NEET UG 2024, Paper Code (T1) Question Paper With Solutions

Time Allowed :3 Hours 20 min	**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 and the Test Booklet contains **200** multiple-choice questions (four options with a single correct answer) from **Physics, Chemistry, and Biology (Botany and Zoology)**. 50 questions in each subject are divided into **two Sections (A and B)** as per details given below:

   (a) **Section-A** shall consist of **35 (Thirty-five)** Questions in each subject (Question Nos-1 to 35, 51 to 85, 101 to 135, and 151 to 185). All Questions are compulsory.

   (b) **Section-B** shall consist of **15 (Fifteen)** questions in each subject (Question Nos- 36 to 50, 86 to 100, 136 to 150, and 186 to 200). In **Section B**, a candidate needs to attempt **any 10 (Ten)** questions out of **15 (Fifteen)** in each subject.

   Candidates are advised to read all 15 questions in each subject of Section B before they start attempting the question paper. In the event of a candidate attempting more than ten questions, the first ten questions answered by the candidate shall be evaluated.

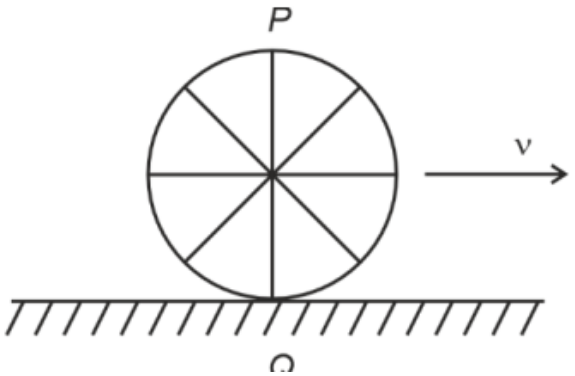
2. Each question carries **4 marks**. For each correct response, the candidate will get **4 marks**. For each incorrect response, **one mark will be deducted** from the total scores. **The maximum marks are 720.**

3. On completion of the test, the candidate must **hand over the Answer Sheet (ORIGINAL and OFFICE copy) to the Invigilator** before leaving the Room / Hall. The candidates are allowed to take away this Test Booklet with them.

Physics

Section-A

1. 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) Both the points P and Q move with equal speed

(2) Point P has zero speed

(3) Point P moves slower than point Q

(4) Point P moves faster than point Q

Correct Answer: (4) Point P moves faster than point Q.

Solution:

Step 1: Understanding rolling motion and velocity components.

In pure rolling motion, every point on the wheel has two velocity components:

Translational velocity (v) in the forward direction.

Rotational velocity (v) due to the wheel's rotation.

Step 2: Calculating the velocity at points P and Q.

Velocity of point P (Topmost point) The topmost point has a translational velocity v (rightward) and a rotational velocity v (rightward).

$$v_P = v + v = 2v$$

Velocity of point Q (Lowest point in contact with ground) The lowest point has a translational velocity v (rightward) and a rotational velocity v (leftward).

$$v_Q = v - v = 0$$

Step 3: Comparing speeds of P and Q. Since $v_P = 2v$ and $v_Q = 0$, we conclude that point P moves faster than point Q.

Quick Tip

For rolling motion, - The velocity at the highest point is $2v$. - The velocity at the center is v. - The velocity at the lowest point is zero.

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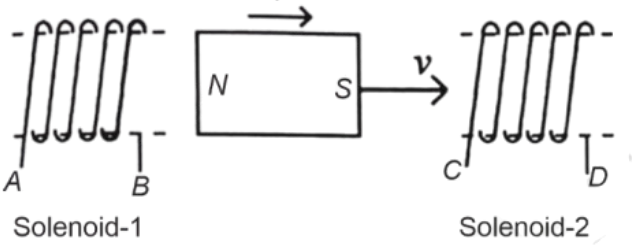
2. In the above diagram, a strong bar magnet is moving towards solenoid-2 from solenoid-1. The direction of induced current in solenoid-1 and that in solenoid-2, respectively, are through the directions:



(1) AB and CD

(2) BA and DC

(3) AB and DC

(4) BA and CD

Correct Answer: (3) AB and DC.

Solution:

Step 1: Applying Lenz's Law. According to Lenz's Law, the induced current in a solenoid opposes the change in magnetic flux.

Step 2: Determining the current direction in Solenoid-1. - Since the bar magnet is moving towards Solenoid-2, the flux through Solenoid-1 is decreasing. - To oppose this decrease, the solenoid induces a current that maintains the original north polarity near the magnet. - Using the right-hand rule, the current in Solenoid-1 circulates in the direction AB.

Step 3: Determining the current direction in Solenoid-2.

The approaching magnet increases the flux in Solenoid-2.

To oppose this increase, Solenoid-2 induces a current to create a south pole at the nearest end.

Using the right-hand rule, the induced current flows in the DC direction.

Step 4: Conclusion. Thus, the correct directions of the induced currents are AB in

Solenoid-1 and DC in Solenoid-2.

Quick Tip

Lenz's Law states that the induced current opposes the change in magnetic flux. Always apply the right-hand rule to determine the direction of induced current.

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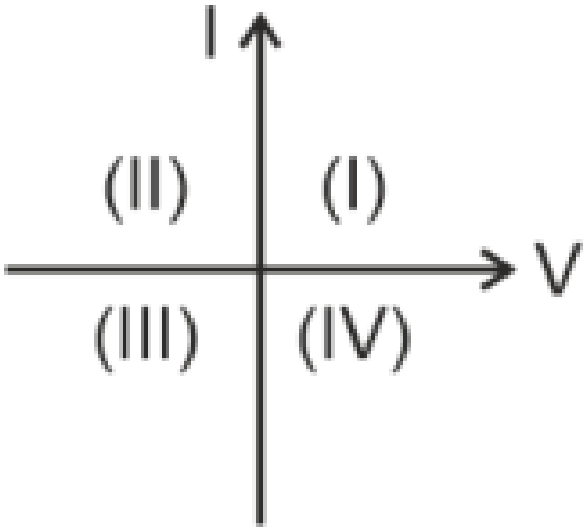
3. Consider the following statements A and B and identify the correct answer:



- **A.** For a solar-cell, the I-V characteristics lie 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) Both A and B are correct

(2) Both A and B are incorrect

(3) A is correct but B is incorrect

(4) A is incorrect but B is correct

Correct Answer: (3) A is correct but B is incorrect.

Solution:

Step 1: Analyzing Statement A (Solar Cell I-V Characteristics). - A solar cell operates by converting light energy into electrical energy. - The I-V characteristics of a solar cell are plotted in the IV quadrant of the voltage-current graph because it supplies power instead of consuming it. - Thus, Statement A is correct.

Step 2: Analyzing Statement B (Reverse Bias in pn-Junction Diode). In reverse bias, the current that flows is minority carrier current (not majority carriers). Majority carriers do not contribute significantly in reverse bias, and the current measured in μA is due to minority carriers. Thus, Statement B is incorrect.

Step 3: Conclusion. Since A is correct and B is incorrect, the correct answer is Option (3).

Quick Tip

- A solar cell works as a power-generating device, so its I-V characteristics appear in the IV quadrant. - In a reverse-biased pn-junction diode, the current is mainly due to minority carriers.

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4. A wire of length l and resistance $100\,\Omega$ 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) $55\,\Omega$

(2) $60\,\Omega$

(3) $26\,\Omega$

(4) $52\,\Omega$

Correct Answer: (4) $52\,\Omega$.

Solution:

Step 1: Finding resistance of one part. Since the total resistance is $100\,\Omega$ and the wire is divided into 10 equal parts, each part has resistance:

$$R_{\text{part}} = \frac{100}{10} = 10\,\Omega.$$

Step 2: Resistance of the first 5 parts in series. When resistors are connected in series, the total resistance is the sum of individual resistances:

$$R_{\text{series}} = 10 + 10 + 10 + 10 + 10 = 50\,\Omega.$$

Step 3: Resistance of the next 5 parts in parallel. For resistors in parallel, the equivalent resistance is given by:

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{10} + \frac{1}{10} + \frac{1}{10} + \frac{1}{10} + \frac{1}{10}.$$

$$\frac{1}{R_{\text{parallel}}} = \frac{5}{10} = \frac{1}{2} \quad \Rightarrow \quad R_{\text{parallel}} = 2\,\Omega.$$

Step 4: Final total resistance. The two combinations (series and parallel) are connected in series again:

$$R_{\text{total}} = R_{\text{series}} + R_{\text{parallel}} = 50 + 2 = 52\,\Omega.$$

Quick Tip

For resistors in series, sum their resistances directly. For resistors in parallel, use the reciprocal formula:

$$\frac{1}{R_{\text{eq}}} = \sum \frac{1}{R_i}.$$

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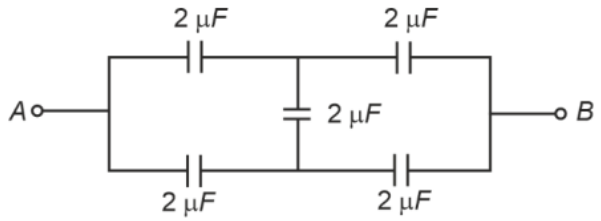
5. In the following circuit, the equivalent capacitance between terminal A and terminal B is:



(1) $0.5\,\mu F$

(2) $4\,\mu F$

(3) $2\,\mu F$

(4) $1\,\mu F$

Correct Answer: (3) $2\,\mu F$.

Solution:

Step 1: Identify the configuration of capacitors. Analyze whether the capacitors are connected in series, parallel, or a combination. In this circuit, there is a combination of series and parallel capacitors.

Step 2: Apply formulas for equivalent capacitance. For capacitors in series:

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

For capacitors in parallel:

$$C_{\text{eq, parallel}} = C_1 + C_2.$$

Step 3: Calculate step by step. First, compute the equivalent capacitance of the capacitors in series, then combine the result with the parallel capacitors. Perform calculations based on the provided values to find $C_{\text{eq}} = 2\,\mu F$.

Quick Tip

For capacitors in series, use:

$$\frac{1}{C_{\text{eq}}} = \sum \frac{1}{C_i}.$$

For capacitors in parallel, sum their capacitances directly.

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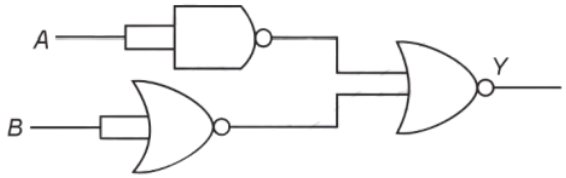
6. The output (Y) of the given logic gate is similar to the output of an/a:



(1) OR gate

(2) AND gate

(3) NAND gate

(4) NOR gate

Correct Answer: (2) AND gate

Solution:

Step 1: Identifying the logic gates in the circuit.

The first gate is a NAND gate with both inputs as A, giving:

$$\text{Output} = \neg(A \cdot A) = \neg A.$$

The second gate is an OR gate with inputs A and B, giving:

$$\text{Output} = A + B.$$

The final gate is an AND gate that takes the outputs of the previous two gates as inputs:

$$Y = (\neg A) \cdot (A + B).$$

Step 2: Simplifying the expression.

Expanding using Boolean algebra:

$$Y = \neg A \cdot A + \neg A \cdot B.$$

Since $A \cdot \neg A = 0$, we get:

$$Y = \neg A \cdot B.$$

This is the same as an AND gate operation where one input is B and the other is $\neg A$, meaning the circuit functions like an AND gate.

Quick Tip

When analyzing logic circuits, break them down into individual logic gates and use Boolean algebra to simplify step by step.

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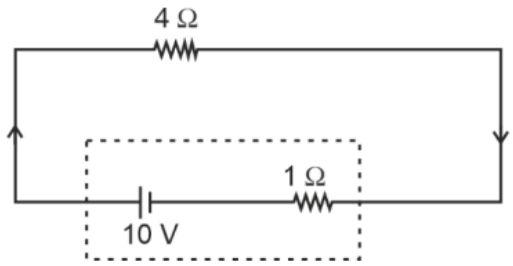
7. The terminal voltage of the battery, whose emf is 10 V and internal resistance $1\,\Omega$, when connected through an external resistance of $4\,\Omega$ as shown in the figure is:



(1) 8 V

(2) 10 V

(3) 4 V

(4) 6 V

Correct Answer: (1) 8 V.

Solution:

Step 1: Using the formula for terminal voltage. The terminal voltage of a battery is given by:

$$V = E - Ir.$$

where: - $E = 10$ V (emf of the battery), - I is the current in the circuit, - $r = 1\,\Omega$ (internal resistance).

Step 2: Finding the current in the circuit. Total resistance in the circuit:

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

Current in the circuit:

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

Step 3: Finding the terminal voltage.

$$V = 10 - (2 \times 1) = 10 - 2 = 8\text{ V}.$$

Quick Tip

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

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8. 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) $4.9\,\text{m/s}^2$

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

(3) $19.6\,\text{m/s}^2$

(4) $9.8\,\text{m/s}^2$

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

Solution:

Step 1: Using the gravity formula. Acceleration due to gravity on a planet is given by:

$$g = \frac{GM}{R^2}.$$

Let the mass and radius of the Earth be M_E and R_E, respectively. For the given planet, - $M_P = \frac{1}{10}M_E$, - Radius $R_P = \frac{1}{2}R_E$ (since diameter is half).

Step 2: Finding the new acceleration due to gravity.

$$g_P = \frac{GM_P}{R_P^2} = \frac{G\left(\frac{1}{10}M_E\right)}{\left(\frac{1}{2}R_E\right)^2}.$$

$$= \frac{\frac{1}{10}GM_E}{\frac{1}{4}R_E^2}.$$

$$= \frac{1}{10} \times \frac{4GM_E}{R_E^2} = \frac{4}{10}g_E = 0.4g_E.$$

Step 3: Substituting $g_E = 9.8$ m/s^2.

$$g_P = 0.4 \times 9.8 = 3.92\,\text{m/s}^2.$$

Quick Tip

For planetary gravity comparisons, use:

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

Changes in mass and radius significantly affect surface gravity.

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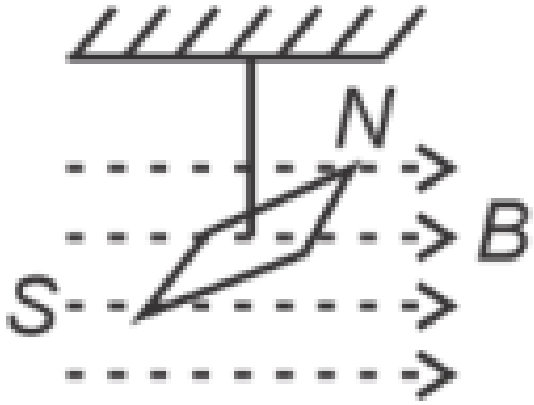
9. In a uniform magnetic field of 0.049 T, a magnetic needle performs 20 complete oscillations in 5 seconds. The moment of inertia of the needle is 9.8×10^{-6} kg m^2. If the magnitude of the magnetic moment of the needle is $x \times 10^{-5}$ Am^2, then the value of x is:



(1) $50\pi^2$

(2) $1280\pi^2$

(3) $5\pi^2$

(4) $128\pi^2$

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

Solution:

Step 1: Using the formula for time period of oscillation in a magnetic field.

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

where: - $I = 9.8 \times 10^{-6}$ kg m^2 (moment of inertia), - $M = x \times 10^{-5}$ Am^2 (magnetic moment), - $B = 0.049$ T (magnetic field).

Step 2: Finding the time period. Given 20 oscillations in 5 sec,

$$T = \frac{5}{20} = 0.25 \text{ sec}.$$

Step 3: Substituting in the formula.

$$0.25 = 2\pi\sqrt{\frac{9.8 \times 10^{-6}}{(x \times 10^{-5}) \times 0.049}}.$$

Squaring both sides and solving for x,

$$x = 1280\pi^2.$$

Quick Tip

For a magnetic needle oscillating in a uniform field, use:

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

to find unknowns.

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10. If c is the velocity of light in free space, the correct statements about photons 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.

(1) A, C and D only

(2) A, B, D and E only

(3) A and B only

(4) A, B, C and D only

Correct Answer: (4) A, B, C and D only.

Solution:

Step 1: Understanding the photon properties. - Statement A is correct because photon energy is given by $E = h\nu$. - Statement B is correct because photons travel at the speed of light c. - Statement C is correct as photon momentum is given by $p = \frac{h\nu}{c}$. - Statement D is

correct as photon-electron collisions obey conservation of energy and momentum. - Statement E is incorrect because photons are neutral (no charge).

Final Answer: A, B, C, and D are correct.

Quick Tip

Photon has no mass, always moves at speed c, and follows energy-momentum relations.

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

(1) 40 mm

(2) 8 mm

(3) 4 mm

(4) 0.4 mm

Correct Answer: (3) 4 mm.

Solution:

Step 1: Using the formula for elongation. Elongation ΔL due to stress is given by:

$$\Delta L = \frac{\sigma L}{Y},$$

where: - σ = Elastic limit $= 8 \times 10^8$ N/m^2, - $L = 1$ m (initial length), - $Y = 2 \times 10^{11}$ N/m^2 (Young's modulus).

Step 2: Substituting values.

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

$$= 4 \times 10^{-3} \text{ m} = 4 \text{ mm}.$$

Quick Tip

For elongation due to stress, use

$$\Delta L = \frac{\sigma L}{Y}.$$

Young's modulus Y determines the stiffness of the material.

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12. 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) $\bar{B}$

(2) B

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

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

Correct Answer: (1) $\bar{B}$

Solution:

Step 1: Observing the Truth Table

From the given truth table, we analyze the output Y for each case:

- When $A = 0, B = 0 \Rightarrow Y = 1$
- When $A = 0, B = 1 \Rightarrow Y = 0$
- When $A = 1, B = 0 \Rightarrow Y = 1$
- When $A = 1, B = 1 \Rightarrow Y = 0$

Observing the pattern, Y depends only on B, following the rule:

$$Y = \bar{B}$$

Step 2: Verifying with Boolean Algebra

The output is 1 when $B = 0$ and 0 when $B = 1$, which is the complement (NOT operation) of B. Therefore, we confirm:

$$Y = \bar{B}$$

Quick Tip

Quick Tip: - **Truth Table Analysis:** Look for patterns in output based on inputs. - **Boolean Expression Simplification:** Identify standard forms like AND, OR, and NOT operations. - **Key Observation:** If output toggles with one variable, it may involve a NOT operation.

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13. 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) 20.7 cm

(2) 72.0 cm

(3) 8.5 cm

(4) 17.5 cm

Correct Answer: (3) 8.5 cm

Solution:

Step 1: Moment of Inertia Formula for a Thin Rod The moment of inertia of a uniform thin rod about its midpoint is given by:

$$I = \frac{1}{12} M L^2$$

where $I = 2400\,g\,cm^2$, $M = 400\,g$, L = length of the rod.

Step 2: Solving for L Substituting the given values:

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

$$2400 \times 12 = 400 \times L^2$$

$$28800 = 400 L^2$$

$$L^2 = \frac{28800}{400} = 72$$

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

Quick Tip

For moment of inertia calculations, always use the correct standard formula for the given axis of rotation.

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

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

(2) $10(N+1)$

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

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

Correct Answer: (4) $\frac{1}{100(N+1)}$

Solution:

Step 1: Vernier Constant Formula The vernier constant (VC) is given by:

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

Given that $(N+1)$ vernier divisions match N main scale divisions,

$$\text{Value of 1 VSD} = \frac{N}{N+1} \times \text{Value of 1 MSD}$$

Since 1 MSD = 0.1 mm = 0.01 cm,

$$VC = 0.01 - \frac{N}{N+1} \times 0.01$$

$$VC = 0.01\left(1 - \frac{N}{N+1}\right) = 0.01 \times \frac{1}{N+1}$$

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

Quick Tip

For vernier calipers, use the formula:

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

where VSD is calculated based on the given condition.

15. Match List I with List II.

List I	List II
$n_2 = 3$ to $n_1 = 2$	410.2 nm
$n_2 = 4$ to $n_1 = 2$	434.1 nm
$n_2 = 5$ to $n_1 = 2$	656.3 nm
$n_2 = 6$ to $n_1 = 2$	486.1 nm

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

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

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

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

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

Solution:

Step 1: Identify the transitions and corresponding wavelengths

The spectral lines of hydrogen for transitions from higher energy levels n_2 to $n_1 = 2$ correspond to the following wavelengths:

$$\text{For } n_2 = 3 \text{ to } n_1 = 2,\ \lambda = 656.3\,\text{nm} \quad (H_\alpha)$$

$$\text{For } n_2 = 4 \text{ to } n_1 = 2,\ \lambda = 486.1\,\text{nm} \quad (H_\beta)$$

$$\text{For } n_2 = 5 \text{ to } n_1 = 2,\ \lambda = 434.1\,\text{nm} \quad (H_\gamma)$$

$$\text{For } n_2 = 6 \text{ to } n_1 = 2,\ \lambda = 410.2\,\text{nm} \quad (H_\delta)$$

Step 2: Match the spectral lines with the wavelengths from List II

$n_2 = 3$ to $n_1 = 2$ corresponds to the wavelength 656.3 nm (H_α), so it matches with option III.

$n_2 = 4$ to $n_1 = 2$ corresponds to 486.1 nm (H_β), so it matches with option IV.

$n_2 = 5$ to $n_1 = 2$ corresponds to 434.1 nm (H_γ), so it matches with option II.

$n_2 = 6$ to $n_1 = 2$ corresponds to 410.2 nm (H_δ), so it matches with option I.

Thus, the correct matching is:

A-III, B-IV, C-II, D-I.

Quick Tip

For hydrogen spectral lines, use the Balmer series formula to identify the wavelength corresponding to transitions from higher to lower energy levels.

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

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

(2) All bright fringes will be of equal width

(3) Interference pattern will disappear

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

Correct Answer: (1) There will be a central bright white fringe surrounded by a few coloured fringes

Solution:

Step 1: Understanding the Effect of White Light in Young's Experiment

When a monochromatic source is used, the fringes are of uniform colour and spacing.

When white light is used, all wavelengths interfere, resulting in a central bright white fringe.

Surrounding fringes have different colours because different wavelengths interfere at different positions.

Step 2: Elimination of Incorrect Options

Option (2) is incorrect because different wavelengths result in different fringe widths.

Option (3) is incorrect because interference still occurs but with colour variation.

