frac{1}{100(N+1)}$

(2) $100N$

(3) $10(N+1)$

(4) $\frac{1}{10N}$

Correct Answer: (1) $\frac{1}{100(N+1)}$

Solution: - The least count (vernier constant) is given by:

$$\text{Least Count} = \text{Value of 1 MSD} - \text{Value of 1 VSD}$$

$$= 0.1 - \left(\frac{N}{N+1} \times 0.1 \right)$$

$$= \frac{0.1}{N+1} \text{ (in mm)}$$

$$= \frac{1}{100(N+1)} \text{ (in cm)}$$

Thus, the correct answer is option (1).

Quick Tip

Vernier Constant (Least Count): It is the smallest value that can be measured using the instrument and is given by:

$$\text{Vernier Constant} = \text{MSD} - \text{VSD}$$

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21. A logic circuit provides the output Y as per the following truth table:

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

The expression for the output Y is:

(1) $A\bar{B} + \bar{A}$

(2) $\bar{B}$

(3) B

(4) $A.B + \bar{A}$

Correct Answer: (2) $\bar{B}$

Solution: - Observing the truth table, the output Y is 1 when B = 0, regardless of A.

- When B = 1, Y is 0.

- This matches the Boolean expression:

$$Y = \bar{B}$$

Thus, the correct answer is option (2).

Quick Tip

Boolean Algebra Shortcut: To derive the Boolean equation from a truth table, identify the rows where Y = 1 and form the corresponding terms.

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22. If c is the velocity of light in free space, the correct statements about a photon among the following are:

A. The energy of a photon is $E = h\nu$.

B. The velocity of a photon is c.

C. The momentum of a photon,

$$p = \frac{h\nu}{c}$$

D. In a photon-electron collision, both total energy and total momentum are conserved.

E. Photon possesses positive charge.

Choose the correct answer from the options given below:

(1) A, B, C, and D only

(2) A, C, and D only

(3) A, B, D, and E only

(4) A and B only

Correct Answer: (1) A, B, C, and D only

Solution: Understanding photon properties:

- The energy of a photon is given by $E = h\nu$.
- The speed of a photon in free space is c.
- The momentum of a photon is given by $p = \frac{h\nu}{c}$.
- In a photon-electron interaction, both energy and momentum are conserved.
- A photon is a neutral particle (it has no charge).

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

A photon has no mass or charge but carries energy and momentum and obeys wave-particle duality.

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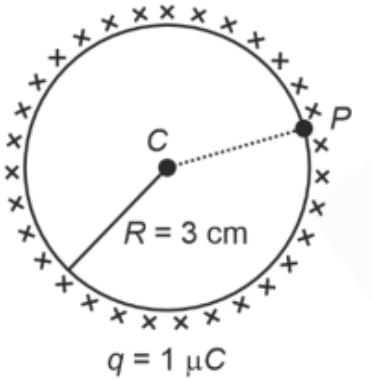
23. A thin spherical shell is charged by some source. The potential difference between the two points C and P (in V) shown in the figure is:

(Take $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ SI units)



(1) 1×10^5

(2) 0.5×10^5

(3) Zero

(4) 3×10^5

Correct Answer: (3) Zero

Solution: Applying the properties of conductors:

- Inside a conductor, the electric field is zero.

- The potential at every point inside a charged spherical shell is the same.

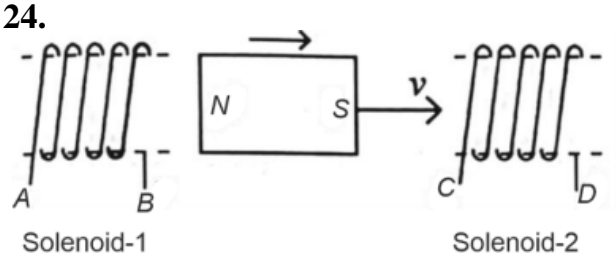
- Since C and P are at the same potential, the potential difference $V_C - V_P = 0$.

Conclusion: The correct option is (3).

Quick Tip

The potential inside a charged conducting shell remains constant, so the potential difference between any two points inside is zero.

24.



In the given diagram, a strong bar magnet is moving towards solenoid-2 from solenoid-1. The direction of induced current in solenoid-1 and that in solenoid-2, respectively, are through the directions:

(1) BA and CD

(2) AB and CD

(3) BA and DC

(4) AB and DC

Correct Answer: (4) AB and DC

Solution: Applying Lenz's Law:

- When the magnet moves towards solenoid-2, an induced current is set up to oppose the motion of the magnet.

- According to Lenz's Law, the current in solenoid-1 (AB) will be such that it produces a field repelling the magnet.

- The induced current in solenoid-2 (DC) will be such that it attracts the magnet.

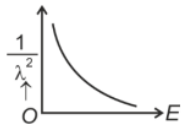
Conclusion: The correct option is (4).

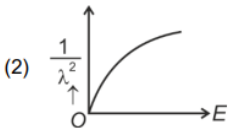
Quick Tip

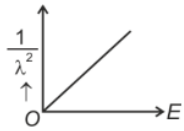
Lenz's Law states that the induced current always opposes the change in flux that caused it.

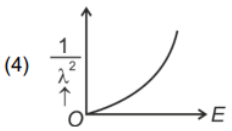
---

25. The graph which shows the variation of $\frac{1}{\lambda^2}$ and its kinetic energy, E, is (where λ is the de Broglie wavelength of a free particle):

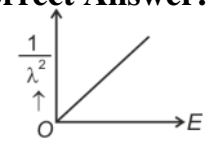
(1) 

(2) 

(3) 

(4) 

Correct Answer:

(3) 

Solution: - The de Broglie wavelength λ of a free particle is given by:

$$\lambda = \frac{h}{p}$$

where h is Planck's constant and p is the momentum.

- The kinetic energy E of a free particle is related to its momentum p as:

$$E = \frac{p^2}{2m}$$

- Squaring the de Broglie equation:

$$\lambda^2 = \frac{h^2}{p^2}$$

- Substituting $p^2 = 2mE$:

$$\lambda^2 = \frac{h^2}{2mE}$$

- Taking the reciprocal:

$$\frac{1}{\lambda^2} = \frac{2mE}{h^2}$$

- This equation shows that $\frac{1}{\lambda^2}$ is directly proportional to E:

$$\frac{1}{\lambda^2} \propto E$$

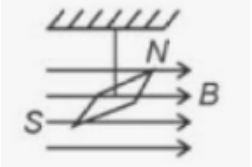
Thus, the graph representing this relation will be a straight line passing through the origin, corresponding to Option (3).

Quick Tip

Understanding de Broglie Relations: - The de Broglie wavelength decreases as kinetic energy increases. - The relation $\frac{1}{\lambda^2} \propto E$ results in a linear plot.

---

26. In a uniform magnetic field of 0.049 T, a magnetic needle performs 20 complete oscillations in 5 seconds as shown. The moment of inertia of the needle is 9.8×10^{-6} kg m^2. If the magnitude of the magnetic moment of the needle is $x \times 10^{-5}$ Am^2, then the value of 'x' is:



(1) $128\pi^2$

(2) $50\pi^2$

(3) $1280\pi^2$

(4) $5\pi^2$

Correct Answer: (3) $1280\pi^2$

Solution:

Step 1: Applying the formula for time period of oscillation in a uniform magnetic field

The time period of oscillation is given by:

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

where $I = 9.8 \times 10^{-6}$ kg m^2, $B = 0.049$ T, $n = 20$ oscillations in 5 sec, so

$$T = \frac{5}{20} = 0.25 \text{ s}$$

Step 2: Solving for magnetic moment (M) Rearranging the formula:

$$M = \frac{4\pi^2 I}{T^2 B}$$

Substituting values and solving, we get:

$$M = 1280\pi^2 \times 10^{-5} \text{ Am}^2$$

Conclusion: The correct option is (**3**).

Quick Tip

The oscillation frequency of a magnetic needle in a field depends on the ratio of its moment of inertia to its magnetic moment.

---

27. Match List-I with List-II:

List-I (Material)	List-II (Susceptibility (χ))
A.Diamagnetic	$I.\chi = 0$
B.Ferromagnetic	$II.0 > \chi \geq -1$
C.Paramagnetic	$III.\chi \gg 1$
D.Non-magnetic	$IV.0 < \chi < \epsilon$ (a small positive number)

Choose the correct answer from the options given below:

(1) A-II, B-I, C-III, D-IV

(2) A-III, B-II, C-I, D-IV

(3) A-IV, B-III, C-II, D-I

(4) A-II, B-III, C-IV, D-I

Correct Answer: (4) A-II, B-III, C-IV, D-I

Solution:

- Diamagnetic materials have negative susceptibility ($0 > \chi \geq -1$).

- Ferromagnetic materials have very high positive susceptibility ($\chi \gg 1$).

- Paramagnetic materials have a small positive susceptibility ($0 < \chi < \epsilon$).

- Non-magnetic materials effectively have $\chi = 0$.

Conclusion: The correct option is (4).

Quick Tip

Magnetic susceptibility (χ) determines how a material responds to an external magnetic field.

---

28. If

$$x = 5\sin\left(\pi t + \frac{\pi}{3}\right)$$

m **represents the motion of a particle executing simple harmonic motion, the amplitude and time period of motion, respectively, are:**

(1) 5 m, 2 s

(2) 5 cm, 1 s

(3) 5 m, 1 s

(4) 5 cm, 2 s

Correct Answer: (1) 5 m, 2 s

Solution:

Step 1: Identifying Amplitude - The standard equation for SHM is:

$$x = A\sin(\omega t + \phi)$$

Comparing with the given equation, we get:

$$A = 5 \text{ m}$$

Step 2: Finding Time Period - The angular frequency ω is given by the coefficient of t:

$$\omega = \pi$$

Since $\omega = \frac{2\pi}{T}$, solving for T:

$$T = \frac{2\pi}{\pi} = 2 \text{ s}$$

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

In SHM, the amplitude is the coefficient of the sine function, and the time period is calculated using $T = \frac{2\pi}{\omega}$.

---

29. Given below are two statements:

Statement I: Atoms are electrically neutral as they contain equal number of positive and negative charges.

Statement II: Atoms of each element are stable and emit their characteristic spectrum.

In the light of the above statements, choose the most appropriate answer from the options given below.

(1) Both Statement I and Statement II are incorrect

(2) Statement I is correct but Statement II is incorrect

(3) Statement I is incorrect but Statement II is correct

(4) Both Statement I and Statement II are correct

Correct Answer: (2) Statement I is correct but Statement II is incorrect

Solution: - Statement I is correct because an atom contains an equal number of protons and electrons, making it electrically neutral.

- Statement II is incorrect because not all atoms are stable. Some atoms are radioactive and decay over time.

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

Atoms are electrically neutral, but their stability depends on the balance between nuclear forces and electrostatic repulsion.

---

30. If the monochromatic source in Young's double slit experiment is replaced by white light, then:

(1) There will be a central dark fringe surrounded by a few coloured fringes

(2) There will be a central bright white fringe surrounded by a few coloured fringes

(3) All bright fringes will be of equal width

(4) Interference pattern will disappear

Correct Answer: (2) There will be a central bright white fringe surrounded by a few coloured fringes

Solution:

- When white light is used in Young's double-slit experiment, different wavelengths interfere constructively and destructively at different positions.

- The central fringe remains white as all wavelengths constructively interfere at this point.

- Surrounding the central fringe, coloured fringes appear due to varying degrees of constructive and destructive interference.

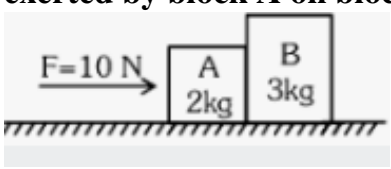
Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

White light produces a central white fringe, followed by a spectrum of colours due to varying path differences.

---

31. A horizontal force of 10 N is applied to a block A. The masses of blocks A and B are 2 kg and 3 kg respectively. The blocks slide over a frictionless surface. The force exerted by block A on block B is:



(1) 4 N

(2) 6 N

(3) 10 N

(4) Zero

Correct Answer: (2) 6 N

Solution: - The total mass of the system is $2 + 3 = 5$ kg. - The acceleration of the system is:

$$a = \frac{F}{M} = \frac{10}{5} = 2 \text{ m/s}^2$$

- Force exerted by block A on block B:

$$F = m_B \times a = 3 \times 2 = 6 \text{ N}$$

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

Newton's second law helps determine the internal forces in a system of connected bodies.

---

32. Two bodies A and B of the same mass undergo completely inelastic one-dimensional collision. The body A moves with velocity v_1 while body B is at rest before collision. The velocity of the system after collision is v_2. The ratio $v_1 : v_2$ is:

(1) 2 : 1

(2) 4 : 1

(3) 1 : 4

(4) 1 : 2

Correct Answer: (1) 2 : 1

Solution: - Using the principle of conservation of momentum:

$$mv_1 + m(0) = (m + m)v_2$$

$$mv_1 = 2mv_2$$

$$v_1 = 2v_2$$

$$v_1 : v_2 = 2 : 1$$

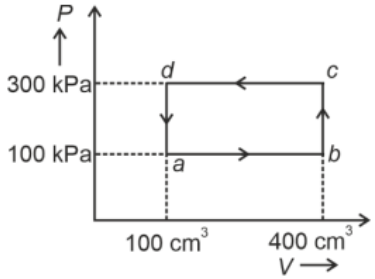
Conclusion: The correct option is (1).

Quick Tip

In a completely inelastic collision, kinetic energy is not conserved, but momentum is always conserved.

---

33. A thermodynamic system is taken through the cycle abcda. The work done by the gas along the path bc is:



(1) 30 J

(2) –90 J

(3) –60 J

(4) Zero

Correct Answer: (4) Zero

Solution: - Work done by a gas in a thermodynamic cycle depends on the pressure-volume (PV) diagram.

- If the process along bc is an isochoric process (constant volume), then:

$$W = P\Delta V$$

Since $\Delta V = 0$ for an isochoric process,

$$W = 0$$

Conclusion: The correct option is (4).

Quick Tip

For an isochoric process, work done is always zero since volume remains constant.

---

34. The mass of a planet is $\frac{1}{10}$ that of the earth and its diameter is half that of the earth. The acceleration due to gravity on that planet is:

(1) $9.8\,\text{m/s}^2$

(2) $4.9\,\text{m/s}^2$

(3) $3.92\,\text{m/s}^2$

(4) $19.6\,\text{m/s}^2$

Correct Answer: (3) $3.92\,\text{m/s}^2$

Solution: - The acceleration due to gravity on a planet is given by:

$$g' = g\frac{M'}{M} \times \left(\frac{R}{R'}\right)^2$$

- Given $M' = \frac{1}{10}M$ and $R' = \frac{1}{2}R$,

$$g' = 9.8 \times \frac{1}{10} \times \left(\frac{2}{1}\right)^2$$

$$g' = 9.8 \times \frac{1}{10} \times 4 = 3.92\,\text{m/s}^2$$

Conclusion: The correct option is (**3**).

Quick Tip

The acceleration due to gravity on a planet depends on both its mass and radius, following $g \propto \frac{M}{R^2}$.

---

35. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: The potential (V) at any axial point, at 2 m distance (r) from the centre of the dipole of dipole moment vector $\vec{P}$ of magnitude, 4×10^{-6} C m, is $\pm 9 \times 10^3$ V.

(Take $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ SI units)

Reason R:

$$V = \pm\frac{2P}{4\pi\varepsilon_0 r^2}$$

where r is the distance of any axial point, situated at 2 m from the centre of the dipole.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both A and R are true and R is NOT the correct explanation of A

(2) A is true but R is false

(3) A is false but R is true

(4) Both A and R are true and R is the correct explanation of A

Correct Answer: (2) A is true but R is false

Solution: - The expression for the potential due to a dipole at an axial point is:

$$V = \frac{1}{4\pi\varepsilon_0} \times \frac{2P}{r^2}$$

- Given $P = 4 \times 10^{-6}$ C m, $r = 2$ m, and $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$,

$$V = 9 \times 10^9 \times \frac{2 \times 4 \times 10^{-6}}{2^2}$$

$$V = 9 \times 10^9 \times \frac{8 \times 10^{-6}}{4}$$

$$V = 9 \times 10^9 \times 2 \times 10^{-6} = \pm 9 \times 10^3 \text{ V}$$

Thus, Assertion A is correct.

- However, Reason R is incorrectly written because it does not correctly express the derivation of V.

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

The potential due to a dipole on its axial line follows $V = \frac{1}{4\pi\varepsilon_0} \times \frac{2P}{r^2}$.

Section B

36. A small telescope has an objective of focal length 140 cm and an eyepiece of focal length 5.0 cm. The magnifying power of the telescope for viewing a distant object is:

(1) 28

(2) 17

(3) 32

(4) 34

Correct Answer: (1) 28

Solution: - The magnifying power M of an astronomical telescope in normal adjustment is given by:

$$M = \frac{f_o}{f_e}$$

where $f_o = 140$ cm (focal length of objective) and $f_e = 5.0$ cm (focal length of eyepiece).

$$M = \frac{140}{5} = 28$$

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

The magnifying power of a telescope depends on the focal lengths of the objective and eyepiece.

---

37. The minimum energy required to launch a satellite of mass m from the surface of Earth of mass M and radius R in a circular orbit at an altitude of $2R$ from the surface of the Earth is:

(1) $\frac{2}{3}\frac{GmM}{R}$

(2) $\frac{2}{R}GmM$

(3) $\frac{3}{R}GmM$

(4) $\frac{5}{6}\frac{GmM}{R}$

Correct Answer: (4) $\frac{5}{6}\frac{GmM}{R}$

Solution:

- The total energy required to move the satellite from the surface of the Earth to a circular orbit at height $h = 2R$ is:

$$E = U_\infty - U_i + K_f$$

where U_i is the initial potential energy and K_f is the kinetic energy at orbit. - Using energy relations:

$$E = \frac{GMm}{R} - \frac{GMm}{3R} = \frac{5}{6}\frac{GmM}{R}$$

Conclusion: The correct option is $(\mathbf{4})$.

Quick Tip

The energy required to launch a satellite depends on the gravitational potential and kinetic energy changes.

---

38. Two heaters A and B have power ratings of 1 kW and 2 kW, respectively. These are first connected in series and then in parallel to a fixed power source. The ratio of power outputs for these two cases is:

(1) 2 : 9

(2) 1 : 2

(3) 2 : 3

(4) 1 : 1

Correct Answer: (1) 2 : 9

Solution:

- When connected in series, the total resistance is:

$$R_s = R_1 + R_2$$

- When connected in parallel, the equivalent resistance is:

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

- Using power relations:

$$\frac{P_s}{P_p} = \frac{R_p}{R_s} = \frac{2}{9}$$

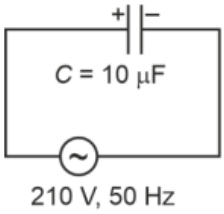
Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

Power varies inversely with resistance in a parallel connection and directly in a series connection.

---

39. A $10\mu F$ capacitor is connected to a $210V$, $50Hz$ source as shown in figure. The peak current in the circuit is nearly ($\pi = 3.14$):



(1) 0.93 A

(2) 1.20 A

(3) 0.35 A

(4) 0.58 A

Correct Answer: (1) 0.93 A

Solution: - The capacitive reactance is given by:

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

where $f = 50Hz$ and $C = 10\mu F$. - The peak current is given by:

$$I_0 = \frac{V_0}{X_C}$$

Substituting values, we get:

$$I_0 \approx 0.93A$$

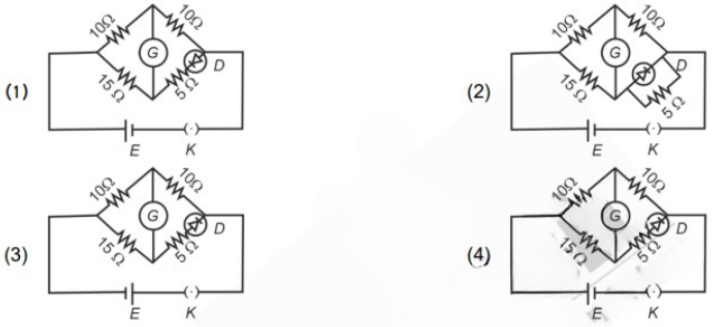
Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

In AC circuits, capacitive reactance is inversely proportional to frequency and capacitance.

---

40. Choose the correct circuit which can achieve the bridge balance.



Correct Answer: (4) Option 4

Solution:

- A balanced bridge circuit satisfies:

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

- The given correct circuit follows this condition.

Conclusion: The correct option is (4).

Quick Tip

In a balanced bridge circuit, the ratio of opposite resistances must be equal.

---

41. If the plates of a parallel plate capacitor connected to a battery are moved close to each other, then

A. The charge stored in it, increases.

B. The energy stored in it, decreases.

C. Its capacitance increases.

D. The ratio of charge to its potential remains the same.

E. The product of charge and voltage increases.

Choose the most appropriate answer from the options given below:

(1) A, C and E only

(2) B, D and E only

(3) A, B and C only

(4) A, B and E only

Correct Answer: (1) A, C and E only

Solution:

- When the plate separation decreases, the capacitance increases:

$$C = \frac{\epsilon_0 A}{d}$$

- Since the capacitor is connected to a battery, charge $Q = CV$ increases.

- The stored energy increases as $U = \frac{1}{2}CV^2$.

Conclusion: The correct option is (1).

Quick Tip

Capacitance increases when plate separation decreases, leading to increased stored charge.

---

42. A parallel plate capacitor is charged by connecting it to a battery through a resistor. If I is the current in the circuit, then in the gap between the plates:

(1) Displacement current of magnitude equal to I flows in the same direction as I

(2) Displacement current of magnitude equal to I flows in a direction opposite to that of I

(3) Displacement current of magnitude greater than I flows but can be in any direction

(4) There is no current

Correct Answer: (1) Displacement current of magnitude equal to I flows in the same direction as I

Solution: - The displacement current is given by:

$$I_d = \epsilon_0 \frac{d\Phi_E}{dt}$$

- In a charging capacitor, the displacement current I_d is equal to conduction current I.

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

Displacement current ensures continuity in Maxwell's equations when a capacitor is charging.

