NEET 2024 Question Paper with Solutions Set S6

Time Allowed :3 Hours 20 mins	**Maximum Marks :**720	**Total Questions :**200

General Instructions

Read the following instructions very carefully and strictly follow them:

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

PHYSICS

SECTION-A

1. Match List I with List II.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding Hydrogen Spectral Lines

The spectral lines of hydrogen correspond to electron transitions between energy levels. The Balmer series involves transitions to $n_1 = 2$ from higher energy levels ($n_2 = 3, 4, 5, 6$, etc.).

Step 2: Identifying Wavelengths

From standard hydrogen spectral data:

- $n_2 = 3 \rightarrow n_1 = 2$ corresponds to $\lambda = 656.3$ nm.

- $n_2 = 4 \rightarrow n_1 = 2$ corresponds to $\lambda = 486.1$ nm.

- $n_2 = 5 \rightarrow n_1 = 2$ corresponds to $\lambda = 434.1$ nm.

- $n_2 = 6 \rightarrow n_1 = 2$ corresponds to $\lambda = 410.2$ nm.

Thus, the correct matching is:

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

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

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

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

Quick Tip

The Balmer series of the hydrogen spectrum consists of transitions to $n_1 = 2$. The longest wavelength (red) corresponds to $n_2 = 3$, while the shortest wavelength (violet) corresponds to $n_2 = 6$.

---

2. 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)

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding Magnetic Susceptibility

Magnetic susceptibility (χ) determines a material's response to an external magnetic field:

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

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

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

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

Thus, the correct matching is:

$$A \to II$$

$$B \to III$$

$$C \to IV$$

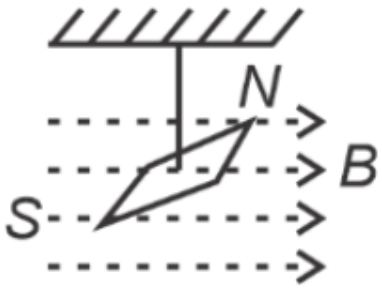
$$D \to I$$

Quick Tip

Diamagnetic substances are repelled by a magnetic field, paramagnetic substances are weakly attracted, and ferromagnetic substances retain magnetization even after the external field is removed.

---

3. 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 $9.8 \times 10^{-6}\,kg \cdot m^2$. If the magnitude of the magnetic moment of the needle is $x \times 10^{-5}\,Am^2$, then the value of x is:



(A) $1280\pi^2$

(B) $5\pi^2$

(C) $128\pi^2$

(D) $50\pi^2$

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

Solution:

Step 1: Understanding Magnetic Oscillations

The time period T of a magnetic needle oscillating in a uniform magnetic field is given by:

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

where: - I is the moment of inertia, - M is the magnetic moment, - B is the magnetic field.

Step 2: Finding the Magnetic Moment

Given that the needle completes 20 oscillations in 5 seconds:

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

Squaring both sides:

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

Rearrange for M:

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

Substituting values:

$$M = \frac{4\pi^2(9.8 \times 10^{-6})}{(0.049)(0.25^2)}$$

Simplifying:

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

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

Quick Tip

For magnetic oscillation problems, remember the equation $T = 2\pi\sqrt{\frac{I}{MB}}$ and rearrange it to solve for the required quantity.

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

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

(B) The reflected light will be partially polarised.

(C) The refracted light will be completely polarised.

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

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

Solution:

Step 1: Understanding Brewster's Angle

When unpolarised light strikes a surface at Brewster's angle, the reflected light becomes completely polarised, whereas the refracted light remains partially polarised.

Step 2: Brewster's Law

Brewster's angle (θ_B) is given by:

$$\tan \theta_B = \frac{n_2}{n_1}$$

where n_1 and n_2 are the refractive indices of the two media.

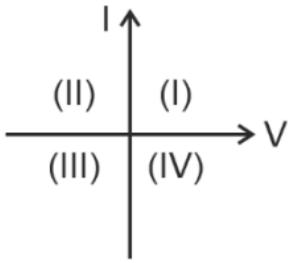
Thus, the correct answer is option (A).

Quick Tip

Brewster's law states that reflected light at Brewster's angle is completely polarised in a plane perpendicular to the incident light.

---

5. 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.