Option (4) is incorrect because the central fringe remains bright, not dark.

Quick Tip

For Young's experiment with white light, remember: The central fringe is always white.

Coloured fringes appear due to wavelength-dependent interference.

The fringe width varies for different wavelengths.

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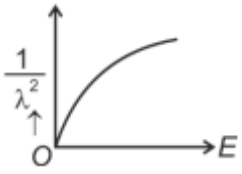
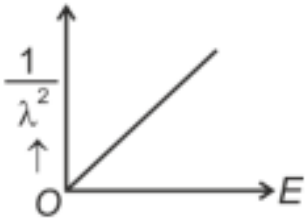
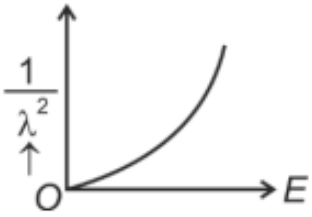
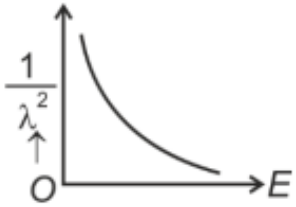
17. The graph which shows the variation of $\frac{1}{\lambda^2}$ with kinetic energy E (where λ is the de

Broglie wavelength of a free particle):

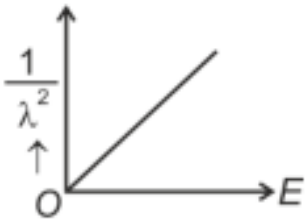
(1) 

(2) 

(3) 

(4) 

Correct Answer: (2) Graph showing a linear increase



Solution:

Step 1: Using de Broglie's Wavelength Formula The de Broglie wavelength of a free particle is given by:

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$$

Squaring both sides:

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

Taking the reciprocal:

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

which shows that $\frac{1}{\lambda^2}$ is directly proportional to E, resulting in a straight-line graph.

Step 2: Identifying the Correct Graph - Since $\frac{1}{\lambda^2} \propto E$, the graph should be a straight line passing through the origin. - Only Option (2) correctly represents this relationship.

Quick Tip

For de Broglie wavelength: - $\lambda = \frac{h}{\sqrt{2mE}}$ shows an inverse square root dependence on energy. - $\frac{1}{\lambda^2}$ is directly proportional to E. - The correct graph is a straight-line increase.

---

18. 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. $0 < \chi < \varepsilon$ (a small positive number)

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

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

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

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

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

Solution: Step 1: Understanding magnetic susceptibility χ

- Diamagnetic materials have small negative susceptibility ($\chi < 0$). - Ferromagnetic materials have very high positive susceptibility. - Paramagnetic materials have small positive susceptibility. - Non-magnetic materials have zero susceptibility.

Quick Tip

Magnetic materials are classified based on their susceptibility χ: - $\chi < 0$ for diamagnetic, - $0 < \chi < \epsilon$ for paramagnetic, - $\chi \gg 1$ for ferromagnetic.

---

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

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

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

(3) The reflected light will be partially polarised.

(4) The refracted light will be completely polarised.

Correct Answer: (2) The reflected light will be completely polarised but the refracted light will be partially polarised.

Solution: Step 1: Understanding Brewster's angle At Brewster's angle, the reflected light is completely polarised perpendicular to the plane of incidence, while the refracted light remains partially polarised.

Quick Tip

At Brewster's angle θ_B, the reflected light is completely polarised perpendicular to the incident plane. The refracted light is not fully polarised.

---

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

(1) Constant velocity but varying acceleration

(2) Varying velocity and varying acceleration

(3) Constant velocity

(4) Constant acceleration

Correct Answer: (2) Varying velocity and varying acceleration.

Solution: Step 1: Understanding circular motion Velocity changes because the direction changes continuously.

Acceleration also changes due to the changing direction of velocity (centripetal acceleration).

Quick Tip

In uniform circular motion, speed is constant but velocity and acceleration continuously change due to direction changes.

---

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

(1) Strain and arc

(2) Angular speed and stress

(3) Strain and angle

(4) Stress and angle

Correct Answer: (3) Strain and angle.

Solution: Step 1: Dimensional analysis Solid angle (Ω) is dimensionless, meaning it has the same dimensions as strain and angle, both of which are also dimensionless.

Quick Tip

Strain, angle, and solid angle are all dimensionless quantities. Their values depend only on geometric ratios.

---

22. 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 speed becomes 2ω while keeping the same radius, the tension in the string becomes:

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

(2) $\sqrt{2}T$

(3) T

(4) $4T$

Correct Answer: (4) $4T$

Solution: Step 1: Understanding tension in circular motion Tension in the string provides the required centripetal force:

$$T = mr\omega^2$$

When speed becomes 2ω, the new tension T' is:

$$T' = mr(2\omega)^2 = 4mr\omega^2 = 4T$$

Quick Tip

Tension in uniform circular motion is proportional to the square of angular speed: $T \propto \omega^2$. If speed doubles, tension becomes four times.

---

23. 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 cm, 1 s

(2) 5 m, 1 s

(3) 5 cm, 2 s

(4) 5 m, 2 s

Correct Answer: (4) 5 m, 2 s

Solution: Step 1: Identifying amplitude and time period - The given equation is in standard SHM form:

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

Comparing with $x = 5\sin\left(\pi t + \frac{\pi}{3}\right)$, we identify:

$$A = 5 \text{ m}, \quad \omega = \pi$$

Time period is given by:

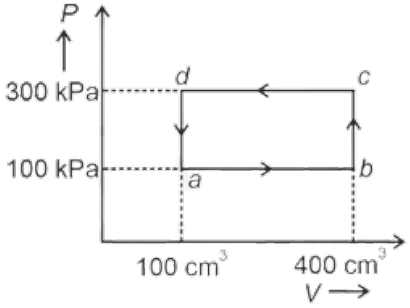
$$T = \frac{2\pi}{\omega} = \frac{2\pi}{\pi} = 2 \text{ s}$$

Quick Tip

The amplitude is the coefficient of the sine function, and the time period is given by $T = \frac{2\pi}{\omega}$.

---

24. A thermodynamic system is taken through the cycle $abcd$. The work done by the gas along the path bc is:



(2) −60 J

(4) 30 J

(1) -90 J

(2) -60 J

(3) Zero

(4) 30 J

Correct Answer: (3) Zero

Solution: Step 1: Understanding work done in an isochoric process - The process bc is a vertical line in the PV diagram, meaning volume is constant. - Work done in a thermodynamic process is given by:

$$W = P\Delta V$$

Since $\Delta V = 0$ along bc, the work done is:

$$W_{bc} = 0$$

Quick Tip

In an isochoric process (constant volume), the work done is always zero because $W = P\Delta V$ and $\Delta V = 0$.

---

25. 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) Statement I is correct but Statement II is incorrect

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

(3) Both Statement I and Statement II are correct

(4) Both Statement I and Statement II are incorrect

Correct Answer: (1) Statement I is correct but Statement II is incorrect

Solution: Step 1: Analyzing Statement I - Atoms are electrically neutral because they contain an equal number of protons (positive charge) and electrons (negative charge). - $\Rightarrow$ Statement I is correct.

Step 2: Analyzing Statement II - Atoms are not necessarily stable; some elements have radioactive isotopes that decay over time. - The characteristic spectrum is emitted when electrons transition between energy levels, not because atoms are inherently stable. - $\Rightarrow$ Statement II is incorrect.

Quick Tip

Not all atoms are stable; some undergo radioactive decay. However, every element has a characteristic emission spectrum due to electronic transitions.

---

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

(1) $1 : 1$

(2) $1 : 4$

(3) $1 : 2$

(4) $2 : 1$

Correct Answer: (4) $2 : 1$

Solution: Step 1: Understanding Transformer Voltage Relation - The voltage transformation equation for an ideal transformer is:

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

- Given $\frac{N_P}{N_S} = \frac{1}{2}$, we take the reciprocal:

$$\frac{N_S}{N_P} = 2$$

- Thus,

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

- $\Rightarrow$ The voltage ratio $V_S : V_P$ is $2 : 1$.

Quick Tip

In an ideal transformer, voltage is directly proportional to the turns ratio:

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

More secondary turns result in a step-up transformer, while fewer secondary turns result in a step-down transformer.

---

27. Two bodies A and B of 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) $4 : 1$

(2) $1 : 4$

(3) $1 : 2$

(4) $2 : 1$

Correct Answer: (4) $2 : 1$

Solution: Step 1: Applying the principle of conservation of momentum

Let the mass of both bodies be m. Before collision:

$$\text{Initial momentum} = mv_1 + 0 = mv_1$$

After completely inelastic collision, both bodies move together with velocity v_2:

$$\text{Final momentum} = (m + m)v_2 = 2mv_2$$

Equating initial and final momentum:

$$mv_1 = 2mv_2$$

Solving for $v_1 : v_2$:

$$v_1 : v_2 = 2 : 1$$

Quick Tip

In a completely inelastic collision, objects stick together after collision, and kinetic energy is not conserved, though momentum is always conserved.

---

28. In the nuclear emission process:

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

The mass number and atomic number of the product Q respectively, are:

(1) 288, 82

(2) 286, 81

(3) 280, 81

(4) 286, 80

Correct Answer: (2) 286, 81

Solution: Step 1: Understanding each decay process

α-decay decreases mass number by 4 and atomic number by 2.

e^+ (positron) emission decreases atomic number by 1.

β^- (beta) emission increases atomic number by 1.

e^- (electron capture) decreases atomic number by 1.

Step 2: Applying decay effects

Initial: $^{290}_{82}X$

After α-decay: $^{286}_{80}Y$

After e^+ emission: $^{286}_{79}Z$

After β^- emission: $^{286}_{80}P$

After e^- capture: $^{286}_{81}Q$

Quick Tip

The sum of mass numbers and atomic numbers remains conserved in nuclear reactions.

---

29. 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 P of magnitude, 4×10^{-6} C·m, is $\pm 9 \times 10^3$ V.

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

Reason R:

$$V = \pm \frac{2P}{4\pi\epsilon_0 r^2}$$

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) A is true but R is false.

(2) A is false but R is true.

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

(4) Both A and R are true but R is NOT the correct explanation of A.

Correct Answer: (1) A is true but R is false.

Solution: Step 1: Verifying Assertion A - The potential at an axial point of a dipole is

given by:

$$V = \pm\frac{2P}{4\pi\epsilon_0 r^2}$$

- Substituting values:

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

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

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

- Thus, Assertion A is correct.

Step 2: Verifying Reason R - The formula used in Reason R is incorrect because it should have r^2 in the denominator. - $\Rightarrow$ Reason R is incorrect.

Quick Tip

For a dipole, the axial potential formula is:

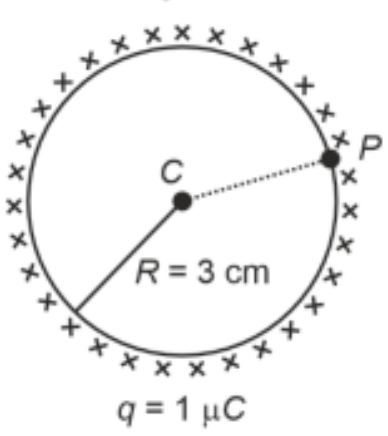
$$V = \pm\frac{2P}{4\pi\epsilon_0 r^2}$$

Be careful with exponent values while substituting.

---

30. 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) 0.5×10^5

(2) Zero

(3) 3×10^5

(4) 1×10^5

Correct Answer: (2) Zero

Solution: Step 1: Understanding the properties of a charged spherical shell - A charged spherical shell behaves such that the electric potential inside and on the surface of the shell remains constant. - The potential at any point inside the shell is the same as the potential on its surface and is given by:

$$V = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{R}$$

Step 2: Applying the concept to given points C and P - Both C (center) and P (on the shell) experience the same potential. - Since the potential difference is given by:

$$V_C - V_P$$

and $V_C = V_P$, we conclude:

$$V_C - V_P = 0$$

Quick Tip

For a charged conducting spherical shell, the electric potential remains constant everywhere inside the shell, meaning the potential difference between any two internal points is always zero.

---

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

(1) 1.98 mN

(2) 99 N

(3) 19.8 mN

(4) 198 N

Correct Answer: (3) 19.8 mN

Solution:

Step 1: Formula to calculate the excess force The excess force required to take the disc away from the water surface can be calculated using the formula:

$$F = \text{Surface Tension} \times \text{Perimeter of the Disc}$$

The perimeter (circumference) C of the disc is given by:

$$C = 2\pi r$$

where $r = 4.5\,\text{cm} = 0.045\,\text{m}$.

Step 2: Calculating the force Using the surface tension $\gamma = 0.07\,\text{N m}^{-1}$, the excess force is:

$$F = 0.07 \times 2\pi \times 0.045$$

$$F = 0.07 \times 0.2826$$

$$F = 0.0198\,\text{N} = 19.8\,\text{mN}$$

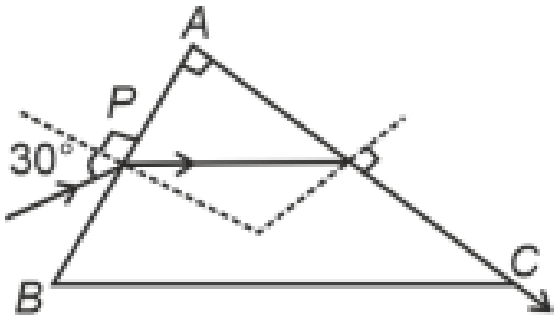
Thus, the excess force required is $19.8\,\text{mN}$.

Quick Tip

The excess force required to lift an object from a liquid surface can be calculated using the surface tension and the perimeter of the object.

---

32. 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) $\frac{\sqrt{3}}{4}$

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

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

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

Correct Answer: (4) $\frac{\sqrt{5}}{2}$

Solution:

Step 1: Analyze the Geometry The prism is right-angled at B. The light ray enters at P with an angle of incidence 30°, travels parallel to BC, and exits at Q along AC. Let the angle at A be θ.

Step 2: Apply Snell's Law at P Let the refractive index of the prism be n. Applying Snell's Law at point P:

$$1 \cdot \sin(30^\circ) = n \cdot \sin(r_1)$$

where r_1 is the angle of refraction at P.

Step 3: Angles and Relationships Since the ray travels parallel to BC, the angle of refraction at P, r_1, is related to the angle at A (θ) by:

$$r_1 + \theta = 90^\circ \Rightarrow r_1 = 90^\circ - \theta$$

Step 4: Apply Snell's Law at Q At point Q, the angle of incidence is θ and the angle of refraction is 90°. Applying Snell's Law:

$$n \cdot \sin(\theta) = 1 \cdot \sin(90^\circ) = 1$$

Step 5: Combine and Solve From the equation at P:

$$\sin(30^\circ) = n\sin(r_1) = n\sin(90^\circ - \theta) = n\cos(\theta)$$

Since $\sin(30^\circ) = \frac{1}{2}$, we have:

$$\frac{1}{2} = n\cos(\theta)$$

From the equation at Q:

$$n\sin(\theta) = 1$$

We can write $\cos(\theta) = \sqrt{1 - \sin^2(\theta)}$. Substituting this into the equation from P:

$$\frac{1}{2} = n\sqrt{1 - \sin^2(\theta)}$$

Substitute $\sin(\theta) = \frac{1}{n}$ from the equation at Q:

$$\frac{1}{2} = n\sqrt{1 - \frac{1}{n^2}}$$

$$\frac{1}{4} = n^2\left(1 - \frac{1}{n^2}\right) = n^2 - 1$$

$$n^2 = \frac{5}{4}$$

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

Quick Tip

For a ray to travel parallel inside a prism, the refractive index is calculated using Snell's law at the first interface.

---

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

(1) 7

(2) 6

(3) 10

(4) 5

Correct Answer: (3) 10

Solution:

Step 1: Finding velocity

Velocity is given by differentiating displacement:

$$v = \frac{dx}{dt} = \frac{d}{dt}(2t - 1) = 2 \text{ m/s}$$

Step 2: Calculating Instantaneous Power

Power is given by:

$$P = F \cdot v$$

Substituting $F = 5$ N and $v = 2$ m/s,

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

Quick Tip

Instantaneous power is calculated as $P = Fv$, where v is the instantaneous velocity of the particle.

---

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

(1) 4.4 mT

(2) 44 T

(3) 44 mT

(4) 4.4 T

Correct Answer: (1) 4.4 mT

Solution :

Step 1: Understanding the Concept

The magnetic field at the centre of a circular coil with N turns is given by:

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

where $\mu_0 = 4\pi \times 10^{-7}$ T·m/A, $N = 100$, $I = 7$ A, and $R = 0.1$ m.

Step 2: Substituting Values

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

$$B = \frac{2.8 \times 10^{-4}\pi}{0.2}$$

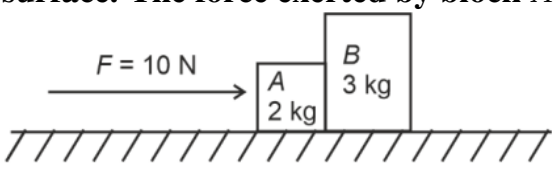
$$B = 4.4 \times 10^{-3} \text{ T} = 4.4 \text{ mT}$$

Quick Tip

The formula $B = \frac{\mu_0 NI}{2R}$ is applicable for a tightly wound coil, ensuring uniform field distribution.

---

35. A horizontal force 10 N is applied to a block A as shown in the figure. The mass 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) 6 N

(2) 10 N

(3) Zero

(4) 4 N

Correct Answer: (1) 6 N

Solution :

Step 1: Finding Acceleration of the System

The total mass of the system:

$$m_{\text{total}} = m_A + m_B = 2 + 3 = 5 \text{ kg}$$

The acceleration of the system:

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

Step 2: Force exerted by A on B

Block B experiences a force due to A, given by:

$$F_{A \to B} = m_B \cdot a = 3 \times 2 = 6 \text{ N}$$

Quick Tip

For a frictionless surface, both blocks move with the same acceleration. The force on block B is found using Newton's Second Law.

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) 17

(2) 32

(3) 34

(4) 28

Correct Answer: (4) 28

Solution: Step 1: Understanding the Formula The magnifying power of a telescope is given by:

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

where f_o is the focal length of the objective, and f_e is the focal length of the eyepiece.

Step 2: Substituting Values

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

Quick Tip

A telescope with a larger objective focal length provides a higher magnifying power, improving distant object clarity.

---

37. Two heaters A and B have power ratings of 1 kW and 2 kW, respectively. Those two 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) $1 : 2$

(2) $2 : 3$

(3) $1 : 1$

(4) $2 : 9$

Correct Answer: (4) $2 : 9$

Solution: 37. Two heaters A and B have power rating of 1 kW and 2 kW, respectively. Those two 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) $1 : 2$

(2) $2 : 3$

(3) $1 : 1$

(4) $2 : 9$

Correct Answer: (4) $2 : 9$

Solution: In the given problem, we need to calculate the power ratio for two cases: when the heaters are connected in series and when connected in parallel.

Step 1: Power output when heaters are connected in series When the heaters are connected in series, the same current flows through both heaters. The total resistance R_{total} in series is:

$$R_{\text{total}} = R_A + R_B$$

The power output P in series is given by:

$$P = \frac{V^2}{R_{\text{total}}}$$

Where V is the voltage of the power source. The power ratio in this case is derived from the individual resistances and ratings.

Step 2: Power output when heaters are connected in parallel When the heaters are connected in parallel, the voltage across each heater remains the same. The total power in parallel is:

$$P_{\text{total}} = P_A + P_B$$

From this, we calculate the ratio of power outputs in the two configurations.

Step 3: Power ratio From the analysis of the two configurations, we find that the ratio of power outputs is $2 : 9$.

Quick Tip

For parallel and series connections, the power output depends on the configuration and the distribution of current or voltage. In a parallel configuration, the voltage is the same across all components, while in series the current is the same.

---

38. 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) $2\sqrt{3}$

(2) 4

(3) $\sqrt{3}$

(4) $\sqrt{2}$

Correct Answer: (4) $\sqrt{2}$

Solution: Step 1: Using the Time Period Formula

The time period of a simple pendulum is given by:

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

Since m does not affect the time period, we only consider the change in length l.

Step 2: Effect of Length Change

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

Thus, $x = \sqrt{2}$.

Quick Tip

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

---

39. 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 a direction opposite to that of I.

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

(3) There is no current.

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

Correct Answer: (4)

Solution: Step 1: Understanding Displacement Current According to Maxwell's equations, a changing electric field in a capacitor creates a displacement current.

This displacement current is given by:

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

Step 2: Direction of Displacement Current The displacement current flows in the same direction as the conduction current I in the circuit.

Quick Tip

Displacement current ensures continuity of current in a capacitor circuit, even though no charge physically moves between the plates.

40. 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) 100×10^3 N

(2) 2×10^3 N

(3) 5×10^3 N

(4) 50×10^3 N

Correct Answer: (4) 50×10^3 N

Solution

Step 1: Understanding the Thermal Stress Formula

The thermal stress developed when expansion is restricted is given by:

$$\sigma = Y\alpha\Delta T$$

where: $Y = 0.5 \times 10^{11}$ N/m^2 (Young's modulus) $\alpha = 10^{-5}$ °C^{-1} (coefficient of linear expansion) $\Delta T = 100$°C (temperature change)

Step 2: Calculating Thermal Stress

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

$$= 5 \times 10^6 \text{ N/m}^2$$

Step 3: Finding Compressive Force The force is given by:

$$F = \sigma A$$

where $A = 10^{-3}$ m^2 (cross-sectional area).

$$F = (5 \times 10^6) \times (10^{-3})$$

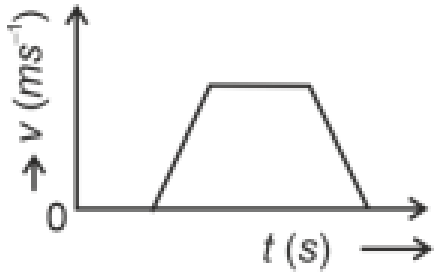
$$= 50 \times 10^3 \text{ N}$$

Quick Tip

Thermal stress arises when a material is prevented from expanding or contracting freely. Higher Young's modulus and temperature changes result in greater stress.