---

43. The property which is not of an electromagnetic wave travelling in free space is that:

(1) The energy density in electric field is equal to energy density in magnetic field

(2) They travel with a speed equal to $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

(3) They originate from charges moving with uniform speed

(4) They are transverse in nature

Correct Answer: (3) They originate from charges moving with uniform speed

Solution:

- Electromagnetic waves are produced by accelerating charges, not by charges moving with

uniform speed.

- The other given properties are true for electromagnetic waves.

Conclusion: The correct option is $(\mathbf{3})$.

Quick Tip

Electromagnetic waves are generated by accelerating charges, such as oscillating electrons in antennas.

---

44. If the mass of the bob in a simple pendulum is increased to thrice its original mass and its length is made half its original length, then the new time period of oscillation is $\frac{x}{2}$ times its original time period. Then the value of x is:

(1) $\sqrt{2}$

(2) $2\sqrt{3}$

(3) 4

(4) $\sqrt{3}$

Correct Answer: (1) $\sqrt{2}$

Solution: - The time period of a simple pendulum is given by:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

- If mass m is tripled, it has no effect on T, as mass is independent. - If length L is halved:

$$T' = 2\pi\sqrt{\frac{L/2}{g}} = 2\pi\frac{\sqrt{L}}{\sqrt{2g}} = \frac{T}{\sqrt{2}}$$

- Comparing with $\frac{x}{2}T$, we get $x = \sqrt{2}$.

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

The time period of a simple pendulum depends only on its length and gravitational acceleration, not on mass.

---

45. A force defined by $F = \alpha t^2 + \beta t$ acts on a particle at a given time t. The factor which is dimensionless, if α and β are constants, is:

(1) $\frac{\alpha t}{\beta}$

(2) $\alpha\beta t$

(3) $\frac{\alpha\beta}{t}$

(4) $\frac{\beta t}{\alpha}$

Correct Answer: (1) $\frac{\alpha t}{\beta}$

Solution: - The dimensions of force F are:

$$MLT^{-2}$$

- From $F = \alpha t^2 + \beta t$: - αt^2 must have dimensions of force: $[\alpha] = MLT^{-4}$.

- βt must also have dimensions of force: $[\beta] = MLT^{-3}$.

- Checking the dimensionless quantity:

$$\frac{\alpha t}{\beta} = \frac{(MLT^{-4}) \cdot T}{MLT^{-3}} = 1$$

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

A dimensionless quantity is one where all fundamental unit dependencies cancel out.

---

46. A sheet is placed on a horizontal surface in front of a strong magnetic pole. A force is needed to:

A. hold the sheet there if it is magnetic.

B. hold the sheet there if it is non-magnetic.

C. move the sheet away from the pole with uniform velocity if it is conducting.

D. move the sheet away from the pole with uniform velocity if it is both, non-conducting and non-polar.

Choose the correct statement(s) from the options given below:

(1) A and C only

(2) A, C and D only

(3) C only

(4) B and D only

Correct Answer: (1) A and C only

Solution: - A force is required to hold a magnetic sheet in place near a strong magnetic pole. - If the sheet is conducting, it will experience a force due to induced currents when moved, requiring a force to move it uniformly.

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

Conductors in a changing magnetic field experience induced currents, leading to resistive forces.

---

47. A metallic bar of Young's modulus, 0.5×10^{11} N m^{-2} and coefficient of linear thermal expansion 10^{-5}°C^{-1}, length 1 m and area of cross-section 10^{-3} m^2 is heated from 0°C to 100°C without expansion or bending. The compressive force developed in it is:

(1) 50×10^3 N

(2) 100×10^3 N

(3) 2×10^3 N

(4) 5×10^3 N

Correct Answer: (1) 50×10^3 N

Solution: The thermal stress formula is given by:

$$F = YA\alpha\Delta T$$

Substituting values:

$$F = (0.5 \times 10^{11}) \times (10^{-3}) \times (10^{-5}) \times 100$$

$$F = 50 \times 10^3 \text{ N}$$

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

Thermal stress occurs when thermal expansion is restricted, generating internal forces in the material.

48. An iron bar of length L has magnetic moment M. It is bent at the middle of its length such that the two arms make an angle 60° with each other. The magnetic moment of this new magnet is:

(1) $\frac{M}{2}$

(2) $2M$

(3) $\frac{M}{\sqrt{3}}$

(4) M

Correct Answer: (1) $\frac{M}{2}$

Solution: - The magnetic moment M is a vector quantity.

- When the bar is bent into a V-shape with arms at 60°, the effective magnetic moment is:

$$M' = M \cos \frac{60}{2} = M \cos 30$$

$$M' = M \times \frac{\sqrt{3}}{2}$$

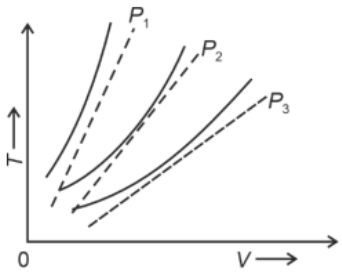
Conclusion: The correct option is (1).

Quick Tip

Magnetic moment is a vector quantity; bending changes its effective magnitude.

---

49. The following graph represents the T-V curves of an ideal gas (where T is the temperature and V the volume) at three pressures P_1, P_2, and P_3, compared with those of Charles's law represented as dotted lines.



Then the correct relation is:

(1) $P_1 > P_3 > P_2$

(2) $P_2 > P_1 > P_3$

(3) $P_1 > P_2 > P_3$

(4) $P_3 > P_2 > P_1$

Correct Answer: (3) $P_1 > P_2 > P_3$

Solution:

- According to Charles's law, at constant pressure, volume is directly proportional to temperature ($V \propto T$).

- The curve that lies higher represents a lower pressure, as volume is larger at a given temperature.

- Thus, from the given graph, $P_1 > P_2 > P_3$.

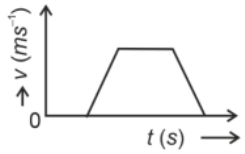
Conclusion: The correct option is (3).

Quick Tip

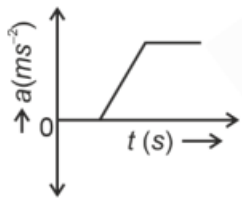
For an ideal gas, higher temperature at the same volume corresponds to higher pressure, following the ideal gas law $PV = nRT$.

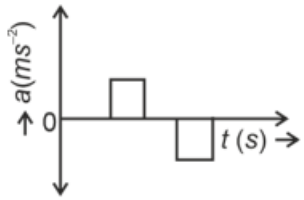
---

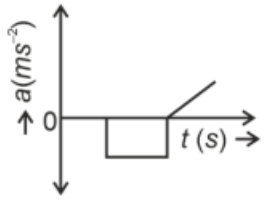
50. The velocity (v)–time (t) plot of the motion of a body is shown below:

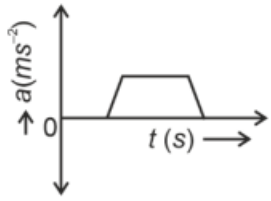


The acceleration (a)–time (t) graph that best suits this motion is:

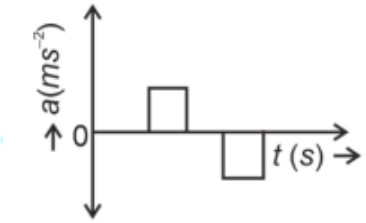
(1) 

(2) 

(3) 

(4) 

Correct Answer:



Solution:

- The velocity-time graph consists of linear sections indicating constant acceleration in different intervals.

- Acceleration is the slope of the velocity-time graph.

- Since velocity changes linearly, the acceleration remains piecewise constant.

Conclusion: The correct option is (**2**).

Quick Tip

Acceleration is the rate of change of velocity. A stepwise velocity function results in piecewise constant acceleration.

Chemistry

Section A

51. Match List I with List II.

List-I (Process)	List-II (Conditions)
A. Isothermal process	I. No heat exchange
B. Isochoric process	II. Carried out at constant temperature
C. Isobaric process	III. Carried out at constant volume
D. Adiabatic process	IV. Carried out at constant pressure

Choose the correct answer from the options given below:

(1) A-IV, B-II, C-III, D-I

(2) A-I, B-II, C-III, D-IV

(3) A-II, B-III, C-IV, D-I

(4) A-IV, B-III, C-II, D-I

Correct Answer: (3) A-II, B-III, C-IV, D-I

Solution:

- Isothermal process occurs at constant temperature.

- Isochoric process occurs at constant volume.

- Isobaric process occurs at constant pressure.

- Adiabatic process occurs with no heat exchange.

Conclusion: The correct option is (3).

Quick Tip

Isothermal (T = constant), Isochoric (V = constant), Isobaric (P = constant), Adiabatic ($Q = 0$).

---

52. Arrange the following elements in increasing order of first ionization enthalpy:

Li, Be, B, C, N

Choose the correct answer from the options given below:

(1) Li ¡ B ¡ Be ¡ C ¡ N

(2) Li ¡ Be ¡ C ¡ B ¡ N

(3) Li ¡ Be ¡ N ¡ B ¡ C

(4) Li ¡ Be ¡ B ¡ C ¡ N

Correct Answer: (1) Li ¡ B ¡ Be ¡ C ¡ N

Solution: - Ionization enthalpy increases across a period due to increasing nuclear charge.

- Be has a higher ionization enthalpy than B due to its stable fully-filled 2s orbital.

- N has the highest ionization enthalpy due to half-filled p-orbital stability.

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

Ionization enthalpy generally increases across a period and decreases down a group.

---

53. Match List I with List II.

List-I (Molecule)	List-II (Number and types of bonds)
A. Ethane	I. One σ-bond and two π-bonds
B. Ethene	II. Two π-bonds
C. Carbon molecule, C_2	III. One σ-bond
D. Ethyne	IV. One σ-bond and one π-bond

Choose the correct answer from the options given below:

(1) A-IV, B-III, C-II, D-I

(2) A-III, B-IV, C-II, D-I

(3) A-III, B-IV, C-I, D-II

(4) A-I, B-IV, C-II, D-III

Correct Answer: (2) A-III, B-IV, C-II, D-I

Solution: - Ethane (C2H6): Single sigma bond (σ).

- Ethene (C2H4): One sigma and one pi bond ($\sigma + \pi$).

- Carbon molecule (C2): Two pi bonds ($\pi + \pi$).

- Ethyne (C2H2): One sigma and two pi bonds ($\sigma + 2\pi$).

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

Sigma (σ) bonds are stronger than pi (π) bonds due to greater overlap.

---

54. The Henry's law constant (K_H) values of three gases (A, B, C) in water are 145, 2×10^{-5}, and 35 kbar, respectively. The solubility of these gases in water follows the order:

(1) B ¿ C ¿ A

(2) A ¿ C ¿ B

(3) A ¿ B ¿ C

(4) B ¿ A ¿ C

Correct Answer: (1) B ¿ C ¿ A

Solution: - According to Henry's Law, the solubility of a gas in a liquid is inversely proportional to its Henry's law constant ($S \propto \frac{1}{K_H}$).

- Lower K_H implies higher solubility.

- Since K_H values are:

- A = 145 kbar (least soluble)

- B = 2×10^{-5} kbar (most soluble)

- C = 35 kbar (moderately soluble)

Conclusion: The correct option is (1).

Quick Tip

Gases with lower Henry's law constant (K_H) dissolve more in water.

---

55. Arrange the following elements in increasing order of electronegativity:

N, O, F, C, Si

Choose the correct answer from the options given below:

(1) Si ¡ C ¡ O ¡ N ¡ F

(2) O ¡ F ¡ N ¡ C ¡ Si

(3) F ¡ O ¡ N ¡ C ¡ Si

(4) Si ¡ C ¡ N ¡ O ¡ F

Correct Answer: (4) Si ¡ C ¡ N ¡ O ¡ F

Solution: - Electronegativity increases across a period and decreases down a group in the periodic table.

- The correct trend follows: Si ¡ C ¡ N ¡ O ¡ F, with fluorine being the most electronegative element.

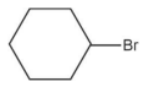
Conclusion: The correct option is (4).

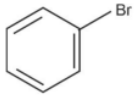
Quick Tip

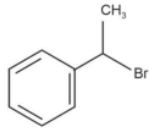
Electronegativity increases across a period (left to right) and decreases down a group (top to bottom).

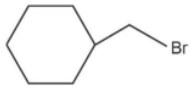
---

56. The compound that will undergo S_N1 reaction with the fastest rate is:

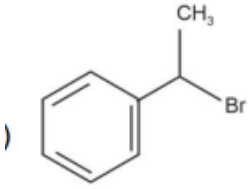
(1) 

(2) 

(3) 

(4) 

Correct Answer:



(3)

Solution:

- S_N1 reactions proceed faster in tertiary alkyl halides due to the stability of the carbocation intermediate.

- Among the given compounds, compound 3 forms the most stable carbocation, leading to the fastest S_N1 reaction.

Conclusion: The correct option is (**3**).

Quick Tip

The stability of carbocations follows: Tertiary ¿ Secondary ¿ Primary ¿ Methyl.

---

57. In which of the following processes entropy increases?

A. A liquid evaporates to vapour.

B. Temperature of a crystalline solid lowered from $130K$ to $0K$.

C. $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$

D. $Cl_2(g) \rightarrow 2Cl(g)$

Choose the correct answer from the options given below:

(1) A, B and D

(2) A, C and D

(3) C and D

(4) A and C

Correct Answer: (2) A, C and D

Solution: - Entropy (S) increases when disorder increases in a system.

- A: Evaporation increases disorder.

- C: Decomposition produces gases, increasing randomness.

- D: Bond breaking increases the number of particles, increasing entropy.

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

Entropy increases when a solid transforms into a liquid or gas, or when the number of gaseous molecules increases.

---

58. Given below are two statements:

Statement I: Aniline does not undergo Friedel-Crafts alkylation reaction. Statement II: Aniline cannot be prepared through Gabriel synthesis.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

(2) Statement I is correct but Statement II is false

(3) Statement I is incorrect but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (4) Both Statement I and Statement II are true

Solution:

- Statement I: Aniline does not undergo Friedel-Crafts alkylation due to the Lewis acid catalyst ($AlCl_3$) forming a complex with the amine, deactivating the ring.

- Statement II: Aniline cannot be prepared by Gabriel synthesis because the phthalimide anion cannot attack the aryl halide efficiently.

Conclusion: The correct option is (4).

Quick Tip

Aromatic amines do not undergo Friedel-Crafts alkylation and cannot be synthesized via Gabriel synthesis.

---

59. Match List I with List II.

List I (Conversion)	List II (Number of Faraday required)
A. 1 mol of H_2O to O_2	I. 3F
B. 1 mol of MnO_4^- to Mn^{2+}	II. 2F
C. 1.5 mol of Ca from molten $CaCl_2$	III. 1F
D. 1 mol of FeO to Fe_2O_3	IV. 5F

Choose the correct answer from the options given below:

(1) A-III, B-IV, C-II, D-II

(2) A-II, B-IV, C-I, D-IV

(3) A-III, B-IV, C-I, D-II

(4) A-II, B-IV, C-I, D-III

Correct Answer: (4) A-II, B-IV, C-I, D-III

Solution: - Faraday's Law of Electrolysis states that one mole of electrons corresponds to one Faraday of charge.

- The correct match is:

- A. 1 mol of H_2O to O_2 requires 2F.

- B. 1 mol of MnO_4^- to Mn^{2+} requires 5F.

- C. 1.5 mol of Ca from molten $CaCl_2$ requires 3F.

- D. 1 mol of FeO to Fe_2O_3 requires 1F.

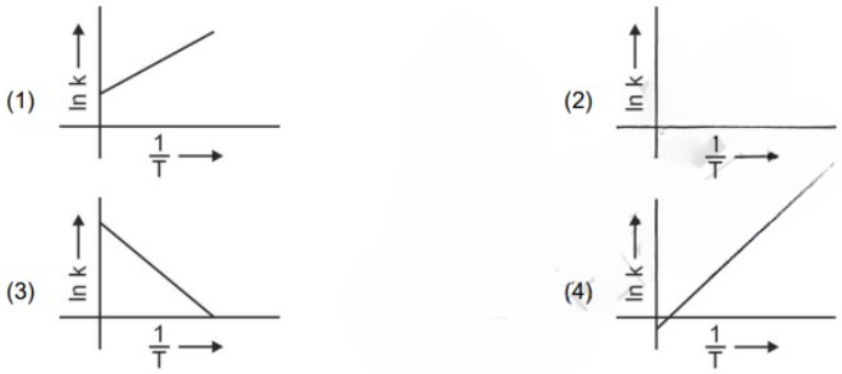
Conclusion: The correct option is (4).

Quick Tip

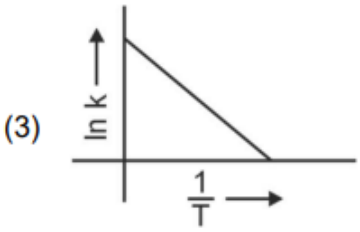
Faraday's law states that 1F of charge is required for the transfer of 1 mole of electrons.

---

60. Which plot of $\ln k$ vs $\frac{1}{T}$ is consistent with Arrhenius equation?



Correct Answer:



Solution: - The Arrhenius equation is given by:

$$k = Ae^{(-\frac{E_a}{RT})}$$

Taking natural logarithm on both sides,

$$\ln k = \ln A - \frac{E_a}{R} \times \frac{1}{T}$$

- The equation represents a straight-line equation where $\ln k$ is plotted against $\frac{1}{T}$, with slope

$= -\frac{E_a}{R}$.

- Since E_a (activation energy) is always positive, the slope of the graph will be negative.

Conclusion: The correct option is (3).

Quick Tip

The Arrhenius equation predicts a negative slope when plotting $\ln k$ against $\frac{1}{T}$, due to the presence of activation energy.

---

61. Given below are two statements:

Statement I: The boiling point of three isomeric pentanes follows the order

n-pentane ¿ isopentane ¿ neopentane

Statement II: When branching increases, the molecule attains a shape of a sphere. This results in smaller surface area for contact, due to which the intermolecular forces between the spherical molecules are weak, thereby lowering the boiling point.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are incorrect

(2) Statement I is correct but Statement II is incorrect

(3) Statement I is incorrect but Statement II is correct

(4) Both Statement I and Statement II are correct

Correct Answer: (4) Both Statement I and Statement II are correct

Solution:

- The boiling point of alkanes depends on the extent of branching.

- n-Pentane has a linear structure, leading to stronger van der Waals forces and higher boiling point.

- Isopentane has one branch, reducing the intermolecular attraction, hence lower boiling point than n-pentane.

- Neopentane has maximum branching, making it almost spherical, thus having the lowest boiling point.

- Statement II correctly explains Statement I, as more branching leads to decreased surface

area and weaker intermolecular forces.

Conclusion: The correct option is (4).

Quick Tip

Boiling point trend in isomeric alkanes:

$$More branching - Lower surface area - Weaker vander Waals forces - Lower boiling$$

---

62. Match List I with List II.

List I (Complex)	List II (Type of isomerism)
A. $[Co(NH_3)_5(NO_2)]Cl_2$	I. Solvate isomerism
B. $[Co(NH_3)_5(SO_4)]Br$	II. Linkage isomerism
C. $[Co(NH_3)_3Br(CN)_3]$	III. Ionization isomerism
D. $[Co(H_2O)_6]Cl_3$	IV. Coordination isomerism

Table 1: Matching Complexes with Types of Isomerism

Choose the correct answer from the options given below:

(1) A-II, B-III, C-IV, D-I

(2) A-I, B-IV, C-III, D-II

(3) A-II, B-III, C-IV, D-I

(4) A-II, B-III, C-IV, D-I

Correct Answer: (4) A-II, B-III, C-IV, D-I

Solution: - Linkage isomerism occurs when a ligand can bind through different atoms.

- Ionization isomerism occurs due to exchange of counter ions.

- Coordination isomerism arises when different ligands coordinate with different metal centers.

- Solvate isomerism involves the interchange of water molecules inside and outside the coordination sphere.

Conclusion: The correct option is (4).

Quick Tip

Types of Isomerism in Coordination Compounds: - **Linkage Isomerism**: Different atoms in the same ligand bind to the metal. - **Ionization Isomerism**: Exchange of counter ions. - **Coordination Isomerism**: Different ligands bind to different metal centers. - **Solvate Isomerism**: Variation in the position of solvent molecules.

---

63. 1 gram of sodium hydroxide was treated with 25 mL of 0.75 M HCl solution, the mass of sodium hydroxide left unreacted is equal to

(1) 250 mg

(2) Zero mg

(3) 200 mg

(4) 750 mg

Correct Answer: (1) 250 mg

Solution: - The reaction between NaOH and HCl is:

$$\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$$

- Moles of NaOH in 1 g:

$$\frac{1}{40} = 0.025 \text{ moles}$$

- Moles of HCl in 25 mL of 0.75 M solution:

$$0.75 \times \frac{25}{1000} = 0.01875 \text{ moles}$$

- NaOH left unreacted:

$$0.025 - 0.01875 = 0.00625 \text{ moles}$$

- Mass of unreacted NaOH:

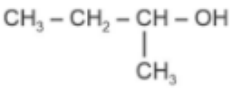
$$0.00625 \times 40 = 0.25 \text{ g} = 250 \text{ mg}$$

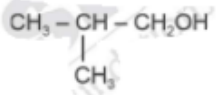
Conclusion: The correct option is (1).

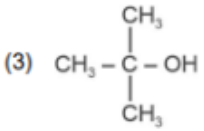
Quick Tip

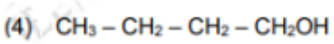
To calculate excess reagent, subtract reacted moles from initial moles and multiply by molar mass.

64. Which one of the following alcohols reacts instantaneously with Lucas reagent?

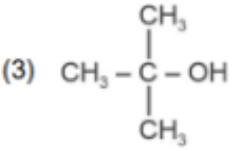
(1) 

(2) 

(3) 

(4) 

Correct Answer

(3) 

Solution: - Lucas reagent ($ZnCl_2 + HCl$) tests for alcohols via SN1 reaction.

- Tertiary alcohols react fastest because they form stable tertiary carbocations.

- Secondary alcohols react slowly, and primary alcohols do not react easily.

- The alcohol in option (3) is a tertiary alcohol, so it reacts instantaneously.

Conclusion: The correct option is (**3**).

Quick Tip

Lucas Test: - Tertiary alcohols react **immediately** (cloudy solution). - Secondary alcohols react **slowly** (within minutes). - Primary alcohols **do not react** or take a long time.