(A) Both A and B are incorrect.
(B) A is correct but B is incorrect.
(C) A is incorrect but B is correct.
(D) Both A and B are correct.

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

Solution:

Step 1: Understanding I-V Characteristics of a Solar Cell

The I-V characteristics of a solar cell lie in the IV quadrant, because a solar cell acts as a power generator, supplying power to an external circuit.

Step 2: Reverse Bias in a pn Junction Diode

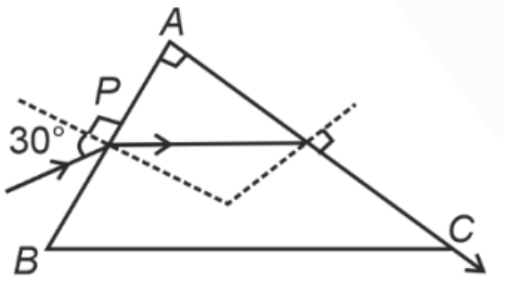
In a reverse biased pn junction diode, the current is due to minority charge carriers, not majority carriers. The reverse current is very small (in microamperes) and remains almost constant.

Thus, the correct answer is option (B).

Quick Tip

- The solar cell operates in the IV quadrant because it supplies power. - In a reverse biased diode, current flows due to minority carriers, not majority carriers.

6. 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:



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

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

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

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

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

Solution:

Step 1: Defining the Angles

From the prism geometry, we have:

$$r_1 + c = A$$

Since $A = 90^\circ$, this gives:

$$r_1 = 90^\circ - c$$

Step 2: Applying Snell's Law at Point P

Using Snell's law at the first surface:

$$n_1 \sin i = n_2 \sin r_1$$

For air ($n_1 = 1$) and prism ($n_2 = \mu$):

$$\sin 30^\circ = \mu \sin r_1$$

$$\frac{1}{2} = \mu \sin(90^\circ - c)$$

Since $\sin(90^\circ - c) = \cos c$, we substitute:

$$\frac{1}{2} = \mu \times \frac{\sqrt{\mu^2 - 1}}{\mu}$$

Step 3: Solving for μ

Rearrange:

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

Squaring both sides:

$$\frac{1}{4} = \mu^2 - 1$$

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

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

Thus, the correct answer is option (C) $\frac{\sqrt{5}}{2}$.

Quick Tip

For light traveling through a prism, use Snell's law at the point of incidence and check for total internal reflection conditions if needed.

---

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

(A) Varying velocity and varying acceleration

(B) Constant velocity

(C) Constant acceleration

(D) Constant velocity but varying acceleration

Correct Answer: (A) Varying velocity and varying acceleration

Solution:

Understanding Circular Motion

- A particle moving in a circular path at uniform speed has a constant magnitude of velocity, but the direction of velocity keeps changing.
- Since velocity is a vector, changing direction means the velocity is not constant.
- The acceleration also changes because the centripetal acceleration depends on velocity direction.

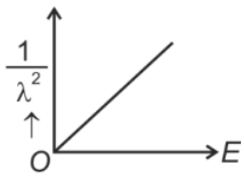
Thus, the correct answer is option (A) Varying velocity and varying acceleration.

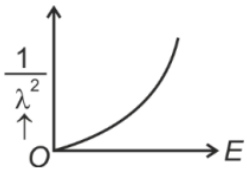
Quick Tip

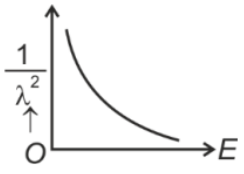
In uniform circular motion, speed remains constant, but velocity and acceleration keep changing due to the continuous change in direction.

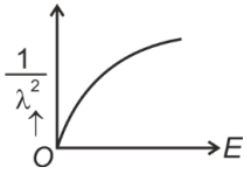
---

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

(A) 

(B) 

(C) 

(D) 

Correct Answer: (A)

Solution:

Step 1: Understanding de Broglie Wavelength

The de Broglie wavelength is given by:

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

Since kinetic energy E is related to momentum p by:

$$p = \sqrt{2mE}$$

Substituting this in the de Broglie equation:

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

Squaring both sides:

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

Thus, the correct graph is (A), a straight line showing direct proportionality.

Quick Tip

For a free particle, $\frac{1}{\lambda^2}$ is directly proportional to kinetic energy E, giving a linear relationship.