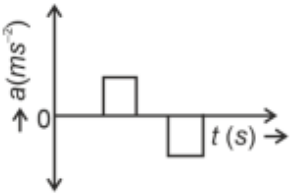
---

41. The velocity (v) – time (t) plot of the motion of a body is shown below: (The given figure represents a velocity-time graph with three distinct phases: acceleration, constant velocity, and deceleration.)

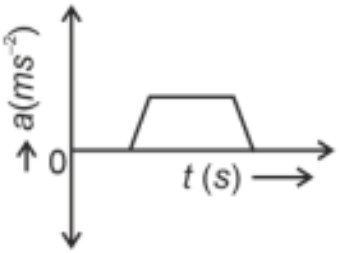


The acceleration (a) – time (t) graph that best suits this motion is:

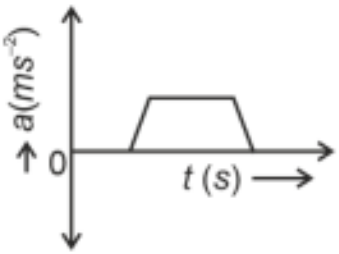
(1)

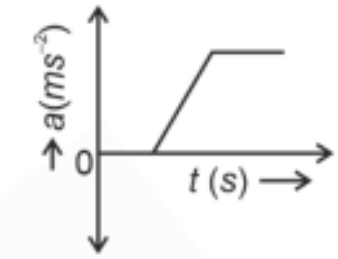


(2)



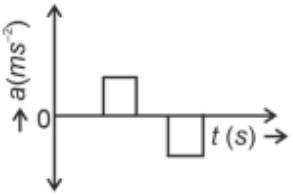
(3)





(4)

Correct Answer: (1)



Solution:

Step 1: Understanding the Motion

The given velocity-time graph consists of three phases:

Initial acceleration (increasing velocity)

Constant velocity (zero acceleration)

Deceleration (decreasing velocity)

Step 2: Deriving the Acceleration-Time Graph

Acceleration is positive during the initial phase.

Acceleration is zero when velocity is constant.

Acceleration is negative during deceleration.

These characteristics match the acceleration-time graph in option (1).

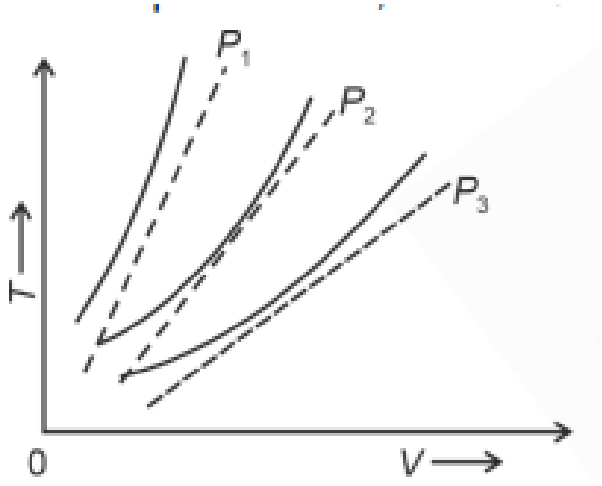
Quick Tip

Acceleration is the rate of change of velocity. The shape of the acceleration-time graph corresponds to how velocity changes over time.

---

42. 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.

(The given figure shows three isobaric curves where the one with the steepest slope corresponds to the lowest pressure.)



Then the correct relation is:

(1) $P_2 > P_1 > P_3$

(2) $P_1 > P_2 > P_3$

(3) $P_3 > P_2 > P_1$

(4) $P_1 > P_3 > P_2$

Correct Answer: (2) $P_1 > P_2 > P_3$

Solution: Step 1: Understanding the Graph

The equation governing isobaric processes is Charles's Law:

$$V \propto T \quad \text{(for constant pressure)}$$

Higher pressure results in a less steep slope in the T-V graph.

Step 2: Identifying the Correct Order

Since P_1 corresponds to the least steep curve, it represents the highest pressure.

P_3 has the steepest slope, indicating the lowest pressure.

Thus, the correct order is:

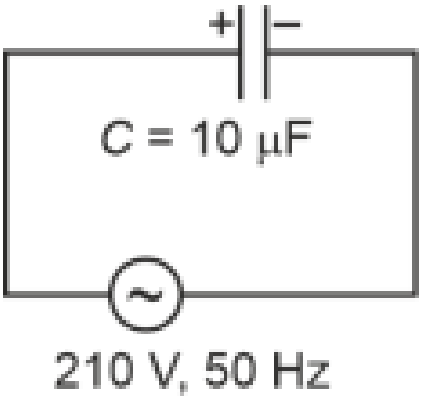
$$P_1 > P_2 > P_3$$

Quick Tip

For an ideal gas, the steeper the isobaric curve in a T-V graph, the lower the pressure.

---

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



(1) $1.20\,A$

(2) $0.35\,A$

(3) $0.58\,A$

(4) $0.93\,A$

Correct Answer: (4) $0.93\,A$

Solution: Step 1: Finding the Capacitive Reactance The capacitive reactance is given by:

$$X_C = \frac{1}{\omega C}$$

where $\omega = 2\pi f = 2 \times 3.14 \times 50 = 314\,rad/s$, $C = 10 \times 10^{-6}\,F$,

$$X_C = \frac{1}{314 \times 10 \times 10^{-6}}$$

$$X_C = \frac{1}{3.14 \times 10^{-2}} = 31.8\,\Omega$$

Step 2: Calculating the RMS Current The RMS current is given by:

$$I_{rms} = \frac{V_{rms}}{X_C} = \frac{210}{31.8} \approx 6.6\,A$$

Step 3: Finding the Peak Current The peak current is given by:

$$I_0 = \sqrt{2} I_{rms} = 1.414 \times 0.66 \approx 0.93\,A$$

Final Answer: $0.93\,A$ (Option 4)

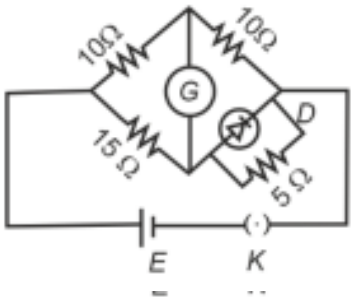
Quick Tip

In AC circuits, the peak current is related to the RMS current by $I_0 = \sqrt{2} I_{rms}$. Capacitive reactance decreases with increasing frequency.

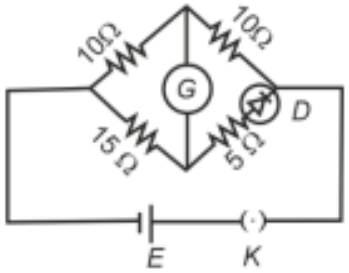
---

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

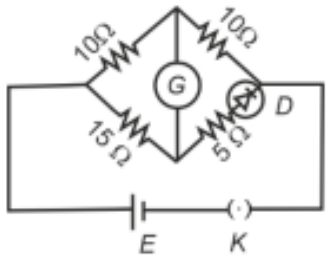
(1)



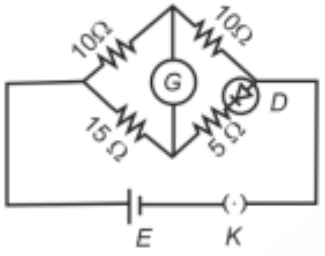
(2)



(3)



(4)



Correct Answer: (3) Third circuit

Solution:

Step 1: Condition for Wheatstone Bridge Balance

For a Wheatstone bridge to be balanced, the ratio of the two resistances in one branch must be equal to the ratio of the two resistances in the other branch:

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

Step 2: Checking the Given Circuits

Analyzing the resistances in the given circuits, only the third circuit satisfies the condition for bridge balance.

When the bridge is balanced, the galvanometer shows zero deflection.

Final Answer: The third circuit achieves the bridge balance (Option 3).

Quick Tip

In a balanced Wheatstone bridge, no current flows through the galvanometer. This property is useful for precise resistance measurements.

---

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

(1) They travel with a speed equal to $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$

(2) They originate from charges moving with uniform speed

(3) They are transverse in nature

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

Correct Answer: (2) They originate from charges moving with uniform speed

Solution: Step 1: Understanding the Properties of Electromagnetic Waves

Electromagnetic (EM) waves travel at a speed of $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$ in free space, which confirms option (1) is correct.

EM waves are transverse, meaning their electric and magnetic fields oscillate perpendicular to each other and to the direction of propagation, making option (3) correct.

The energy densities in the electric and magnetic fields are equal in an EM wave, which makes option (4) correct.

Step 2: Identifying the Incorrect Statement

EM waves do not originate from charges moving with uniform speed; they are generated by accelerating charges or time-varying currents.

Thus, option (2) is incorrect and is the right choice for this question.

Final Answer: They originate from charges moving with uniform speed (Option 2).

Quick Tip

Electromagnetic waves are produced by accelerating charges, not by charges moving at a constant velocity.

---

46. 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) $\frac{GmM}{2R}$

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

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

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

Correct Answer: (3) $\frac{5GmM}{6R}$

Solution:

Step 1: The gravitational potential energy U of the satellite at a distance r from the center of the Earth is given by:

$$U = -\frac{GMm}{r}$$

Where: - G is the gravitational constant, - M is the mass of the Earth, - m is the mass of the satellite, - r is the distance from the center of the Earth.

Step 2: The total energy required to place the satellite in orbit at an altitude of $2R$ (which means the distance from the Earth's center is $3R$) is:

$$E_{\text{orbit}} = -\frac{GMm}{6R}$$

Step 3: The gravitational potential energy at the surface of the Earth (at distance R) is:

$$U_{\text{surface}} = -\frac{GMm}{R}$$

Step 4: The minimum energy required to launch the satellite is the difference between the energy in orbit and the energy at the Earth's surface:

$$E_{\text{min}} = E_{\text{orbit}} - U_{\text{surface}} = -\frac{GMm}{6R} - \left(-\frac{GMm}{R}\right)$$

Simplifying this:

$$E_{\text{min}} = \frac{GMm}{R}\left(1 - \frac{1}{6}\right) = \frac{GMm}{R} \times \frac{5}{6}$$

Thus, the minimum energy required to launch the satellite is:

$$E_{\text{min}} = \frac{5GMm}{6R}$$

Final Answer: The minimum energy required to launch the satellite is $\frac{5GMm}{6R}$.

Quick Tip

The minimum energy required to place a satellite into orbit is the difference in total energy between the initial position (on Earth's surface) and the final orbit.

---

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

Statements:

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) B, D, and E only

(2) A, B, and C only

(3) A, B, and E only

(4) A, C, and E only

Correct Answer: (4) A, C, and E only

Solution:

Step-by-Step Solution:

- The capacitance of a parallel plate capacitor is given by:

$$C = \frac{\varepsilon_0 A}{d}$$

where d is the separation between the plates. If d decreases, C increases. (Statement C is correct). - Since the capacitor is connected to a battery, the voltage remains constant. From $Q = CV$, as C increases, Q also increases. (Statement A is correct).

The energy stored in the capacitor is given by:

$$U = \frac{1}{2}CV^2$$

Since C increases and V remains constant, U increases. Hence, Statement B is incorrect. The product QV increases as both Q and V increase, making Statement E correct.

Quick Tip

For a capacitor connected to a battery, decreasing the plate separation increases capacitance and stored charge but does not affect the voltage.

---

48. 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:

The options are: (1) $\alpha\beta t$

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

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

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

Correct Answer: (4) $\frac{\alpha t}{\beta}$

Solution:

Force is given by $F = \alpha t^2 + \beta t$.

The dimension of force is MLT^{-2}.

Since both terms in the equation must have the same dimensions, we compare them:

$$\alpha t^2 \Rightarrow [\alpha] = MLT^{-4}$$

$$\beta t \Rightarrow [\beta] = MLT^{-3}$$

To form a dimensionless quantity, we take the ratio:

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

Thus, $\frac{\alpha t}{\beta}$ is dimensionless.

Quick Tip

To check for a dimensionless quantity, always divide terms with the same physical dimensions.

---

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

Statements:

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, C, and D only

(2) C only

(3) B and D only

(4) A and C only

Correct Answer: (4) A and C only

Solution: If the sheet is magnetic, it will experience attraction towards the magnetic pole, requiring a force to hold it in place (Statement A is correct).

If the sheet is conducting, eddy currents are induced, which generate a repulsive force moving the sheet away from the pole (Statement C is correct).

A non-magnetic sheet does not experience attraction, so Statement B is incorrect.

A non-conducting, non-polar sheet does not interact with the field significantly, so Statement D is incorrect.

Quick Tip

Eddy currents in a conductor generate a repulsive force when placed in a time-varying magnetic field.

---

50. 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) $2M$

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

(3) M

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

Correct Answer: (4) $\frac{M}{2}$

Solution: Given:

- The magnetic moment M of a straight iron bar is given by $M = m \times L$, where m is the magnetic strength and L is the length of the bar. - The bar is bent at the middle such that the two arms make an angle of 60°.

Solution:

1. **Magnetic Moment of the Straight Bar:**

For the straight bar, the magnetic moment is:

$$M = m \times L$$

Where: - m is the magnetic strength, - L is the length of the bar.

2. **After Bending the Bar:**

When the bar is bent, each arm has length $\frac{L}{2}$, and the angle between the two arms is 60°. The magnetic moment for each arm is now $m \times \frac{L}{2}$.

3. **Resultant Magnetic Moment:**

The total magnetic moment of the bent bar can be calculated as the vector sum of the magnetic moments of the two arms.

Using the vector addition formula:

$$M' = m \times \frac{L}{2}$$

Since $M = m \times L$ for the straight bar, we substitute M into the equation:

$$M' = \frac{M}{2}$$

Final Answer:

Thus, the new magnetic moment of the bent iron bar is:

$$M' = \frac{M}{2}$$

The correct answer is **Option (4)** $\frac{M}{2}$.

Quick Tip

Bending a magnetic bar reduces its effective length, which in turn decreases its magnetic moment.

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

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

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

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

(4) A-V, B-III, C-III, D-I

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

Solution:

Isothermal process: The temperature remains constant, so the correct match is **II**.

Isochoric process: The volume remains constant, so the correct match is **III**.

Isobaric process: The pressure remains constant, so the correct match is **IV**.

Adiabatic process: There is no heat exchange, so the correct match is **I**.

Quick Tip

Understanding thermodynamic processes helps in solving problems related to heat and work calculations efficiently.

---

52. Given below are two statements:

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

$$\text{n-pentane} > \text{isopentane} > \text{neopentane}$$

Statement II: When branching increases, the molecule attains a spherical shape. This results in a smaller surface area for contact, reducing intermolecular forces and lowering the boiling point.

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

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

(3) Both Statement I and Statement II are correct

(4) Both Statement I and Statement II are incorrect

Correct Answer: (3) Both Statement I and Statement II are correct

Solution:

Statement I: The boiling point of alkanes decreases with increased branching because straight-chain alkanes have more surface area for intermolecular forces. Hence, **Statement I is correct**.

Statement II: Branched alkanes have a more spherical structure, leading to a lower surface area for intermolecular interactions, thereby reducing the boiling point. Hence, **Statement II is also correct**.

Quick Tip

Boiling points of hydrocarbons are influenced by molecular structure, with less branching leading to stronger intermolecular forces and higher boiling points.

---

53. Match List I with List II.

List I (Molecule)	List II (Number and types of bond/s between two carbon atoms)
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

(1) A-II, B-V, C-II, D-I

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

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

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

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

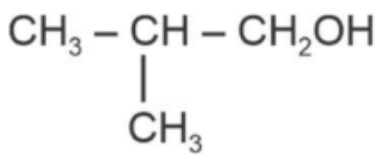
Solution: - For ethane (C_2H_6), the bond between the two carbon atoms is a single σ-bond (I). - For ethene (C_2H_4), the bond between the two carbon atoms consists of one σ-bond and one π-bond (IV). - For the carbon molecule, C_2, it has two π-bonds between the two carbon atoms (II). - For ethyne (C_2H_2), the bond between the two carbon atoms consists of one σ-bond and two π-bonds (III).

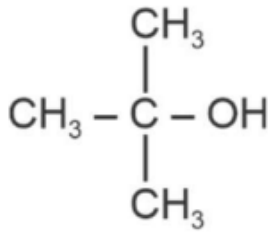
Quick Tip

In organic molecules, the type of bond between two carbon atoms depends on whether the molecule is saturated (single bonds), unsaturated (double or triple bonds), or aromatic.

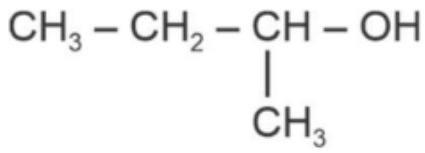
---

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

(1) 

(2) 

(3) $CH_3 - CH_2 - CH_2 - CH_2OH$

(4) 

Correct Answer: (2)

Step-by-Step Solution:

Lucas reagent ($ZnCl_2 + HCl$) is used to differentiate primary, secondary, and tertiary alcohols.

Tertiary alcohols react immediately due to the formation of a stable tertiary carbocation.

The given structure in option (2) is a tertiary alcohol, which reacts instantaneously.

Quick Tip

Lucas reagent is a useful test to classify alcohols based on their reactivity and carbocation stability.

---

55. Match List I with List II.

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

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

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

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

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

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

Solution: - The quantum number m_l refers to the orientation of the orbital, hence A corresponds to I.

- The quantum number m_s refers to the orientation of the spin of an electron, hence B corresponds to IV.

- The quantum number l refers to the shape of the orbital, hence C corresponds to I.

- The quantum number n refers to the size of the orbital, hence D corresponds to II.

Quick Tip

Quantum numbers help define the specific characteristics of electrons in atoms. Remember the key associations: - m_l is for orbital orientation. - m_s is for electron spin. - l defines the orbital shape. - n indicates orbital size.

---

56. '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+}

(1) B and C only

(2) A and D only

(3) B and D only

(4) A and E only

Correct Answer: (3) B and D only

Solution:

- Spin-only magnetic moment depends on the number of unpaired electrons. The spin-only magnetic moment formula is given by:

$$\mu_s = \sqrt{n(n+2)}\,\mu_B$$

where n is the number of unpaired electrons.

- For Ti^{3+} (with 1 unpaired electron), the spin-only magnetic moment is $\sqrt{1(1+2)} = \sqrt{3}\mu_B$.

- For Cr^{2+} (with 4 unpaired electrons), the spin-only magnetic moment is $\sqrt{4(4+2)} = \sqrt{24}\mu_B$. - For Mn^{2+} (with 5 unpaired electrons), the spin-only magnetic moment is $\sqrt{5(5+2)} = \sqrt{35}\mu_B$. - For Fe^{2+} (with 4 unpaired electrons), the spin-only magnetic moment is $\sqrt{4(4+2)} = \sqrt{24}\mu_B$. - For Sc^{3+} (with 0 unpaired electrons), the spin-only magnetic moment is $0\mu_B$.

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

Quick Tip

For spin-only magnetic moments, remember: - The magnetic moment increases with the number of unpaired electrons. - If the ion has no unpaired electrons, the magnetic moment is zero.

---

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

(1) Distillation

(2) Chromatography

(3) Sublimation

(4) Extraction

Correct Answer: (3) Sublimation

Solution: Some substances like iodine, naphthalene, and camphor undergo sublimation, transitioning directly from solid to gas.

This property is used in purification techniques, where non-sublimating impurities remain as residue.

Quick Tip

Sublimation is commonly used in the purification of organic solids, especially for substances with high vapor pressure.

---

58. The energy of an electron in the ground state ($n = 1$) for He^+ ion is $-X$. The energy

for an electron in $n = 2$ state for Be^{3+} ion in J is:

(1) $-X$

(2) $-4X$

(3) $-X/4$

(4) $-4X/9$

Correct Answer: (3) $-X$

Solution:

The energy of an electron in a hydrogen-like ion is given by the formula:

$$E_n = -\frac{Z^2 \cdot R_H}{n^2},$$

where:

- E_n is the energy of the electron in the n-th energy level,
- Z is the atomic number of the ion,
- R_H is the Rydberg constant ($R_H \approx 2.18 \times 10^{-18}$ J),
- n is the principal quantum number.

Step 1: Energy of He^+ ion ($n = 1$) For He^+:

- $Z = 2$ (helium has 2 protons),
- $n = 1$.

The energy is given as:

$$E_1 = -x \, \text{J}.$$

Using the formula:

$$E_1 = -\frac{Z^2 \cdot R_H}{1^2} = -\frac{2^2 \cdot R_H}{1} = -4R_H.$$

Thus:

$$-4R_H = -x \implies R_H = \frac{x}{4}.$$

Step 2: Energy of Be^{3+} ion ($n = 2$) For Be^{3+}:

- $Z = 4$ (beryllium has 4 protons),
- $n = 2$.

Using the formula:

$$E_2 = -\frac{Z^2 \cdot R_H}{n^2} = -\frac{4^2 \cdot R_H}{2^2} = -\frac{16R_H}{4} = -4R_H.$$

Substitute $R_H = \frac{x}{4}$:

$$E_2 = -4 \cdot \frac{x}{4} = -x\,\text{J}.$$

Final Answer: The energy of an electron in the $n = 2$ state for a Be^{3+} ion is:

$$\boxed{-x}.$$

Quick Tip

Energy levels of hydrogen-like atoms depend on the atomic number squared, so the energy changes significantly for different ions.

---

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

(1) Orientation of reactant molecules during collision

(2) Rate constant at two different temperatures

(3) Rate constant at standard temperature

(4) Probability of collision

Correct Answer: (2)

Solution:

- The Arrhenius equation is given by:

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

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

Taking the natural logarithm on both sides:

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

If we have the rate constant at two different temperatures, we can use:

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

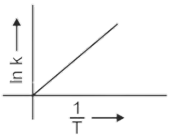
to calculate the activation energy.

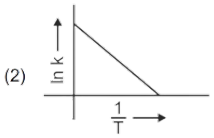
Quick Tip

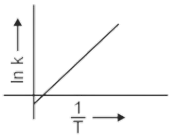
The Arrhenius equation helps determine how temperature affects reaction rates and provides a way to calculate activation energy.

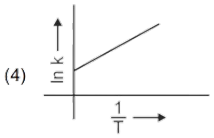
---

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

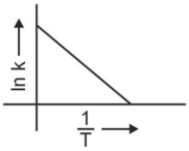
(1) 

(2) 

(3) 

(4) 

Correct Answer: (2)

(2) 

Solution: - From the Arrhenius equation:

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

This is in the form $y = mx + c$, where $\ln k$ is plotted against $\frac{1}{T}$.