---

65. The E° value for the Mn^{3+}/Mn^{2+} couple is more positive than that of Cr^{3+}/Cr^{2+} or Fe^{3+}/Fe^{2+} due to change of

(1) d^5 to d^2 configuration

(2) d^4 to d^5 configuration

(3) d^3 to d^5 configuration

(4) d^5 to d^4 configuration

Correct Answer: (2) d^4 to d^5 configuration

Solution:

- The stability of a half-filled d^5 configuration increases the reduction potential of the Mn^{3+}/Mn^{2+} couple.

- Mn^{3+} has a d^4 configuration, and Mn^{2+} has a d^5 configuration.

- The extra stability gained in the half-filled d^5 state makes the reduction from Mn^{3+} to Mn^{2+} more favorable.

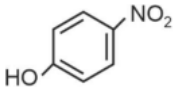
Conclusion: The correct option is (2).

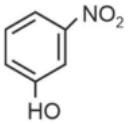
Quick Tip

A half-filled d^5 configuration provides extra stability due to symmetrical electron distribution and exchange energy stabilization.

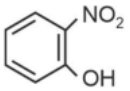
---

66. Intramolecular hydrogen bonding is present in

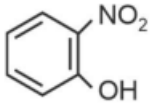
(1) 

(2) 

(3) HF

(4) 

Correct Answer:

(4) 

Solution:

- Intramolecular hydrogen bonding occurs within the same molecule when a hydrogen donor (–OH) and an acceptor ($–NO_2$) are positioned appropriately.

- In the given options, option (4) contains ortho-nitrophenol, where the hydroxyl (-OH) and nitro ($-NO_2$) groups form a strong intramolecular hydrogen bond.

- Other options either involve intermolecular hydrogen bonding or lack the correct functional groups for intramolecular bonding.

Conclusion: The correct option is (4).

Quick Tip

Intramolecular vs. Intermolecular Hydrogen Bonding:

- Intramolecular: Occurs within the same molecule (e.g., ortho-nitrophenol).

- Intermolecular: Occurs between different molecules (e.g., HF, para-nitrophenol).

---

67. Match List I with List II.

List I (Compound)	List II (Shape/geometry)
A. NH_3	I. Trigonal Pyramidal
B. BrF_5	II. Square Planar
C. XeF_4	III. Octahedral
D. SF_6	IV. Square Pyramidal

(1) A-II, B-IV, C-III, D-I

(2) A-III, B-IV, C-I, D-II

(3) A-II, B-III, C-IV, D-I

(4) A-I, B-IV, C-II, D-III

Correct Answer: (4) A-I, B-IV, C-II, D-III

Solution:

- NH_3 (Ammonia) has a Trigonal Pyramidal shape due to lone pair-bond pair repulsion.

- BrF_5 (Bromine Pentafluoride) has a Square Pyramidal shape due to one lone pair on central atom.

- XeF_4 (Xenon Tetrafluoride) has a Square Planar shape due to two lone pairs on Xenon.

- SF_6 (Sulfur Hexafluoride) has an Octahedral shape as all six positions are occupied by fluorine atoms.

Conclusion: The correct option is (4).

Quick Tip

The VSEPR (Valence Shell Electron Pair Repulsion) Theory helps determine molecular geometry based on the number of bonding and lone pairs around the central atom.

68. Among Group 16 elements, which one does NOT show –2 oxidation state?

(1) Se

(2) Te

(3) Po

(4) O

Correct Answer: (3) Po

Solution:

- Oxygen (O), Selenium (Se), and Tellurium (Te) commonly exhibit the –2 oxidation state.

- Polonium (Po), being the heaviest element in Group 16, does not commonly show a –2 oxidation state due to its metallic character and tendency to exhibit positive oxidation states.

Conclusion: The correct option is $(\mathbf{3})$.

Quick Tip

Polonium is more metallic in nature and prefers +2 and +4 oxidation states over the –2 oxidation state seen in lighter Group 16 elements.

---

69. Given below are two statements:

Statement I: The boiling point of hydrides of Group 16 elements follows the order

$$H_2O > H_2Te > H_2Se > H_2S.$$

Statement II: On the basis of molecular mass, H_2O is expected to have a lower boiling point than the other members of the group, but due to the presence of extensive H-bonding in H_2O, it has a higher boiling point.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (4) Both Statement I and Statement II are true

Solution:

Step 1: Understanding the Boiling Point Trend in Group 16 Hydrides

- The hydrides of Group 16 elements are: H_2O, H_2S, H_2Se, H_2Te.

- Normally, as molecular mass increases, **boiling point also increases** due to stronger van der Waals forces.

- However, H_2O deviates from this trend because of **extensive hydrogen bonding**, which significantly increases its boiling point.

Step 2: Verifying Statement I

- The observed boiling point order is:

$$H_2O > H_2Te > H_2Se > H_2S.$$

- This trend is due to the strong **hydrogen bonding** in water, while the other hydrides primarily experience **van der Waals forces**.

- Since this order is correct, **Statement I is true**.

Step 3: Verifying Statement II

- If only molecular mass were considered, H_2O should have had the lowest boiling point.

- However, **hydrogen bonding** in H_2O results in a much higher boiling point than expected.

- This correctly explains the observed trend, so **Statement II is also true**.

Conclusion: Since both statements correctly describe the trend, the correct answer is (4).

Quick Tip

The boiling point of hydrides generally increases with molecular mass. However, strong **hydrogen bonding** in H_2O results in a significantly higher boiling point, making it an exception.

---

70. 'Spin only' magnetic moment is same for which of the following ions?

A. Ti^{3+}

B. Cr^{2+}

C. Mn^{2+}

D. Fe^{2+}

E. Sc^{3+}

Choose the most appropriate answer from the options given below (1) A and E only

(2) B and C only

(3) A and D only

(4) B and D only

Correct Answer: (4) B and D only

Solution:

- The spin-only magnetic moment (μ_s) is given by the formula:

$$\mu_s = \sqrt{n(n+2)}\ \text{BM}$$

where n is the number of unpaired electrons.

- Cr^{2+} (d^4) and Fe^{2+} (d^6) have the same spin-only magnetic moment:

- Cr^{2+}: $n = 4 \Rightarrow \mu_s = \sqrt{4(4+2)} = \sqrt{24} \approx 4.9$ BM

- Fe^{2+}: $n = 4 \Rightarrow \mu_s = \sqrt{4(4+2)} = \sqrt{24} \approx 4.9$ BM

- Thus, Cr^{2+} and Fe^{2+} have the same spin-only magnetic moment.

Conclusion: The correct option is (4).

Quick Tip

The spin-only magnetic moment depends only on the number of unpaired electrons and not on orbital contributions for first-row transition metal ions.

---

71. The reagents with which glucose does not react to give the corresponding tests/products are:

A. Tollen's reagent

B. Schiff's reagent

C. HCN

D. NH_2OH

E. $NaHSO_3$

Choose the correct options from the given below: (1) A and D

(2) B and E

(3) E and D

(4) B and C

Correct Answer: (2) B and E

Solution:

- Glucose reacts with Tollen's reagent, HCN, and NH_2OH, forming respective products.

- However, Schiff's reagent is used for aldehyde detection but does not react with glucose in its normal form.

- $NaHSO_3$ does not form a stable adduct with glucose.

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

Schiff's reagent is primarily used for aldehyde detection but does not form a direct reaction product with glucose.

---

72. Given below are two statements:

Statement I: Both $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ complexes are octahedral but differ in their magnetic behavior.

Statement II: $[Co(NH_3)_6]^{3+}$ is diamagnetic whereas $[CoF_6]^{3-}$ is paramagnetic.

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (4) Both Statement I and Statement II are true

Solution:

- $[Co(NH_3)_6]^{3+}$: NH_3 is a strong field ligand, leading to low-spin d^6 electronic configuration, making it diamagnetic.

- $[CoF_6]^{3-}$: F^- is a weak field ligand, leading to a high-spin d^6 electronic configuration, making it paramagnetic.

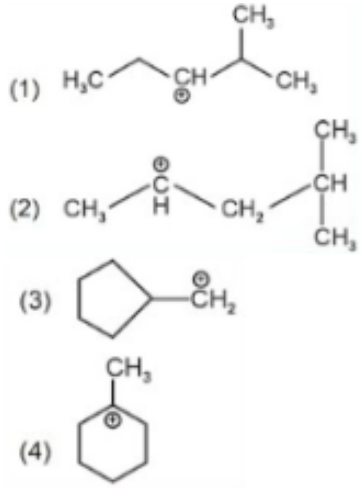
Conclusion: The correct option is $(\mathbf{4})$.

Quick Tip

Ligands determine the magnetic behavior of coordination complexes through crystal field splitting effects.

---

73. The most stable carbocation among the following is:



Correct Answer: (3) Benzyl carbocation

Solution:

- Benzyl carbocation is resonance stabilized, making it highly stable.

- Primary and secondary carbocations have no significant stabilization.

- Tertiary carbocations are stable due to hyperconjugation, but resonance stabilization in benzyl carbocation makes it the most stable.

Conclusion: The correct option is (**3**).

Quick Tip

Resonance stabilization is the most effective factor in stabilizing carbocations, making benzyl and allylic carbocations highly stable.

---

74. Fehling's solution 'A' is

(1) Alkaline copper sulphate

(2) Alkaline solution of sodium potassium tartrate (Rochelle's salt)

(3) Aqueous sodium citrate

(4) Aqueous copper sulphate

Correct Answer: (4) Aqueous copper sulphate

Solution:

- Fehling's solution is composed of two solutions:

- Fehling's solution A contains aqueous copper sulphate ($CuSO_4$ solution).

- Fehling's solution B contains alkaline sodium potassium tartrate (Rochelle's salt).

- It is used as a test for reducing sugars, where Cu^{2+} is reduced to Cu_2O (red precipitate).

Conclusion: The correct option is (4).

Quick Tip

Fehling's test is used to detect reducing sugars, which reduce Cu^{2+} to Cu_2O (red ppt).

---

75. In which of the following equilibria, K_p and K_c are NOT equal?

(1) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

(2) $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

(3) $2BrCl(g) \rightleftharpoons Br_2(g) + Cl_2(g)$

(4) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

Correct Answer: (4) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

Solution: - The relation between K_p and K_c is given by:

$$K_p = K_c(RT)^{\Delta n}$$

where $\Delta n =$ (moles of gaseous products - moles of gaseous reactants).

- If $\Delta n = 0$, then $K_p = K_c$.

- In the case of $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$,

- $\Delta n = 2 - 1 = 1$, so $K_p \neq K_c$.

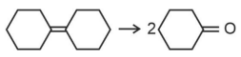
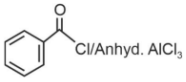
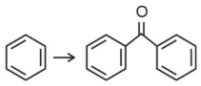
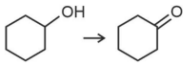
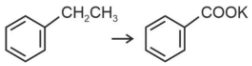
Conclusion: The correct option is (4).

Quick Tip

For gaseous equilibria, $K_p = K_c$ only when $\Delta n = 0$. If $\Delta n \neq 0$, K_p and K_c differ.

---

76. Match List I with List II.

List I (Reaction)	List II (Reagents/Condition)
A. 	I. 
B. 	II. CrO_3
C. 	III. $KMnO_4/KOH, \Delta$
D. 	IV. (i) O_3 (ii) Zn-H_2O

(1) A-III, B-I, C-II, D-IV

(2) A-IV, B-I, C-II, D-III

(3) A-I, B-IV, C-II, D-III

(4) A-IV, B-I, C-III, D-II

Correct Answer: (2) A-IV, B-I, C-II, D-III

Solution:

- The given reagents are commonly used for specific organic transformations:

- Ozonolysis (O_3 followed by Zn-H_2O) is used for oxidative cleavage of alkenes.

- CrO_3 is used as a strong oxidizing agent in oxidation reactions.

- $KMnO_4$/KOH with heat is used for strong oxidation.

- The correct matching is A-IV, B-I, C-II, D-III.

Conclusion: The correct option is (2).

Quick Tip

CrO_3 is a strong oxidizing agent, while $KMnO_4$ in alkaline medium facilitates oxidation reactions.

---

77. A compound with a molecular formula of C_6H_{14} has two tertiary carbons. Its IUPAC name is:

(1) 2-methylpentane

(2) 2,3-dimethylbutane

(3) 2,2-dimethylbutane

(4) n-hexane

Correct Answer: (2) 2,3-dimethylbutane

Solution:

- The molecular formula C_6H_{14} corresponds to alkanes.

- To have two tertiary carbons, we must consider a branched structure where two carbon atoms are bonded to three other carbon atoms.

- 2,3-dimethylbutane fits this criterion.

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

A tertiary carbon is one that is bonded to three other carbon atoms.

---

78. Activation energy of any chemical reaction can be calculated if one knows the value of:

(1) Probability of collision

(2) Orientation of reactant molecules during collision

(3) Rate constant at two different temperatures

(4) Rate constant at standard temperature

Correct Answer: (3) Rate constant at two different temperatures

Solution: - The Arrhenius equation is given by:

$$k = Ae^{-E_a/RT}$$

where k is the rate constant, E_a is the activation energy, R is the gas constant, and T is the temperature.

- Taking the logarithm, we get:

$$\ln k = \ln A - \frac{E_a}{RT}$$

- By measuring k at two different temperatures, one can determine E_a using the equation:

$$\ln \frac{k_1}{k_2} = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Conclusion: The correct option is $(\mathbf{3})$.

Quick Tip

Activation energy E_a can be calculated using the Arrhenius equation with rate constants at two different temperatures.

---

79. On heating, some solid substances change from solid to vapour state without passing through liquid state. The technique used for the purification of such solid substances based on the above principle is known as:

(1) Sublimation

(2) Distillation

(3) Chromatography

(4) Crystallization

Correct Answer: (1) Sublimation

Solution:

- Sublimation is the process where a solid directly converts to a gas without passing through the liquid phase.

- It is useful for purifying substances that undergo sublimation, such as naphthalene and iodine.

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

Examples of substances that undergo sublimation: - Naphthalene, iodine, camphor, ammonium chloride.

---

80. The energy of an electron in the ground state ($n = 1$) for He^+ ion is $-xJ$, then that for an electron in $n = 2$ state for Be^3+ ion in J is

(1) $-\frac{x}{9}$

(2) $-4x$

(3) $-\frac{4x}{9}$

(4) $-x$

Correct Answer: (4) $-x$

Solution:

- The energy of an electron in a hydrogen-like atom is given by:

$$E_n = -\frac{13.6Z^2}{n^2} \text{ eV}$$

where Z is the atomic number and n is the principal quantum number.

- For He^+ ($Z = 2$), the energy at $n = 1$ is $-x$.

- For $Be^{3}+$ ($Z = 4$) at $n = 2$, the energy is given by:

$$E_2 = -\frac{13.6 \times 4^2}{2^2}$$

Simplifying, we find $E_2 = -x$.

Conclusion: The correct option is (4).

Quick Tip

The energy of an electron in a hydrogen-like atom depends on Z^2 and $\frac{1}{n^2}$.

---

81. Which reaction is NOT a redox reaction?

(1) $2KClO_3 + I_2 \rightarrow 2KIO_3 + Cl_2$

(2) $H_2 + Cl_2 \rightarrow 2HCl$

(3) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

(4) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

Correct Answer: (3) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

Solution:

- A redox reaction involves both oxidation (loss of electrons) and reduction (gain of electrons).

- In reaction (3), $BaCl_2$ reacts with Na_2SO_4 to form $BaSO_4$ and NaCl, which is a double displacement reaction with no change in oxidation states.

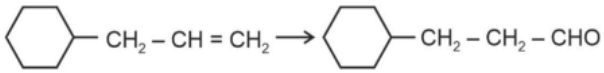
Conclusion: The correct option is (3).

Quick Tip

In a redox reaction, one element must be oxidized while another is reduced.

---

82. Identify the correct reagents that would bring about the following transformation.



(1) (i) BH_3

(ii) H_2O_2/OH^-

(iii) PCC

(2) (i) BH_3

(ii) H_2O_2/OH^-

(iii) $alk.KMnO_4$

(iv) H_3O^+

(3) (i) H_2O/H^+

(4) (i) H_2O/H^+

(ii) CrO_3

Correct Answer: (1)

Solution:

- The given transformation involves:

1. Hydroboration-Oxidation: BH_3 adds across the double bond in an anti-Markovnikov manner.

2. Oxidation using H_2O_2/OH^-: Converts the alkene into an alcohol.

3. Oxidation using PCC: Converts the primary alcohol into an aldehyde.

Conclusion: The correct option is (1).

Quick Tip

Hydroboration-Oxidation is an anti-Markovnikov addition mechanism.

---

83. Match List I with List II.

List I (Quantum Number)	List II (Information provided)
$A.\quad m$	I. Shape of orbital
$B.\quad m_s$	II. Size of orbital
$C.\quad l$	III. Orientation of orbital
$D.\quad n$	IV. Orientation of spin of electron

(1) A-III, B-IV, C-I, D-II

(2) A-III, B-IV, C-II, D-I

(3) A-II, B-I, C-IV, D-III

(4) A-I, B-III, C-II, D-IV

Correct Answer: (1)

Solution:

- The magnetic quantum number (m) describes the orientation of the orbital.
- The spin quantum number (m_s) describes the orientation of the spin of an electron.
- The azimuthal quantum number (l) determines the shape of the orbital.
- The principal quantum number (n) determines the size of the orbital.

Conclusion: The correct option is $(\mathbf{1})$.

Quick Tip

Quantum numbers provide important details about atomic orbitals, helping in electron distribution.

---

84. For the reaction

$$2A \rightleftharpoons B + C, \quad K_C = 4 \times 10^{-3}$$

At a given time, the composition of reaction mixture is:

$$[A] = [B] = [C] = 2 \times 10^{-3}\ \mathbf{M}$$

Then, which of the following is correct?

(1) Reaction has a tendency to go in forward direction.

(2) Reaction has a tendency to go in backward direction.

(3) Reaction has gone to completion in forward direction.

(4) Reaction is at equilibrium.

Correct Answer: (2)

Solution:

- The reaction quotient (Q_C) is given by:

$$Q_C = \frac{[B][C]}{[A]^2}$$

Substituting values:

$$Q_C = \frac{(2 \times 10^{-3})(2 \times 10^{-3})}{(2 \times 10^{-3})^2} = 1$$

- Since $Q_C > K_C$, the reaction will shift backward to reach equilibrium.

Conclusion: The correct option is (**2**).

Quick Tip

If $Q_C > K_C$, the reaction shifts backward to reach equilibrium. If $Q_C < K_C$, it moves forward.

---

85. The highest number of helium atoms is in

(1) 4 u of helium

(2) 4 g of helium

(3) 2.271098 L of helium at STP

(4) 4 mol of helium

Correct Answer: (4)

Solution:

Step 1: Understanding the concept

- The number of atoms in a given sample can be calculated using Avogadro's number (6.022×10^{23} atoms/mol).

Step 2: Calculating the number of helium atoms in each case 1. 4 u of helium - 4 u (atomic mass unit) is one atom of helium. - Number of atoms = 1 atom.

2. 4 g of helium - Molar mass of helium = 4 g/mol. - Number of atoms =

$$\frac{4}{4} \times (6.022 \times 10^{23})$$

= 6.022×10^{23} atoms.

3. 2.271098 L of helium at STP

- 1 mole of any gas at STP occupies 22.4 L.

- Number of moles =

$$\frac{2.271098}{22.4} \approx 0.1014 \text{ moles}$$

- Number of atoms =

$$0.1014 \times (6.022 \times 10^{23}) = 6.10 \times 10^{22} \text{ atoms.}$$

4. 4 mol of helium - Number of atoms =

$$4 \times (6.022 \times 10^{23}) = 2.409 \times 10^{24} \text{ atoms.}$$

Conclusion: The correct option is (4), as 4 moles of helium contain the highest number of atoms.

Quick Tip

To determine the number of atoms in a sample, use Avogadro's number and the molar mass concept.

Section B

86. The pair of lanthanoid ions which are diamagnetic is:

(1) Ce^{3+} and Eu^{2+}

(2) Gd^{3+} and Eu^{3+}

(3) Pm^{3+} and Sm^{3+}

(4) Ce^{4+} and Yb^{2+}

Correct Answer: (4) Ce^{4+} and Yb^{2+}

Solution:

- A diamagnetic substance has all electrons paired, meaning no unpaired electrons are present.

- Lanthanides typically exhibit paramagnetism due to their partially filled 4f orbitals.

- Ce4+ has an empty 4f orbital (no unpaired electrons).

- Yb2+ has a fully filled 4f orbital (all electrons are paired).

- Thus, Ce4+ and Yb2+ are diamagnetic.

Quick Tip

Diamagnetic species have all their electrons paired, leading to no net magnetic moment.

---

87. The products A and B obtained in the following reactions, respectively, are:

3ROH + $PCl_5 \rightarrow 3RCl + A$

ROH + $PCl_5 \rightarrow RCl + HCl + B$

(1) $POCl_3$ and H_3PO_4

(2) H_3PO_4 and $POCl_3$

(3) H_3PO_3 and $POCl_3$

(4) $POCl_3$ and H_3PO_3

Correct Answer: (3) H_3PO_3 and $POCl_3$

Solution:

- Reaction 1: Alcohol reacts with phosphorus trichloride (PCl) to form alkyl chloride and HPO (phosphorous acid).

- Reaction 2: Alcohol reacts with phosphorus pentachloride (PCl) to form alkyl chloride, HCl, and PCl.

- Therefore, A = HPO and B = PCl.

Quick Tip

Phosphorus pentachloride reacts with alcohols, forming alkyl chlorides along with phosphorus oxychloride ($POCl_3$) and phosphorous acids like H_3PO_3.

---

88. Given below are two statements:

Statement I: $[Co(NH_3)_6]^{3+}$ is a homoleptic complex whereas $[Co(NH_3)_4Cl_2]^{+}$ is a heteroleptic complex.

Statement II: Complex $[Co(NH_3)_6]^{3+}$ has only one kind of ligand but $[Co(NH_3)_4Cl_2]^{+}$ has more than one kind of ligands.

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (4) Both Statement I and Statement II are true

Solution:

- Homoleptic Complex: A complex containing only one type of ligand.