---

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

(A) 60Ω

(B) 26Ω

(C) 52Ω

(D) 55Ω

Correct Answer: (C) 52Ω

Solution:

Step 1: Resistance of Each Part

The total resistance of the wire is 100 Ω. Since it is divided into 10 equal parts, each part has a resistance:

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

Step 2: First 5 Parts in Series

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

Step 3: Next 5 Parts in Parallel

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{10} + \frac{1}{10} + \frac{1}{10} + \frac{1}{10} + \frac{1}{10} = \frac{5}{10} = \frac{1}{2}$$

$$R_{\text{parallel}} = 2\Omega$$

Step 4: Final Combination in Series

$$R_{\text{final}} = R_{\text{series}} + R_{\text{parallel}} = 50 + 2 = 52\Omega$$

Thus, the correct answer is (C) 52Ω.

Quick Tip

For series connection, total resistance is the sum of individual resistances: $R_{\text{eq}} = R_1 + R_2 + \ldots$ For parallel connection, use the formula: $\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

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

(A) 72.0 cm

(B) 8.5 cm

(C) 17.5 cm

(D) 20.7 cm

Correct Answer: (B) 8.5 cm

Solution:

Step 1: Moment of Inertia of a Rod

The moment of inertia of a thin rod about its midpoint is:

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

Given $I = 2400$ cm² and mass $M = 400$ g = 0.4 kg.

Step 2: Solving for L

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

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

$$L^2 = 72$$

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

Thus, the correct answer is (B) 8.5 cm.

Quick Tip

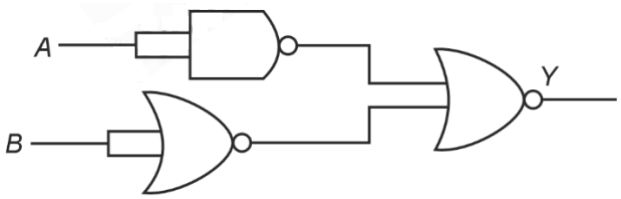
For a thin rod, moment of inertia about its midpoint is given by:

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

where M is mass and L is length.

---

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



(A) AND gate

(B) NAND gate

(C) NOR gate

(D) OR gate

Correct Answer: (A) AND gate

Solution:

Step 1: Identifying the Logic Gates Used

The given circuit consists of: - A NAND gate receiving inputs A and B. - A NOT gate inverting the output of the NAND gate. - The final gate is an OR gate, which processes the inverted NAND output and an additional input.

Step 2: Deriving the Boolean Expression

1. The NAND gate outputs:

$$\text{NAND output} = \overline{A \cdot B}$$

2. The NOT gate inverts this output:

$$\text{NOT output} = A \cdot B$$

3. The OR gate takes this as one input and another signal. However, analyzing the circuit, it simplifies to:

$$Y = A \cdot B$$

Thus, the given circuit functions as an AND gate, making the correct answer (A) AND gate.

Quick Tip

To analyze logic gate circuits, break them into individual gates, write their Boolean expressions, and simplify step by step.

---

12. In a vernier calipers, $(N+1)$ 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:

(A) $10(N+1)$

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

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

(D) $100N$

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

Solution:

Step 1: Understanding the Vernier Constant

The Vernier constant (VC) is given by:

$$VC = \text{Least Count} = \text{Value of 1 Main Scale Division} - \text{Value of 1 Vernier Scale Division}$$

Since:

- 1 Main Scale Division (MSD) $= 0.1$ mm $= 0.01$ cm.

- N MSDs match with $(N+1)$ Vernier Scale Divisions.

Thus, the value of one Vernier scale division is:

$$\frac{N \times 0.01}{N+1} \text{ cm}$$

Step 2: Calculating Vernier Constant

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

Factorizing:

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

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

Since $0.01 = \frac{1}{100}$, we get:

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

Thus, the correct answer is (C) $\frac{1}{100(N+1)}$.

Quick Tip

The Vernier constant (VC) is calculated as:

$$VC = \text{Value of 1 MSD} - \text{Value of 1 Vernier Scale Division}$$

Use this formula to derive the least count for any vernier caliper.