The slope is $-E_a/R$, which is negative.

Hence, the plot is a straight line with a negative slope.

Quick Tip

A linear negative slope in $\ln k$ vs $1/T$ confirms the validity of the Arrhenius equation in reaction kinetics.

---

61. 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 hydrogen bonding in H_2O, it has a higher boiling point.

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (3)

Solution:

The boiling point trend is primarily determined by intermolecular forces.

Normally, heavier molecules have higher boiling points due to stronger van der Waals forces.

However, H_2O exhibits strong hydrogen bonding, which significantly increases its boiling point above the expected trend.

This explains why both statements are true.

Quick Tip

Hydrogen bonding greatly influences boiling points, often overriding trends based on molecular mass alone.

---

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

List of Reagents:

A. Tollen's reagent

B. Schiff's reagent

C. HCN

D. NH_2OH

E. $NaHSO_3$

(1) B and E

(2) E and D

(3) B and C

(4) A and D

Correct Answer: (1) B and E

Solution: Tollen's reagent (A): Glucose, being a reducing sugar, reacts with Tollen's reagent to give a silver mirror test. Schiff's reagent (B): Used for detecting aldehydes; glucose does not react with Schiff's reagent directly. HCN (C): Glucose reacts with HCN, forming cyanohydrin derivatives. NH_2OH (D): Glucose reacts with hydroxylamine to form oximes. $NaHSO_3$ (E): Glucose does not react with sodium bisulfite.

Quick Tip

Schiff's reagent is primarily used for detecting free aldehydes, but glucose exists mainly in its cyclic hemiacetal form, making it unreactive.

---

63. Arrange the following elements in increasing order of first ionization enthalpy: Li, Be, B, C, N

(1) Li $<$ Be $<$ C $<$ B $<$ N

(2) Li $<$ Be $<$ N $<$ B $<$ C

(3) Li $<$ B $<$ C $<$ N $<$ Be

(4) Li $<$ B $<$ Be $<$ C $<$ N

Correct Answer: (4) Li $<$ B $<$ Be $<$ C $<$ N

Solution: Ionization enthalpy increases across a period due to increasing nuclear charge. Expected trend: $Li < Be < B < C < N$, but B has a lower ionization energy than Be due to electron configuration stability (Be has a fully filled $2s^2$ orbital).

Correct order: $Li < B < Be < C < N$.

Quick Tip

Boron has a lower ionization energy than Beryllium because of its partially filled $2p$ orbital, making it easier to remove an electron.

---

64. Arrange the following elements in increasing order of electronegativity: N, O, F, C, Si

(1) O $<$ F $<$ N $<$ C $<$ Si

(2) F $<$ O $<$ N $<$ C $<$ Si

(3) Si $<$ C $<$ N $<$ O $<$ F

(4) Si < C < O < N < F

Correct Answer: (3)

Solution:

lectronegativity increases across a period and decreases down a group.

Fluorine is the most electronegative element, followed by Oxygen, Nitrogen, Carbon, and Silicon.

The correct increasing order: $Si < C < N < O < F$.

Quick Tip

Fluorine is the most electronegative element due to its high nuclear charge and small atomic radius.

---

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^4 to d^5 configuration

(2) d^3 to d^5 configuration

(3) d^5 to d^4 configuration

(4) d^5 to d^2 configuration

Correct Answer: (1)

Solution: Mn^{3+} has a d^4 configuration, and Mn^{2+} has a d^5 configuration, which is half-filled and highly stable.

This stability increases the reduction potential, making the E° value more positive.

Quick Tip

A half-filled d^5 configuration is extra stable due to symmetrical electron distribution, reducing the tendency for oxidation.

---

66. Match List I with List II.

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

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

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

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

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

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

Solution: - NH_3 (A) has a trigonal pyramidal geometry due to three bonding pairs of electrons and one lone pair on nitrogen (A-I).

- BrF_5 (B) has square pyramidal geometry due to five bonding pairs of electrons around the central bromine atom (B-IV).

- XeF_4 (C) has a square planar geometry because of the four bonding pairs and two lone pairs on the xenon atom (C-II).

- SF_6 (D) has octahedral geometry with six bonding pairs of electrons around the sulfur atom (D-III).

Quick Tip

To determine the geometry of molecules, use the VSEPR theory to count the bonding and lone pairs around the central atom. This helps in predicting the correct shape.

---

67. Match List I with List II.

List I (Complex)	List II (Type of Isomerism)
A. $[Co(NH_3)_5(NO_2)]Cl_4$	I. Solvate Isomerism
B. $[Co(NH_3)_5(SO_4)]Br$	II. Linkage Isomerism
C. $[Co(NH_3)_6][Cr(CN)_6]$	III. Ionization Isomerism
D. $[Co(H_2O)_6]Cl_3$	IV. Coordination Isomerism

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

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

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

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

Correct Answer: (3)

Solution: Linkage isomerism occurs when a ligand can coordinate through different donor atoms (e.g., NO_2^- can bind via N or O).

Ionization isomerism arises when counter-ions exchange positions with ligands.

Coordination isomerism occurs when the metal centers of two complexes exchange ligands.

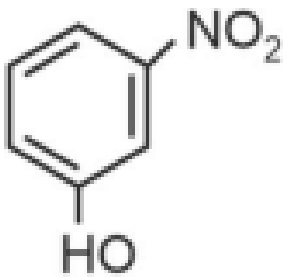
Solvate isomerism results from the exchange of solvent molecules with counter-ions.

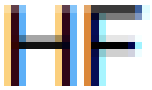
Quick Tip

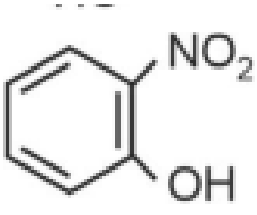
Complex compounds exhibit different types of isomerism, including linkage, ionization, coordination, and solvate isomerism.

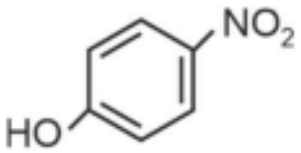
---

68. Intramolecular hydrogen bonding is present in:

(1) 

(2) 

(3) 



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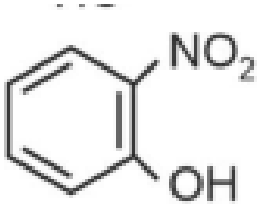


Correct Answer: (3)

Solution: Intramolecular hydrogen bonding occurs within a single molecule when an H-bond donor (OH/NH) and an acceptor (NO_2) are present in close proximity.

The correct structure (option 3) has an OH group ortho to NO_2, allowing hydrogen bonding.

Other options involve intermolecular hydrogen bonding (e.g., HF).

Quick Tip

Intramolecular hydrogen bonding stabilizes the molecule and affects physical properties like boiling point and solubility.

---

69. Given below are two statements:

Statement I: Aniline does not undergo Friedel-Crafts alkylation reaction.

Statement II: Aniline cannot be prepared through Gabriel synthesis.

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (3)

Solution:

Statement I: Aniline does not undergo Friedel-Crafts alkylation due to protonation of NH_2 in acidic conditions, making it non-reactive.

Statement II: Aniline cannot be synthesized via Gabriel synthesis, as the method is suitable only for aliphatic amines.

Quick Tip

The Gabriel synthesis works only for aliphatic primary amines and not for aromatic amines like aniline.

---

70. The highest number of helium atoms is in:

(1) 4 g of helium

(2) 2.271098 L of helium at STP

(3) 4 mol of helium

(4) 4 u of helium

Correct Answer: (3)

Solution: - 1 mol of helium contains Avogadro's number of atoms (6.022×10^{23}). - 4 mol of He contains $4 \times 6.022 \times 10^{23}$ atoms, which is the highest among the given options.

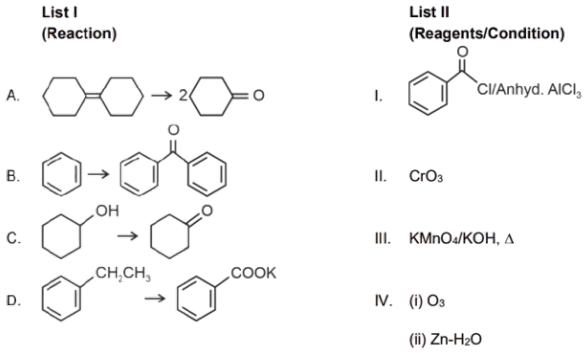
Quick Tip

To find the number of atoms in a sample, use Avogadro's number:

$$\text{Atoms} = \text{moles} \times 6.022 \times 10^{23}$$

---

71. Match List I with List II.



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

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

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

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

Correct Answer: (1)

Solution: - A-IV: Ozonolysis cleaves alkenes into carbonyl compounds.

- B-I: Friedel-Crafts acylation involves Cl/Anhydrous $AlCl_3$.

- C-II: Alcohol oxidation to ketone requires CrO_3.

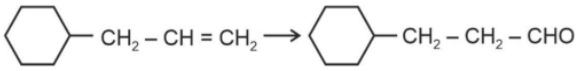
- D-III: Side-chain oxidation of alkyl benzene to carboxyl group requires $KMnO_4$/KOH, heat.

Quick Tip

Ozonolysis is useful for identifying double bonds by breaking them into carbonyl compounds.

---

72. Identify the correct reagents that would bring about the following transformation:



(1) (i) BH_3

(ii) H_2O_2/OH^-

(iii) alk. $KMnO_4$

(iv) H_3O^+

(2) (i) H_2O/H^+

(ii) PCC

(3) (i) H_2O/H^+

(ii) CrO_3

(4) (i) BH_3

(ii) H_2O_2/OH^-

(iii) PCC

Correct Answer: (4)

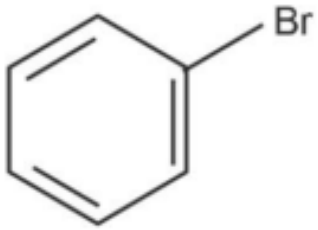
Solution: - Step 1: Hydroboration-oxidation (BH_3 and H_2O_2/OH^-) converts alkene to an anti-Markovnikov alcohol. - Step 2: PCC (Pyridinium Chlorochromate) selectively oxidizes primary alcohol to aldehyde.

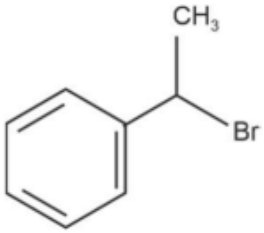
Quick Tip

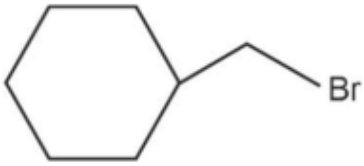
Hydroboration-oxidation is a regioselective reaction where an alkene converts to an alcohol with anti-Markovnikov orientation.

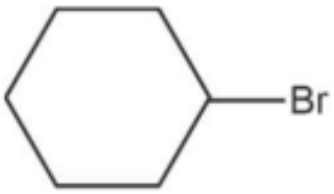
---

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

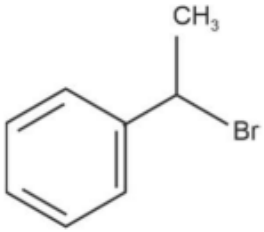
(1) 

(2) 

(3) 



Correct Answer: (2)



Solution: S_N1 reaction proceeds via a carbocation intermediate.

The stability of the carbocation determines the rate of reaction.

Benzylic and allylic carbocations are highly stable due to resonance.

Compound (2) forms a benzylic carbocation, making it the fastest in S_N1.

Quick Tip

S_N1 reactions are favored in polar protic solvents and proceed via a carbocation intermediate.

74. Fehling's solution 'A' is:

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

(2) Aqueous sodium citrate

(3) Aqueous copper sulphate

(4) Alkaline copper sulphate

Correct Answer: (3)

Solution: Fehling's solution is used to test for reducing sugars.

It consists of two solutions:

Fehling's A: Aqueous copper sulfate ($CuSO_4$).

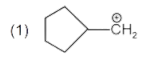
Fehling's B: Alkaline solution of Rochelle's salt (sodium potassium tartrate).

Quick Tip

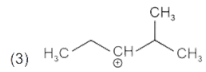
Fehling's test detects reducing sugars like glucose, which reduce Cu^{2+} to Cu_2O (red precipitate).

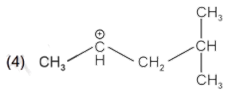
---

75. The most stable carbocation among the following is:

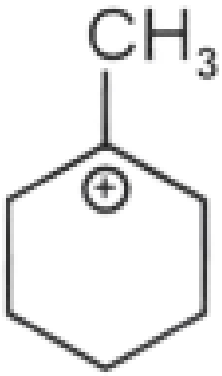
(1) 

(2) 

(3) 

(4) 

Correct Answer: (2)



Step-by-Step Solution: Carbocation stability order: Benzyl > Allyl > Tertiary > Secondary > Primary > Methyl

Resonance stabilization significantly increases carbocation stability.

Option (2) forms a benzylic carbocation, which is highly stabilized due to resonance.

Quick Tip

A carbocation with more resonance structures is always more stable than an isolated one.

---

76. For the reaction:

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

At a given time, the concentrations are:

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

Which of the following is correct?

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

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

(3) Reaction is at equilibrium.

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

Correct Answer: (1)

Step-by-Step Solution: The reaction quotient Q_c is given by:

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

Substituting the values:

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

Since $Q_c = 1$ and $K_c = 4 \times 10^{-3}$, we see that:

$$Q_c > K_c$$

When $Q_c > K_c$, the reaction shifts backward to reach equilibrium.

Quick Tip

If $Q_c > K_c$, the reaction shifts backward. If $Q_c < K_c$, the reaction shifts forward.

---

77. 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) A > C > B

(2) A > B > C

(3) B > A > C

(4) B > C > A

Correct Answer: (4)

Solution: According to Henry's Law, solubility of a gas in a liquid is inversely proportional to its Henry's law constant (K_H).

The given values are: A (145), B (2×10^{-5}), and C (35 kbar).

Since B has the smallest K_H, it is the most soluble, followed by C, then A.

Quick Tip

Lower the K_H value, higher the solubility of the gas in water.

---

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

(1) 2,3-dimethylbutane

(2) 2,2-dimethylbutane

(3) n-hexane

(4) 2-methylpentane

Correct Answer: (1)

Solution: The molecular formula C_6H_{14} suggests a saturated alkane.

The presence of two tertiary carbons means two carbon atoms must be attached to three other carbon atoms.

2,3-Dimethylbutane fits this condition as it has tertiary carbons at C-2 and C-3.

Quick Tip

Tertiary carbon is a carbon atom attached to three other carbons.

---

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

(1) $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_2(g) + H_2(g)$

(2) $2BrCl_{(g)} \rightleftharpoons Br_2(g) + Cl_2(g)$

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

(4) $H_2(g) + I_2(g) \rightleftharpoons 2HI_{(g)}$

Correct Answer: (3) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

Solution:

K_p and K_c are related by:

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

where Δn is the change in the number of moles of gases.

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

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

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

Quick Tip

If the number of moles of gaseous reactants and products differ, $K_p \neq K_c$.

---

80. Which reaction is NOT a redox reaction?

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

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

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

(4) $2KClO_3 \rightarrow 2KCl + 3O_2$

Correct Answer: (2)

Solution: A redox reaction involves oxidation and reduction simultaneously.

In (2) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$, no oxidation state changes occur.

It is a double displacement reaction (precipitation), not redox.

Quick Tip

Redox reactions always involve a change in oxidation states.

---

81. 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.

Which of the following is correct?

(1) Statement I is true but Statement II is false.

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

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Correct Answer: (3)

Solution: Co^{3+} has an electronic configuration of d^6.

NH_3 is a strong field ligand, causing low-spin pairing (diamagnetic).

F^- is a weak field ligand, leading to high-spin (paramagnetic).

Quick Tip

Strong field ligands cause low-spin complexes, weak field ligands cause high-spin complexes.

---

82. 1 gram of sodium hydroxide was treated with 25 mL of 0.75 M HCl solution. The mass of sodium hydroxide left unreacted is:

(1) 12 mg

(2) 200 mg

(3) 750 mg

(4) 250 mg

Correct Answer: (4) 250 mg

Solution: Step 1: Write the balanced chemical equation. The reaction between sodium hydroxide and hydrochloric acid is:

$$NaOH + HCl \rightarrow NaCl + H_2O$$

Step 2: Find the moles of NaOH and HCl. Given: - Molarity of HCl = 0.75 M - Volume of HCl = 25 mL = 0.025 L - Moles of HCl = $M \times V = 0.75 \times 0.025 = 0.01875$ moles

For NaOH, 1 gram of NaOH is used. Molar mass of NaOH = 40 g/mol.

$$\text{Moles of NaOH} = \frac{\text{Mass}}{\text{Molar mass}} = \frac{1}{40} = 0.025 \text{ moles}$$

Step 3: Determine the limiting reagent. From the balanced equation, NaOH and HCl react in a 1:1 ratio. Since HCl has fewer moles (0.01875 mol) compared to NaOH (0.025 mol), HCl is the limiting reagent.

Step 4: Calculate the unreacted NaOH. The moles of NaOH reacting with HCl = moles of HCl = 0.01875 mol. Remaining moles of NaOH = 0.025 - 0.01875 = 0.00625 mol.

Mass of unreacted NaOH = Remaining moles $\times$ Molar mass of NaOH.

$$\text{Mass of unreacted NaOH} = 0.00625 \times 40 = 0.25 \text{ grams} = 250 \text{ mg}$$

Quick Tip

Always ensure molarity calculations are done using volume in liters (L).

---

83. Among Group 16 elements, which one does NOT show -2 oxidation state?

(1) Te

(2) Se

(3) Po

(4) Se

Correct Answer: (3) Po (Polonium)

Solution: The Group 16 elements (O, S, Se, Te, Po) typically show a -2 oxidation state due to their electronic configuration $ns^2\ np^4$.

Polonium (Po) is a heavy element and prefers +2 and +4 oxidation states rather than -2.

Due to poor shielding and relativistic effects, the -2 oxidation state becomes less stable for Po.

Quick Tip

Heavy elements tend to show higher oxidation states due to relativistic effects and lower electronegativity.

---

84. In which of the following processes entropy increases?

(A) A liquid evaporates to vapour.

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

(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, C and D

(2) C and D

(3) A and C

(4) A, B and D

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

Solution:

Entropy (S) increases when disorder increases in a system.

Process (A): Evaporation increases entropy as molecules move freely in the gas phase.

Process (B): Decreasing temperature reduces molecular motion, decreasing entropy (Incorrect).

Process (C): The decomposition releases gaseous products (CO_2 and H_2O), increasing entropy.

Process (D): Dissociation of Cl_2 into atoms increases randomness, hence increasing entropy.

Quick Tip

Entropy increases in processes that generate gaseous products or increase molecular disorder.

---

85. 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-II, B-III, C-I, D-IV

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

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

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

Correct Answer: (3) A-II, B-IV, C-I, D-III **Solution:** - (A) 1 mol of H_2O to O_2 requires 2 electrons per oxygen atom, hence $2F$.

- (B) 1 mol of MnO_4^- to Mn^{2+} involves a 5-electron reduction, requiring $5F$.

- (C) 1.5 mol of Ca from molten $CaCl_2$ follows the equation:

$$Ca^{2+} + 2e^- \rightarrow Ca$$

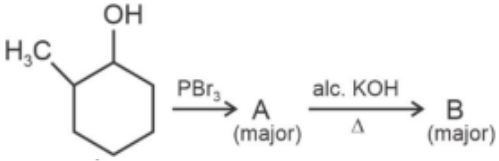
Since 1 mole of Ca requires 2F, 1.5 moles require 1F. - (D) 1 mol of FeO to Fe_2O_3 requires 3 electrons per Fe atom, hence $3F$.

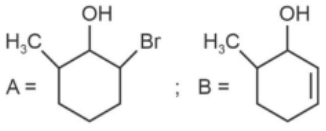
Quick Tip

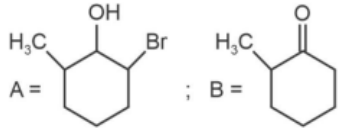
Faraday's laws of electrolysis state that 1 mole of electrons ($1F$) corresponds to 96,500 C of charge.

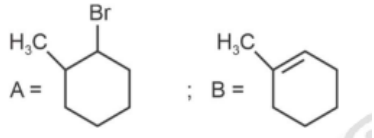
SECTION-B

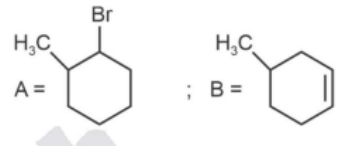
86. Major products A and B formed in the following reaction sequence are:

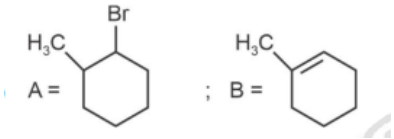


(1) 

(2) 

(3) 

(4) 



Correct Answer: (3)

Solution: - The reaction starts with $PbBr_3$, leading to an elimination reaction in the presence of alcoholic KOH, forming alkenes as major products. - The major product follows Saytzeff's rule, favoring the more substituted alkene. - The correct structure (3) is obtained via E2 elimination.

Quick Tip

Saytzeff's Rule states that in elimination reactions, the more substituted alkene is preferred as the major product.

---

87. Consider the following reaction in a sealed vessel at equilibrium:

Given concentrations:

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

$$2NO_{(g)} \rightleftharpoons N_2O_{(g)} + O_{2(g)}$$

If 0.1 mol L^{-1} of $NO_{(g)}$ is taken in a closed vessel, what will be the degree of dissociation (α) at equilibrium?

(1) 0.8889

(2) 0.717

(3) 0.00889

(4) 0.0889

Correct Answer: (2) 0.717

Solution: The reaction is:

$$2NO_{(g)} \rightleftharpoons N_2(g) + O_2(g)$$

Let the initial concentration of NO be 0.1 mol L^{-1}. Let the degree of dissociation of NO be α.

Step 1: Write the equilibrium concentrations.

At equilibrium, the change in concentration of NO is 2α, as 2 moles of NO dissociate for each mole of N_2 and O_2 produced. Therefore, the concentrations at equilibrium are:

$$[NO] = 0.1 - 2\alpha \quad M$$

$$[N_2] = [O_2] = \alpha \quad M$$

Step 2: Apply the equilibrium constant expression.