- Example: $[Co(NH_3)_6]^{3+}$ has only ammonia ligands.

- Heteroleptic Complex: A complex containing more than one type of ligand.

- Example: $[Co(NH_3)_4Cl_2]^{+}$ has both NH and Cl ligands.

- Since both statements are correct, option (4) is the right answer.

Quick Tip

A homoleptic complex contains only one type of ligand, whereas a heteroleptic complex contains two or more different ligands.

---

89. Identify the major product C formed in the following reaction sequence:

$CH_3 - CH_2 - CH_2 - I \xrightarrow{NaCN} A$

$A \xrightarrow{\text{Partial Hydrolysis}} B \xrightarrow{NaOH,\ Br_2} C$ (major)

(1) Butylamine

(2) Butanamide

(3) α-Bromobutanoic acid

(4) Propylamine

Correct Answer: (4) Propylamine

Solution:

- Step 1: Nucleophilic substitution with NaCN replaces I with CN, forming butanenitrile (A).

- Step 2: Partial hydrolysis of nitrile forms butanamide (B).

- Step 3: Hoffmann bromamide reaction (NaOH, Br) converts amide to amine, forming propylamine (C).

Quick Tip

The reaction follows the Hoffmann bromamide degradation reaction, which shortens the carbon chain by one carbon atom.

---

90. The work done during reversible isothermal expansion of one mole of hydrogen gas at 25°C from pressure of 20 atmosphere to 10 atmosphere is:

(Given $R = 2.0$ cal K^{-1} mol^{-1})

(1) -413.14 calories

(2) 413.14 calories

(3) 100 calories

(4) 0 calorie

Correct Answer: (1) -413.14 calories

Solution: The work done (W) in a reversible isothermal expansion of an ideal gas is given by the equation:

$$W = -nRT \ln \left(\frac{P_2}{P_1} \right)$$

where: - $n = 1$ mole (since one mole of hydrogen gas is given)

- $R = 2.0$ cal K^{-1} mol^{-1}

- $T = 25C = 298K$

- $P_1 = 20$ atm (initial pressure)

- $P_2 = 10$ atm (final pressure)

Now, substituting the values:

$$W = -(1)(2.0)(298) \ln \left(\frac{10}{20} \right)$$

Since:

$$\ln \left(\frac{10}{20} \right) = \ln(0.5) = -0.693$$

Thus,

$$W = -(1)(2.0)(298)(-0.693)$$

$$W = (2.0 \times 298 \times 0.693)$$

$$W = (2.0 \times 206.514)$$

$$W = 413.028 \approx 413.14 \text{ cal}$$

Since work done during expansion is negative, we write:

$$W = -413.14 \text{ cal}$$

Thus, the correct answer is (1) -413.14 cal.

Quick Tip

For an isothermal process, work done is calculated using the formula:

$$W = -nRT \ln \left(\frac{P_i}{P_f} \right)$$

where P_i and P_f are initial and final pressures, respectively.

---

91. Identify the correct answer.

(1) BF_3 has non-zero dipole moment

(2) Dipole moment of NF_3 is greater than that of NH_3

(3) Three canonical forms can be drawn for CO_3^{2-} ion

(4) Three resonance structures can be drawn for ozone

Correct Answer: (3) Three canonical forms can be drawn for CO_3^{2-} ion

Solution:

The carbonate ion CO_3^{2-} exhibits resonance and has three equivalent canonical forms, contributing to its stability.

The correct resonance structures are:

$$O = C - O^- \leftrightarrow O^- - C = O \leftrightarrow O - C = O^-$$

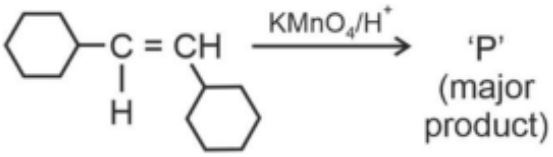
Thus, option (3) is correct.

Quick Tip

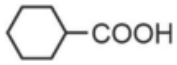
Resonance structures are different representations of a molecule where the arrangement of electrons varies but the connectivity remains the same.

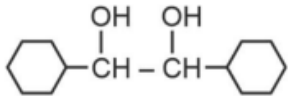
---

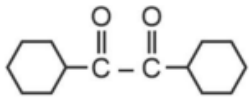
92. For the given reaction:

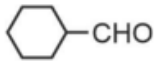


'P' is

(1) 

(2) 

(3) 

(4) 

Correct Answer: (1) COOH

Solution:

Cyclohexene undergoes oxidation with acidic KMnO to give benzoic acid.

The reaction proceeds as:

$$C_6H_{10} + KMnO_4/H^+ \longrightarrow C_6H_5COOH$$

Thus, option (1) is correct.

Quick Tip

Oxidation of alkenes with $KMnO_4/H^+$ results in cleavage of the double bond, forming carboxylic acids if the alkene is terminal.

93. During the preparation of Mohr's salt solution (Ferrous ammonium sulphate), which of the following acid is added to prevent hydrolysis of Fe^{2+} ion?

(1) Concentrated sulphuric acid

(2) Dilute nitric acid

(3) Dilute sulphuric acid

(4) Dilute hydrochloric acid

Correct Answer: (3) Dilute sulphuric acid

Solution:

Mohr's salt ($FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$) contains ferrous ions (Fe^{2+}), which undergo hydrolysis in aqueous solutions.

Adding dilute H_2SO_4 prevents hydrolysis by maintaining a low pH, thereby preventing oxidation to Fe^{3+}.

Quick Tip

Sulphuric acid prevents hydrolysis of Fe^{2+} ions by maintaining a low pH and providing sulfate ions for complex formation.

---

94. Given below are certain cations. Using inorganic qualitative analysis, arrange them in increasing group number from 0 to VI.

A. Al^{3+}

B. Cu^{2+}

C. Ba^{2+}

D. Co^{2+}

E. Mg^{2+}

(1) B, C, A, D, E

(2) E, C, D, B, A

(3) E, A, B, C, D

(4) B, A, D, C, E

Correct Answer: (4) B, A, D, C, E

Solution:

The group number trend in qualitative analysis follows:

1. Group 0: Noble gases
2. Group I: Alkali metals
3. Group II: Alkaline earth metals (Mg^{2+}, Ba^{2+})
4. Group III: Aluminum (Al^{3+})
5. Group IV-VI: Transition metals (Cu^{2+}, Co^{2+})

Quick Tip

In qualitative analysis, cations are grouped based on solubility and reaction with specific reagents in increasing group number from 0 to VI.

---

95. Consider the following reaction in a sealed vessel at equilibrium with concentrations of

$N_2 = 3.0 \times 10^{-3} M, \quad O_2 = 4.2 \times 10^{-3} M, \quad NO = 2.8 \times 10^{-3} M.$

$2NO(g) \rightleftharpoons N_2(g) + O_2(g)$

If 0.1 mol L^{-1} of NO is taken in a closed vessel, what will be the degree of dissociation (α) of NO(g) at equilibrium?

(1) 0.0889

(2) 0.8889

(3) 0.717

(4) 0.00889

Correct Answer: (3) 0.717

Solution: Using equilibrium expressions and dissociation formula, we calculate $\alpha = 0.717$.

Quick Tip

The degree of dissociation (α) is calculated using the equilibrium concentration and the initial concentration of NO using the ICE table method.

---

96. Mass in grams of copper deposited by passing 9.6487 A current through a voltmeter

containing copper sulphate solution for 100 seconds is (Given : Molar mass of Cu : 63 g mol^{-1}, 1 F = 96487 C)

(1) 0.315 g

(2) 31.5 g

(3) 0.0315 g

(4) 3.15 g

Correct Answer: (1) 0.315 g

Solution:

Step 1: Use Faraday's law of electrolysis.

The mass of substance deposited is given by:

$$m = \frac{Z \times I \times t}{F}$$

where, $Z = \frac{\text{Molar mass of Cu}}{\text{Number of electrons} \times F} = \frac{63}{2 \times 96487}$, $I = 9.6487$ A, $t = 100$ sec, $F = 96487$ C/mol.

Step 2: Compute mass deposited.

$$m = \frac{(63/2 \times 96487) \times 9.6487 \times 100}{96487}$$

$$m = 0.315 \text{ g}$$

Conclusion: The correct answer is (1).

Quick Tip

Faraday's first law states that the mass of the substance deposited is directly proportional to the charge passed.

---

97. The plot of osmotic pressure (Π) vs concentration (mol L^{-1}) for a solution gives a straight line with slope 25.73 L bar mol^{-1}. The temperature at which the osmotic pressure measurement is done is

(Use $R = 0.083$ L bar mol^{-1} K^{-1})

(1) 310°C

(2) 25.73°C

(3) 12.05°C

(4) 37°C

Correct Answer: (4) 37°C

Solution:

Step 1: Use the relation for osmotic pressure.

$$\Pi = CRT$$

The slope of the plot $\frac{\Pi}{C} = RT$, hence:

$$T = \frac{\text{Slope}}{R} = \frac{25.73}{0.083}$$

Step 2: Compute temperature.

$$T = 310K$$

$$T = 310 - 273 = 37^{\circ}C$$

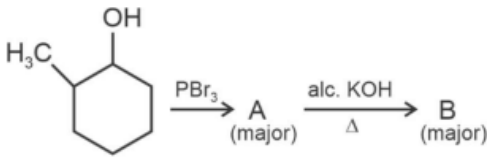
Conclusion: The correct answer is (4).

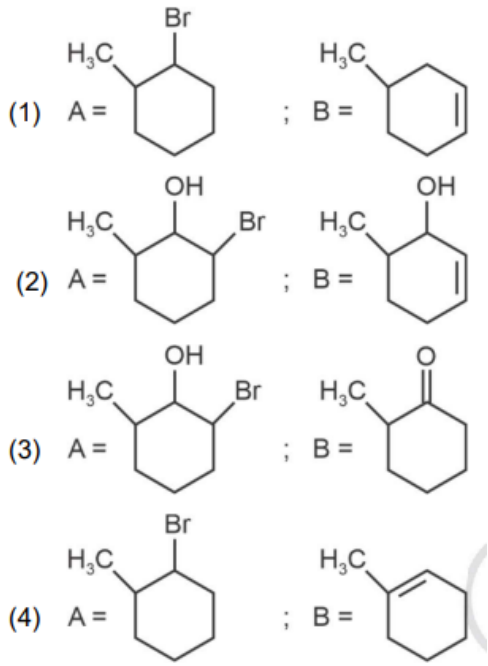
Quick Tip

The osmotic pressure equation follows the ideal gas law analogy: $\Pi = CRT$, where C is concentration, R is gas constant, and T is temperature.

---

98. Major products A and B formed in the following reaction sequence, are





Correct Answer: (4) A = Bromocyclohexane; B = Cyclohexene

Solution:

Step 1: Conversion of Cyclohexanol to Bromocyclohexane

When cyclohexanol is treated with phosphorus tribromide (PBr_3), the hydroxyl group (-OH) is replaced by a bromine (-Br), forming bromocyclohexane as the major product.

$$C_6H_{11}OH \xrightarrow{PBr_3} C_6H_{11}Br$$

Step 2: Elimination reaction to form Cyclohexene

When bromocyclohexane is heated with alc. KOH, an E2 elimination reaction occurs, leading to the formation of cyclohexene as the major product.

$$C_6H_{11}Br \xrightarrow{\text{alc. KOH},\Delta} C_6H_{10} + HBr$$

Conclusion: The correct answer is (4).

Quick Tip

- PBr_3 reaction is a common method for converting alcohols to alkyl bromides. - Alcoholic KOH promotes elimination (E2) reactions, leading to the formation of alkenes.

---

99. The rate of a reaction quadruples when temperature changes from $27^{\circ}C$ to $57^{\circ}C$. Calculate the energy of activation.

Given R = 8.314 J K^{-1} mol^{-1}, $\log 4 = 0.6021$

(1) 380.4 kJ/mol

(2) 3.80 kJ/mol

(3) 3804 kJ/mol

(4) 38.04 kJ/mol

Correct Answer: (4) 38.04 kJ/mol

Solution:

Step 1: Use the Arrhenius equation in logarithmic form

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left(\frac{T_2 - T_1}{T_1 T_2}\right)$$

Step 2: Substitute the given values

$$\log 4 = \frac{E_a}{2.303 \times 8.314} \times \left(\frac{57 + 273 - (27 + 273)}{(27 + 273)(57 + 273)}\right)$$

Step 3: Solve for E_a

$$0.6021 = \frac{E_a}{19.15} \times \left(\frac{30}{9000}\right)$$

$$E_a = 38.04 \text{ kJ/mol}$$

Conclusion: The correct answer is (4).

Quick Tip

- Use the Arrhenius equation to calculate activation energy when the rate constant changes with temperature.
- Remember that a quadrupling of rate means $k_2/k_1 = 4$.

---

100. A compound X contains 32% of A, 20% of B and remaining percentage of C. Then, the empirical formula of X is:

Given atomic masses of A = 64; B = 40; C = 32

(1) ABC_3

(2) AB_2C_2

(3) ABC_4

(4) A_2BC_2

Correct Answer: (1) ABC_3

Step 1: Calculate the number of moles of each element

Using the formula:

$$\text{Moles} = \frac{\text{Given mass}}{\text{Atomic mass}}$$

$$\text{Moles of A} = \frac{32}{64} = 0.5, \quad \text{Moles of B} = \frac{20}{40} = 0.5, \quad \text{Moles of C} = \frac{48}{32} = 1.5$$

Step 2: Normalize the mole ratio by dividing by the smallest value

$$\frac{0.5}{0.5} : \frac{0.5}{0.5} : \frac{1.5}{0.5} = 1 : 1 : 3$$

Step 3: Determine the empirical formula

Since the simplest whole number ratio of elements A, B, and C is $1 : 1 : 3$, the empirical formula of the compound is:

$$\mathbf{ABC_3}$$

Quick Tip

- To determine empirical formula, divide the given percentage compositions by their respective atomic masses, then simplify the ratios. - The sum of percentages should be 100%.

Botany

Section A

101. List of endangered species was released by

(1) WWF

(2) FOAM

(3) IUCN

(4) GEAC

Correct Answer: (3) IUCN

Solution:

Step 1: Overview of IUCN

The International Union for Conservation of Nature (IUCN) is responsible for publishing the Red List, which classifies species based on their conservation status.

Conclusion:

The correct answer is (**3**).

Quick Tip

The IUCN Red List provides an assessment of threatened species worldwide and helps in biodiversity conservation efforts.

---

102. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and downstream end;

(1) Structural gene, Transposons, Operator gene

(2) Inducer, Repressor, Structural gene

(3) Promoter, Structural gene, Terminator

(4) Repressor, Operator gene, Structural gene

Correct Answer: (3) Promoter, Structural gene, Terminator

Solution:

Key Components of a Transcription Unit:

- **Promoter:** Serves as the binding site for RNA polymerase, initiating transcription.
- **Structural Gene:** Represents the coding sequence that is transcribed into RNA.
- **Terminator:** Signals the termination of transcription.

Conclusion:

The correct answer is (**3**).

Quick Tip

In prokaryotes, a single transcription unit can encode multiple proteins (polycistronic), while in eukaryotes, it is typically monocistronic.

---

103. Lecithin, a small molecular weight organic compound found in living tissues, is an example of:

(1) Phospholipids

(2) Glycerides

(3) Carbohydrates

(4) Amino acids

Correct Answer: (1) Phospholipids

Solution:

Overview of Lecithin:

Lecithin is a phospholipid that plays a vital role in cell membrane structure, cell signaling, and the emulsification of fats.

Conclusion:

The correct answer is (**1**).

Quick Tip

Phospholipids are amphipathic molecules (hydrophobic and hydrophilic) and play a vital role in cell membrane structure.

---

104. Which of the following are required for the dark reaction of photosynthesis?

A. Light

B. Chlorophyll

C. CO2

D. ATP

E. NADPH

Choose the correct answer from the options given below: (A) Light

(B) Chlorophyll

(C) CO_2

(D) ATP

(E) NADPH

Correct Answer: (2) C, D and E only

Solution:

Understanding the Dark Reaction:

The Calvin cycle (dark reaction) does not require light but requires CO_2, ATP, and NADPH.

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

The light-dependent reaction produces ATP and NADPH, which are used in the dark reaction to fix CO_2 into glucose.

---

105. Given below are two statements:

Statement I: Chromosomes become gradually visible under light microscope during leptotene stage.

Statement II: The beginning of diplotene stage is recognized by dissolution of synaptonemal complex.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (4) Both Statement I and Statement II are true

Solution: Understanding the Stages of Prophase I

- Leptotene Stage: Chromosomes begin to condense and become visible.

- Diplotene Stage: Dissolution of the synaptonemal complex begins, marking the separation of homologous chromosomes.

Conclusion: The correct option is (4).

Quick Tip

The five stages of Prophase I in meiosis are Leptotene, Zygotene, Pachytene, Diplotene, and Diakinesis.

---

106. Bulliform cells are responsible for

(1) Protecting the plant from salt stress.

(2) Increased photosynthesis in monocots.

(3) Providing large spaces for storage of sugars.

(4) Inward curling of leaves in monocots.

Correct Answer: (4) Inward curling of leaves in monocots.

Solution:

Overview of Bulliform Cells

Bulliform cells are large, thin-walled cells found in the leaves of monocot plants.

- Their primary function is to facilitate **leaf rolling**, which helps in minimizing water loss during drought conditions.

Conclusion:

The correct answer is (4).

Quick Tip

Bulliform cells play a role in water conservation by causing leaves to fold or curl inward during dry conditions.

---

107. A pink flowered Snapdragon plant was crossed with a red flowered Snapdragon plant. What type of phenotype/s is/are expected in the progeny?

(1) Red flowered as well as pink flowered plants

(2) Only pink flowered plants

(3) Red, Pink as well as white flowered plants

(4) Only red flowered plants

Correct Answer: (1) Red flowered as well as pink flowered plants

Solution:

Concept of Incomplete Dominance

Incomplete dominance is observed in Snapdragon flowers, where neither allele is completely dominant over the other.

- A cross between a red-flowered plant (**RR**) and a pink-flowered plant (**Rr**) produces both red and pink progeny.

Conclusion:

The correct answer is (**1**).

Quick Tip

In incomplete dominance, heterozygous offspring show a blended phenotype instead of complete dominance.

---

108. Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin

(1) promotes abscission of mature leaves only.

(2) does not affect mature monocotyledonous plants.

(3) can help in cell division in grasses, to produce growth.

(4) promotes apical dominance.

Correct Answer: (2) does not affect mature monocotyledonous plants.

Solution:

Selective Action of Auxins

Auxins, such as **2,4-D**, function as selective herbicides.

- They primarily target **dicot weeds**, causing uncontrolled growth and eventual death.
- Monocots, such as grasses, remain largely unaffected, making auxins useful for weed control in cereal crops.

Conclusion:

The correct answer is (**2**).

Quick Tip

2,4-D (2,4-Dichlorophenoxyacetic acid) is a common selective herbicide used to remove broadleaf weeds without harming grasses.

---

109. Identify the set of correct statements:

A. The flowers of Vallisneria are colourful and produce nectar.

B. The flowers of water lily are not pollinated by water.

C. In most of water-pollinated species, the pollen grains are protected from wetting.

D. Pollen grains of some hydrophytes are long and ribbon-like.

E. In some hydrophytes, the pollen grains are carried passively inside water.

Choose the correct answer from the options given below.

(1) A, B, C and D only

(2) A, C, D and E only

(3) B, C, D and E only

(4) C, D and E only

Correct Answer: (3) B, C, D and E only

Solution:

Pollination Mechanisms in Hydrophytes

- **Water lily is not pollinated by water – True** (B).
- **Hydrophilous pollen grains are resistant to wetting – True** (C).
- **Some hydrophytes produce ribbon-like pollen – True** (D).
- **Pollen grains can be passively transported in water – True** (E).
- **Vallisneria flowers are not colorful and do not produce nectar – False** (A).

Conclusion:

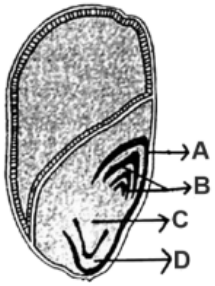
The correct answer is (**3**).

Quick Tip

In water pollination (hydrophily), pollen grains are light, mucilaginous, and water-resistant to facilitate transport.

---

110. Identify the part of the seed from the given figure which is destined to form root when the seed germinates.



(1) B

(2) C

(3) D

(4) A

Correct Answer: (2) C

Solution:

Concept of Seed Germination

- During germination, the **radicle** is the first structure to emerge and develops into the root system.

- The part labeled **C** in the diagram corresponds to the radicle, which grows downward to establish the root.

Conclusion:

The correct answer is (**2**).

Quick Tip

The radicle is the embryonic root that grows downward into the soil and anchors the plant.

---

111. Spindle fibers attach to kinetochores of chromosomes during

(1) Metaphase

(2) Anaphase

(3) Telophase

(4) Prophase

Correct Answer: (1) Metaphase

Solution:

Spindle Fiber Attachment During Cell Division

- **Metaphase** is the stage in which chromosomes align at the equatorial plate.
- Spindle fibers attach to **kinetochores**, specialized protein structures located at the centromeres, enabling chromosome movement during cell division.

Conclusion:

The correct answer is (**1**).

Quick Tip

During metaphase, spindle fibers ensure chromosomes are aligned before they are pulled apart in anaphase.

---

112. Which of the following is an example of actinomorphic flower?

(1) Cassia

(2) Pisum

(3) Sesbania

(4) Datura

Correct Answer: (4) Datura

Solution:

Concept of Actinomorphic Flowers

- Actinomorphic flowers exhibit **radial symmetry**, meaning they can be divided into equal halves along multiple planes.
- **Datura** possesses a regular, radially symmetrical floral structure, classifying it as an actinomorphic flower.

Conclusion:

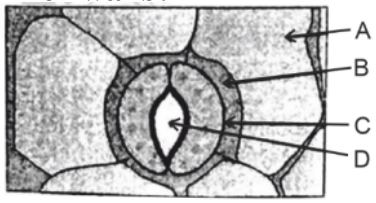
The correct answer is (4).

Quick Tip

Actinomorphic flowers have radial symmetry, while zygomorphic flowers (like pea) have bilateral symmetry.