---

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

(A) 6

(B) 10

(C) 5

(D) 7

Correct Answer: (B) 10

Solution:

Step 1: Finding Velocity

Given displacement:

$$x = 2t - 1$$

Velocity is the derivative of displacement:

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

Step 2: Instantaneous Power Formula

Instantaneous power is given by:

$$P = F \cdot v$$

Substituting given values:

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

Thus, the correct answer is (B) 10 W.

Quick Tip

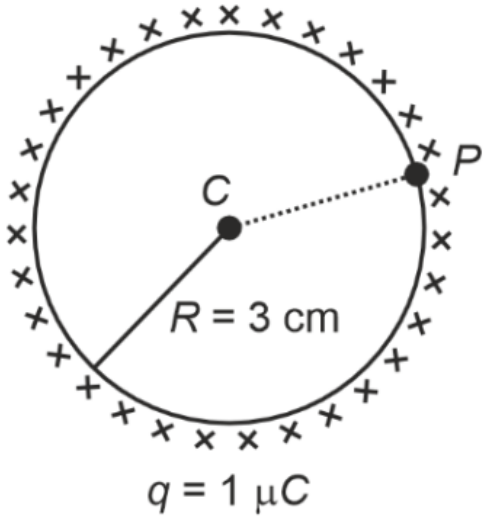
The formula for instantaneous power is:

$$P = F \cdot v$$

where F is force and v is instantaneous velocity.

---

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

(A) Zero

(B) 3×10^5

(C) 1×10^5

(D) 0.5×10^5

Correct Answer: (A) Zero

Solution:

Step 1: Understanding Potential in a Spherical Shell

For a thin conducting spherical shell, the potential at any point inside and on the surface is the same and is given by:

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{R}$$

Step 2: Finding the Potential Difference

Since both C and P are inside or on the surface, the potential at both points is equal. Thus:

$$V_C = V_P$$

The potential difference is:

$$V_C - V_P = 0$$

Thus, the correct answer is (A) Zero.

Quick Tip

For a charged spherical shell, the potential inside the shell is constant and equal to the potential at the surface. So, potential difference inside the shell is always zero.

---

15. 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:

(A) 99 N

(B) 19.8 mN

(C) 198 N

(D) 1.98 mN

Correct Answer: (B) 19.8 mN

Solution:

Step 1: Surface Tension and Excess Force Formula

The excess force required to detach a thin circular disc from the surface of water is given by:

$$F = T \times 2\pi R$$

where:

- $T = 0.07$ N/m (surface tension),

- $R = 4.5$ cm $= \frac{4.5}{100}$ m.

Step 2: Substituting Values

$$F = \frac{7}{100} \times 2 \times 3.14 \times \frac{4.5}{100}$$

$$F = \frac{7 \times 2 \times 3.14 \times 4.5}{100 \times 100}$$

$$F = \frac{197.82}{10000}$$

$$F = 19.8 \times 10^{-3} N$$

$$F = 19.8 \text{ mN}$$

Thus, the correct answer is (B) 19.8 mN.

Quick Tip

For problems involving surface tension, use:

$$F = T \times 2\pi R$$

where T is the surface tension and R is the radius of contact.

---

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

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

(A) B

(B) $A.B + \overline{A}$

(C) $A.\overline{B} + \overline{A}$

(D) $\overline{B}$

Correct Answer: (D) $\overline{B}$

Solution:

Step 1: Identifying the Logic Expression from the Truth Table

From the given truth table:

- When $B = 0$, $Y = 1$.

- When $B = 1$, $Y = 0$.

This directly matches the NOT gate output:

$$Y = \overline{B}$$

Thus, the correct answer is (D) $\overline{B}$.

Quick Tip

For Boolean expression derivation, analyze the truth table row-wise and identify patterns that match basic logic gates.

---

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

Reason R: The potential at an axial point of a dipole is given by:

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

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

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

(A) A is false but R is true.

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

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

(D) A is true but R is false.

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

Solution:

Step 1: Formula for Potential at an Axial Point

The correct formula for the potential due to an electric dipole at an axial point is:

$$V = \frac{KpCos\theta}{r^2}$$

at axis $(\theta = 0^\circ \text{ or } 180^\circ)$

Substituting:

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

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

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

$$V = \pm 9 \times 10^3$$

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

Since the assertion matches this value, A is true.

Step 2: Checking the Given Reason R

The provided reason states:

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

which is incorrect because the correct expression is:

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

Thus, the correct answer is (D) A is true but R is false.