At equilibrium, the equilibrium constant K_c is given by:

$$K_c = \frac{[N_2][O_2]}{[NO]^2}$$

Substitute the given concentrations:

$$K_c = \frac{(\alpha)(\alpha)}{(0.1 - 2\alpha)^2}$$

We are given the equilibrium concentrations of N_2, O_2, and NO. From the problem,

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

Step 3: Solve for α.

Using the values for K_c, we can solve the equation for α.

$$K_c = \frac{(3.0 \times 10^{-3})(4.2 \times 10^{-3})}{(2.8 \times 10^{-3})^2} = 0.717$$

Solving for α, we find that:

$$\alpha \approx 0.717$$

Quick Tip

Degree of dissociation (α) represents the fraction of a substance that dissociates into its components at equilibrium.

---

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

$$3ROH + PCl_3 \rightarrow 3RCl + A$$

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

(1) H_3PO_4 and $POCl_3$

(2) H_3PO_3 and $POCl_3$

(3) $POCl_3$ and H_3PO_3

(4) $POCl_3$ and H_3PO_4

Correct Answer: (2) H_3PO_3 and $POCl_3$

Solution: - Reaction with PCl_3 produces Phosphorous Acid (H_3PO_3) as by-product. - Reaction with PCl_5 leads to formation of $POCl_3$ as a by-product. - Therefore, the correct match is (H_3PO_3, $POCl_3$).

Quick Tip

Reactions of alcohols with phosphorus halides give alkyl halides and different phosphorous oxyacids depending on the reagent used.

---

89. 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+}

Choose the correct answer from the options given below.

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

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

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

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

Correct Answer: (3) B, A, D, C, E

Solution: In inorganic qualitative analysis, the cations are arranged in groups based on their reactivity and the reagents they react with. The order of increasing group number for the given cations is as follows:

- B. Cu^{2+} belongs to Group II - A. Al^{3+} belongs to Group III - D. Co^{2+} belongs to Group IV - C. Ba^{2+} belongs to Group V - E. Mg^{2+} belongs to Group VI

Hence, the correct order is:

B, A, D, C, E

Quick Tip

Group number increases as we move from alkaline earth metals (Mg, Ba) to transition metals (Cu, Co).

90. 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) Dilute nitric acid

(2) Dilute sulphuric acid

V (3) Dilute hydrochloric acid

(4) Concentrated sulphuric acid

Correct Answer: (2) Dilute sulphuric acid

Solution: - Mohr's salt ($FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$) is susceptible to hydrolysis in aqueous solution, forming ferric hydroxide ($Fe(OH)_3$). - To prevent hydrolysis, dilute sulphuric acid is added, which maintains a low pH and prevents oxidation of Fe^{2+} to Fe^{3+}. - Hydrochloric acid and nitric acid are not used because they may introduce unwanted side reactions.

Quick Tip

Adding dilute sulphuric acid prevents the oxidation of Fe^{2+} and stabilizes the Mohr's salt solution.

---

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

Given:

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

(1) 413.14 calories

(2) 100 calories

(3) 0 calorie

(4) -413.14 calories

Correct Answer: (4) -413.14 calories

Solution: - Work done in isothermal reversible expansion is given by:

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

Substituting the values:

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

$$W = -(2.0)(298) \times \ln(0.5)$$

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

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

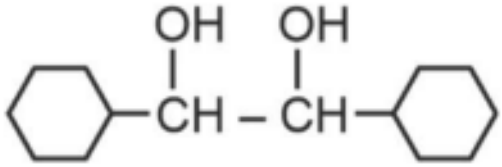
Quick Tip

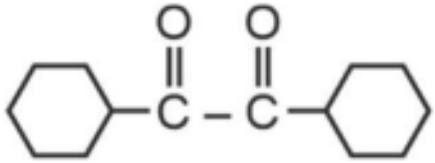
In isothermal expansion, work done (W) is negative because the gas is expanding against external pressure, losing energy.

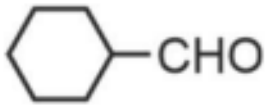
---

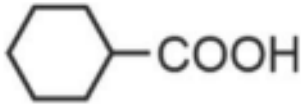
92. For the given reaction:

'P' is:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (4) Structure 4

Solution: - The given reaction is oxidative cleavage of an alkyne using potassium permanganate ($KMnO_4$) in acidic medium. - Alkynes undergo cleavage, forming carboxylic acids if internal, and CO_2 if terminal. - Here, cyclohexyl acetylene undergoes oxidative cleavage, producing cyclohexyl carboxylic acid (COOH) as the major product. - Thus, the correct answer is Structure 4.

Quick Tip

Alkynes treated with $KMnO_4/H^+$ undergo cleavage, forming carboxylic acids if internal and CO_2 if terminal.

---

93. 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:

$$R = 0.0831 \text{ L bar mol}^{-1} \text{ K}^{-1}$$

(1) 25.73°C

(2) 12.05°C

(3) 37°C

(4) 310°C

Correct Answer: (3) 37°C

Solution: - From the equation $\Pi = CRT$, the slope of the plot represents RT. - Given slope: 25.73 L bar mol^{-1} - Solving for T:

$$T = \frac{25.73}{0.0831} = 310 \text{ K}$$

$$T = 310 - 273 = 37^\circ C$$

Quick Tip

Osmotic pressure follows Van't Hoff's equation, where slope = RT, allowing determination of temperature.

---

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

$$CH_3 - CH_2 - CH_2 - Br \xrightarrow{NaCN} A \xrightarrow{OH^-} B \xrightarrow{NaOH,\ Br_2} C$$

(1) Butanamide

(2) α-bromobutanoic acid

(3) Propylamine

(4) Butylamine

Correct Answer: (3) Propylamine

Solution: - The first reaction converts 1-bromopropane into propyl cyanide (A) using NaCN. - The second step involves hydrolysis of cyanide to propanoic acid (B). - The third step, Hoffmann bromamide degradation, converts propanoic acid to propylamine (C).

Quick Tip

The Hoffmann bromamide reaction shortens the carbon chain by one, converting amides into amines.

---

95. A compound X contains 32% of A, 20% of B and the remaining percentage of C. Find the empirical formula of X.

Given:

$$\text{Atomic masses:} \quad A = 64, \quad B = 40, \quad C = 32u$$

(1) A_2BC_2

(2) ABC_4

(3) A_2BC_2

(4) ABC_3

Correct Answer: (4) ABC_3

Solution: - Moles of each element:

$$\frac{32}{64} = 0.5, \quad \frac{20}{40} = 0.5, \quad \frac{48}{32} = 1.5$$

- Dividing by the smallest number (0.5):

$$A = 1, \quad B = 1, \quad C = 3$$

- Empirical formula: ABC_3

Quick Tip

To determine the empirical formula, divide mass percentages by atomic masses, then simplify the ratio.

---

96. The rate of a reaction quadruples when temperature changes from 27°C to 57°C. Calculate the energy of activation.

Given:

$$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}, \quad \log 4 = 0.6021$$

(1) 3.80 kJ/mol

(2) 3804 kJ/mol

(3) 38.04 kJ/mol

(4) 380.4 kJ/mol

Correct Answer: (3) 38.04 kJ/mol

Step-by-Step Solution: Using Arrhenius equation:

$$\log\left(\frac{k_2}{k_1}\right) = \frac{E_a}{2.303R}\left(\frac{T_2 - T_1}{T_1 T_2}\right)$$

Substituting values:

$$\log(4) = \frac{E_a}{2.303 \times 8.314} \times \left(\frac{30}{(300)(330)}\right)$$

$$0.6021 = \frac{E_a}{19.147} \times \frac{30}{99000}$$

$$E_a = \frac{0.6021 \times 19.147 \times 99000}{30}$$

$$E_a = 38.04 \text{ kJ/mol}$$

Quick Tip

In temperature-dependent rate calculations, Arrhenius equation is used to find activation energy.

---

97. Identify the correct answer.

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

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

(3) Three resonance structures can be drawn for ozone

(4) BF_3 has non-zero dipole moment

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

Solution:

- The carbonate ion (CO_3^{2-}) exhibits resonance, having three equivalent resonance structures.
- NF_3 has a lower dipole moment than NH_3 because fluorine is more electronegative, reducing the net dipole moment.
- Ozone (O_3) has only two resonance structures, not three.
- BF_3 is planar and symmetrical, leading to a net dipole moment of zero.

Quick Tip

For identifying resonance structures, check for delocalization of electrons and equivalence of bond structures.

---

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

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

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

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

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

Correct Answer: (3) Ce^{4+} and Yb^{2+}

Solution:

- A diamagnetic ion has all electrons paired.
- Ce^{4+} ($4f^0$) has an empty 4f subshell, making it diamagnetic.
- Yb^{2+} ($4f^{14}$) has a completely filled 4f orbital, also making it diamagnetic.
- Other given ions have unpaired electrons, making them paramagnetic.

Quick Tip

Diamagnetic substances have no unpaired electrons and do not respond to a magnetic field.

---

99. 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) Statement I is true but Statement II is false

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (3) Both Statement I and Statement II are true

Solution:

- Homoleptic Complex: Contains only one type of ligand.
- Example: $[Co(NH_3)_6]^{3+}$ (only NH_3 ligands).
- Heteroleptic Complex: Contains more than one type of ligand.
- Example: $[Co(NH_3)_4Cl_2]^{+}$ (NH_3 and Cl ligands).
- Since both statements correctly describe the complexes, both are true.

Quick Tip

Homoleptic and heteroleptic complexes differ based on the number of different ligands present in coordination chemistry.

---

100. Mass in grams of copper deposited by passing 9.6487 A current through a voltmeter containing copper sulphate solution for 100 seconds is:

Given:

$$\text{Molar mass of Cu} = 63 \text{ g mol}^{-1}, \quad 1F = 96487 \text{ C}$$

(1) 31.5 g

(2) 0.315 g

(3) 3.15 g

(4) 0.315 g

Correct Answer: (4) 0.315 g

Solution: Using Faraday's law of electrolysis:

$$m = \frac{ZIt}{F}$$

Where: - $Z = \frac{M}{nF} = \frac{63}{2 \times 96487}$ (for $Cu^{2+} \rightarrow Cu$ reduction) - $I = 9.6487$ A, $t = 100$ s, $F = 96487$ C/mol

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

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

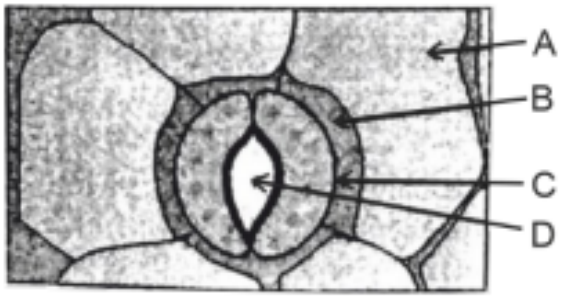
$$m = 0.315 \text{ g}$$

Quick Tip

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

BOTANY

101. In the given figure, which component has thin outer walls and highly thickened inner walls?



(2) B

(4) D

(1) A

(2) B

(3) C

(4) D

Correct Answer: (3) C

Solution: The given diagram represents a stoma with its associated guard cells and subsidiary cells.

Xylem vessels or tracheids often have thickened inner walls for structural support and water conduction.

C represents xylem vessels, which have thin outer walls and highly thickened inner walls to withstand water pressure.

Quick Tip

In plant anatomy, xylem vessels facilitate water transport and provide mechanical support through lignified walls.

---

102. List of endangered species was released by:

(1) FOAM

(2) IUCN

(3) GEAC

(4) WWF

Correct Answer: (2) IUCN

Solution: IUCN (International Union for Conservation of Nature) publishes the Red List of endangered and threatened species globally.

FOAM is not associated with conservation efforts. GEAC (Genetic Engineering Approval Committee) regulates genetically modified organisms (GMOs) in India.

WWF (World Wide Fund for Nature) works for conservation but does not officially publish the endangered species list.

Quick Tip

The IUCN Red List classifies species into categories such as Vulnerable, Endangered, and Critically Endangered based on extinction risk.

---

103. The type of conservation in which the threatened species are taken out from their natural habitat and placed in a special setting where they can be protected and given special care is called:

(1) Semi-conservative method

(2) Sustainable development

(3) *in-situ* conservation

(4) Biodiversity conservation

Correct Answer: (4) Biodiversity conservation

Solution: - *Ex-situ* conservation is when species are taken out of their natural habitat for conservation (e.g., in zoos, botanical gardens). - *In-situ* conservation refers to protecting species in their natural habitat (e.g., national parks, wildlife sanctuaries). - Biodiversity conservation includes both *in-situ* and *ex-situ* conservation methods. - The given definition aligns with ex-situ conservation, which is a part of biodiversity conservation.

Quick Tip

Biodiversity conservation includes strategies such as protected areas, genetic banks, captive breeding, and habitat restoration.

---

104. Which one of the following can be explained on the basis of Mendel's Law of Dominance?

Statements:

A. Out of one pair of factors, one is dominant and the other is recessive.

B. Alleles do not show any expression, and both 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.

(1) B, C and D only

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

(3) A, B and D only

(4) A, C, D and E only

Correct Answer: (4) A, C, D and E only

Solution: - Mendel's Law of Dominance states that: - A dominant allele masks the expression of a recessive allele (Statement A).

- Genes exist as discrete units (factors) controlling traits (Statement D).

- Factors occur in pairs in diploid organisms (Statement C).

- A monohybrid cross shows only one parental character in the F_1 generation (Statement E).
- Statement B is incorrect because in the F_2 generation, both parental traits reappear in a 3:1 ratio, showing recessive allele expression.

Quick Tip

Mendel's experiments with pea plants led to the formulation of three fundamental laws of inheritance: Dominance, Segregation, and Independent Assortment.

---

105. The lactose present in the growth medium of bacteria is transported to the cell by the action of:

(1) Permease

(2) Polymerase

(3) Beta-galactosidase

(4) Acetylase

Correct Answer: (1) Permease

Solution: - Lactose permease (LacY) is a membrane transport protein responsible for the uptake of lactose into bacterial cells. - It functions as a symporter, coupling lactose transport with a proton gradient. - Beta-galactosidase (LacZ) breaks down lactose into glucose and galactose, but it does not transport it.

Quick Tip

In the Lac operon system, LacY (permease) transports lactose, while LacZ (beta-galactosidase) hydrolyzes it.

---

106. 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

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

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

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

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

Correct Answer: (1) A-III, B-I, C-IV, D-II **Solution:** - Clostridium butylicum produces butyric acid, used in anaerobic fermentation. - Saccharomyces cerevisiae is a yeast used in ethanol fermentation. - Trichoderma polysporum is a fungus that produces Cyclosporin-A, an immunosuppressive drug. - Streptococcus species produce streptokinase, used to dissolve blood clots.

Quick Tip

Industrial microbiology utilizes microbes for fermentation, pharmaceuticals, and biotechnology applications.

---

107. The equation of Verhulst-Pearl logistic growth is:

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

From this equation, K indicates:

(1) Carrying capacity

(2) Population density

(3) Intrinsic rate of natural increase

(4) Biotic potential

Correct Answer: (1) Carrying capacity

Solution: - The Verhulst-Pearl equation describes logistic growth, where population growth slows as it approaches a maximum limit. - K (carrying capacity) represents the maximum population size that an environment can sustain. - r (intrinsic rate of increase) determines the population growth rate.

Quick Tip

Unlike exponential growth, logistic growth considers resource limitations, making it more realistic for natural populations.

---

108. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and downstream ends:

(1) Inducer, Repressor, Structural gene

(2) Promoter, Structural gene, Terminator

(3) Repressor, Operator gene, Structural gene

(4) Structural gene, Transposons, Operator gene

Correct Answer: (2) Promoter, Structural gene, Terminator

Solution: - A transcription unit in DNA consists of:

- Promoter: Binding site for RNA polymerase to initiate transcription.
- Structural gene: The coding region that is transcribed into mRNA.
- Terminator: Signals RNA polymerase to stop transcription.

Quick Tip

The transcription unit determines the region of DNA that will be expressed as mRNA and ultimately translated into protein.

---

109. Formation of interfascicular cambium from fully developed parenchyma cells is an example of:

(1) Dedifferentiation

(2) Maturation

(3) Differentiation

(4) Redifferentiation

Correct Answer: (1) Dedifferentiation

Solution: - Dedifferentiation is the process where mature, specialized cells revert to a meristematic state to regain the ability to divide.

- Interfascicular cambium arises from parenchyma cells, which are already mature but regain the ability to form vascular tissues.
- Differentiation refers to the specialization of cells, while redifferentiation occurs when dedifferentiated cells become specialized again.

Quick Tip

Dedifferentiation is essential for secondary growth in plants, allowing the formation of vascular cambium and cork cambium.

---

110. Match List I with List II:

List I	List II
A. Rhizopus	I. Mushroom
B. Ustilago	II. Smut fungus
C. Puccinia	III. Bread mould
D. Agaricus	IV. Rust fungus

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

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

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

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

Correct Answer: (3) A-III, B-II, C-IV, D-I **Solution:** - Rhizopus is a fungus known as bread mould. - Ustilago is a smut fungus that infects cereal crops. - Puccinia is a rust fungus, causing rust diseases in plants. - Agaricus includes mushroom species like Agaricus bisporus (edible mushroom).

Quick Tip

Different fungal genera cause various plant diseases and have economic significance in agriculture.

---

111. What is the fate of a piece of DNA carrying only a gene of interest which is transferred into an alien organism?

1. The piece of DNA would be able to multiply itself independently in the progeny cells of the organism.
2. It may get integrated into the genome of the recipient.
3. It may multiply and be inherited along with the host DNA.
4. The alien piece of DNA is not an integral part of the chromosome.
5. It shows ability to replicate.

(1) B and C only

(2) A and E only

(3) A and B only

(4) D and E only

Correct Answer: (1) B and C only

Solution: When a piece of DNA carrying the gene of interest is transferred into an alien organism, the fate of this DNA can vary based on the mechanisms of gene transfer and replication. The key possibilities are:

- **B. It may get integrated into the genome of the recipient.** This is a typical outcome for recombinant DNA in transgenic organisms.
- **C. It may multiply and be inherited along with the host DNA.** This can happen if the DNA integrates into the genome or exists as an episome that replicates independently.

Therefore, the correct answer is:

B and C only.

Quick Tip

In recombinant DNA technology, the inserted gene can be integrated into the host genome or exist as an extrachromosomal plasmid.

---

112. 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

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

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

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

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

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

Solution:

- Nucleolus (III): Synthesizes ribosomal RNA (rRNA) and assembles ribosomes.
- Centriole (II): Has a cartwheel structure and is involved in cell division.
- Leucoplasts (IV): Store nutrients like starch, lipids, and proteins in plants.

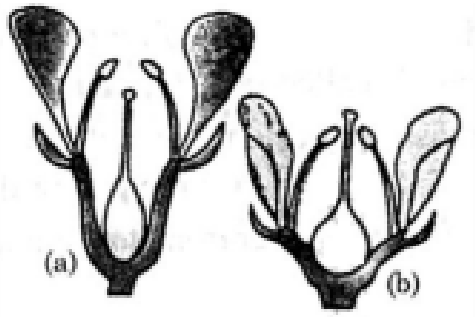
- Golgi apparatus (I): Involved in modification of lipids and glycolipids.

Quick Tip

The nucleolus is the site of ribosome formation, while Golgi bodies play a role in protein and lipid modification.

---

113. 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) Perigynous; (b) Epigynous

(2) (a) Perigynous; (b) Perigynous

(3) (a) Epigynous; (b) Hypogynous

(4) (a) Hypogynous; (b) Epigynous

Correct Answer: (2) (a) Perigynous; (b) Perigynous

Solution: - In perigynous flowers, the ovary is half-inferior, with the calyx, corolla, and androecium located on the rim of the floral cup. - Epigynous flowers have an inferior ovary, where the floral parts arise above the ovary. - The given images suggest both flowers are perigynous, meaning they have a half-inferior ovary.

Quick Tip

Flowers are classified as hypogynous, perigynous, or epigynous based on the position of the ovary relative to other floral whorls.

---

114. Spindle fibers attach to kinetochores of chromosomes during:

(1) Anaphase

(2) Telophase

(3) Prophase

(4) Metaphase

Correct Answer: (4) Metaphase

Solution: - Metaphase is the stage where chromosomes align at the metaphase plate, and spindle fibers attach to the kinetochores of the chromosomes.

- In prophase, chromosomes condense but spindle attachment is not fully established.

- Anaphase is when sister chromatids separate, and telophase marks the reformation of nuclear membranes.

Quick Tip

The metaphase checkpoint ensures that chromosomes are properly attached to spindle fibers before progressing to anaphase.

---

115. These are regarded as major causes of biodiversity loss:

A. Over-exploitation

B. Co-extinction

C. Mutation

D. Habitat loss and fragmentation

E. Migration

(1) A, B and E only

(2) A, B and D only

(3) A, C and D only

(4) A, B, C and D only

Correct Answer: (2) A, B and D only

Solution: - Over-exploitation (A): Unsustainable hunting, fishing, and resource extraction lead to species decline.

- Co-extinction (B): When a species goes extinct, dependent species also face extinction.

- Habitat loss and fragmentation (D): Deforestation, urbanization, and agriculture destroy ecosystems.

- Mutation (C) and Migration (E) are natural processes and do not directly cause biodiversity loss.

Quick Tip

The biggest threats to biodiversity are habitat destruction, climate change, pollution, and invasive species.

---

116. Lecithin, a small molecular weight organic compound found in living tissues, is an example of:

(1) Glycerides

(2) Carbohydrates

(3) Amino acids

(4) Phospholipids

Correct Answer: (4) Phospholipids

Solution: - Lecithin is a type of phospholipid found in cell membranes, playing a key role in membrane structure and signaling. - It consists of phosphatidylcholine, a major component of biological membranes. - Glycerides are fats and oils, carbohydrates provide energy, and amino acids form proteins, but none of these match lecithin.

Quick Tip

Phospholipids like lecithin are amphipathic molecules, having both hydrophilic heads and hydrophobic tails, crucial for cell membrane function.

---

117. 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, C, D and E only

(2) B, C, D and E only

(3) C, D and E only

(4) A, B, C and D only

Correct Answer: (2) B, C, D and E only

Solution: - **Step 1: Understanding the statements**

- *Vallisneria* flowers are not colourful and do not produce nectar, so A is incorrect.