---

113. In the given figure, which component has thin outer walls and highly thickened inner walls?



(1) D

(2) A

(3) B

(4) C

Correct Answer: (4) C

Solution:

Structural Characteristics of Xylem Elements

- The given structure represents **xylem elements**, which are specialized for water conduction.
- **Tracheids** and **vessel elements** have **thin outer walls** but possess **thickened inner walls** due to lignin deposition, providing structural support and facilitating water transport.

Conclusion:

The correct answer is (4).

Quick Tip

The thickened inner walls of xylem vessels provide mechanical support and facilitate water transport in plants.

---

114. Formation of interfascicular cambium from fully developed parenchyma cells is an example for

(1) Redifferentiation

(2) Dedifferentiation

(3) Maturation

(4) Differentiation

Correct Answer: (2) Dedifferentiation

Solution:

Concept of Dedifferentiation

- Dedifferentiation is the process where **mature, specialized cells** regain their ability to divide and re-enter the meristematic state.
- **Interfascicular cambium** is formed when parenchyma cells undergo dedifferentiation, allowing them to function as meristematic tissue.

Conclusion:

The correct answer is (2).

Quick Tip

Dedifferentiation allows specialized cells to revert back to a dividing state, aiding in secondary growth in plants.

---

115. What is the fate of a piece of DNA carrying only gene of interest which is transferred into an alien organism?

A. The piece of DNA would be able to multiply itself independently in the progeny cells of the organism.

B. It may get integrated into the genome of the recipient.

C. It may multiply and be inherited along with the host DNA.

D. The alien piece of DNA is not an integral part of chromosome.

E. It shows ability to replicate.

Choose the correct answer from the options given below:

(1) D and E only

(2) B and C only

(3) A and E only

(4) A and B only

Correct Answer: (2) B and C only

Solution:

Mechanism of DNA Integration in Host Cells

- The **gene of interest** can either integrate into the host genome or exist independently while multiplying along with the host DNA.
- Once integrated, it becomes a part of the host's genetic material, ensuring its **inheritance in subsequent generations**.

Conclusion:

The correct answer is $(\mathbf{2})$.

Quick Tip

A gene of interest must be integrated into the host genome or exist as an extrachromosomal element to be inherited.

---

116. Match List I with List II

List-I (Fungus)	List-II (Type)
$A. Rhizopus$	$I. Mushroom$
$B. Ustilago$	$II. Smut fungus$
$C. Puccinia$	$III. Breadmould$
$D. Agaricus$	$IV. Rust fungus$

Choose the correct answer from the options given below:

(1) A-I, B-III, C-II, D-IV

(2) A-III, B-II, C-I, D-IV

(3) A-IV, B-III, C-II, D-I

(4) A-III, B-II, C-IV, D-I

Correct Answer: (4) A-III, B-II, C-IV, D-I

Solution:

Classification of Fungi

- **Rhizopus** is a bread mold, commonly found on stale food.
- **Ustilago** is a smut fungus that primarily infects cereal crops.
- **Puccinia** is a rust fungus known for causing plant diseases.
- **Agaricus** includes various mushroom species.

Conclusion:

The correct answer is (4).

Quick Tip

Different fungal species cause specific plant diseases or exist as edible fungi like Agaricus (mushroom).

117. Hind II always cuts DNA molecules at a particular point called recognition sequence and it consists of:

(1) 6 bp

(2) 4 bp

(3) 10 bp

(4) 8 bp

Correct Answer: (1) 6 bp

Solution:

Role of Restriction Enzymes

- **Hind II** is a restriction endonuclease that cleaves DNA at specific **palindromic sequences**.
- Its **recognition sequence** consists of **6 base pairs**.

Conclusion:

The correct answer is (1).

Quick Tip

Restriction enzymes recognize specific sequences in DNA (mostly palindromic) and cleave at precise locations.

---

118. The type of conservation in which the threatened species are taken out from their natural habitat and placed in special settings where they can be protected and given special care is called

(1) Biodiversity conservation

(2) Semi-conservative method

(3) Sustainable development

(4) in-situ conservation

Correct Answer: (1) Biodiversity conservation

Solution:

Approaches to Biodiversity Conservation

- **Ex-situ conservation** involves protecting species by relocating them from their natural habitat to controlled environments such as **botanical gardens, zoos, and seed banks**.
- This method plays a crucial role in **biodiversity conservation**, helping prevent species extinction by providing a safe and monitored environment.

Conclusion:

The correct answer is (**1**).

Quick Tip

Conservation strategies are classified into ex-situ (outside natural habitat) and in-situ (within natural habitat) approaches.

---

119. Given below are two statements:

Statement I: Bt toxins are insect group specific and coded by a gene cry IAc.

Statement II: Bt toxin exists as inactive protoxin in *B. thuringiensis*. However, after ingestion by the insect, the inactive protoxin gets converted into active form due to acidic pH of the insect gut.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (2) Statement I is true but Statement II is false

Solution:

Mechanism of Bt Toxin Action

- **Bt toxin** is specific to certain insect groups and is encoded by genes such as **cry IAc**.
- The toxin is initially produced as an inactive **protoxin**, which gets activated in the insect gut due to its **alkaline pH**, not acidic pH.

Conclusion:

The correct answer is (**2**).

Quick Tip

Bt toxins are activated in the alkaline gut of insects, leading to pore formation in the midgut epithelial cells, causing death.

---

120. Match List I with List II:

List I		List II
A. Two or more alternative forms of a gene		I. Back cross
B. Cross of F_1 progeny with homozygous recessive parent		II. Ploidy
C. Cross of F_1 progeny with any of the parents		III. Allele
D. Number of chromosome sets in a plant		IV. Test cross

Choose the **correct** answer from the options given below:

(1) A-II, B-I, C-III, D-IV

(2) A-III, B-IV, C-I, D-II

(3) A-IV, B-III, C-II, D-I

(4) A-I, B-II, C-III, D-IV

Correct Answer: (2) A-III, B-IV, C-I, D-II

Solution:

Step 1: Understanding Genetic Terminology

- Allele (A-III): An allele is one of the two or more alternative forms of a gene found at the same locus on homologous chromosomes.

- Test Cross (B-IV): A test cross involves crossing an **F_1 progeny** with a homozygous recessive parent to determine the genotype of the dominant parent.

- Back Cross (C-I): A back cross is a cross between **F_1 progeny** and any of its parents to recover parental traits.

- Ploidy (D-II): Ploidy refers to the number of chromosome sets in an organism, such as haploid (n), diploid (2n), or polyploid (3n, 4n, etc.).

Step 2: Matching the correct pairs

$$A \rightarrow III \quad \text{(Allele)}$$

$$B \rightarrow IV \quad \text{(Test cross)}$$

$$C \rightarrow I \quad \text{(Back cross)}$$

$$D \rightarrow II \quad \text{(Ploidy)}$$

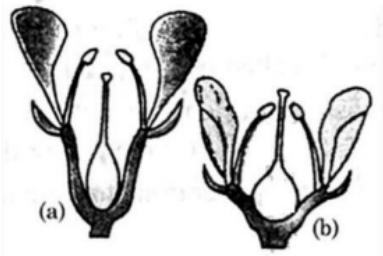
Conclusion: The correct answer is **(2) A-III, B-IV, C-I, D-II**.

Quick Tip

In genetics, an allele is an alternative form of a gene, a test cross is used to determine unknown genotypes, a back cross involves crossing with a parent, and ploidy represents the number of chromosome sets in a cell.

---

121. Identify the type of flowers based on the position of calyx, corolla, and androecium with respect to the ovary from the given figures (a) and (b).



(1) (a) Hypogynous; (b) Epigynous

(2) (a) Perigynous; (b) Epigynous

(3) (a) Perigynous; (b) Perigynous

(4) (a) Epigynous; (b) Hypogynous

Correct Answer: (3) (a) Perigynous; (b) Perigynous

Solution:

Classification of Flower Types Based on Ovary Position

- **Hypogynous:** The ovary is **superior**, and all other floral parts are positioned below it.
- **Epigynous:** The ovary is **inferior**, with floral parts arranged above it.
- **Perigynous:** The ovary is **half-superior/half-inferior**, enclosed within a **cup-like thalamus** where other floral parts are attached.

Conclusion:

The correct answer is (**3**).

Quick Tip

In Perigynous flowers, the ovary is neither fully superior nor inferior; the floral parts form a rim around it.

---

122. Which one of the following is not a criterion for classification of fungi?

(1) Mode of nutrition

(2) Mode of spore formation

(3) Fruiting body

(4) Morphology of mycelium

Correct Answer: (1) Mode of nutrition

Solution:

Criteria for Fungal Classification

Fungi are classified based on the following characteristics:

- **Mode of spore formation:** Classified based on whether spores are formed asexually or sexually.
- **Fruiting body:** Structures such as **Basidiocarp** and **Ascocarp** aid in classification.
- **Morphology of mycelium:** Differentiation occurs based on **septate** or **coenocytic** mycelium.

However, the **mode of nutrition is not a classification criterion** since all fungi are **heterotrophic**.

Conclusion:

The correct answer is (**1**).

Quick Tip

Fungal classification is based on **spore formation, mycelial structure, and reproductive structures**, not on their mode of nutrition.

123. These are regarded as major causes of biodiversity loss:

A. Over exploitation

B. Co-extinction

C. Mutation

D. Habitat loss and fragmentation

E. Migration

Choose the correct option: (1) A, B, C and D only

(2) A, B and E only

(3) A, B and D only

(4) A, C and D only

Correct Answer: (3) A, B and D only

Solution:

Factors Contributing to Biodiversity Loss

- **Over-exploitation:** Activities such as hunting and deforestation accelerate species extinction.
- **Co-extinction:** When a species becomes extinct, dependent species may also face extinction.
- **Habitat loss and fragmentation:** The destruction of ecosystems results in species loss and reduced biodiversity.
- **Mutation and migration:** While mutations drive genetic variation, they are not a primary factor in biodiversity loss. Migration is a natural process rather than a threat to biodiversity.

Conclusion:

The correct answer is $(\mathbf{3})$.

Quick Tip

Habitat destruction, over-exploitation, and co-extinction are the top causes of biodiversity loss.

124. Match List I with List II:

List I		List II
A. *Clostridium butylicum*		I. Ethanol
B. *Saccharomyces cerevisiae*		II. Streptokinase
C. *Trichoderma polysporum*		III. Butyric acid
D. *Streptococcus* sp.		IV. Cyclosporin-A

Choose the **correct** answer from the options given below:

(1) A-II, B-IV, C-III, D-I

(2) A-III, B-I, C-IV, D-II

(3) A-IV, B-I, C-III, D-II

(4) A-III, B-I, C-II, D-IV

Correct Answer: (2) A-III, B-I, C-IV, D-II

Solution:

Step 1: Understanding Microbial Products

- *Clostridium butylicum* (A-III): This bacterium is known for producing **butyric acid**, an important fermentation product.

- *Saccharomyces cerevisiae* (B-I): Also known as brewer's yeast, it is widely used for **ethanol** (alcohol) production through fermentation.

- *Trichoderma polysporum* (C-IV): This fungus produces **Cyclosporin-A**, an immunosuppressant drug.

- *Streptococcus* sp. (D-II): This bacterial genus is responsible for the production of **streptokinase**, an enzyme used to dissolve blood clots.

Step 2: Matching the correct pairs

$$A \to III \quad \text{(Butyric acid)}$$

$$B \to I \quad \text{(Ethanol)}$$

$$C \to IV \quad \text{(Cyclosporin-A)}$$

$$D \to II \quad \text{(Streptokinase)}$$

Conclusion: The correct answer is **(2) A-III, B-I, C-IV, D-II**.

Quick Tip

Microorganisms are widely used in industrial and medical applications. *Saccharomyces cerevisiae* is used for ethanol production, *Clostridium butylicum* for butyric acid, *Trichoderma polysporum* for Cyclosporin-A, and *Streptococcus* sp. for streptokinase.

---

125. In a plant, black seed color (BB/Bb) is dominant over white seed color (bb). In order to find out the genotype of the black seed plant, with which of the following genotype will you cross it?

(1) bb

(2) Bb

(3) BB/Bb

(4) BB

Correct Answer: (1) bb

Solution: Concept of Test Cross

- A **test cross** is conducted to determine whether a black-seeded plant has the genotype **BB** (homozygous dominant) or **Bb** (heterozygous).
- This is done by crossing the plant with a **homozygous recessive** (**bb**) plant.
- If the black-seeded plant is **Bb**, the offspring will be in a **1:1 ratio**, with **50% black** (Bb) and **50% white** (bb).
- If the black-seeded plant is **BB**, all offspring will be **black** (Bb), as they inherit the dominant allele.

Conclusion:

The correct answer is (**1**).

Quick Tip

A test cross always involves a homozygous recessive (bb) organism to determine the genotype of the dominant trait carrier.

---

126. Match List I with List II

	List-I		List-II
A.	Nucleolus	I.	Site of formation of glycolipid
B.	Centriole	II.	Organization like the cartwheel
C.	Leucoplasts	III.	Site for active ribosomal RNA synthesis
D.	Golgi apparatus	IV.	For storing nutrients

Choose the correct answer from the options given below:

(1) A-II, B-III, C-I, D-IV

(2) A-III, B-IV, C-II, D-I

(3) A-I, B-II, C-III, D-IV

(4) A-III, B-II, C-IV, D-I

Correct Answer: (4) A-III, B-II, C-IV, D-I

Solution:

Functions of Cell Organelles

- **Nucleolus:** Primary site for **rRNA synthesis** and ribosome assembly.
- **Centriole:** Plays a crucial role in **microtubule organization** and has a characteristic **cartwheel structure**.
- **Leucoplasts:** Specialized for **nutrient storage**, including starch, proteins, and lipids.
- **Golgi apparatus:** Involved in the **synthesis of glycolipids and glycoproteins**, essential for cell membrane formation and secretion.

Conclusion:

The correct answer is (4).

Quick Tip

Centriole organizes spindle fibers, Nucleolus synthesizes rRNA, Golgi modifies proteins, and Leucoplasts store nutrients.

127. Inhibition of Succinic dehydrogenase enzyme by malonate is a classical example of:

(1) Feedback inhibition

(2) Competitive inhibition

(3) Enzyme activation

(4) Cofactor inhibition

Correct Answer: (2) Competitive inhibition

Solution:

Concept of Competitive Inhibition

- **Malonate** acts as a **structural analog** of succinate.
- It competes with **succinate** for binding to the active site of the enzyme **Succinic dehydrogenase**, thereby inhibiting its function.
- This exemplifies **competitive inhibition**, where malonate occupies the enzyme's active site but is not converted into a product, effectively blocking enzyme activity.

Conclusion:

The correct answer is $(\mathbf{2})$.

Quick Tip

Competitive inhibition occurs when a molecule competes for an enzyme's active site, blocking the substrate.

---

128. Which one of the following can be explained on the basis of Mendel's Law of Dominance?

A. Out of one pair of factors, one is dominant and the other is recessive.

B. Alleles do not show any expression and both the characters appear as such in F_2 generation.

C. Factors occur in pairs in normal diploid plants.

D. The discrete unit controlling a particular character is called a factor.

E. The expression of only one of the parental characters is found in a monohybrid cross.

Choose the correct answer from the options given below:

(1) A, C, D and E only

(2) B, C and D only

(3) A, B, C, D and E

(4) A, B and C only

Correct Answer: (1) A, C, D and E only

Solution:

Mendel's Law of Dominance

- The **Law of Dominance** states that in a heterozygous condition, the **dominant allele** masks the expression of the recessive allele.
- **A – True:** One allele is dominant over the other in a heterozygous individual.
- **C – True:** Factors (**genes**) occur in **pairs in diploid organisms**.
- **D – True: Genes are discrete units** that control specific traits.
- **E – True:** In a **monohybrid cross**, only dominant traits appear in the **F_1 generation**.
- **B – False:** In the **F_2 generation**, recessive traits reappear, but both traits do not manifest simultaneously in a single organism.

Conclusion:

The correct answer is (1).

Quick Tip

Mendel's Law of Dominance states that the dominant allele masks the recessive allele in heterozygous conditions.

---

129. Given below are two statements:

Statement I: Parenchyma is living but collenchyma is dead tissue.

Statement II: Gymnosperms lack xylem vessels but presence of xylem vessels is the characteristic of angiosperms.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (3) Statement I is false but Statement II is true

Solution:

Classification of Plant Tissues

- **Parenchyma and Collenchyma:**
  - **Parenchyma** is a **living tissue** that provides support and plays a role in photosynthesis.
  - **Collenchyma** is also **living**, not dead, and primarily functions in mechanical support.
  - **Thus, Statement I is incorrect.**
- **Gymnosperms vs. Angiosperms:**
  - **Gymnosperms** lack xylem vessels and rely on tracheids for water conduction.
  - **Angiosperms** possess **xylem vessels**, which is a major distinguishing feature.
  - **Thus, Statement II is correct.**

Conclusion:

The correct answer is $(\mathbf{3})$.

Quick Tip

Collenchyma is a living tissue, not dead! Gymnosperms lack xylem vessels, while angiosperms have them.

---

130. How many molecules of ATP and NADPH are required for every molecule of CO_2 fixed in the Calvin cycle?

(1) 2 molecules of ATP and 2 molecules of NADPH

(2) 3 molecules of ATP and 3 molecules of NADPH

(3) 3 molecules of ATP and 2 molecules of NADPH

(4) 2 molecules of ATP and 3 molecules of NADPH

Correct Answer: (3) 3 molecules of ATP and 2 molecules of NADPH

Solution:

Energy Requirements in the Calvin Cycle

- The **Calvin cycle** (C_3 cycle) is responsible for **CO_2 fixation** using ATP and NADPH.
- The energy requirement for fixing **one molecule of CO_2** is:
  - **3 ATP molecules**
  - **2 NADPH molecules**
- The overall **balanced reaction** for the Calvin cycle is:

$$6CO_2 + 18ATP + 12NADPH \rightarrow C_6H_{12}O_6 + 18ADP + 12NADP^+$$

Conclusion:

The correct answer is (**3**).

Quick Tip

For every CO2 fixed in the Calvin cycle, 3 ATP and 2 NADPH molecules are required.

---

131. The equation of Verhulst-Pearl logistic growth is:

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right).$$

From this equation, K indicates:

(1) Biotic potential

(2) Carrying capacity

(3) Population density

(4) Intrinsic rate of natural increase

Correct Answer: (2) Carrying capacity

Solution:

Logistic Growth Model in Population Ecology

- The **logistic growth model** represents population growth under **resource-limited conditions**.
- The governing equation is:

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

where:

  - $\frac{dN}{dt}$ = Rate of population growth
  - r = Intrinsic rate of natural increase
  - N = Current population size
  - K = **Carrying capacity**, the maximum population that the environment can sustain

Conclusion:

The correct answer is $(\mathbf{2})$.

Quick Tip

In logistic growth, K represents the carrying capacity, which is the upper limit of population size that the environment can support.

---

132. Tropical regions show greatest level of species richness because

A. Tropical latitudes have remained relatively undisturbed for millions of years, hence more time was available for species diversification.

B. Tropical environments are more seasonal.

C. More solar energy is available in tropics.

D. Constant environments promote niche specialization.

E. Tropical environments are constant and predictable.

Choose the correct answer from the options given below:

(1) A and B only

(2) A, B and E only

(3) A, B and D only

(4) A, C, D and E only

Correct Answer: (4) A, C, D and E only

Solution:

Factors Contributing to Tropical Biodiversity

- The tropics exhibit **high species richness** due to several ecological and evolutionary factors:
  - **Stable climate** facilitates continuous evolution and diversification (**A**).
  - **Higher solar energy availability** increases primary productivity, supporting diverse ecosystems (**C**).
  - **Constant environmental conditions** promote **niche specialization**, allowing species to adapt efficiently (**D**).
  - **Predictable climatic conditions** enhance **ecosystem stability**, reducing extinction risks (**E**).

Conclusion:

The correct answer is (4).

Quick Tip

Tropical regions support maximum biodiversity due to stable conditions, long evolutionary history, and high productivity.

---

133. The lactose present in the growth medium of bacteria is transported to the cell by the action of:

(1) Acetylase

(2) Permease

(3) Polymerase

(4) Beta-galactosidase

Correct Answer: (2) Permease

Solution:

Function of Permease in Lactose Transport

- **Lactose permease** is a membrane-bound protein that facilitates the **active transport** of lactose into bacterial cells.

- Once inside the cell, **beta-galactosidase** enzymatically hydrolyzes lactose into its monosaccharide components: **glucose** and **galactose**.

Conclusion:

The correct answer is $(\mathbf{2})$.

Quick Tip

Lactose permease is an essential enzyme in the lac operon, enabling bacterial cells to uptake lactose for metabolism.

---

134. The cofactor of the enzyme carboxypeptidase is:

(1) Niacin

(2) Flavin

(3) Haem

(4) Zinc

Correct Answer: (4) Zinc

Solution:

Cofactor Requirement for Carboxypeptidase

- **Carboxypeptidase** is a metalloenzyme that requires **zinc** ($\mathbf{Zn^{2+}}$) as a cofactor for its catalytic function.
- **Zinc** plays a crucial role in **stabilizing the enzyme structure** and facilitates **peptide bond cleavage** during protein digestion.

Conclusion:

The correct answer is $(\mathbf{4})$.

Quick Tip

Metalloenzymes like carboxypeptidase require metal ions as cofactors for enzymatic function.

---

135. The capacity to generate a whole plant from any cell of the plant is called:

(1) Micropropagation

(2) Differentiation

(3) Somatic hybridization

(4) Totipotency

Correct Answer: (4) Totipotency

Solution:

Concept of Totipotency

- **Totipotency** refers to the ability of a single plant cell to regenerate and develop into a complete organism.
- This property is fundamental to **tissue culture** and **cloning** techniques, enabling large-scale plant propagation.

Conclusion:

The correct answer is (4).

Quick Tip

Totipotency is the basis of tissue culture and plant cloning, allowing regeneration of whole plants from a single cell.