Quick Tip

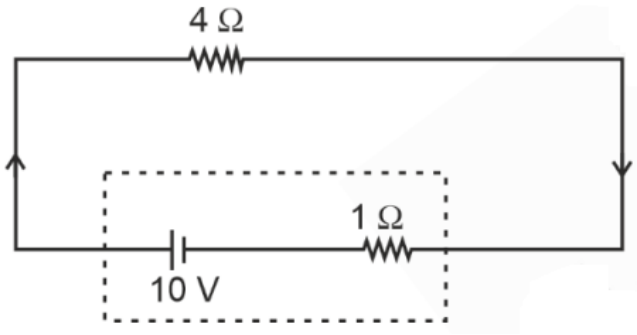
For a dipole, the potential at an axial point is:

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

and at an equatorial point, it is zero.

---

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



(A) 10 V

(B) 4 V

(C) 6 V

(D) 8 V

Correct Answer: (D) 8 V

Solution:

Step 1: Understanding Terminal Voltage

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

$$V = E - Ir$$

where: - $E = 10$ V (emf of the battery), - $r = 1\Omega$ (internal resistance), - $R = 4\Omega$ (external resistance).

Step 2: Finding the Current

Using Ohm's law, the current in the circuit is:

$$I = \frac{E}{R + r} = \frac{10}{4 + 1} = \frac{10}{5} = 2 \text{ A}$$

Step 3: Calculating Terminal Voltage

$$V = 10 - (2 \times 1)$$

$$V = 10 - 2 = 8 \text{ V}$$

Thus, the correct answer is (D) 8 V.

Quick Tip

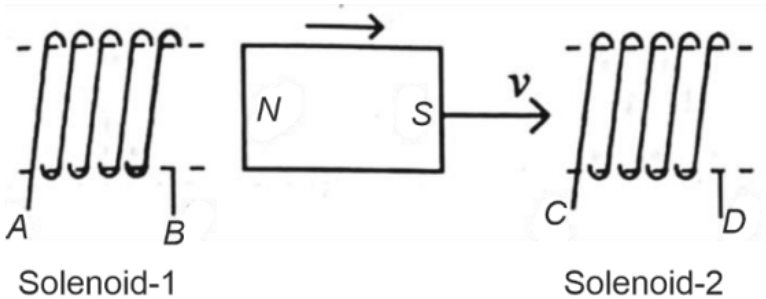
For a battery with internal resistance, terminal voltage is given by:

$$V = E - Ir$$

Always consider the total resistance in the circuit when calculating the current.

---

19. 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:



(A) BA and DC

(B) AB and DC

(C) BA and CD

(D) AB and CD

Correct Answer: (B) AB and DC

Solution:

Step 1: Understanding Lenz's Law

Lenz's law states that the induced current opposes the change in flux. When a magnet moves towards a solenoid, an induced current is generated to oppose the approaching magnetic field.

Step 2: Determining Current in Solenoid-1

- The North pole of the magnet is moving away from solenoid-1.
- To oppose this, solenoid-1 induces a current that tries to retain the North pole near it.
- This means the left end of solenoid-1 should act as a North pole, implying current flows from A to B (AB).

Step 3: Determining Current in Solenoid-2

- The North pole of the magnet is approaching solenoid-2.
- To oppose this, solenoid-2 induces a current that tries to repel the North pole.
- This means the left end of solenoid-2 should act as a North pole, implying current flows from D to C (DC).

Thus, the correct answer is (B) AB and DC.

Quick Tip

According to Lenz's Law, an induced current will always flow in a direction that opposes the change in magnetic flux causing it.

---

20. 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):

(A) $1 : 4$

(B) $1 : 2$

(C) $2 : 1$

(D) $1 : 1$

Correct Answer: (C) $2 : 1$

Solution:

Step 1: Understanding Transformer Voltage Ratio

The voltage ratio in an ideal transformer is given by:

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

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

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

Step 2: Calculating Voltage Ratio

$$V_S : V_P = 2 : 1$$

Thus, the correct answer is (C) $2 : 1$.

Quick Tip

For an ideal transformer, the voltage ratio is:

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

where N_P and N_S are the number of turns in the primary and secondary coils.