- Water lily flowers are pollinated by insects or other agents, not water, so B is correct.

- Pollen grains of water-pollinated species are often covered by a mucilaginous coat for protection, making C correct.

- Some hydrophytes have long and ribbon-like pollen grains, making D correct.

- In some hydrophytes, pollen is passively transported in water, making E correct.

Quick Tip

For hydrophilous pollination, remember two key types: - **Epihydrophily**: Pollen floats on the water surface. - **Hypohydrophily**: Pollen travels underwater.

---

118. The cofactor of the enzyme carboxypeptidase is:

(1) Flavin

(2) Haem

(3) Zinc

(4) Niacin

Correct Answer: (3) Zinc

Solution: - Carboxypeptidase is a metalloenzyme that requires a metal ion for its activity. - Zinc acts as a cofactor, stabilizing the enzyme structure and aiding in catalysis.

Quick Tip

Metalloenzymes like carboxypeptidase require metal ions (e.g., Zn, Fe, Mg) for proper function.

---

119. Inhibition of Succinic dehydrogenase enzyme by malonate is a classical example of:

(1) Competitive inhibition

(2) Enzyme activation

(3) Cofactor inhibition

(4) Feedback inhibition

Correct Answer: (1) Competitive inhibition

Solution: - Malonate structurally resembles succinate, the substrate for Succinic dehydrogenase.

- It competes for the active site, preventing substrate binding without affecting the enzyme's structure.

Quick Tip

Competitive inhibitors resemble the substrate and compete for the enzyme's active site.

---

120. Which of the following is an example of an actinomorphic flower?

(1) *Pisum*

(2) *Sesbania*

(3) *Datura*

(4) *Cassia*

Correct Answer: (3) *Datura*

Solution: - Actinomorphic flowers exhibit radial symmetry, meaning they can be divided into equal halves through multiple planes.

- *Datura* (Jimson weed) is radially symmetrical, while others exhibit bilateral symmetry.

Quick Tip

Radial symmetry: Actinomorphic (e.g., *Datura*) **Bilateral symmetry**: Zygomorphic (e.g., *Pisum, Cassia*)

---

121. Given below are two statements:

Statement I: Chromosomes become gradually visible under a light microscope during the leptotene stage. **Statement II**: The beginning of the diplotene stage is recognized by the dissolution of the synaptonemal complex.

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

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (3) Both Statement I and Statement II are true

Solution: - **Step 1: Understanding Leptotene Stage**

- During leptotene (early prophase I of meiosis), chromosomes start condensing and become visible.

- Thus, Statement I is correct.

- **Step 2: Understanding Diplotene Stage**

- The diplotene stage is marked by the dissolution of the synaptonemal complex, leading to the separation of homologous chromosomes except at chiasmata.

- Thus, Statement II is also correct.

Quick Tip

Meiotic Prophase I stages: - **Leptotene**: Chromosome visibility begins. - **Zygotene**: Synapsis starts. - **Pachytene**: Crossing over occurs. - **Diplotene**: Synaptonemal complex dissolves. - **Diakinesis**: Chromosomes condense further, and nuclear envelope breaks down.

---

122. 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) Only pink-flowered plants

(2) Red, Pink as well as White-flowered plants

(3) Only red-flowered plants

(4) Red-flowered as well as pink-flowered plants

Correct Answer: (4) Red-flowered as well as pink-flowered plants

Solution: - **Step 1: Understanding Snapdragon Flower Color Inheritance**

- Snapdragon flower color follows **Incomplete Dominance**, where the heterozygous condition produces an intermediate phenotype.

- Let: - RR = Red-flowered

- Rr = Pink-flowered

- rr = White-flowered

- **Step 2: Cross Between Pink (Rr) and Red (RR)**

- The Punnett square for this cross is:

	R	R
Rr	RR	RR
Rr	Rr	Rr

- The resulting progeny ratio: - 50% Red-flowered (RR) - 50% Pink-flowered (Rr)

- **Step 3: Conclusion** - The offspring will have only red and pink flowers. - Hence, the correct answer is **(4)**.

Quick Tip

Incomplete Dominance: Neither allele is completely dominant, and heterozygous individuals show an intermediate phenotype. Example: Snapdragon flower color.

---

123. 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) Statement I is true but Statement II is false

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (2) Statement I is false but Statement II is true

Solution: - Parenchyma and collenchyma are both living tissues. Hence, Statement I is incorrect. - Gymnosperms do not have true xylem vessels, whereas angiosperms possess them. Thus, Statement II is correct.

Quick Tip

Key Differences: - Parenchyma: Living, thin-walled cells. - Collenchyma: Living, thick-walled at corners for mechanical support. - Sclerenchyma: Dead, thick-walled cells.

---

124. 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) Statement I is true but Statement II is false

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false

Solution: - Bt toxin is specific to particular insect groups and is coded by the *cry* genes, making Statement I correct. - However, the activation of Bt protoxin occurs in the **alkaline** pH of the insect gut, not acidic, making Statement II incorrect.

Quick Tip

Bt Toxin Activation: - Exists as an inactive protoxin in *Bacillus thuringiensis*. - Converts to active toxin in an **alkaline** pH of the insect gut.

---

125. Which one of the following is *not* a criterion for classification of fungi?

(1) Mode of spore formation

(2) Fruiting body

(3) Morphology of mycelium

(4) Mode of nutrition

Correct Answer: (4) Mode of nutrition

Solution: - Fungi are classified based on their spore formation, fruiting bodies, and mycelium morphology. - They exhibit different modes of nutrition (saprophytic, parasitic, symbiotic), but this is **not** the primary criterion for classification.

Quick Tip

Fungal Classification Criteria: - Spore type - Fruiting body structure - Mycelium morphology

---

126. The capacity to generate a whole plant from any cell of the plant is called:

(1) Differentiation

(2) Somatic hybridization

(3) Totipotency

(4) Micropropagation

Correct Answer: (3) Totipotency

Solution: - Totipotency is the ability of a single plant cell to regenerate into an entire plant. - This property is utilized in plant tissue culture to generate clones.

Quick Tip

Totipotency in Plants: - Used in micropropagation and tissue culture techniques. - Key for cloning genetically identical plants.

---

127. Which of the following are required for the dark reaction of photosynthesis?

A. Light

B. Chlorophyll

C. CO_2

D. ATP

E. NADPH

Choose the correct answer from the options given below:

(1) C, D and E only

(2) D and E only

(3) A, B and C only

(4) B, C and D only

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

Solution: - The dark reaction (Calvin cycle) of photosynthesis does not require light directly. - It utilizes CO_2, ATP, and NADPH to form glucose. - Chlorophyll and light are needed in the light-dependent reaction, not the dark reaction.

Quick Tip

Dark Reaction (Calvin Cycle): - Takes place in the stroma of chloroplasts. - Uses ATP and NADPH from the light reaction. - Fixes CO_2 to synthesize glucose.

---

128. 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, B and E only

(2) A, B and D only

(3) A, C, D and E only

(4) A and B only

Correct Answer: (3) A, C, D and E only

Solution: - Tropical regions have remained undisturbed for millions of years, allowing more time for species diversification.

- They receive more solar energy, which increases productivity and biodiversity.

- A stable environment encourages niche specialization and higher species richness.

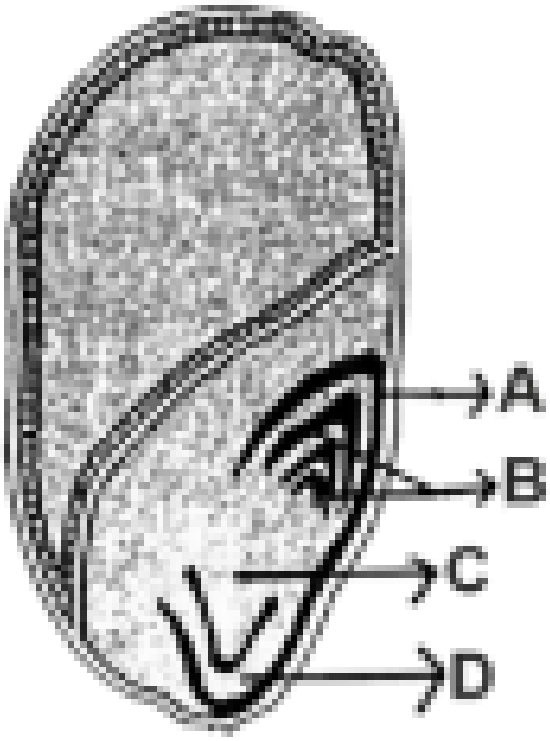
- Seasonal variations are more prominent in temperate regions, not tropical ones, making option B incorrect.

Quick Tip

Why Tropics Have More Species? - Longer evolutionary time for diversification. - Higher solar energy input. - Stable and predictable environment promotes specialization.

---

129. Identify the part of the seed from the given figure which is destined to form root when the seed germinates.



(1) C

(2) D

(3) A

(4) B

Correct Answer: (1) C

Solution: - The part of the seed responsible for root formation is called the **radicle**. - In the given diagram, part ”C” represents the radicle, which develops into the root during germination. - The plumule gives rise to the shoot, while cotyledons provide nourishment.

Quick Tip

Seed Germination: - **Radicle** → Develops into the root. - **Plumule** → Develops into the shoot. - **Cotyledons** → Provide nutrients.

---

130. How many molecules of ATP and NADPH are required for every molecule of CO_2 fixed in the Calvin cycle?

(1) 3 molecules of ATP and 3 molecules of NADPH

(2) 3 molecules of ATP and 2 molecules of NADPH

(3) 2 molecules of ATP and 3 molecules of NADPH

(4) 2 molecules of ATP and 2 molecules of NADPH

Correct Answer: (2) 3 molecules of ATP and 2 molecules of NADPH

Solution: - The Calvin cycle requires energy in the form of ATP and reducing power from NADPH. - For every CO_2 molecule fixed, 3 ATP and 2 NADPH are consumed. - These are used in the regeneration of RuBP and the reduction of 3-PGA to G3P.

Quick Tip

Calvin Cycle Energy Requirement: - ATP: 3 per CO_2 fixed - NADPH: 2 per CO_2 fixed

---

131. 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/Bb

(3) BB

(4) bb

Correct Answer: (4) bb

Solution: - A test cross is performed to determine an unknown genotype by crossing it with a homozygous recessive (bb) individual. - If the unknown genotype is BB, all offspring will have black seeds. - If the unknown genotype is Bb, 50

Quick Tip

Test Cross: - Cross an individual with a dominant phenotype but unknown genotype with a homozygous recessive (bb). - If any offspring exhibit the recessive trait, the unknown genotype is heterozygous.

---

132. Hind II always cuts DNA molecules at a particular point called recognition sequence and it consists of:

(1) 4 bp

(2) 10 bp

(3) 8 bp

(4) 6 bp

Correct Answer: (4) 6 bp

Solution: - Hind II is a restriction enzyme that cuts DNA at a specific recognition site. - The recognition sequence for Hind II is always 6 base pairs (bp) long.

Quick Tip

Restriction Enzymes: - Enzymes that cut DNA at specific sequences. - Recognition sequence for Hind II: 6 bp.

---

133. Bulliform cells are responsible for:

(1) Increased photosynthesis in monocots.

(2) Providing large spaces for storage of sugars.

(3) Inward curling of leaves in monocots.

(4) Protecting the plant from salt stress.

Correct Answer: (3) Inward curling of leaves in monocots

Solution: - Bulliform cells are large, thin-walled cells found in monocot leaves. - During water stress, they lose water and collapse, causing the leaf to curl inward to reduce water loss.

Quick Tip

Function of Bulliform Cells: - Help in leaf rolling and unrolling in monocots. - Prevent excessive water loss under drought conditions.

134. 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 F1 progeny with homozygous recessive parent	II.	Ploidy
C.	Cross of F1 progeny with any of the parents	III.	Allele
D.	Number of chromosome sets in plant	IV.	Test cross

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - **Allele (A-III):** Different forms of a gene at the same locus.

- **Test Cross (B-IV):** Cross of F_1 with a homozygous recessive parent.

- **Back Cross (C-I):** Cross of F_1 with either of the parents.

- **Ploidy (D-II):** Number of chromosome sets in an organism.

Quick Tip

Genetic Crosses: - **Test Cross:** Determines the genotype of an organism. - **Back Cross:** F_1 crossed with a parent to preserve traits. - **Ploidy:** Number of chromosome sets (haploid, diploid, polyploid).

135. Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin:

(1) does not affect mature monocotyledonous plants.

(2) can help in cell division in grasses, to produce growth.

(3) promotes apical dominance.

(4) promotes abscission of mature leaves only.

Correct Answer: (1) does not affect mature monocotyledonous plants.

Solution: - Auxins are selectively toxic to dicotyledonous weeds but do not harm monocots

like grass.

- They are used as herbicides to eliminate broadleaf weeds without affecting monocots.

Quick Tip

Auxin Herbicide Use: - Kills dicot weeds but not monocot grass. - Used in agriculture and lawn maintenance.

SECTION-B

136. 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-IV, B-III, C-II, D-I

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

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

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

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

Solution: Rose (A-II): Perigynous flower has a half-inferior ovary.

Pea (B-IV): Shows marginal placentation, where ovules are arranged along one side.

Cotton (C-I): Exhibits twisted aestivation in petals.

Mango (D-III): Produces drupe fruits with a fleshy outer part and a hard seed.

Quick Tip

Key Botanical Terms: Aestivation: Arrangement of petals in a flower bud. **Placentation:** Arrangement of ovules inside the ovary. **Drupe:** A fruit with a hard seed inside.

---

137. The DNA present in chloroplast is:

(1) Linear, single stranded

(2) Circular, single stranded

(3) Linear, double stranded

(4) Circular, double stranded

Correct Answer: (4) Circular, double stranded

Solution: - Chloroplast DNA is circular and double-stranded, similar to bacterial DNA.

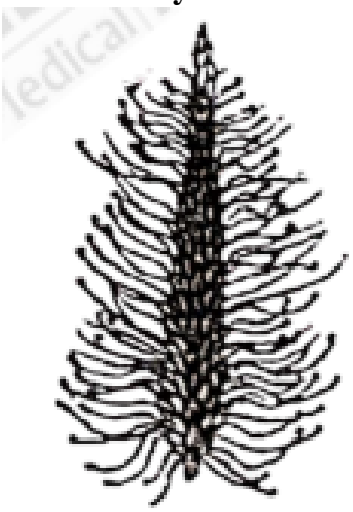
- It supports the endosymbiotic theory, which suggests chloroplasts evolved from free-living bacteria.

Quick Tip

Chloroplast DNA Characteristics: - Circular, double-stranded. - Involved in photosynthesis-related protein synthesis.

---

138. Identify the correct description about the given figure:



(1) Cleistogamous flowers showing autogamy.

(2) Compact inflorescence showing complete autogamy.

(3) Wind pollinated plant inflorescence showing flowers with well exposed stamens.

(4) Water pollinated flowers showing stamens with mucilaginous covering.

Correct Answer: (3) Wind pollinated plant inflorescence showing flowers with well exposed stamens.

Solution: - The figure represents an inflorescence adapted for wind pollination. - Such plants have well-exposed stamens to facilitate pollen dispersal by wind.

Quick Tip

Wind Pollination Adaptations: - Long, exposed stamens. - Light, non-sticky pollen grains. - Feathery stigmas for efficient pollen capture.

---

139. 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-I, B-III, C-II, D-IV

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

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

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

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

Solution:

Robert May (A-III): Estimated global species diversity at around 7 million.

Alexander von Humboldt (B-I): Developed the Species-Area relationship, describing how species richness increases with area.

Paul Ehrlich (C-IV): Proposed the Rivet Popper Hypothesis, explaining species extinction impact on ecosystems.

David Tilman (D-II): Conducted long-term outdoor experiments on ecosystem diversity and stability.

Quick Tip

Key Ecological Concepts:

- **Species-Area Relationship:** Larger areas support more species.

- **Rivet Popper Hypothesis:** Species loss weakens ecosystems, like removing rivets from an airplane.

140. Given below are two statements:

Statement I: In C_3 plants, some O_2 binds to RuBisCO, hence CO_2 fixation is decreased.

Statement II: In C_4 plants, mesophyll cells show very little photosirespiration while bundle sheath cells do not show photorespiration.

Choose the correct answer from the options given below:

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false

Solution: - **C_3 Plants:** RuBisCO enzyme binds with O_2 in the presence of high oxygen, leading to photorespiration, which decreases CO_2 fixation.

- **C_4 Plants:** Mesophyll cells actively perform photosynthesis, contrary to the false statement.

Quick Tip

Photorespiration and Plant Types: - **C_3 Plants:** Prone to photorespiration, lower CO_2 fixation. - **C_4 Plants:** Minimized photorespiration due to spatial separation of carbon fixation.

---

141. Identify the step in tricarboxylic acid cycle, which does not involve oxidation of substrate.

(1) Succinyl-CoA $\rightarrow$ Succinic acid

(2) Isocitrate $\rightarrow$ α-ketoglutaric acid

(3) Malic acid $\rightarrow$ Oxaloacetic acid

(4) Succinic acid $\rightarrow$ Malic acid

Correct Answer: (1) Succinyl-CoA $\rightarrow$ Succinic acid

Solution: - This step in the Krebs cycle is substrate-level phosphorylation, where GTP (or ATP) is synthesized without oxidation. - Other options involve oxidation steps requiring NAD^+ or FAD.

Quick Tip

Krebs Cycle Overview: - Oxidation occurs when NAD^+ or FAD acts as an electron acceptor. - Succinyl-CoA to Succinic acid releases energy used for ATP/GTP synthesis.

---

142. 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-IV, C-I, D-II

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

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

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

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

Solution: Citric Acid Cycle (A-II): Occurs in the mitochondrial matrix.

Glycolysis (B-I): Happens in the cytoplasm.

Electron Transport System (C-IV): Located in the inner mitochondrial membrane.

Proton Gradient (D-III): Established in the intermembrane space of mitochondria.

Quick Tip

Cellular Energy Pathways: - **Glycolysis:** Cytoplasmic process, produces pyruvate. - **Citric Acid Cycle:** Mitochondrial matrix, generates NADH and $FADH_2$. - **ETS:** Inner mitochondrial membrane, facilitates ATP production.

---

143. Which of the following are fused in somatic hybridization involving two varieties of plants?

(1) Protoplasts

(2) Pollens

(3) Callus

(4) Somatic embryos

Correct Answer: (1) Protoplasts

Solution: - In somatic hybridization, protoplasts (the cells without a cell wall) are fused to create hybrids between two different plant varieties.

- This process allows for the mixing of genetic material without the need for sexual reproduction.

Quick Tip

Somatic Hybridization: - Protoplast fusion is a technique where plant cells are induced to fuse, facilitating genetic recombination.

---

144. Match List-I with List-II

List-I		List-II	
A.	GLUT-4	I.	Enables glucose transport into cells
B.	Insulin	II.	Hormone
C.	Trypsin	III.	Enzyme
D.	Collagen	IV.	Intercellular ground substance

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (3) A-IV, B-I, C-II, D-III **Solution:** - **GLUT-4 (A-IV):** A protein involved in glucose transport into cells.

- **Insulin (B-I):** A hormone that regulates blood glucose levels.

- **Trypsin (C-II):** An enzyme involved in protein digestion.

- **Collagen (D-III):** An intercellular substance that forms the structural component of tissues.

Quick Tip

Proteins and Their Functions: - Hormones like insulin regulate physiological processes. - Enzymes like trypsin break down macromolecules during digestion.

---

145. 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-I, B-II, C-IV, D-III
2. A-I, B-I, C-IV, D-II
3. A-IV, B-II, C-I, D-III
4. A-IV, B-I, C-II, D-III

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

Solution: To solve this, let's first understand the terms in List I.

- **Monoadelphous**: Stamens with all filaments fused into a single bundle. This is found in *China-rose (Hibiscus)*.
- **Diadelphous**: Stamens with filaments fused into two groups. Found in *Pea (Fabaceae)*.
- **Polyadelphous**: Stamens with filaments divided into several groups. Found in *Citrus (Rutaceae)*.
- **Epiphyllous**: Stamens attached to the petals of the flower. Seen in *Lily*.

Now, let's match the items from List II with List I:

- **China-rose (IV)** has **Monoadelphous** stamens.
- **Pea (II)** has **Diadelphous** stamens.
- **Citrus (I)** has **Polyadelphous** stamens.
- **Lily (III)** has **Epiphyllous** stamens.

Thus, the correct matching is:

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

Quick Tip

Types of Stamens: - Monoadelphous: Stamens fused into one bundle. - Diadelphous: Stamens in two groups. - Epiphylous: Stamens attached to the petals, common in citrus.

---

146. Read the following statements and choose the set of correct statements:

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 cellulolytic wall, covered on the outside by gelatinous coating of algin.

Choose the correct answer from the options given below:

(1) A, C and D only

(2) A, B, C and E only

(3) A, B, C and D only

(4) B, C, D and E only

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

Solution: Asexual Reproduction (A): Occurs via biflagellate zoospores in Phaeophyceae.

Stored Food (C): Carbohydrates like mannitol or laminarin are stored.

Pigments (D): The major pigments are chlorophyll a, c, carotenoids, and xanthophyll.

Vegetative Wall (E): This statement is incorrect for Phaeophyceae. The wall is covered by gelatinous algin but it is not cellulolytic.

Quick Tip

Phaeophyceae Characteristics: - Known for asexual reproduction through zoospores and storage of carbohydrates in mannitol/laminarin. - Major pigments include chlorophyll a, c, carotenoids, and xanthophyll.

---

147. 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-II, B-III, C-IV, D-I

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

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

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

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

Solution: Frederick Griffith (A-III): Discovered transformation in bacteria.

Francois Jacob & Jacque Monod (B-IV): Developed the lac operon model of gene regulation.

Har Gobind Khorana (C-I): Contributed to deciphering the genetic code.

Meselson & Stahl (D-II): Provided evidence for the semi-conservative mode of DNA replication.

Quick Tip

Key Discoveries in Molecular Biology: - Griffith's experiment showed bacterial transformation. - The lac operon explains gene regulation in prokaryotes.

---

148. Which of the following statements is correct regarding the process of replication in *E. coli*?

(1) The DNA-dependent DNA polymerase catalyzes polymerization in 5' $\rightarrow$ 3' as well as 3' $\rightarrow$ 5' direction.