Section B

136. Match List I with List II

List I	List II
A. Robert May	I. Species-Area relationship
B. Alexander von Humboldt	II. Long-term ecosystem experiment using outdoor plots
C. Paul Ehrlich	III. Global species diversity at about 7 million
D. David Tilman	IV. Rivet popper hypothesis

Choose the correct answer from the options given below:

(1) A-III, B-I, C-IV, D-II

(2) A-I, B-III, C-II, D-IV

(3) A-III, B-IV, C-II, D-I

(4) A-II, B-III, C-I, D-IV

Correct Answer: (1) A-III, B-I, C-IV, D-II

Solution:

Key Contributions of Scientists to Biodiversity Studies

- **Robert May:** Estimated that the total global species diversity is approximately **7 million**.
- **Alexander von Humboldt:** Observed that **species richness increases with area** and formulated the **Species-Area Relationship**.
- **Paul Ehrlich:** Proposed the **Rivet Popper Hypothesis**, emphasizing the critical role of biodiversity in maintaining **ecosystem stability**.
- **David Tilman:** Conducted **long-term ecosystem experiments** to study the impact of **biodiversity loss** on ecosystem functioning.

Conclusion:

The correct answer is (**1**).

Quick Tip

Biodiversity conservation is supported by various models like Species-Area relationships and Rivet Popper Hypothesis.

---

137. Match List I with List II

List I (Types of Stamens)	List II (Example)
A. Monoadelphous	I. Citrus
B. Diadelphous	II. Pea
C. Polyadelphous	III. Lily
D. Epiphyllous	IV. China-rose

Choose the correct answer from the options given below:

(1) A-IV, B-I, C-II, D-III

(2) A-I, B-II, C-IV, D-III

(3) A-III, B-I, C-IV, D-II

(4) A-IV, B-II, C-I, D-III

Correct Answer: (4) A-IV, B-II, C-I, D-III

Solution: Understanding Types of Stamens

- Monoadelphous stamens are fused into a single bundle, seen in China-rose.

- Diadelphous stamens are arranged in two bundles, as found in Pea.

- Polyadelphous stamens form multiple bundles, characteristic of Citrus.

- Epiphyllous stamens are attached to the petals, as observed in Lily.

Conclusion: The correct option is (4).

Quick Tip

Understanding different stamen arrangements is crucial for plant identification and classification.

---

138. Read the following statements and choose the set of correct statements:

In the members of **Phaeophyceae**,

A. Asexual reproduction occurs usually by biflagellate zoospores.

B. Sexual reproduction is by oogamous method only.

C. Stored food is in the form of carbohydrates which is either mannitol or laminarin.

D. The major pigments found are chlorophyll a, c and carotenoids and xanthophyll.

E. Vegetative cells have a cellulosic wall, usually covered on the outside by gelatinous coating of algin.

Choose the correct answer from the options given below:

(1) B, C, D and E only

(2) A, C, D and E only

(3) A, B, C and E only

(4) A, B, C and D only

Correct Answer: (2) A, C, D and E only

Solution:

Characteristics of Phaeophyceae (Brown Algae)

- **Asexual reproduction** occurs through **biflagellate zoospores**.
- **Sexual reproduction** can be **isogamous, anisogamous, or oogamous**, meaning it is not exclusively oogamous.
- **Stored food** reserves include **mannitol** and **laminarin**.
- They contain **chlorophyll a, chlorophyll c, carotenoids, and xanthophylls**, which contribute to their brown coloration.
- Their **vegetative cells** possess a **cellulosic wall**, covered externally by a **gelatinous algin coat**.

Conclusion:

The correct answer is (**2**).

Quick Tip

Phaeophyceae (Brown Algae) store food as laminarin and mannitol and have cell walls covered with algin.

---

139. The DNA present in chloroplast is:

(1) Circular, double stranded

(2) Linear, single stranded

(3) Circular, single stranded

(4) Linear, double stranded

Correct Answer: (1) Circular, double stranded

Solution: Understanding Chloroplast DNA

- Chloroplasts have their own circular, double-stranded DNA, similar to prokaryotes.

- It supports the endosymbiotic theory, indicating that chloroplasts originated from free-living cyanobacteria.

Conclusion: The correct option is (**1**).

Quick Tip

Chloroplast DNA is circular and double-stranded, similar to bacterial genomes, supporting the endosymbiotic theory.

---

140. Match List I with List II

List I	List II
A. Frederick Griffith	I. Genetic code
B. Francois Jacob & Jacque Monod	II. Semi-conservative mode of DNA replication
C. Har Gobind Khorana	III. Transformation
D. Meselson & Stahl	IV. Lac operon

Choose the correct answer from the options given below:

(1) A-III, B-IV, C-I, D-II

(2) A-II, B-III, C-IV, D-I

(3) A-IV, B-I, C-II, D-III

(4) A-III, B-II, C-I, D-IV

Correct Answer: (1) A-III, B-IV, C-I, D-II

Solution: Understanding Contributions to Genetics

- Frederick Griffith discovered transformation using Streptococcus pneumoniae.

- Francois Jacob & Jacque Monod proposed the Lac operon model for gene regulation.

- Har Gobind Khorana contributed to decoding the genetic code.

- Meselson & Stahl proved the semi-conservative model of DNA replication.

Conclusion: The correct option is (1).

Quick Tip

Griffith's transformation experiment paved the way for discovering DNA as the genetic material.

---

141. Which of the following statement is correct regarding the process of replication in

E. coli?

(1) The DNA-dependent RNA polymerase catalyses polymerization in one direction, that is 5' $\rightarrow$ 3'

(2) The DNA-dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' as well as 3' $\rightarrow$ 5' direction

(3) The DNA-dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' direction

(4) The DNA-dependent DNA polymerase catalyses polymerization in one direction that is 3' $\rightarrow$ 5'

Correct Answer: (3) The DNA-dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' direction

Solution: Understanding DNA Polymerization Direction

- DNA-dependent DNA polymerase in *E. coli* only adds nucleotides in the 5' $\rightarrow$ 3' direction.
- The 3' $\rightarrow$ 5' direction is only for exonuclease activity (proofreading), not polymerization.
- RNA polymerase synthesizes mRNA but is not involved in DNA replication.

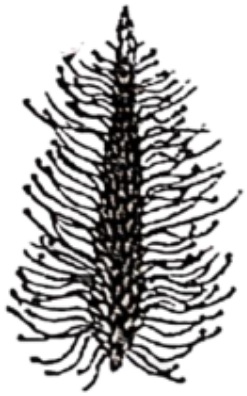
Conclusion: The correct option is (**3**).

Quick Tip

DNA polymerase synthesizes new DNA strands in the 5' $\rightarrow$ 3' direction but proofreads in the 3' $\rightarrow$ 5' direction.

---

142. Identify the correct description about the given figure:



(1) Water pollinated flowers showing stamens with mucilaginous covering.

(2) Cleistogamous flowers showing autogamy.

(3) Compact inflorescence showing complete autogamy.

(4) Wind pollinated plant inflorescence showing flowers with well exposed stamens.

Correct Answer: (4) Wind pollinated plant inflorescence showing flowers with well exposed stamens.

Solution: Characteristics of Wind Pollination:

- Wind-pollinated plants have well-exposed stamens for efficient pollen dispersal.
- Light and non-sticky pollen grains facilitate transport by wind.
- Large feathery stigma increases the chances of pollen capture.

Conclusion: The correct option is (4).

Quick Tip

Wind pollinated flowers (anemophilous flowers) have exposed stamens and feathery stigma for efficient pollen dispersal.

---

143. Which of the following are fused in somatic hybridization involving two varieties of plants?

(1) Somatic embryos

(2) Protoplasts

(3) Pollens

(4) Callus

Correct Answer: (2) Protoplasts

Solution:

Concept of Somatic Hybridization

- **Protoplast fusion** is the fundamental process involved in somatic hybridization.
- The **cell walls** of two plant cells are enzymatically removed to generate **protoplasts**, which are then fused together.
- This technique is widely used in **plant breeding** to create **somatic hybrids**, allowing the combination of desirable traits from different species.

Conclusion:

The correct answer is (2).

Quick Tip

Somatic hybridization involves the fusion of protoplasts from different plant varieties to produce hybrids.

---

144. Given below are two statements:

Statement I: In C3 plants, some O_2 binds to RuBisCO, hence CO_2 fixation is decreased.

Statement II: In C4 plants, mesophyll cells show very little photorespiration while bundle sheath cells do not show photorespiration.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (2) Statement I is true but Statement II is false

Solution:

Photorespiration and the C_4 Pathway

- In **C_3 plants**, **RuBisCO** exhibits **oxygenase activity**, leading to **photorespiration** and a reduction in CO_2 fixation efficiency.
- **C_4 plants** minimize photorespiration by **spatially separating CO_2 fixation** in **mesophyll cells** and the **Calvin cycle** in **bundle sheath cells**.
- However, despite this adaptation, **bundle sheath cells in C_4 plants** still exhibit a certain level of **photorespiration**.

Conclusion:

The correct answer is $(\mathbf{2})$.

Quick Tip

C4 plants minimize photorespiration by spatial separation of CO_2 fixation in mesophyll and Calvin cycle in bundle sheath cells.

145. Match List I with List II

List I	List II
A. Rose	I. Twisted aestivation
B. Pea	II. Perigynous flower
C. Cotton	III. Drupe
D. Mango	IV. Marginal placentation

Choose the correct answer from the options given below:

(1) A-I, B-II, C-III, D-IV

(2) A-IV, B-III, C-II, D-I

(3) A-II, B-III, C-IV, D-I

(4) A-II, B-IV, C-I, D-III

Correct Answer: (4) A-II, B-IV, C-I, D-III

Solution:

Understanding Floral and Fruit Characteristics

- Rose (A) is a Perigynous flower (floral parts are attached to a cup-shaped structure).
- Pea (B) shows Marginal placentation, where ovules are arranged along the margin.
- Cotton (C) has Twisted aestivation (one margin overlaps with the next).
- Mango (D) is a Drupe fruit, where the seed is enclosed within a hard endocarp.

Conclusion: The correct option is (4).

Quick Tip

Perigynous flowers (e.g., Rose) have floral parts attached to a cup-like structure, and mango is a drupe fruit.

---

146. In an ecosystem if the Net Primary Productivity (NPP) of first trophic level is $100x$ (kcal m^{-2}yr^{-1}), what would be the GPP (Gross Primary Productivity) of the third trophic level of the same ecosystem?

(1) x (kcal m^{-2}yr^{-1})

(2) $10x$ (kcal m^{-2}yr^{-1})

(3) $\frac{100x}{3}$ (kcal $m^{-2}yr^{-1}$)

(4) $\frac{x}{10}$ (kcal $m^{-2}yr^{-1}$)

Correct Answer: (2) $10x$ (kcal $m^{-2}yr^{-1}$)

Solution:

Energy Transfer in an Ecosystem

- Energy transfer in a trophic system follows the **10 Percent Law** (**Lindeman's Law**), where only **10%** of the energy is passed to the next trophic level.
- If the **Net Primary Productivity (NPP)** at the first trophic level is $100x$, then:
  - The second trophic level receives:

$$\frac{100x}{10} = 10x$$

  - The third trophic level receives:

$$\frac{10x}{10} = x$$

Conclusion:

The correct answer is (**2**).

Quick Tip

Only 10 percent of energy is transferred to the next trophic level, while 90 percent is lost as heat during metabolic processes.

---

147. Identify the step in tricarboxylic acid cycle, which does not involve oxidation of substrate.

(1) Succinic acid $\rightarrow$ Malic acid

(2) Succinyl-CoA $\rightarrow$ Succinic acid

(3) Isocitrate $\rightarrow$ α-ketoglutaric acid

(4) Malic acid $\rightarrow$ Oxaloacetic acid

Correct Answer: (2) Succinyl-CoA $\rightarrow$ Succinic acid

Solution: Understanding the TCA Cycle (Krebs Cycle)

- The Krebs cycle (TCA cycle) consists of oxidation and decarboxylation reactions.

- The conversion of Succinyl-CoA to Succinic acid is catalyzed by Succinyl-CoA synthetase and involves the formation of ATP/GTP, but **no oxidation occurs**.
- The other steps listed involve oxidation reactions mediated by NAD^+ or FAD.

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

Succinyl-CoA to Succinic acid is a substrate-level phosphorylation step in the TCA cycle, not an oxidation reaction.

---

148. Match List-I with List-II:

List-I		List-II
A. GLUT-4		I. Hormone
B. Insulin		II. Enzyme
C. Trypsin		III. Intercellular ground substance
D. Collagen		IV. Enables glucose transport into cells

Choose the **correct** answer from the options given below:

(1) A-I, B-II, C-III, D-IV

(2) A-II, B-III, C-IV, D-I

(3) A-III, B-IV, C-I, D-II

(4) A-IV, B-I, C-II, D-III

Correct Answer: (4) A-IV, B-I, C-II, D-III

Solution:

Step 1: Understanding the Biological Roles

- GLUT-4 (A-IV): GLUT-4 is a **glucose transporter protein** that facilitates **glucose uptake into cells**, particularly in muscle and adipose tissues.
- Insulin (B-I): Insulin is a **hormone** secreted by the pancreas that regulates blood sugar levels.
- Trypsin (C-II): Trypsin is an **enzyme** involved in protein digestion, breaking down proteins into smaller peptides.
- Collagen (D-III): Collagen is an **intercellular ground substance**, providing structural

support in connective tissues.

Step 2: Matching the correct pairs

$$A \to IV \quad \text{(Enables glucose transport into cells)}$$

$$B \to I \quad \text{(Hormone)}$$

$$C \to II \quad \text{(Enzyme)}$$

$$D \to III \quad \text{(Intercellular ground substance)}$$

Conclusion: The correct answer is **(4) A-IV, B-I, C-II, D-III**.

Quick Tip

GLUT-4 is a glucose transporter, insulin is a hormone, trypsin is a digestive enzyme, and collagen is an important structural protein in connective tissues.

---

149. Match List-I with List-II:

List-I		List-II
A. Citric acid cycle		I. Cytoplasm
B. Glycolysis		II. Mitochondrial matrix
C. Electron transport system		III. Intermembrane space of mitochondria
D. Proton gradient		IV. Inner mitochondrial membrane

Choose the **correct** answer from the options given below:

(1) A-II, B-I, C-IV, D-III

(2) A-III, B-IV, C-I, D-II

(3) A-IV, B-III, C-II, D-I

(4) A-I, B-II, C-III, D-IV

Correct Answer: (1) A-II, B-I, C-IV, D-III

Solution:

Step 1: Understanding Cellular Respiration Pathways

- Citric acid cycle (A-II): Also known as the **Krebs cycle**, it occurs in the **mitochondrial matrix**, where acetyl-CoA is oxidized to produce ATP, NADH, and $FADH_2$.

- Glycolysis (B-I): Glycolysis takes place in the **cytoplasm**, where glucose is broken down into pyruvate.

- Electron transport system (C-IV): The ETS is located in the **inner mitochondrial membrane**, where electrons are transferred through a series of complexes to drive ATP synthesis.

- Proton gradient (D-III): The accumulation of protons occurs in the **intermembrane space of mitochondria**, creating a gradient that drives ATP synthesis via chemiosmosis.

Step 2: Matching the correct pairs

$$A \to II \quad \text{(Mitochondrial matrix)}$$

$$B \to I \quad \text{(Cytoplasm)}$$

$$C \to IV \quad \text{(Inner mitochondrial membrane)}$$

$$D \to III \quad \text{(Intermembrane space of mitochondria)}$$

Conclusion: The correct answer is **(1) A-II, B-I, C-IV, D-III**.

Quick Tip

Cellular respiration consists of glycolysis (cytoplasm), the citric acid cycle (mitochondrial matrix), and the electron transport system (inner mitochondrial membrane), with the proton gradient forming in the intermembrane space.

---

150. Spraying sugarcane crop with which of the following plant growth regulators increases the length of the stem, thus increasing the yield?

(1) Gibberellin

(2) Cytokinin

(3) Abscisic acid

(4) Auxin

Correct Answer: (1) Gibberellin

Solution:

Role of Gibberellins in Plant Growth - Gibberellins are plant hormones that promote stem elongation by stimulating cell division and elongation.

- In sugarcane, gibberellins increase the internodal length, which enhances sugar production and overall crop yield.

- Cytokinins primarily promote cell division, auxins regulate apical dominance, and abscisic

acid is a growth inhibitor.

Conclusion: The correct option is (1).

Quick Tip

Gibberellins are widely used in agriculture to increase sugarcane yield and promote fruit growth in grapes.

Zoology

Section A

151. Given below are two statements: one is labelled as Assertion A and the other as Reason R:

Assertion A: FSH acts upon ovarian follicles in females and Leydig cells in males.

Reason R: Growing ovarian follicles secrete estrogen in females while interstitial cells secrete androgen in male human beings.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both A and R are true but R is NOT the correct explanation of A

(2) A is true but R is false

(3) A is false but R is true

(4) Both A and R are true and R is the correct explanation of A

Correct Answer: (3) A is false but R is true

Solution: Step 1: Understanding FSH Action

- FSH (Follicle-Stimulating Hormone) acts on ovarian follicles in females to stimulate their growth and maturation.

- However, in males, FSH stimulates the Sertoli cells (not Leydig cells) to support spermatogenesis.

Step 2: Understanding Estrogen and Androgen Secretion

- Ovarian follicles secrete estrogen, which is correct.

- Leydig cells secrete testosterone (androgen) in males, which is also correct.

Conclusion: Since A states that FSH acts on Leydig cells (which is incorrect), the correct answer is (3).

Quick Tip

FSH acts on Sertoli cells, while LH (Luteinizing Hormone) acts on Leydig cells to stimulate testosterone production.

---

152. Match List I with List II

List I	List II
$A. Lipase$	$I. Peptidebond$
$B. Nuclease$	$II. Esterbond$
$C. Protease$	$III. Glycosidicbond$
$D. Amylase$	$IV. Phosphodiesterbond$

(1) A-III, B-II, C-I, D-IV

(2) A-II, B-IV, C-I, D-III

(3) A-IV, B-I, C-III, D-II

(4) A-IV, B-II, C-III, D-I

Correct Answer: (2) A-II, B-IV, C-I, D-III

Solution:

Understanding the Enzyme Functions :

- Lipase hydrolyzes fats, breaking down ester bonds in lipids.
- Nuclease breaks phosphodiester bonds in nucleic acids.
- Protease hydrolyzes peptide bonds in proteins.
- Amylase breaks glycosidic bonds in carbohydrates.

Conclusion: The correct option is (2).

Quick Tip

Enzymes catalyze specific biochemical reactions by targeting specific bonds in macromolecules.

---

153. Following are the stages of the pathway for conduction of an action potential through the heart:

A. AV bundle

B. Purkinje fibres

C. AV node

D. Bundle branches

E. SA node

Choose the correct sequence of the pathway from the options given below:

(1) A-E-C-B-D

(2) B-D-E-C-A

(3) E-A-D-B-C

(4) E-C-A-D-B

Correct Answer: (4) E-C-A-D-B

Solution:

Cardiac Conduction Pathway

- **SA node (Sinoatrial node):** Acts as the **pacemaker** of the heart, initiating the heartbeat.
- **AV node (Atrioventricular node):** Delays the electrical impulse before transmitting it to the ventricles.
- **AV bundle (Bundle of His):** Conducts impulses from the atria to the ventricles.
- **Bundle branches:** Transmit the impulse to both ventricles.
- **Purkinje fibers:** Distribute the impulse throughout the ventricles, leading to **ventricular contraction**.

Conclusion:

The correct sequence is $E \to C \to A \to D \to B$, corresponding to option (4).

Quick Tip

The SA node is the natural pacemaker of the heart, setting the rhythm of cardiac contractions.

154. Match List I with List II:

	List I		List II
A.	Pons	I.	Provides additional space for Neurons, regulates posture and balance.
B.	Hypothalamus	II.	Controls respiration and gastric secretions.
C.	Medulla	III.	Connects different regions of the brain.
D.	Cerebellum	IV.	Neuro secretory cells

(1) A-III, B-IV, C-II, D-I

(2) A-I, B-III, C-II, D-IV

(3) A-II, B-I, C-III, D-IV

(4) A-II, B-III, C-I, D-IV

Correct Answer: (1) A-III, B-IV, C-II, D-I

Solution: Understanding Brain Regions

- Pons connects different brain regions, facilitating communication.

- Hypothalamus contains neurosecretory cells regulating homeostasis.

- Medulla oblongata controls involuntary functions such as respiration and digestion.

- Cerebellum coordinates posture, balance, and fine motor movements.

Conclusion: The correct option is (1).

Quick Tip

The cerebellum is essential for motor coordination, while the medulla controls vital autonomic functions.

---

155. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?

(1) Genetic drift

(2) Gene migration

(3) Constant gene pool

(4) Genetic recombination

Correct Answer: (3) Constant gene pool

Solution: Understanding Hardy-Weinberg Equilibrium

- Hardy-Weinberg equilibrium states that allele frequencies in a population remain constant unless disturbed by evolutionary forces.
- Factors affecting equilibrium include genetic drift, gene migration, mutation, selection, and recombination.

Conclusion: A constant gene pool maintains equilibrium, so the correct option is (3).

Quick Tip

For a population to be in Hardy-Weinberg equilibrium, it must have random mating, large population size, and no mutation, selection, or migration.

---

156. In both sexes of cockroach, a pair of jointed filamentous structures called anal cerci are present on:

(1) 10th segment

(2) 8th and 9th segment

(3) 11th segment

(4) 5th segment

Correct Answer: (1) 10th segment

Solution: Understanding Cockroach Anatomy

- Anal cerci are sensory appendages present on the 10th segment in both male and female cockroaches.
- They detect vibrations and help in reflexive responses to threats.

Conclusion: The correct answer is (1).

Quick Tip

Anal cerci are sensitive to vibrations and function as sensory organs in cockroaches.