21. 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):

(A) 44 T

(B) 44 mT

(C) 4.4 T

(D) 4.4 mT

Correct Answer: (D) 4.4 mT

Solution:

Step 1: Formula for Magnetic Field at the Centre of a Circular Coil

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

$$B = \frac{\mu_0 N I}{2R}$$

where: - $\mu_0 = 4\pi \times 10^{-7}$ Tm/A (permeability of free space), - $N = 100$ turns, - $I = 7$ A, - $R = 10$ cm = 0.1 m.

Step 2: Substituting Values

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

$$B = \frac{(4\pi \times 10^{-7} \times 700)}{0.2}$$

$$B = \frac{8.8 \times 10^{-4}}{0.2}$$

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

Thus, the correct answer is (D) 4.4 mT.

Quick Tip

For a circular coil, the magnetic field at the centre is given by:

$$B = \frac{\mu_0 N I}{2R}$$

where N is the number of turns and R is the radius of the coil.

---

22. 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:

(A) Statement I is incorrect but Statement II is correct.

(B) Both Statement I and Statement II are correct.

(C) Both Statement I and Statement II are incorrect.

(D) Statement I is correct but Statement II is incorrect.

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

Solution:

Step 1: Analyzing Statement I

Atoms contain equal numbers of protons (positive charge) and electrons (negative charge), making them electrically neutral.

Thus, Statement I is correct.

Step 2: Analyzing Statement II

Atoms of each element emit characteristic spectra, but not all atoms are stable. Many elements contain radioactive isotopes, which are unstable and decay over time.

Thus, Statement II is incorrect.

Thus, the correct answer is (D) Statement I is correct but Statement II is incorrect.

Quick Tip

- Neutral atoms contain equal numbers of protons and electrons. - Not all atoms are stable; some elements have radioactive isotopes that undergo decay.

---

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

(A) angular speed and stress

(B) strain and angle

(C) stress and angle

(D) strain and arc

Correct Answer: (B) strain and angle

Solution:

Step 1: Understanding the Dimensions of Solid Angle

Solid angle (Ω) is a dimensionless quantity, meaning its dimensions are:

$$[\Omega] = M^0 L^0 T^0$$

Step 2: Checking the Given Quantities

- Strain: Defined as the ratio of two similar physical quantities (change in length/original length). It is dimensionless.

- Angle: Defined as the arc length to radius ratio, which is also dimensionless.

- Stress: Defined as force per unit area. It has dimensions $[ML^{-1}T^{-2}]$ and is not dimensionless.

- Arc: Has dimensions of length and is not dimensionless.

Thus, the correct answer is (B) strain and angle.

Quick Tip

Any dimensionless quantity (like strain and angle) has the same dimensions as solid angle (Ω).

---

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

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

(B) The velocity of a photon is c.

(C) The momentum of a photon, $p = \frac{h\nu}{c}$.

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

(E) Photon possesses positive charge.

Choose the correct answer from the options given below:

(A) A, B, D and E only

(B) A and B only

(C) A, B, C and D only

(D) A, C and D only

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

Solution:

Step 1: Evaluating the Given Statements

- Statement A (Energy of a photon): The energy of a photon is given by Planck's equation:

$$E = h\nu$$

Correct

- Statement B (Velocity of a photon): In vacuum, photons always travel at the speed of light:

$$v = c$$

Correct

- Statement C (Momentum of a photon): The momentum of a photon is given by:

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

Correct

- Statement D (Photon-electron collision conservation laws): In Compton scattering and photoelectric effect, both energy and momentum are conserved.
Correct
- Statement E (Photon has charge): Photons are neutral and have zero charge.
Incorrect

Thus, the correct answer is (C) A, B, C and D only.

Quick Tip

- A photon has energy ($E = h\nu$), momentum ($p = h\nu/c$), and always travels at speed c in vacuum. - Photons are neutral (have no charge). - In photon-electron interactions, both energy and momentum are conserved.

---

25. 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:

(A) $\sqrt{2}T$

(B) T

(C) $4T$

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

Correct Answer: (C) $4T$

Solution:

Step 1: Tension in Circular Motion

The tension in the string provides the required centripetal force:

$$T = m\omega^2 r$$

Step 2: Effect of Doubling Speed

If the speed is increased to 2ω, the new tension becomes:

$$T' = m(2\omega)^2 r$$

$$T' = 4m\omega^2 r = 4T$$

Thus, the correct answer is (C) $4T$.