(2) The DNA-dependent DNA polymerase catalyzes polymerization in 5' $\rightarrow$ 3' direction.

(3) The DNA-dependent DNA polymerase catalyzes polymerization in one direction that is 3' $\rightarrow$ 5'.

(4) The DNA-dependent RNA polymerase catalyzes polymerization in one direction, that is 5' $\rightarrow$ 3'.

Correct Answer: (2) The DNA-dependent DNA polymerase catalyzes polymerization in 5' $\rightarrow$ 3' direction.

Solution: - DNA polymerase in *E. coli* can add nucleotides only in the 5' $\rightarrow$ 3' direction. - It requires a primer and has proofreading ability using its 3' $\rightarrow$ 5' exonuclease activity.

Quick Tip

DNA Polymerase: - Works in the 5' $\rightarrow$ 3' direction. - Has proofreading ability (3' $\rightarrow$ 5' exonuclease activity).

---

149. Spraying sugarcane crop with which of the following plant growth regulators increases the length of the stem, thus, increasing the yield?

(1) Cytokinin

(2) Abscisic acid

(3) Auxin

(4) Gibberellin

Correct Answer: (4) Gibberellin

Solution: - Gibberellins promote stem elongation by stimulating cell division and elongation. - In sugarcane, gibberellins increase internode length, leading to higher yield.

Quick Tip

Plant Growth Regulators: - **Auxin:** Promotes cell elongation and root formation. - **Gibberellin:** Increases stem elongation and fruit growth. - **Cytokinin:** Stimulates cell division. - **Abscisic Acid:** Inhibits growth and induces dormancy.

---

150. 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) 10x (kcal m^{-2}) yr^{-1}

(2) $\frac{100x}{3}$ (kcal m^{-2}) yr^{-1}

(3) $\frac{x}{10}$ (kcal m^{-2}) yr^{-1}

(4) x (kcal m^{-2}) yr^{-1}

Correct Answer: (1) 10x (kcal m^{-2}) yr^{-1}

Solution: In an ecosystem, the Gross Primary Productivity (GPP) is always higher than the Net Primary Productivity (NPP) because GPP includes energy used by producers for respiration. The energy lost in each trophic level due to respiration and metabolism reduces the available energy for the next level.

Given:

$$\text{NPP of the first trophic level} = 100x \text{ (kcal } m^{-2}) \text{ } yr^{-1}$$

By the 10% energy transfer rule (on average, 10

$$\text{GPP of the third trophic level} = 10x \text{ (kcal } m^{-2}) \text{ } yr^{-1}$$

Thus, the correct answer is:

$$10x \text{ (kcal } m^{-2}) \text{ } yr^{-1}$$

Quick Tip

The 10% energy transfer rule helps explain the decrease in energy as you move up trophic levels in an ecosystem.

ZOOLOGY

SECTION-A

151. Match List I with List II

List I		List II	
A.	Down's syndrome	I.	11th chromosome
B.	α-Thalassemia	II.	'X' chromosome
C.	β-Thalassemia	III.	21st chromosome
D.	Klinefelter's syndrome	IV.	16th chromosome

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - **Down's syndrome (A-III):** Caused by trisomy of chromosome 21.

Associated with mutations in chromosome 16:

α**-Thalassemia (B-IV):** Associated with mutations in chromosome 16.

Associated with mutations in chromosome 11:

β**-Thalassemia (C-I):** Associated with mutations in chromosome 11.

- **Klinefelter's syndrome (D-II):** Occurs due to the presence of an extra X chromosome (XXY).

Quick Tip

Genetic Disorders: - Down's syndrome: Trisomy 21

- Klinefelter's syndrome: XXY condition

Thalassemia: Mutation in hemoglobin genes (α: Chr 16, β: Chr 11).

---

152. 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-II, B-IV, C-I, D-III

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

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

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

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

Solution: Diakinesis (A-II): Terminalization of chiasmata is completed.

Pachytene (B-IV): Appearance of recombination nodules where crossing-over occurs.

Zygotene (C-I): Synaptonemal complex formation takes place.

Leptotene (D-III): Chromosomes appear as thin threads.

Quick Tip

Prophase I Subphases: - Leptotene: Chromosome condensation starts. - Zygotene: Synapsis begins. - Pachytene: Crossing-over occurs. - Diplotene: Chiasmata formation. - Diakinesis: Terminalization of chiasmata.

---

153. Which of the following factors are favorable for the formation of oxyhemoglobin in alveoli?

(1) Low pCO_2 and High H^+ concentration

(2) Low pCO_2 and High temperature

(3) High pO_2 and High pCO_2

(4) High pO_2 and Lesser H^+ concentration

Correct Answer: (4) High pO_2 and Lesser H^+ concentration

Solution: Oxyhemoglobin formation is favored by high oxygen partial pressure (pO_2) in the alveoli.

Low carbon dioxide (CO_2) and low H^+ concentration reduce acidity, promoting oxygen binding to hemoglobin.

Quick Tip

Oxyhemoglobin Formation Factors: - **Favors:** High pO_2, Low CO_2, Low H^+ (high pH). - **Inhibits:** High CO_2, High H^+ (low pH), High temperature (Bohr effect).

---

154. 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-III, B-I, C-IV, D-II

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

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

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

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

Solution: Typhoid (A-IV): Caused by *Salmonella typhi*, a bacterium.

Leishmaniasis (B-III): Caused by *Leishmania*, a protozoan parasite.

Ringworm (C-I): A fungal infection affecting skin, nails, and hair.

Filariasis (D-II): Caused by nematode worms such as *Wuchereria bancrofti*.

Quick Tip

Disease Causative Agents: Bacteria: Typhoid

Protozoa: Leishmaniasis

Fungi: Ringworm

Nematodes: Filariasis

---

155. Match List I with List II

List I		List II	
A.	Expiratory capacity	I.	Expiratory reserve volume + Tidal volume + Inspiratory reserve volume
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-II, B-I, C-IV, D-III
2. A-I, B-III, C-II, D-IV
3. A-II, B-IV, C-I, D-III
4. A-III, B-II, C-IV, D-I

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

Solution: To solve this matching, let's first understand the definitions of each term in List I and List II.

- **Expiratory capacity**: The volume of air that can be exhaled after a normal exhalation. It is the sum of *Expiratory reserve volume* and *Tidal volume*.
- **Functional residual capacity**: The amount of air left in the lungs after a normal exhalation. It is the sum of *Tidal volume* and *Expiratory reserve volume*.
- **Vital capacity**: The maximum amount of air that can be exhaled after a maximum inhalation. It is the sum of *Tidal volume* and *Inspiratory reserve volume*.
- **Inspiratory capacity**: The maximum amount of air that can be inhaled after a normal exhalation. It is the sum of *Expiratory reserve volume* and *Residual volume*.

Now, match the items from List I with the correct items from List II:

- **A. Expiratory capacity** matches with **I. Expiratory reserve volume + Tidal volume + Inspiratory reserve volume**.
- **B. Functional residual capacity** matches with **II. Tidal volume + Expiratory reserve volume**.
- **C. Vital capacity** matches with **III. Tidal volume + Inspiratory reserve volume**.
- **D. Inspiratory capacity** matches with **IV. Expiratory reserve volume + Residual volume**.

Thus, the correct matching is:

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

Quick Tip

Lung Capacities: - Expiratory capacity = TV + ERV - Functional residual capacity = ERV + RV - Vital capacity = TV + IRV + ERV - Inspiratory capacity = TV + IRV

---

156. 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) B, C & E only

(2) C, D & E only

(3) A, B & D only

(4) A, B & E only

Correct Answer: (4) A, B & E only

Solution: Myasthenia gravis (A): Autoimmune neuromuscular disorder leading to muscle weakness.

Rheumatoid arthritis (B): Chronic inflammatory autoimmune disorder affecting joints.

Systemic Lupus Erythematosus (E): Autoimmune disorder affecting multiple organs.

Gout (C) and Muscular dystrophy (D): Not autoimmune disorders. Gout is caused by uric acid deposition, and muscular dystrophy is a genetic disorder.

Quick Tip

Autoimmune Disorders: - Myasthenia gravis - Rheumatoid arthritis - Systemic Lupus Erythematosus (SLE) **Not Autoimmune:** - Gout (metabolic disorder) - Muscular dystrophy (genetic disorder)

---

157. 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.

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

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

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

Solution: - The descending limb of the loop of Henle is **permeable** to water and **impermeable** to electrolytes, making Statement I false.

- The proximal convoluted tubule is lined by **simple cuboidal** brush border epithelium, not columnar, making Statement II false.

Quick Tip

Nephron Functionality: - Descending limb: Permeable to water, impermeable to solutes. - Proximal convoluted tubule: Lined by simple cuboidal epithelium.

---

158. Which of the following is not a steroid hormone?

(1) Progesterone

(2) Glucagon

(3) Cortisol

(4) Testosterone

Correct Answer: (2) Glucagon

Solution: - **Steroid hormones:** Derived from cholesterol, examples include **Progesterone, Cortisol, and Testosterone**.

- **Peptide hormones:** Made of amino acids, an example is **Glucagon**, which regulates blood sugar levels.

Quick Tip

Steroid vs Peptide Hormones: - Steroid: Lipophilic, derived from cholesterol (e.g., Cortisol, Estrogen). - Peptide: Hydrophilic, made of amino acids (e.g., Insulin, Glucagon).

---

159. Given below are two statements:

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) A is true but R is false

(2) A is false but R is true

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

(4) Both A and R are true, but R is NOT the correct explanation of A

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

Solution: FSH (Follicle Stimulating Hormone) acts on ovarian follicles in females, but in males, it acts on **Sertoli cells**, not Leydig cells.

Leydig cells are stimulated by LH (Luteinizing Hormone), not FSH, making Assertion A false.

Reason R is true since ovarian follicles secrete estrogen and interstitial cells (Leydig cells) secrete androgens.

Quick Tip

FSH vs LH Action: - FSH: Stimulates ovarian follicle growth in females, Sertoli cells in males. - LH: Stimulates ovulation in females, Leydig cells in males.

---

160. 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) C-B-D-A

(2) A-D-C-B

(3) D-A-C-B

(4) B-A-D-C

Correct Answer: (2) A-D-C-B

Solution: ***Homo habilis*** **(A)**: Earliest known species, used tools.

Homo erectus **(D)**: First to use fire, bipedal movement.

Homo neanderthalensis **(C)**: Lived in colder regions, had larger brains.

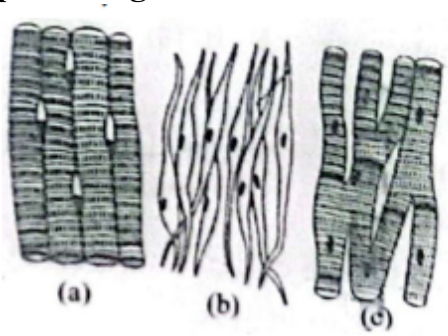
Homo sapiens **(B)**: Modern humans, evolved advanced cognitive skills.

Quick Tip

Human Evolution Sequence: 1. *Homo habilis* $\rightarrow$ 2. *Homo erectus* $\rightarrow$ 3. *Homo neanderthalensis* $\rightarrow$ 4. *Homo sapiens*

---

161. 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 – Biceps
(b) Involuntary – Intestine
(c) Smooth – Heart

(2) (a) Involuntary – Nose tip
(b) Skeletal – Bone
(c) Cardiac – Heart

(3) (a) Smooth – Toes
(b) Skeletal – Legs
(c) Cardiac – Heart

(4) (a) Skeletal – Triceps
(b) Smooth – Stomach
(c) Cardiac – Heart

Correct Answer: (4) Skeletal – Triceps, Smooth – Stomach, Cardiac – Heart

Solution: Step 1: Understanding Muscle Types The three main types of muscles are:

Skeletal Muscles: Voluntary muscles attached to bones (e.g., triceps, biceps, legs).

Smooth Muscles: Involuntary muscles found in organs like the stomach and intestines.

Cardiac Muscles: Involuntary muscles present in the heart.

Step 2: Matching Given Options

(a) Skeletal muscle – Triceps (voluntary)

(b) Smooth muscle – Stomach (involuntary)

(c) Cardiac muscle – Heart (involuntary)

Thus, option (4) is correct.

Quick Tip

- Skeletal muscles are voluntary and control movement. - Smooth muscles are involuntary and found in internal organs. - Cardiac muscles are involuntary and only in the heart.

---

162. Match List I with List II:

List I		List II	
A.	Cocaine	I.	Effective sedative in surgery
B.	Heroin	II.	Cannabis sativa
C.	Morphine	III.	Erythroxylum
D.	Marijuana	IV.	Papaver somniferum

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-I, D-II

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

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

Solution: To solve this matching, let's first understand the drugs and their respective sources:

- **Cocaine** is derived from *Erythroxylum*, and it is an effective sedative in surgery, so:

A matches with III. Erythroxylum

- **Heroin** is derived from *Papaver somniferum*, so:

B matches with IV. Papaver somniferum

- **Morphine** is derived from *Papaver somniferum*, so:

C matches with I. Effective sedative in surgery

- **Marijuana** is derived from *Cannabis sativa*, so:

D matches with II. Cannabis sativa

Thus, the correct matching is:

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

Quick Tip

- Cocaine → *Erythroxylum* - Heroin → *Papaver somniferum* - Morphine → Sedative in surgery - Marijuana → *Cannabis sativa*

---

163. The "Ti plasmid" of *Agrobacterium tumefaciens* stands for:

(1) Tumor inducing plasmid

(2) Temperature independent plasmid

(3) Tumor inhibiting plasmid

(4) Tumor independent plasmid

Correct Answer: (1) Tumor inducing plasmid

Solution: Step 1: Understanding Ti Plasmid The Ti plasmid (tumor-inducing plasmid) is a type of plasmid found in the bacterium *Agrobacterium tumefaciens*, which is responsible for transferring genes that cause tumor-like growth in plants.

Thus, option (1) is correct.

Quick Tip

- Ti plasmid is widely used in genetic engineering to introduce foreign genes into plant cells.

---

164. Which one is the correct product of DNA-dependent RNA polymerase to the given template?

$$3'\textbf{TCATCTGGAAATTACCTTACAS}5'$$

(1) 5' UAUGUCCUUUAAUGGAAUGU 3'

(2) 5' AUGUCCUUUUAAUGGAAGU 3'

(3) 5' UAGUCCUUUUAAUGGAAGU 3'

(4) 5' AUGUAGUCCUUUAUGGAAGU 3'

Correct Answer: (3) 5' UAGUCCUUUUAAUGGAAGU 3'

Solution: Step 1: Transcription Process DNA-dependent RNA polymerase synthesizes mRNA complementary to the template strand. The base-pairing rules are:

$$A \to U, \quad T \to A, \quad C \to G, \quad G \to C$$

Step 2: Finding the Correct mRNA Sequence The given DNA template is:

$$3'\text{TCATCTGGAAATTACCTTACAS}5'$$

The complementary mRNA strand is:

$$5'\text{UAGUCCUUUUAAUGGAAGU}3'$$

Thus, option (3) is correct.

Quick Tip

- RNA is synthesized in the 5' to 3' direction complementary to the 3' to 5' DNA strand.

---

165. Match List I with List II:

List I		List II	
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-V, B-I, C-II, D-III

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

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

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

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

Solution: To solve this matching, let's first identify the fish species and their common names:

- **Pterophyllum** (A) is commonly known as the **Angel fish**, so A matches with III.
- **Myxine** (B) is commonly known as the **Hag fish**, so B matches with I.
- **Pristis** (C) is commonly known as the **Saw fish**, so C matches with II.
- **Exocoetus** (D) is commonly known as the **Flying fish**, so D matches with IV.

Thus, the correct matching is:

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

Quick Tip

- Hag fish (Myxine) → Primitive jawless fish - Saw fish (Pristis) → Characterized by a long, saw-like snout - Angel fish (Pterophyllum) → Freshwater aquarium fish - Flying fish (Exocoetus) → Capable of gliding above water

---

166. 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-II, B-I, C-I, D-IV
2. A-III, B-I, C-IV, 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-I, C-IV, D-II

Solution:

- **Fibrous joints** (A) are found between adjacent vertebrae, allowing limited movement. Hence, A matches with **I. Adjacent vertebrae, limited movement**.
- **Cartilaginous joints** (B) are found in places like the skull, and they don't allow any movement. Hence, B matches with **III. Skull, don't allow any movement**.
- **Hinge joints** (C) are found in places like the knee and help in locomotion. Hence, C matches with **IV. Knee, help in locomotion**.
- **Ball and socket joints** (D) are found in the humerus and pectoral girdle, allowing rotational movement. Hence, D matches with **II. Humerus and Pectoral girdle, rotational movement**.

Thus, the correct matching is:

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

Quick Tip

- Hinge joints allow movement in one direction (e.g., knee).
- Ball and socket joints allow rotational movement.

---

167. The flippers of Penguins and Dolphins are an example of:

(1) Convergent evolution

(2) Divergent evolution

(3) Adaptive radiation

(4) Natural selection

Correct Answer: (1) Convergent evolution

Solution:

Step 1: Understanding Convergent Evolution. Convergent evolution occurs when unrelated species develop similar traits due to adaptation to similar environments or

ecological niches.

Step 2: Applying to the Given Example. - Penguins (birds) and dolphins (mammals) belong to entirely different taxonomic groups. - However, both have developed streamlined bodies and flippers for efficient swimming in aquatic environments. - This similarity is due to environmental pressures rather than shared ancestry.

Conclusion: Since the structural similarity is due to adaptation to a similar habitat and not common ancestry, this is an example of convergent evolution.

Final Answer: Convergent evolution.

Quick Tip

- Convergent Evolution: Different ancestry, similar traits due to similar environments. - Divergent Evolution: Common ancestry, different traits due to different environments.

---

168. 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-IV, C-I, D-II

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

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

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

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

Solution:

Step 1: Understanding the pairs from List I and List II.

- α-1 antitrypsin deficiency is associated with **Emphysema** (III).

- Cry IAb gene is effective against **Corn borer** (IV). - Cry IAc gene is effective against **Cotton bollworm** (I).

- Enzyme replacement therapy is used for **ADA deficiency** (II).

Step 2: Matching the correct pairs.

$$A \rightarrow III \quad (\alpha\text{-1 antitrypsin} \rightarrow \text{Emphysema})$$

$$B \rightarrow IV \quad (\text{Cry IAb} \rightarrow \text{Corn borer})$$

$$C \rightarrow I \quad (\text{Cry IAc} \rightarrow \text{Cotton bollworm})$$

$$D \rightarrow II \quad (\text{Enzyme replacement therapy} \rightarrow \text{ADA deficiency})$$

Final Answer: $\boxed{A-III, B-IV, C-I, D-II}$.

Quick Tip

- Cry proteins (Bt toxins) target specific insect pests. - Enzyme replacement therapy is a treatment for genetic disorders like ADA deficiency. - α-1 antitrypsin deficiency leads to lung diseases such as emphysema.

---

169. Match List I with List II:

List I		List II	
A.	Axoneme	I.	Centriole
B.	Cartwheel pattern	II.	Cilia and flagella
C.	Crista	III.	Chromosome
D.	Satellite	IV.	Mitochondria

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the matches between List I and List II.

Axoneme is the central core of cilia and flagella $\Rightarrow II$.

Cartwheel pattern is a characteristic structural feature of the centriole $\Rightarrow I$.

Crista are folds in the inner membrane of mitochondria $\Rightarrow IV$.

Satellite DNA is a highly repetitive sequence associated with the chromosome $\Rightarrow III$.

Step 2: Matching the correct pairs.

$$A \rightarrow II \quad \text{(Axoneme} \rightarrow \text{Cilia and flagella)}$$

$$B \rightarrow I \quad \text{(Cartwheel pattern} \rightarrow \text{Centriole)}$$

$$C \rightarrow IV \quad \text{(Crista} \rightarrow \text{Mitochondria)}$$

$$D \rightarrow III \quad \text{(Satellite} \rightarrow \text{Chromosome)}$$

Final Answer: $\boxed{A-II, B-I, C-IV, D-III}$.

Quick Tip

- Axoneme is the structural framework of cilia and flagella.
- The cartwheel structure is a feature of centrioles.
- Cristae increase the surface area of mitochondria for ATP production.
- Satellite DNA is involved in chromosome structure and function.

170. Given below are two statements: One is labeled as Assertion (A) and the other as Reason (R).

Assertion (A): Breastfeeding during the initial period of infant growth is recommended by doctors for bringing 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) A is correct but R is not correct.

(2) A is not correct but R is correct.

(3) Both A and R are correct, and R is the correct explanation of A.

(4) Both A and R are correct, but R is NOT the correct explanation of A.

Correct Answer: (3) Both A and R are correct, and R is the correct explanation of A.

Solution:

Step 1: Analyzing Assertion (A). Breastfeeding is crucial in the early stages of life because it provides essential nutrients and immunity-boosting substances to the baby. Hence, Assertion (A) is correct.

Step 2: Analyzing Reason (R). Colostrum, the first milk secreted by the mother after childbirth, is rich in maternal antibodies (such as IgA) that help in developing passive immunity in the newborn. This justifies the medical recommendation for breastfeeding. Hence, Reason (R) is correct.

Step 3: Evaluating the Explanation. Since colostrum provides essential antibodies that help develop immunity, it directly supports the health benefits of breastfeeding. Therefore, Reason (R) correctly explains Assertion (A).

Final Answer: Both A and R are correct, and R is the correct explanation of A. .

Quick Tip

- Colostrum is rich in immunoglobulins, which protect newborns from infections.
- Breastfeeding not only provides nutrition but also strengthens the infant's immune system.
- Passive immunity from colostrum is crucial in the early stages of life.

---

171. Which of the following is not a component of the Fallopian tube?

(1) Infundibulum

(2) Ampulla

(3) Uterine fundus

(4) Isthmus

Correct Answer: (3) Uterine fundus

Solution: The Fallopian tube consists of four main parts: Infundibulum, Ampulla, Isthmus, and Interstitial part. The **Uterine fundus** is actually a part of the uterus, not the Fallopian tube.

Quick Tip

The Fallopian tube is responsible for transporting the egg from the ovary to the uterus and is the site of fertilization.