---

157. Match List I with List II:

List I		List II
A. Expiratory capacity		I. Expiratory reserve volume + Tidal volume + Inspiratory reserv
B. Functional residual capacity		II. Tidal volume + Expiratory reserve volume
C. Vital capacity		III. Tidal volume + Inspiratory reserve volume
D. Inspiratory capacity		IV. Expiratory reserve volume + Residual volume

Choose the **correct** answer from the options given below:

(1) A-III, B-II, C-IV, D-I

(2) A-II, B-I, C-IV, D-III

(3) A-I, B-III, C-II, D-IV

(4) A-II, B-IV, C-I, D-III

Correct Answer: (4) A-II, B-IV, C-I, D-III

Solution:

Step 1: Understanding Lung Capacities and Their Components

- Expiratory capacity (A-II): The total volume of air that can be exhaled after normal inspiration.

$$\text{Expiratory capacity} = \text{Tidal volume} + \text{Expiratory reserve volume}$$

- Functional residual capacity (B-IV): The volume of air remaining in the lungs after normal expiration.

$$\text{Functional residual capacity} = \text{Expiratory reserve volume} + \text{Residual volume}$$

- Vital capacity (C-I): The maximum volume of air a person can exhale after a deep inspiration.

$$\text{Vital capacity} = \text{Expiratory reserve volume} + \text{Tidal volume} + \text{Inspiratory reserve volume}$$

- Inspiratory capacity (D-III): The maximum volume of air that can be inhaled after a normal expiration.

$$\text{Inspiratory capacity} = \text{Tidal volume} + \text{Inspiratory reserve volume}$$

Step 2: Matching the correct pairs

$A \rightarrow II$ (Tidal volume + Expiratory reserve volume)

$B \rightarrow IV$ (Expiratory reserve volume + Residual volume)

$C \rightarrow I$ (Expiratory reserve volume + Tidal volume + Inspiratory reserve volume)

$D \rightarrow III$ (Tidal volume + Inspiratory reserve volume)

Conclusion: The correct answer is **(4) A-II, B-IV, C-I, D-III**.

Quick Tip

Lung capacities are combinations of different lung volumes. Expiratory capacity is the sum of tidal volume and expiratory reserve volume, while functional residual capacity includes the residual volume. Vital capacity is the total air exhaled after deep inspiration, and inspiratory capacity is the sum of tidal volume and inspiratory reserve volume.

---

158. The flippers of Penguins and Dolphins are an example of:

(1) Natural selection

(2) Convergent evolution

(3) Divergent evolution

(4) Adaptive radiation

Correct Answer: (2) Convergent evolution

Solution: Understanding Evolutionary Trends

- Convergent evolution occurs when unrelated species evolve similar traits due to adaptation to similar environments.

- Flippers of Penguins (birds) and Dolphins (mammals) evolved independently for swimming, despite their different ancestral origins.

Conclusion: Since Penguins and Dolphins evolved similar features independently, the correct answer is $(\mathbf{2})$.

Quick Tip

Convergent evolution results in analogous structures, while divergent evolution results in homologous structures.

159. Match List I with List II:

List I		List II
A. α-1 antitrypsin		I. Cotton bollworm
B. Cry IAb		II. ADA deficiency
C. Cry IAc		III. Emphysema
D. Enzyme replacement therapy		IV. Corn borer

Choose the **correct** answer from the options given below:

(1) A-III, B-I, C-II, D-IV

(2) A-III, B-IV, C-I, D-II

(3) A-II, B-IV, C-I, D-III

(4) A-II, B-I, C-IV, D-III

Correct Answer: (2) A-III, B-IV, C-I, D-II

Solution:

Step 1: Understanding the Functions of the Given Terms

- α-1 antitrypsin (A-III): It is a protein that protects lung tissue from damage and its deficiency leads to **emphysema**.

- Cry IAb (B-IV): This gene from **Bacillus thuringiensis (Bt)** produces a toxin effective against the **corn borer**.

- Cry IAc (C-I): This Bt toxin specifically targets **cotton bollworm**.

- Enzyme replacement therapy (D-II): This therapy is used to treat **ADA deficiency**, a disorder affecting the immune system.

Step 2: Matching the Correct Pairs

$$A \to III \quad \text{(Emphysema)}$$

$$B \to IV \quad \text{(Corn borer)}$$

$$C \to I \quad \text{(Cotton bollworm)}$$

$$D \to II \quad \text{(ADA deficiency)}$$

Conclusion: The correct answer is **(2) A-III, B-IV, C-I, D-II**.

Quick Tip

α**-1 antitrypsin** prevents lung damage; **Cry IAb** targets **corn borer**, and **Cry IAc** targets **cotton bollworm**. **Enzyme replacement therapy** is a treatment for **ADA deficiency**.

---

160. Match List I with List II:

	List I		List II
A.	Down's syndrome	I.	11^{th} chromosome
B.	α-Thalassemia	II.	'X' chromosome
C.	β-Thalassemia	III.	21^{st} chromosome
D.	Klinefelter's syndrome	IV.	16^{th} chromosome

(1) A-II, B-III, C-IV, D-I

(2) A-I, B-IV, C-III, D-II

(3) A-I, B-II, C-IV, D-III

(4) A-IV, B-II, C-III, D-I

Correct Answer: (2) A-I, B-IV, C-III, D-II

Solution: Understanding Chromosomal Disorders

- Down's syndrome results from trisomy of the 21st chromosome.

- α-Thalassemia is associated with deletions in the 16th chromosome, affecting hemoglobin production.

- β-Thalassemia is linked to mutations in the X chromosome, causing anemia.

- Klinefelter's syndrome (XXY condition) occurs due to an extra X chromosome in males.

Conclusion: The correct match is (**2**).

Quick Tip

Genetic disorders can be caused by trisomy (e.g., Down's syndrome) or chromosomal mutations affecting specific gene loci.

---

161. Given below are two statements:

Statement I: The presence or absence of hymen is not a reliable indicator of virginity.

Statement II: The hymen is torn during the first coitus only.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (2) Statement I is true but Statement II is false

Solution: Understanding the Role of Hymen

- The hymen can be torn due to several activities, including sports, cycling, or medical examinations, apart from sexual intercourse.

- Thus, it is not a reliable indicator of virginity.

Conclusion: The correct option is $(\mathbf{2})$.

Quick Tip

Virginity is a social concept and cannot be medically determined by the presence or absence of the hymen.

---

162. Match List I with List II:

List I	List II
$A. Common cold$	$I. Plasmodium$
$B. Haemozoin$	$II. Typhoid$
$C. Widal test$	$III. Rhinoviruses$
$D. Allergy$	$IV. Dust mites$

(1) A-I, B-III, C-II, D-IV

(2) A-III, B-I, C-II, D-IV

(3) A-IV, B-II, C-III, D-I

(4) A-II, B-IV, C-III, D-I

Correct Answer: (2) A-III, B-I, C-II, D-IV

Solution: Understanding Disease and Diagnostic Associations

- Common cold is caused by rhinoviruses.
- Haemozoin is a byproduct of Plasmodium, the parasite responsible for malaria.
- Widal test is used for diagnosing typhoid fever.
- Allergies can be triggered by dust mites and other allergens.

Conclusion: The correct match is (**2**).

Quick Tip

Plasmodium causes malaria, and its breakdown of hemoglobin results in haemozoin, which causes fever recurrence.

---

163. Which of the following is not a component of the Fallopian tube?

(1) Isthmus

(2) Infundibulum

(3) Ampulla

(4) Uterine fundus

Correct Answer: (4) Uterine fundus

Solution:

Structure of the Fallopian Tube

- The **Fallopian tube** consists of four distinct regions:
  1. **Infundibulum:** A funnel-shaped opening near the ovary.
  2. **Ampulla:** The widest section where **fertilization** occurs.
  3. **Isthmus:** A narrow segment connecting to the uterus.
  4. **Interstitial (Intramural) part:** The portion passing through the **uterine wall**.
- The **Uterine Fundus** is **not** a part of the Fallopian tube; instead, it is the **topmost portion of the uterus**.

Conclusion:

The correct answer is (**4**).

Quick Tip

Fertilization occurs in the ampulla of the Fallopian tube, making it a crucial structure in reproduction.

---

164. Following are the stages of cell division:

A. Gap 2 phase

B. Cytokinesis

C. Synthesis phase

D. Karyokinesis

E. Gap 1 phase

Choose the correct sequence of stages from the options given below:

(1) E-B-D-A-C

(2) B-D-E-A-C

(3) E-C-A-D-B

(4) C-E-D-A-B

Correct Answer: (3) E-C-A-D-B

Solution: Understanding Cell Cycle Phases

- Gap 1 phase (G1): The first growth phase, preparing for DNA replication.

- Synthesis phase (S): DNA replication occurs.

- Gap 2 phase (G2): Preparation for mitosis.

- Karyokinesis: Nuclear division (mitosis).

- Cytokinesis: Division of cytoplasm leading to two daughter cells.

Conclusion: The correct sequence is $\mathbf{E} \rightarrow \mathbf{C} \rightarrow \mathbf{A} \rightarrow \mathbf{D} \rightarrow \mathbf{B}$.

Quick Tip

The cell cycle consists of interphase (G1, S, G2) followed by mitotic phase (M), which includes karyokinesis and cytokinesis.

---

165. Match List I with List II:

List I	List II
$A. Axoneme$	$I. Centriole$
$B. Cartwheelpattern$	$II. Ciliaandflagella$
$C. Crista$	$III. Chromosome$
$D. Satellite$	$IV. Mitochondria$

(1) A-IV, B-II, C-III, D-I

(2) A-II, B-IV, C-I, D-III

(3) A-II, B-I, C-IV, D-III

(4) A-IV, B-III, C-II, D-I

Correct Answer: (3) A-II, B-I, C-IV, D-III

Solution: Understanding the Cellular Structures

- Axoneme is the structural core of cilia and flagella.

- Cartwheel pattern is seen in centrioles during cell division.

- Crista are folds in the inner membrane of mitochondria.

- Satellite regions are part of chromosomes involved in rRNA synthesis.

Conclusion: The correct match is (**3**).

Quick Tip

Cilia and flagella are supported by axonemes, while mitochondria have crista to increase surface area for ATP synthesis.

---

166. Given below are two statements:

Assertion A: Breast-feeding during the initial period of infant growth is recommended by doctors for bringing up a healthy baby.

Reason R: Colostrum contains several antibodies absolutely essential to develop resistance for the newborn baby.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both A and R are correct but R is NOT the correct explanation of A

(2) A is correct but R is not correct

(3) A is not correct but R is correct

(4) Both A and R are correct and R is the correct explanation of A

Correct Answer: (4) Both A and R are correct and R is the correct explanation of A

Solution: Understanding the Role of Breastfeeding

- Colostrum, the first milk produced by the mother, is rich in immunoglobulins (IgA) that help protect the newborn.

- Breastfeeding also provides essential nutrients for growth and brain development.

Conclusion: Since colostrum helps in immunity development, it supports the assertion. Hence, (4) is correct.

Quick Tip

Colostrum is crucial for newborn immunity, providing passive immunity against infections.

---

167. Match List I with List II:

	List I (Sub Phases of Prophase I)		List II (Specific Characters)
A.	Diakinesis	I.	Synaptonemal complex formation
B.	Pachytene	II.	Completion of terminalisation of chiasmata
C.	Zygotene	III.	Chromosomes look like thin threads
D.	Leptotene	IV.	Appearance of recombination nodules

Choose the correct answer from the options given below:

(1) A-I, B-II, C-IV, D-III

(2) A-II, B-IV, C-I, D-III

(3) A-IV, B-III, C-II, D-I

(4) A-IV, B-II, C-III, D-I

Correct Answer: (2) A-II, B-IV, C-I, D-III

Solution: Understanding the Sub Phases of Prophase I

- Leptotene: Chromosomes appear as thin threads.

- Zygotene: Synaptonemal complex formation occurs.

- Pachytene: Recombination nodules appear, crossing over occurs.

- Diakinesis: Terminalisation of chiasmata completes, preparing for metaphase.

Conclusion: The correct match is (**2**).

Quick Tip

Prophase I is the longest meiotic phase, crucial for genetic variation due to recombination.

---

168. Match List I with List II:

List I	List II
$A. Fibrous joints$	$I. Adjacent vertebrae, limited movement$
$B. Cartilaginous joints$	$II. Humerus and Pectoral girdle, rotational movement$
$C. Hinge joints$	$III. Skull, don't allow any movement$
$D. Ball and socket joints$	$IV. Knee, help in locomotion$

Choose the correct answer from the options given below:

(1) A-I, B-III, C-II, D-IV

(2) A-II, B-III, C-I, D-IV

(3) A-III, B-I, C-IV, D-II

(4) A-IV, B-II, C-III, D-I

Correct Answer: (3) A-III, B-I, C-IV, D-II

Solution: Understanding Types of Joints

- Fibrous Joints: Found in the skull, with no movement.

- Cartilaginous Joints: Found between vertebrae, allowing limited movement.

- Hinge Joints: Present in knees, allowing movement in one plane.

- Ball and Socket Joints: Shoulder and hip joints allow multi-directional movement.

Conclusion: The correct match is $(\mathbf{3})$.

Quick Tip

Joints allow mobility while maintaining structural integrity; different types provide different movement ranges.

---

169. Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?

(1) High pO2 and Lesser H+ concentration

(2) Low pCO2 and High H+ concentration

(3) Low pCO2 and High temperature

(4) High pO2 and High pCO2

Correct Answer: (1) High pO2 and Lesser H+ concentration

Solution: Conditions for Oxyhaemoglobin Formation

- High pO2 promotes oxygen binding with haemoglobin.

- Low H+ concentration prevents haemoglobin from releasing oxygen.

- Low pCO2 prevents the Bohr effect, which enhances oxygen loading.

Conclusion: (1) is correct.

Quick Tip

Oxygen binds to haemoglobin in high pO2 environments (lungs) and is released in low pO2 tissues.

---

170. Which of the following is not a natural/traditional contraceptive method?

(1) Periodic abstinence

(2) Lactational amenorrhea

(3) Vaults

(4) Coitus interruptus

Correct Answer: (3) Vaults

Solution: Understanding Contraceptive Methods

- Periodic abstinence: Avoiding intercourse during the fertile window.

- Lactational amenorrhea: Temporary infertility during breastfeeding.

- Coitus interruptus: Withdrawal before ejaculation.

- Vaults: Barrier method, not natural.

Conclusion: (3) is correct.

Quick Tip

Natural contraceptive methods rely on physiological changes and awareness, while barrier methods like vaults are artificial.

171. Which of the following are Autoimmune disorders?

A. Myasthenia gravis

B. Rheumatoid arthritis

C. Gout

D. Muscular dystrophy

E. Systemic Lupus Erythematosus (SLE)

Choose the most appropriate answer from the options given below:

(1) A, B E only

(2) B, C E only

(3) C, D E only

(4) A, B D only

Correct Answer: (1) A, B E only

Solution: Understanding Autoimmune Disorders

- Myasthenia gravis: An autoimmune disorder affecting neuromuscular function.

- Rheumatoid arthritis: An autoimmune disease causing joint inflammation.

- Systemic Lupus Erythematosus (SLE): A systemic autoimmune disease.

- Gout: A metabolic disorder, not autoimmune.

- Muscular dystrophy: A genetic disorder, not autoimmune.

Conclusion: The correct answer is (1).

Quick Tip

Autoimmune disorders occur when the immune system mistakenly attacks the body's own cells.

---

172. The "Ti plasmid" of Agrobacterium tumefaciens stands for

(1) Tumor independent plasmid

(2) Tumor inducing plasmid

(3) Temperature independent plasmid

(4) Tumour inhibiting plasmid

Correct Answer: (2) Tumor inducing plasmid

Solution: Understanding Ti Plasmid

- Agrobacterium tumefaciens is a bacterium that causes crown gall disease in plants.

- The Ti plasmid (Tumor-inducing plasmid) carries genes responsible for transforming plant cells.

- It is widely used in genetic engineering to transfer foreign genes into plants.

Conclusion: The correct answer is $(\mathbf{2})$.

Quick Tip

Ti plasmid is an essential tool in plant biotechnology, enabling genetic modifications in crops.

---

173. Which one is the correct product of DNA-dependent RNA polymerase to the given template?

3'-TACATGGCAAATATCCATTCA-5'

(1) 5'-AUGUAAAGUUUAUAGGUAAGU-3'

(2) 5'-AUGUACCGUUUAUAGGGAAGU-3'

(3) 5'-ATGTACCGTTTATAGGTAAGT-3'

(4) 5'-AUGUACCGUUUAUAGGUAAGU-3'

Correct Answer: (4) 5'-AUGUACCGUUUAUAGGUAAGU-3'

Solution: Step 1: Understanding Transcription

- The given DNA template is 3' to 5', and RNA polymerase synthesizes mRNA in the 5' to 3' direction.

- Base pairing rules for transcription:

- A (Adenine) $\rightarrow$ U (Uracil)

- T (Thymine) $\rightarrow$ A (Adenine)

- C (Cytosine) $\rightarrow$ G (Guanine)

- G (Guanine) $\rightarrow$ C (Cytosine)

Step 2: Complementary mRNA Formation

DNA template: 3'-TACATGGCAAATATCCATTCA-5'

mRNA strand: 5'-AUGUACCGUUUAUAGGUAAGU-3'

Conclusion: The correct answer is (4).

Quick Tip

Transcription produces mRNA, which is complementary to the DNA template and replaces thymine (T) with uracil (U).

---

174. Which of the following statements is incorrect?

(1) Most commonly used bio-reactors are of stirring type

(2) Bio-reactors are used to produce small scale bacterial cultures

(3) Bio-reactors have an agitator system, an oxygen delivery system and foam control system

(4) A bio-reactor provides optimal growth conditions for achieving the desired product

Correct Answer: (2) Bio-reactors are used to produce small scale bacterial cultures

Solution: Understanding Bio-reactors

- Bio-reactors are used for large-scale production of microbial cultures.

- Small-scale cultures are grown in flasks or test tubes rather than in bio-reactors.

- Bio-reactors provide controlled temperature, pH, aeration, and mixing to maximize product yield.

Conclusion: The correct answer is (2).

Quick Tip

Bio-reactors are essential in industrial biotechnology for large-scale microbial culture and fermentation processes.

---

175. Match List I with List II

List I (Drug)	List II (Source)
A.Cocaine	I.Effective sedative in surgery
B.Heroin	II.Cannabis sativa
C.Morphine	III.Erythroxylum
D.Marijuana	IV.Papaver somniferum

(1) A-I, B-III, C-II, D-IV

(2) A-II, B-I, C-III, D-IV

(3) A-III, B-IV, C-I, D-II

(4) A-IV, B-III, C-I, D-II

Correct Answer: (3) A-III, B-IV, C-I, D-II

Solution: - Cocaine is derived from **Erythroxylum** plant.

- Heroin is synthesized from morphine, which is obtained from **Papaver somniferum**.

- Morphine is an effective sedative used in surgery.

- Marijuana comes from Cannabis sativa.

Conclusion: The correct answer is (**3**).

Quick Tip

Drugs derived from plants have significant medicinal and recreational impacts.

---

176. Which of the following is not a steroid hormone?

(1) Testosterone

(2) Progesterone

(3) Glucagon

(4) Cortisol

Correct Answer: (3) Glucagon

Solution: - Steroid hormones include testosterone, progesterone, and cortisol.

- Glucagon is a peptide hormone, not a steroid hormone.

- It is produced by pancreatic alpha cells and regulates blood glucose.

Conclusion: The correct answer is (**3**).

Quick Tip

Steroid hormones are derived from cholesterol and regulate metabolism, inflammation, and reproductive functions.

---

177. Match List I with List II

List I (Contraceptive Method)	List II (Example)
A.Non-medicated IUD	I.Multiload 375
B.Copper releasing IUD	II.Progestogens
C.Hormone releasing IUD	III.Lippes loop
D.Implants	IV.LNG-20

(1) A-I, B-III, C-IV, D-II

(2) A-IV, B-I, C-II, D-III

(3) A-III, B-I, C-IV, D-II

(4) A-III, B-I, C-II, D-IV

Correct Answer: (3) A-III, B-I, C-IV, D-II

Solution: - Non-medicated IUD: **Lippes loop**.

- Copper releasing IUD: **Multiload 375**.

- Hormone releasing IUD: **LNG-20**.

- Implants: **Progestogens**.

Conclusion: The correct answer is (3).

Quick Tip

IUDs (Intrauterine Devices) are effective birth control methods with varying mechanisms.

---

178. Given below are two statements:

Statement I: In the nephron, the descending limb of the loop of Henle is impermeable to water and permeable to electrolytes.

Statement II: The proximal convoluted tubule is lined by simple columnar brush

border epithelium and increases the surface area for reabsorption.

(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are true

Correct Answer: (1) Both Statement I and Statement II are false

Solution:

Understanding Nephron Structure and Function

- The **descending limb of the loop of Henle** is **permeable to water** but **partially permeable to electrolytes**, making the given statement **incorrect**.
- The **proximal convoluted tubule (PCT)** is lined with **simple cuboidal brush border epithelium**, not **columnar epithelium**, which makes the given statement **incorrect**.

Conclusion:

The correct answer is (1).

Quick Tip

Nephrons regulate water and electrolyte balance through selective permeability in different segments.

---

179. Given below are some stages of human evolution. Arrange them in correct sequence (Past to Recent).

A. Homo habilis

B. Homo sapiens

C. Homo neanderthalensis

D. Homo erectus

Choose the correct sequence of human evolution from the options given below:

(1) B-A-D-C

(2) C-B-D-A

(3) A-D-C-B

(4) D-A-C-B

Correct Answer: (3) A-D-C-B

Solution: - Homo habilis (Earliest tool-user, appeared 2.1 million years ago).

- Homo erectus (More advanced, first to use fire).

- Homo neanderthalensis (Coexisted with early Homo sapiens, adapted to cold).

- Homo sapiens (Modern humans, dominant species today).

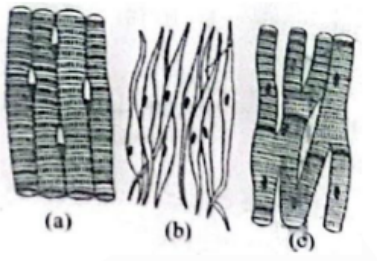
Conclusion: The correct sequence is A-D-C-B.

Quick Tip

Human evolution involved gradual brain development, tool usage, and social complexity.

---

180. Three types of muscles are given as a, b, and c. Identify the correct matching pair along with their location in the human body:



(1) (a) Skeletal - Triceps,

(b) Smooth - Stomach,

(c) Cardiac - Heart

(2) (a) Skeletal - Biceps,

(b) Involuntary - Intestine,

(c) Smooth - Heart

(3) (a) Involuntary - Nose tip,

(b) Skeletal - Bone,

(c) Cardiac - Heart

(4) (a) Smooth - Toes,

(b) Skeletal - Legs,

(c) Cardiac - Heart

Correct Answer: (1) Skeletal - Triceps, Smooth - Stomach, Cardiac - Heart

Solution: - Skeletal muscles: Voluntary, attached to bones (e.g., triceps, biceps).