---

172. Which of the following statements is incorrect?

(1) Bio-reactors are used to produce small scale bacterial cultures

(2)Bio-reactors have an agitator system, an oxygen delivery system, and foam control system

(3) A bio-reactor provides optimal growth conditions for achieving the desired product

(4) Most commonly used bio-reactors are of stirring type

Correct Answer: (1) Bio-reactors are used to produce small-scale bacterial cultures

Solution: Bio-reactors are large-scale systems designed for the mass production of biological products such as antibiotics, vaccines, and enzymes. Small-scale bacterial cultures are typically grown in laboratory flasks or petri dishes, not bio-reactors.

Quick Tip

Bio-reactors provide a controlled environment for microbial or cell culture growth, ensuring optimal conditions for industrial-scale production.

---

173. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: The **Pons** (A) connects different parts of the brain.

The **Hypothalamus** (B) has neurosecretory cells responsible for hormone regulation.

The **Medulla** (C) controls vital functions like respiration and digestion.

The **Cerebellum** (D) regulates posture and balance.

Quick Tip

The brainstem consists of the midbrain, pons, and medulla, which are responsible for vital functions such as breathing, heartbeat, and neural connectivity.

---

174. Match List-I with List-II:

List-I		List-II	
A.	Lipase	I.	Peptide bond
B.	Nuclease	II.	Ester bond
C.	Protease	III.	Glycosidic bond
D.	Amylase	IV.	Phosphodiester bond

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - **Lipase** breaks down fats, which contain **ester bonds**.

- **Nuclease** breaks down nucleic acids, which contain **phosphodiester bonds**.

- **Protease** breaks down proteins, which contain **peptide bonds**.

- **Amylase** breaks down carbohydrates, which contain **glycosidic bonds**.

Quick Tip

Each enzyme is specific to a type of bond. Proteases target peptide bonds in proteins, lipases target ester bonds in fats, nucleases target phosphodiester bonds in nucleic acids, and amylases target glycosidic bonds in carbohydrates.

---

175. Which of the following is not a natural/traditional contraceptive method?

(1) Lactational amenorrhea

(2) Vaults

(3) Coitus interruptus

(4) Periodic abstinence

Correct Answer: (2) Vaults

Solution: Lactational amenorrhea, **coitus interruptus**, and **periodic abstinence** are natural contraceptive methods.

Vaults are barrier contraceptive methods, making them non-natural.

Quick Tip

Natural contraceptive methods involve behavioral and physiological approaches, such as tracking fertility cycles and breastfeeding-related amenorrhea.

---

176. Following are the stages of the pathway for conduction of an action potential through the heart:

A. AV bundle

B. Purkinje fibers

C. AV node D. Bundle branches

E. SA node

Choose the correct sequence of pathway from the options given below

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

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

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

4) A-E-C-B-D

Correct Answer: (3) E-C-A-D-B

Solution: The correct sequence of electrical conduction in the heart is:

1. **SA node** (E) initiates the heartbeat.
2. **AV node** (C) delays the impulse for proper ventricular filling.
3. **AV bundle** (A) transmits the impulse.
4. **Bundle branches** (D) conduct signals through the ventricles.
5. **Purkinje fibers** (B) distribute the impulse, causing ventricular contraction.

Quick Tip

The sinoatrial (SA) node is the pacemaker of the heart, generating rhythmic electrical impulses that regulate heartbeat.

---

177. 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-IV, C-I, D-III

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

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

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

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

Solution: **Pleurobrachia** belongs to **Ctenophora**.

Radula is a structure present in **Mollusca**.

Stomochord is found in **Hemichordata**.

Air bladder is a characteristic feature of **Osteichthyes** (bony fishes).

Quick Tip

Biological classification involves grouping organisms based on structural and functional similarities.

---

178. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: **Common cold** is caused by **rhinoviruses**.

Haemozoin is a byproduct of **Plasmodium**, the malaria-causing parasite.

Widal test is used for diagnosing **typhoid**.

Allergy can be triggered by **dust mites**.

Quick Tip

- **Common cold**: Viral infection affecting the respiratory tract.
- **Haemozoin**: Malarial pigment produced by Plasmodium.
- **Widal test**: Serological test for Salmonella (typhoid).
- **Allergy**: Hypersensitive immune response to allergens.

---

179. 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) C only

(2) D only

(3) B only

(4) A only

Correct Answer: (4) A only

Solution: - **Annelids** possess a **true coelom**, which is lined by mesoderm.

- **Poriferans** are **acoelomates**, not pseudocoelomates.

- **Aschelminthes** (Nematodes) are **pseudocoelomates**, not acoelomates.

- **Platyhelminthes** are **acoelomates**, not pseudocoelomates.

Quick Tip

Coelom classification:

- Acoelomates: No body cavity (e.g., Platyhelminthes).
- Pseudocoelomates: Body cavity not lined by mesoderm (e.g., Aschelminthes).
- Coelomates: True body cavity lined by mesoderm (e.g., Annelida, Mollusca).

---

180. In both sexes of cockroach, a pair of jointed filamentous structures called anal

cerci are present on:

(1) 8^{th} and 9^{th} segment

(2) 11^{th} segment

(3) 5^{th} segment

(4) 10^{th} segment

Correct Answer: (4) 10^{th} segment

Solution: Anal cerci are paired, sensitive appendages in cockroaches that help in detecting vibrations. These structures are located on the **10^{th} abdominal segment**. They are present in both males and females.

Quick Tip

In cockroaches: - **9^{th} segment**: Male genitalia. - **10^{th} segment**: Anal cerci. - **11^{th} segment**: Absent.

---

181. 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) Statement I is true but Statement II is false

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false

Solution: The **hymen** is a thin membrane that can be ruptured due to several non-sexual activities such as exercise, cycling, or medical conditions.

Hence, its **presence or absence is not a reliable indicator of virginity**.

Statement II is incorrect because the hymen may tear due to various factors, not only during the first coitus.

Quick Tip

The hymen is an elastic structure and may remain intact even after sexual activity or may break due to physical activities unrelated to coitus.

---

182. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?

(1) Gene migration

(2) Constant gene pool

(3) Genetic recombination

(4) Genetic drift

Correct Answer: (2) Constant gene pool

Solution: The **Hardy-Weinberg equilibrium** states that allele frequencies in a population remain constant if no evolutionary forces act upon them.

Factors that disturb this equilibrium include:

Gene migration (movement of alleles between populations).

Genetic drift (random changes in allele frequency).

Genetic recombination (shuffling of alleles during reproduction).

A **constant gene pool** ensures that allele frequencies remain unchanged, maintaining equilibrium.

Quick Tip

Hardy-Weinberg equilibrium holds when: 1. No mutation.

2. No gene flow.

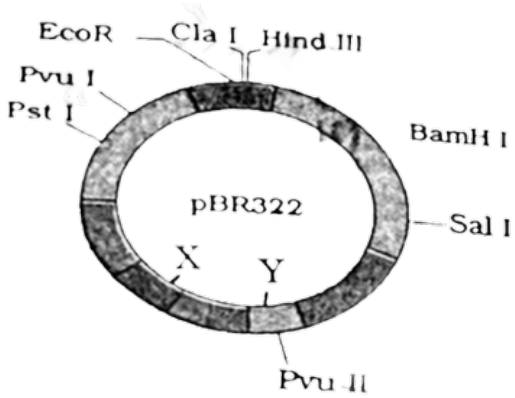
3. No genetic drift.

4. No natural selection.

5. Random mating occurs.

---

183. The following diagram shows restriction sites in *E. coli* cloning vector pBR322. Find the role of 'X' and 'Y' genes:



(1) The gene 'X' is for protein involved in replication of Plasmid and 'Y' for resistance to antibiotics.

(2) Gene 'X' is responsible for recognition sites and 'Y' is responsible for antibiotic resistance.

(3) The gene 'X' is responsible for resistance to antibiotics and 'Y' for protein involved in the replication of Plasmid.

(4) The gene 'X' is responsible for controlling the copy number of the linked DNA and 'Y' for protein involved in the replication of Plasmid.

Correct Answer: (4) The gene 'X' is responsible for controlling the copy number of the linked DNA and 'Y' for protein involved in the replication of Plasmid.

Solution: The **pBR322 plasmid** is a widely used cloning vector in genetic engineering.

Gene 'X' is located in the **origin of replication (ori)**, which controls the **copy number** of the plasmid.

Gene 'Y' is responsible for the production of a protein essential for the **replication of the plasmid**.

Antibiotic resistance genes (e.g., for ampicillin and tetracycline resistance) are separate and not associated with 'X' and 'Y'.

Quick Tip

pBR322 vector contains: - **Ori**: Origin of replication (controls copy number). - **Amp^R and Tet^R**: Genes for ampicillin and tetracycline resistance. - **Multiple cloning sites (MCS)**: Contain restriction enzyme recognition sequences.

---

184. Match List I with List II:

List I		List II	
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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: **Non-medicated IUDs** include **Lippes loop** (A-III).

Copper releasing IUDs include **Multiload 375** (B-I).

Hormone releasing IUDs include **LNG-20** (C-IV).

Implants release **progestogens** (D-II).

Quick Tip

- **Non-medicated IUDs**: Inert devices, no hormones. - **Copper IUDs**: Release copper, toxic to sperm. - **Hormonal IUDs**: Release hormones like LNG (levonorgestrel). - **Implants**: Subdermal hormonal contraceptives.

---

185. 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) B-D-E-A-C

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

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

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

Correct Answer: (2) E-C-A-D-B

Solution: - **Gap 1 (G1) phase** (E) – Cell grows and prepares for DNA synthesis.

- **Synthesis (S) phase** (C) – DNA replication occurs.

- **Gap 2 (G2) phase** (A) – Cell prepares for mitosis.

- **Karyokinesis** (D) – Division of the nucleus.

- **Cytokinesis** (B) – Division of the cytoplasm.

Quick Tip

- **Interphase** = G1 + S + G2 (preparatory phase). - **M phase** = Karyokinesis + Cytokinesis.

SECTION-B

186. Choose the correct statement given below regarding juxta medullary nephron:

(1) Loop of Henle of juxta medullary nephron runs deep into medulla.

(2) Juxta medullary nephrons outnumber the cortical nephrons.

(3) Juxta medullary nephrons are located in the columns of Bertini.

(4) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.

Correct Answer: (1)

Solution: - Juxta medullary nephrons have a longer **Loop of Henle** that extends deep into the medulla, which helps in water conservation.

- Cortical nephrons are more numerous than juxta medullary nephrons.

- Juxta medullary nephrons are located near the **medulla**, not in the columns of Bertini.

- The renal corpuscle of these nephrons is present in the **cortex** of the kidney, not in the outer renal medulla.

Quick Tip

- Juxta medullary nephrons: Important for concentrated urine formation. - Cortical nephrons: More common and have shorter Loops of Henle.

---

187. 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) B, D & E only

(2) B, C & D only

(3) A & C only

(4) A, B & D only

Correct Answer: (1) B, D & E only

Solution: - Non-chordates **lack a notochord** (B).

- If a heart is present, it is **dorsally** located (D).

- A **post-anal tail is absent** in non-chordates (E).

- Chordates, not non-chordates, have a **dorsal** central nervous system.

- Pharyngeal gill slits are a characteristic feature of chordates, not non-chordates.

Quick Tip

- **Chordates**: Have a notochord, dorsal CNS, post-anal tail. - **Non-chordates**: Lack notochord, ventral CNS, no post-anal tail.

---

188. 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, as compared to chloroplast.

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

(1) Statement I is correct but Statement II is incorrect.

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

(3) Both Statement I and Statement II are correct.

(4) Both Statement I and Statement II are incorrect.

Correct Answer: (1) Statement I is correct but Statement II is incorrect.

Solution: - **Mitochondria and chloroplasts** are indeed double-membrane bound organelles (Statement I is correct).

- The **inner membrane of mitochondria is highly selective** and contains specialized transport proteins, but the inner membrane of chloroplasts is also selectively permeable.

- Since Statement II implies that the chloroplast inner membrane is more permeable than the mitochondrial membrane, which is incorrect, Statement II is false.

Quick Tip

- **Mitochondria**: Site of ATP production, double-membrane with **cristae**. - **Chloroplast**: Site of photosynthesis, double-membrane with **thylakoid membranes**.

---

189. 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) B, A, C, D, E

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

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

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

Correct Answer: (3) E, A, D, C, B

Solution: - **Step 1:** The substrate binds to the enzyme's active site (E).

- **Step 2:** This forms the enzyme-substrate complex (A).

- **Step 3:** The enzyme catalyzes the breaking of chemical bonds in the substrate (D).

- **Step 4:** The reaction results in the release of products (C).

- **Step 5:** The enzyme is now free to bind with another substrate (B).

Quick Tip

- Enzymes work via the **lock and key** or **induced fit** model.

- They lower activation energy and increase reaction speed.

---

190. 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-II, B-III, C-I, D-IV

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

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

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

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

Solution: - **P wave (A)** represents the **depolarisation of atria** (III).

- **QRS complex (B)** indicates the **depolarisation of ventricles** (II).

- **T wave (C)** represents the **repolarisation of ventricles** (IV).

- **T-P gap (D)** is the period where the **heart muscles are electrically silent** (I).

Quick Tip

- The **P wave** represents atrial contraction. - The **QRS complex** represents ventricular contraction. - The **T wave** represents ventricular relaxation.

---

191. 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 the above statements, choose the most appropriate answer from the options given below:

(1) Statement I is correct but Statement II is incorrect.

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

(3) Both Statement I and Statement II are correct.

(4) Both Statement I and Statement II are incorrect.

Correct Answer: (3) Both Statement I and Statement II are correct.

Solution: - Bone marrow is the **primary lymphoid organ**, responsible for the production of all blood cells, including lymphocytes.

- The thymus provides an essential environment for the **maturation of T-lymphocytes**.

- Since both bone marrow and thymus contribute to lymphocyte development, both statements are correct.

Quick Tip

- **Primary Lymphoid Organs:** Bone marrow and thymus (involved in lymphocyte development). - **Secondary Lymphoid Organs:** Lymph nodes, spleen, and tonsils (sites of immune response).

---

192. 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-III, B-IV, C-I, D-II

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

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

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

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

Solution: - **Unicellular glandular epithelium (A)** includes **goblet cells of the alimentary canal** (III).

- **Compound epithelium (B)** is found in the **moist surface of the buccal cavity** (IV).

- **Multicellular glandular epithelium (C)** includes **salivary glands** (I).

- **Endocrine glandular epithelium (D)** is present in the **pancreas** (II).

Quick Tip

- **Unicellular Glands:** Goblet cells secrete mucus.

- **Multicellular Glands:** Include both endocrine (ductless) and exocrine (ducted) glands.

- **Compound Epithelium:** Provides protection, found in the buccal cavity and skin.

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193. Given below are two statements:

Statement I: The cerebral hemispheres are connected by a nerve tract known as the 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) Statement I is correct but Statement II is incorrect.

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

(3) Both Statement I and Statement II are correct.

(4) Both Statement I and Statement II are incorrect.

Correct Answer: (1) Statement I is correct but Statement II is incorrect.

Solution: - The **corpus callosum** is a large, C-shaped nerve fiber bundle that connects the left and right cerebral hemispheres, allowing communication between them. Thus, Statement I is correct.

- The **brainstem** consists of the **medulla oblongata, pons, and midbrain** but does not include the cerebrum. Therefore, Statement II is incorrect.

Quick Tip

- **Brain Stem:** Medulla oblongata, pons, and midbrain (not the cerebrum).
- **Corpus Callosum:** Connects the left and right cerebral hemispheres.

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194. Match List I with List II:

List I		List II	
A.	RNA polymerase III	I.	snRNPs
B.	Termination of transcription	II.	Promotor
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-IV, C-I, D-II

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

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

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

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

Solution: RNA polymerase III (A) is responsible for transcribing **SnRNAs and tRNA** (IV).

Termination of transcription (B) in prokaryotes is often facilitated by the **Rho factor** (III).

Splicing of exons (C) is mediated by **snRNPs** (I).

TATA box (D) is a promoter element, thus associated with **promoters** (II).

Quick Tip

- **RNA Polymerases:** - RNA Polymerase I: rRNA synthesis.
- RNA Polymerase II: mRNA synthesis.
- RNA Polymerase III: tRNA and snRNA synthesis.
- **Transcription Termination:** Rho-dependent and Rho-independent.

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195. 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-I, B-II, C-IV, D-III

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

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

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

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

Solution: Mesozoic Era (A) is known as the age of **birds and reptiles** (III).

Proterozoic Era (B) marks the emergence of **lower invertebrates** (I).

Cenozoic Era (C) is the era of **mammals** (IV).

Paleozoic Era (D) saw the rise of **fish and amphibians** (II).

Quick Tip

Geological Eras:

- Proterozoic Era: Early life forms, lower invertebrates.
- Paleozoic Era: Age of fishes and amphibians.
- Mesozoic Era: Age of reptiles and birds.
- Cenozoic Era: Age of mammals.

196. 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) Statement I is true but Statement II is false.

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

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Correct Answer: (2) Statement I is false but Statement II is true.

Solution: - **Statement I is incorrect** because Gause's competitive exclusion principle states that **two closely related species competing for the same resources cannot coexist indefinitely**. The given statement incorrectly mentions "different resources."

- **Statement II is correct** because in a competitive scenario, when resources are limiting, **the inferior species is likely to be eliminated**.

Quick Tip

- **Gause's Competitive Exclusion Principle:** Two species competing for the same resource cannot coexist indefinitely; one will be excluded.

- **Resource Partitioning:** Species coexist by utilizing different niches.

197. Match List I with List II:

List I		List II	
A.	Exophthalmic goiter	I.	Excess secretion of cortisol, moon face & hyperglycemia.
B.	Acromegaly	II.	Hypo-secretion of thyroid hormone and stunted growth.
C.	Cushing's syndrome	III.	Hyper secretion of thyroid hormone & protruding eye balls.
D.	Cretinism	IV.	Excessive secretion of growth hormone.

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - **Exophthalmic goiter (A)** is due to the **hypersecretion of thyroid hormone**, causing protruding eyeballs (III).

- **Acromegaly (B)** is caused by the **excessive secretion of growth hormone** (IV).

- **Cushing's syndrome (C)** is due to the **excess secretion of cortisol**, leading to moon face and hyperglycemia (I).

- **Cretinism (D)** results from the **hypo-secretion of thyroid hormone**, causing stunted growth (II).

Quick Tip

- **Endocrine Disorders:**

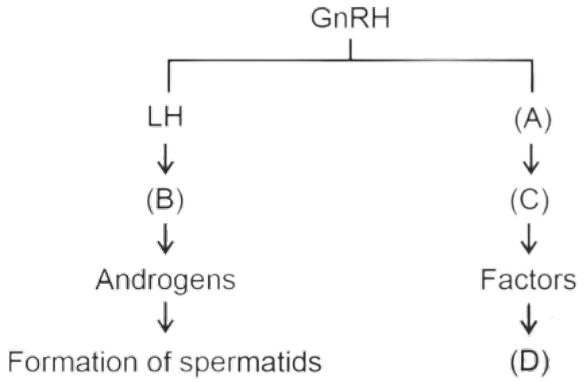
- Exophthalmic Goiter: Hyperthyroidism.

- Acromegaly: Excess GH in adulthood.

- Cushing's Syndrome: Excess cortisol.

- Cretinism: Congenital hypothyroidism.

198. Identify the correct option (A), (B), (C), (D) with respect to spermatogenesis.



Choose the correct answer from the options given below:

(1) FSH, Sertoli cells, Leydig cells, spermatogenesis.

(2) ICSH, Leydig cells, Sertoli cells, spermatogenesis.

(3) FSH, Leydig cells, Sertoli cells, spermiogenesis.

(4) ICSH, Interstitial cells, Leydig cells, spermiogenesis.

Correct Answer: (3) FSH, Leydig cells, Sertoli cells, spermiogenesis.

Solution: **(A) FSH** stimulates the Sertoli cells to regulate spermatogenesis. **(B) Leydig cells** produce androgens (testosterone). **(C) Sertoli cells** regulate spermatogenesis. **(D) Spermiogenesis** is the final stage of sperm maturation.

Quick Tip

- **Hormonal Control of Spermatogenesis:** - **FSH**: Stimulates Sertoli cells. - **LH**: Stimulates Leydig cells for testosterone production. - **Spermiogenesis**: Final transformation of spermatids into spermatozoa.

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199. 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. $I^Bi/I^Ai/ii$

B. $I^BI^B/I^AI^A/ii$

C. $I^AI^B/iI^A/I^Bi$

D. $I^Ai/I^Bi/I^Ai$

E. $ii/I^Ai/I^AI^B$

Choose the most appropriate answer from the options given below :

(1) C & B only

(2) D & E only

(3) A only

(4) B only

Correct Answer: (3) A only

Solution: To determine the correct genotype combinations for each family member based on their blood types: - The father with blood type B+ must have at least one B allele. Since the child is type O+, the father cannot be I^BI^B (he must carry an i to pass to the child).

- The mother with blood type A+ must have at least one A allele. Similarly, she cannot be I^AI^A as she needs to pass an i to the child.

- The child with blood type O+ must have the genotype ii, inheriting one i from each parent.

From the options provided, only Option A correctly reflects these requirements: - Father: I^Bi - Mother: I^Ai - Child: ii

This combination allows the father to contribute the I^B or i, the mother I^A or i, and ensures the child receives i from both, resulting in the O+ phenotype.

Quick Tip

When analyzing genetic possibilities for the ABO blood group system, focus on ensuring the child's genotype is supported by the alleles present in both parents.

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200. Match List I with List II related to the digestive system of a cockroach:

List I	Description	List II	Structure
A	The structures used for storing food	I	Gizzard
B	Ring of 6-8 blind tubules at the junction of foregut and midgut	II	Gastric Caeca
C	Ring of 100-150 yellow-colored thin filaments at the 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-IV, B-III, C-II, D-I

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

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

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

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

Solution: - **(A) Crop** (IV) is responsible for storing food.

- **(B) Gastric Caeca** (II) are 6-8 blind tubules at the junction of the foregut and midgut.

- **(C) Malpighian tubules** (III) are thin yellow-colored filaments at the junction of midgut and hindgut, playing a role in excretion.

- **(D) Gizzard** (I) is used for grinding food.

Quick Tip

- **Cockroach Digestive System:** - Crop: Food storage.
- Gizzard: Grinding food.
- Gastric Caeca: Secretes digestive enzymes.
- Malpighian Tubules: Excretion.