- Smooth muscles: Involuntary, found in digestive organs (e.g., stomach, intestine).

- Cardiac muscles: Specialized involuntary muscles in the heart.

Conclusion: The correct option is (1).

Quick Tip

Muscle types differ in function: Skeletal (voluntary), Smooth (involuntary), and Cardiac (automatic rhythmic contractions).

---

181. Match List I with List II

	List I		List II
A.	Pleurobrachia	I.	Mollusca
B.	Radula	II.	Ctenophora
C.	Stomochord	III.	Osteichthyes
D.	Air bladder	IV.	Hemichordata

Choose the correct answer from the options given below :

(1) A-II, B-I, C-IV, D-III

(2) A-II, B-IV, C-I, D-III

(3) A-IV, B-III, C-II, D-I

(4) A-IV, B-II, C-III, D-I

Correct Answer: (1) A-II, B-I, C-IV, D-III

Solution:

- Pleurobrachia: Ctenophora, known as comb jellies.

- Radula: Mollusca, rasping organ used for feeding.

- Stomochord: Hemichordata, structure similar to notochord.

- Air bladder: Osteichthyes (bony fish), used for buoyancy.

Conclusion: The correct option is (1).

Quick Tip

Animal classification is based on body structure, function, and evolutionary lineage.

---

182. Match List I with List II

List I (Fish Species)	List II (Common Name)
A.Pterophyllum	I.Hag fish
B.Myxine	II.Saw fish
C.Pristis	III.Angel fish
D.Exocoetus	IV.Flying fish

Choose the correct answer from the options given below :

(1) A-III, B-I, C-II, D-IV

(2) A-IV, B-I, C-II, D-III

(3) A-III, B-II, C-I, D-IV

(4) A-II, B-I, C-III, D-IV

Correct Answer: (1) A-III, B-I, C-II, D-IV

Solution: - Pterophyllum (Angel fish) is a popular aquarium fish.

- Myxine (Hag fish) is a jawless fish known for its slime production.

- Pristis (Saw fish) has a long, saw-like rostrum.

- Exocoetus (Flying fish) can glide above water using wing-like fins.

Conclusion: The correct option is (1).

Quick Tip

Different fish species have unique adaptations for survival, such as gliding, slime production, and specialized feeding structures.

---

183. Match List I with List II

	List I		List II
A.	Typhoid	I.	Fungus
B.	Leishmaniasis	II.	Nematode
C.	Ringworm	III.	Protozoa
D.	Filariasis	IV.	Bacteria

Choose the correct answer from the options given below:

(1) A-IV, B-III, C-I, D-II

(2) A-III, B-I, C-IV, D-II

(3) A-II, B-IV, C-III, D-I

(4) A-I, B-III, C-II, D-IV

Correct Answer: (1) A-IV, B-III, C-I, D-II

Solution:

- Typhoid is caused by the bacterium *Salmonella typhi*.
- Leishmaniasis is caused by the protozoan *Leishmania*.
- Ringworm is a fungal infection affecting the skin.
- Filariasis is caused by a nematode (Wuchereria bancrofti).

Conclusion: The correct option is (1).

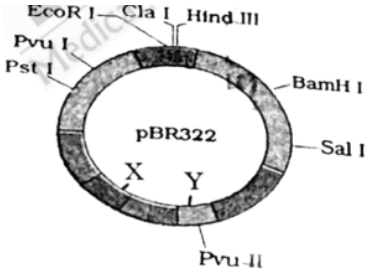
Quick Tip

Different types of pathogens (bacteria, protozoa, fungi, and nematodes) cause various infectious diseases in humans.

---

184. The following diagram shows restriction sites in E. coli cloning vector pBR322.

Find the role of 'X' and 'Y' genes:



(1) The gene 'X' controls the copy number of the linked DNA, and 'Y' codes for a protein

involved in plasmid replication.

(2) The gene ‘X’ codes for a protein involved in plasmid replication, and ‘Y’ provides antibiotic resistance.

(3) Gene ‘X’ is responsible for recognition sites, and ‘Y’ is responsible for antibiotic resistance.

(4) The gene ‘X’ provides antibiotic resistance, and ‘Y’ codes for a protein involved in plasmid replication.

Correct Answer: (1) The gene ‘X’ controls the copy number of the linked DNA, and ‘Y’ codes for a protein involved in plasmid replication.

Solution: - Gene ‘X’: Regulates plasmid copy number, crucial for cloning efficiency.

- Gene ‘Y’: Produces a protein essential for plasmid replication.

Conclusion: The correct option is (1).

Quick Tip

Plasmid vectors such as pBR322 play a critical role in genetic engineering by allowing gene insertion and controlled replication.

---

185. Consider the following statements:

A. Annelids are true coelomates

B. Poriferans are pseudocoelomates

C. Aschelminthes are acoelomates

D. Platyhelminthes are pseudocoelomates

Choose the correct answer from the options given below :

(1) A only

(2) C only

(3) D only

(4) B only

Correct Answer: (1) A only

Solution: - Annelids (e.g., earthworms) have a true coelom (coelomates).

- Poriferans (sponges) lack body cavities and are acoelomates.

- Aschelminthes (roundworms) have a pseudocoelom, not an acoelom.

- Platyhelminthes (flatworms) are also acoelomates, not pseudocoelomates.

Conclusion: The correct statement is (A: Annelids are true coelomates).

Quick Tip

Coelom classification: Coelomates (Annelids), Pseudocoelomates (Aschelminthes), Acoelomates (Platyhelminthes, Porifera).

Section B

186. Choose the correct statement given below regarding juxta medullary nephron.

(1) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.

(2) Loop of Henle of juxta medullary nephron runs deep into medulla.

(3) Juxta medullary nephrons outnumber the cortical nephrons.

(4) Juxta medullary nephrons are located in the columns of Bertini.

Correct Answer: (2) Loop of Henle of juxta medullary nephron runs deep into medulla.

Solution:

Juxta Medullary and Cortical Nephrons: Key Differences

- **Juxta medullary nephrons** have their **renal corpuscle** positioned deep within the **renal cortex**.
- Their **Loop of Henle** extends significantly into the **renal medulla**, enabling **enhanced water reabsorption**.
- **Cortical nephrons** are **more abundant** than juxta medullary nephrons.
- The **Columns of Bertini** do not house nephrons; they primarily serve as **support structures** for the **renal pyramids**.

Conclusion:

The correct answer is (**2**).

Quick Tip

Juxta medullary nephrons play a crucial role in urine concentration by maintaining the osmotic gradient in the medulla.

---

187. Given below are two statements:

Statement I: Bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced.

Statement II: Both bone marrow and thymus provide microenvironments for the development and maturation of T-lymphocytes.

In the light of above statements, choose the most appropriate answer from the options given below :

(1) Both Statement I and Statement II are incorrect.

(2) Statement I is correct but Statement II is incorrect.

(3) Statement I is incorrect but Statement II is correct.

(4) Both Statement I and Statement II are correct.

Correct Answer: (4) Both Statement I and Statement II are correct.

Solution:

- Bone marrow is the primary lymphoid organ responsible for blood cell formation, including lymphocytes.

- T-lymphocytes mature in the thymus, which provides the necessary microenvironment for their differentiation.

- Both bone marrow and thymus play key roles in immune system development.

Conclusion: The correct option is (4).

Quick Tip

Bone marrow is the primary site of hematopoiesis, while the thymus is essential for T-cell maturation.

---

188. Match List I with List II related to the digestive system of cockroach.

	List I		List II
A.	The structures used for storing of food	I.	Gizzard
B.	Ring of 6-8 blind tubules at junction of foregut and midgut.	II.	Gastric Caeca
C.	Ring of 100-150 yellow coloured thin filaments at junction of midgut and hindgut.	III.	Malpighian tubules
D.	The structures used for grinding the food.	IV.	Crop

Choose the correct answer from the options given below:

(1) A-I, B-II, C-III, D-IV

(2) A-IV, B-III, C-II, D-I

(3) A-III, B-II, C-IV, D-I

(4) A-IV, B-II, C-III, D-I

Correct Answer: (4) A-IV, B-II, C-III, D-I

Solution:

- Crop (A-IV): Stores food before digestion.

- Gastric Caeca (B-II): Secretes digestive enzymes.

- Malpighian Tubules (C-III): Excretory structures involved in osmoregulation.

- Gizzard (D-I): Helps in mechanical grinding of food.

Conclusion: The correct option is (4).

Quick Tip

Cockroach digestive system includes the foregut (crop and gizzard), midgut (gastric caeca), and hindgut (Malpighian tubules for excretion).

---

189. Match List I with List II:

	List I		List II
A.	P wave	I.	Heart muscles are electrically silent.
B.	QRS complex	II.	Depolarisation of ventricles.
C.	T wave	III.	Depolarisation of atria.
D.	T-P gap	IV.	Repolarisation of ventricles.

Choose the correct answer from the options given below :

(1) A-III, B-II, C-IV, D-I

(2) A-II, B-III, C-I, D-IV

(3) A-IV, B-II, C-I, D-III

(4) A-I, B-III, C-IV, D-II

Correct Answer: (1) A-III, B-II, C-IV, D-I

Solution:

- P wave represents atrial depolarization, indicating contraction of the atria.

- QRS complex represents ventricular depolarization, indicating contraction of the ventricles.

- T wave represents ventricular repolarization, meaning ventricles relax.

- T-P gap is the period when the heart is electrically silent before the next cycle.

Conclusion: The correct option is (1).

Quick Tip

ECG is an important tool in cardiology, where each wave corresponds to specific electrical events in the heart.

---

190. As per ABO blood grouping system, the blood group of father is B+, mother is A+, and child is O+. Their respective genotype can be:

(A) I^Bi/I^Ai

(B) I^BI^B/I^Ai

(C) I^AB/I^AI^B

(D) I^Ai/I^BI^A

(E) ii/I^AI^B

Choose the most appropriate answer from the options given below :

(1) B only

(2) C & B only

(3) D & E only

(4) A only

Correct Answer: (4) A only

Solution:

- Since the child has O+ blood type, both parents must have one recessive 'i' allele.

- Possible parental genotypes are:

- Father (B+): I^Bi

- Mother (A+): I^Ai

- This allows the child to inherit 'i' from both parents, resulting in O+ blood type.

Conclusion: The correct option is (4).

Quick Tip

The ABO blood group system follows Mendelian inheritance, where 'A' and 'B' are dominant over 'O'.

---

191. Match List I with List II:

List I		List II
A. RNA polymerase III		I. snRNPs
B. Termination of transcription		II. Promoter
C. Splicing of Exons		III. Rho factor
D. TATA box		IV. SnRNAs, tRNA

Choose the **correct** answer from the options given below:

(1) A-III, B-II, C-IV, D-I

(2) A-III, B-IV, C-I, D-II

(3) A-IV, B-III, C-I, D-II

(4) A-II, B-IV, C-I, D-III

Correct Answer: (3) A-IV, B-III, C-I, D-II

Solution:

Step 1: Understanding the Functions of the Given Terms

- RNA polymerase III (A-IV): Responsible for the transcription of **small nuclear RNAs (snRNAs)** and **transfer RNAs (tRNA)**.

- Termination of transcription (B-III): The **Rho factor** plays a role in the termination of transcription in prokaryotic cells.

- Splicing of Exons (C-I): Small nuclear ribonucleoproteins (**snRNPs**) participate in **RNA splicing**, removing introns and joining exons.

- TATA box (D-II): A conserved **promoter** sequence that helps in the initiation of transcription.

Step 2: Matching the Correct Pairs

$$A \to IV \quad \text{(SnRNAs, tRNA)}$$

$$B \to III \quad \text{(Rho factor)}$$

$$C \to I \quad \text{(snRNPs)}$$

$$D \to II \quad \text{(Promoter)}$$

Conclusion: The correct answer is **(3) A-IV, B-III, C-I, D-II**.

Quick Tip

RNA polymerase III transcribes snRNAs and tRNA, the Rho factor terminates transcription, snRNPs assist in splicing, and the TATA box is a crucial promoter sequence for gene expression.

---

192. Given below are two statements:

Statement I:Mitochondria and chloroplasts are both double-membrane bound organelles.

Statement II: Inner membrane of mitochondria is relatively less permeable compared to chloroplast.

In the light of the above statements, choose the mis appropriate answer from the options given below:

(1) Both Statement I and Statement II are incorrect.

(2) Statement I is correct but Statement II is incorrect.

(3) Statement I is incorrect but Statement II is correct.

(4) Both Statement I and Statement II are correct.

Correct Answer: (2) Statement I is correct but Statement II is incorrect.

Solution:

- Mitochondria and chloroplasts are double-membrane bound organelles, confirming Statement I is correct.

- However, the inner membrane of chloroplasts is less permeable than mitochondria, making Statement II incorrect.

- The mitochondrial inner membrane is involved in ATP synthesis and has more selective

transporters than chloroplasts.

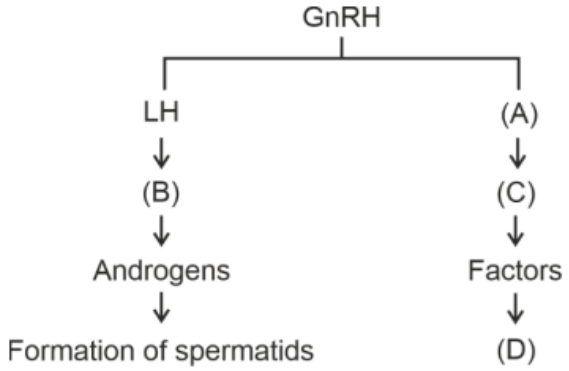
Conclusion: The correct option is (2).

Quick Tip

Mitochondria are the powerhouse of the cell, while chloroplasts are responsible for photosynthesis. Both have their own DNA.

---

193. Identify the correct option (A), (B), (C), (D) with respect to spermatogenesis.



(1) ICSH, Interstitial cells, Leydig cells, spermiogenesis.

(2) FSH, Sertoli cells, Leydig cells, spermatogenesis.

(3) ICSH, Leydig cells, Sertoli cells, spermatogenesis.

(4) FSH, Leydig cells, Sertoli cells, spermiogenesis.

Correct Answer: (4) FSH, Leydig cells, Sertoli cells, spermiogenesis.

Solution: - FSH (Follicle-Stimulating Hormone) stimulates Sertoli cells to support spermatogenesis.

- Leydig cells, stimulated by ICSH (Interstitial Cell-Stimulating Hormone), produce testosterone for sperm development.

- Spermiogenesis is the final transformation of spermatids into mature spermatozoa.

Conclusion: The correct option is (4).

Quick Tip

FSH plays a crucial role in sperm development, while Leydig cells support testosterone production.

---

194. The following are the statements about non-chordates:

A. Pharynx is perforated by gill slits.

B. Notochord is absent.

C. Central nervous system is dorsal.

D. Heart is dorsal if present.

E. Post-anal tail is absent.

Choose the most appropriate answer from the options given below:

(1) A, B & D only

(2) B, D & E only

(3) B, C & D only

(4) A & C only

Correct Answer: (2) B, D & E only

Solution: - Non-chordates lack a notochord and post-anal tail (Statement B, E).

- If a heart is present, it is dorsal (Statement D).

- Gill slits and dorsal CNS are characteristics of chordates, so A and C are incorrect.

Conclusion: The correct option is (2).

Quick Tip

Non-chordates lack a notochord, post-anal tail, and have a ventral nerve cord instead of a dorsal one.

---

195. Given below are two statements:

Statement I: Gause's competitive exclusion principle states that two closely related species competing for different resources cannot exist indefinitely.

Statement II: According to Gause's principle, during competition, the inferior will be eliminated. This may be true if resources are limiting.

In the light of the above statements, choose the correct answer from the options given below :

(1) Both Statement I and Statement II are false.

(2) Statement I is true but Statement II is false.

(3) Statement I is false but Statement II is true.

(4) Both Statement I and Statement II are true.

Correct Answer: (3) Statement I is false but Statement II is true.

Solution: - Gause's principle states that two species competing for the same resources cannot coexist indefinitely, but if they utilize different resources, coexistence is possible.

- Statement I is false, as competition occurs when species compete for same resources.

- Statement II is true, as the inferior competitor is eliminated when resources are limited.

Conclusion: The correct option is (3).

Quick Tip

Competitive exclusion principle states that no two species can occupy the same ecological niche for long.

---

196. Regarding catalytic cycle of an enzyme action, select the correct sequential steps:

A. Substrate enzyme complex formation.

B. Free enzyme ready to bind with another substrate.

C. Release of products.

D. Chemical bonds of the substrate broken.

E. Substrate binding to active site.

Choose the correct answer from the options given below :

(1) A, E, B, D, C

(2) B, A, C, D, E

(3) E, D, C, B, A

(4) E, A, D, C, B

Correct Answer: (4) E, A, D, C, B

Solution: - Step 1 (E): The substrate binds to the active site of the enzyme.

- Step 2 (A): This forms a substrate-enzyme complex.

- Step 3 (D): The enzyme catalyzes the breakage of chemical bonds in the substrate.

- Step 4 (C): The products are released from the enzyme.

- Step 5 (B): The enzyme is free to bind another substrate.

Conclusion: The correct sequence is E $\rightarrow$ A $\rightarrow$ D $\rightarrow$ C $\rightarrow$ B, option (4).

Quick Tip

Enzymes work by lowering the activation energy of a reaction and remain unchanged after the process.

---

197. Given below are two statements:

Statement I: The cerebral hemispheres are connected by nerve tract known as corpus callosum.

Statement II: The brain stem consists of the medulla oblongata, pons and cerebrum.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are incorrect.

(2) Statement I is correct but Statement II is incorrect.

(3) Statement I is incorrect but Statement II is correct.

(4) Both Statement I and Statement II are correct.

Correct Answer: (2) Statement I is correct but Statement II is incorrect.

Solution: - The corpus callosum is a large nerve fiber bundle that connects the two cerebral hemispheres, facilitating communication between them. Statement I is correct.

- The brain stem consists of the midbrain, pons, and medulla oblongata, but not the cerebrum. Statement II is incorrect.

Conclusion: The correct option is (2).

Quick Tip

The brainstem controls vital functions such as breathing, heart rate, and reflexes, while the cerebrum handles higher cognitive functions.

---

198. Match List I with List II:

List I	List II
A. Exophthalmic goiter	I. Excess secretion of cortisol, moon face & hyperglycemia
B. Acromegaly	III. Hyper secretion of thyroid hormone & protruding eye balls
C. Cushing's syndrome	IV. Excessive secretion of growth hormone
D. Cretinism	II. Hypo-secretion of thyroid hormone and stunted growth

Choose the correct answer from the options given below:

(1) A-IV, B-II, C-I, D-III

(2) A-III, B-IV, C-II, D-I

(3) A-III, B-IV, C-I, D-II

(4) A-I, B-III, C-II, D-IV

Correct Answer: (3) A-III, B-IV, C-I, D-II

Solution: - Exophthalmic goiter (Graves' disease) results from hypersecretion of thyroid hormones, leading to protruding eyeballs.

- Acromegaly occurs due to excess growth hormone secretion in adulthood, causing enlarged extremities.

- Cushing's syndrome is caused by excess cortisol secretion, leading to moon face and hyperglycemia.

- Cretinism is due to thyroid hormone deficiency in childhood, causing stunted growth and mental retardation.

Conclusion: The correct option is (3).

Quick Tip

Hormonal imbalances can lead to distinct disorders; thyroid hormones affect metabolism, while cortisol and growth hormone regulate stress and growth.

---

199. Match List I with List II:

	List I		List II
A.	Unicellular glandular epithelium	I.	Salivary glands
B.	Compound epithelium	II.	Pancreas
C.	Multicellular glandular epithelium	III.	Goblet cells of alimentary canal
D.	Endocrine glandular epithelium	IV.	Moist surface of buccal cavity

Choose the correct answer from the options given below:

(1) A-IV, B-III, C-I, D-II

(2) A-III, B-IV, C-I, D-II

(3) A-II, B-I, C-IV, D-III

(4) A-II, B-I, C-III, D-IV

Correct Answer: (2) A-III, B-IV, C-I, D-II

Solution: - Unicellular glandular epithelium consists of goblet cells found in the alimentary canal.

- Compound epithelium forms moist surfaces like the buccal cavity and provides protection.

- Multicellular glandular epithelium is found in salivary glands for secretion.

- Endocrine glandular epithelium includes the pancreas, which secretes hormones.

Conclusion: The correct option is (2).

Quick Tip

Glandular epithelium plays a major role in secretion; unicellular glands release mucus, whereas multicellular glands produce enzymes and hormones.

---

200. Match List I with List II:

	List I		List II
A.	Mesozoic Era	I.	Lower invertebrates
B.	Proterozoic Era	II.	Fish & Amphibia
C.	Cenozoic Era	III.	Birds & Reptiles
D.	Paleozoic Era	IV.	Mammals

Choose the correct answer from the options given below:

(1) A-III, B-I, C-II, D-IV

(2) A-I, B-II, C-IV, D-III

(3) A-III, B-I, C-IV, D-II

(4) A-II, B-I, C-III, D-IV

Correct Answer: (3) A-III, B-I, C-IV, D-II

Solution:

Step 1: Understanding Geological Eras and Their Characteristic Fauna

- Mesozoic Era (A-III): Known as the ”Age of Reptiles,” it saw the dominance of **birds and**

reptiles.

- Proterozoic Era (B-I): Marked by the emergence of **lower invertebrates** such as early multicellular life forms.

- Cenozoic Era (C-IV): Often referred to as the "Age of Mammals," characterized by the evolution and diversification of **mammals**.

- Paleozoic Era (D-II): Notable for the evolution of **fish and amphibians**, which thrived in aquatic environments.

Step 2: Matching the Correct Pairs

$$A \to III \quad \text{(Birds \& Reptiles)}$$

$$B \to I \quad \text{(Lower invertebrates)}$$

$$C \to IV \quad \text{(Mammals)}$$

$$D \to II \quad \text{(Fish \& Amphibia)}$$

Conclusion: The correct answer is **(3) A-III, B-I, C-IV, D-II**.

Quick Tip

The geological time scale classifies Earth's history into different eras. The **Proterozoic Era** saw early multicellular life, the **Paleozoic Era** was dominated by fish and amphibians, the **Mesozoic Era** was the age of reptiles and birds, and the **Cenozoic Era** saw the rise of mammals.