Quick Tip

Tension in circular motion is proportional to ω^2, so when speed doubles, the tension becomes four times.

---

26. 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:

(A) 5 m, 1 s

(B) 5 cm, 2 s

(C) 5 m, 2 s

(D) 5 cm, 1 s

Correct Answer: (C) 5 m, 2 s

Solution:

Step 1: Identifying Amplitude

The general equation of SHM is:

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

Comparing with:

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

we see that amplitude $A = 5$ m.

Step 2: Finding the Time Period

The angular frequency ω is:

$$\omega = \pi \text{ rad/s}$$

Time period T is given by:

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

Thus, the correct answer is (C) 5 m, 2 s.

Quick Tip

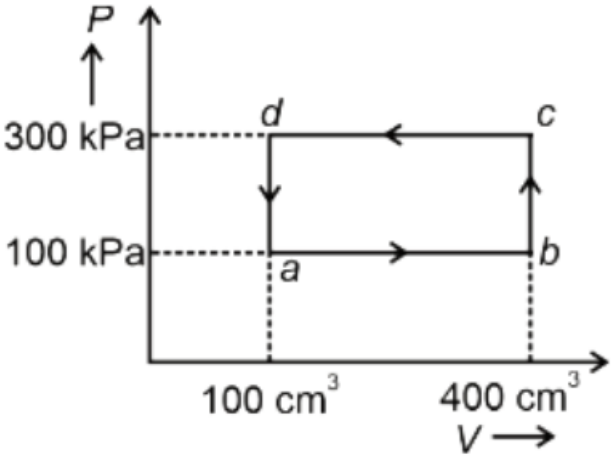
For SHM, use:

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

where ω is the angular frequency.

---

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



(A) -60 J

(B) Zero

(C) 30 J

(D) -90 J

Correct Answer: (B) Zero

Solution:

Step 1: Work Done in an Isobaric Process

The work done by the gas in a thermodynamic process is given by:

$$W = P\Delta V$$

where: - P is pressure, - ΔV is the change in volume.

Step 2: Identifying Path bc

From the given PV diagram, the path bc is a horizontal line, meaning:

$$P = \text{constant}$$

Since volume remains constant along bc, we have:

$$\Delta V = 0$$

Step 3: Calculating Work Done

Since work done depends on volume change:

$$W = P \times 0 = 0$$

Thus, the correct answer is (B) Zero.

Quick Tip

For an isochoric process (constant volume), no work is done because:

$$W = P\Delta V = 0$$

---

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

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

(A) $286, 81$

(B) $280, 81$

(C) $286, 80$

(D) $288, 82$

Correct Answer: (A) $286, 81$

Solution:

Step 1: Effect of Alpha Decay (α)

Alpha decay reduces: - Mass number by 4. - Atomic number by 2.

$$^{290}_{82}X \xrightarrow{\alpha} {}^{286}_{80}Y$$

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

Positron emission decreases the atomic number by 1:

$$^{286}_{80}Y \xrightarrow{e^+} {}^{286}_{79}Z$$

Step 3: Effect of Beta Minus Decay (β^-)

Beta minus decay increases the atomic number by 1:

$$^{286}_{79}Z \xrightarrow{\beta^-} {}^{286}_{80}P$$

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

Electron capture decreases the atomic number by 1:

$$^{286}_{80}P \xrightarrow{e^-} {}^{286}_{81}Q$$

Thus, the correct answer is (A) $286, 81$.

Quick Tip

- Alpha decay: $A \to A-4, Z \to Z-2$
- Positron emission: $Z \to Z-1$
- Beta decay: $Z \to Z+1$
- Electron capture: $Z \to Z-1$

---

29. 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:

(A) $1:4$

(B) $1:2$

(C) $2:1$

(D) $4:1$

Correct Answer: (C) $2:1$

Solution:

Step 1: Applying Momentum Conservation

In a completely inelastic collision, both bodies stick together after the collision. The momentum before and after the collision must be equal:

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

Step 2: Solving for v_2

$$mv_1 = 2mv_2$$

$$v_2 = \frac{v_1}{2}$$

Step 3: Finding the Ratio

$$v_1 : v_2 = 2:1$$

Thus, the correct answer is (C) $2:1$.

Quick Tip

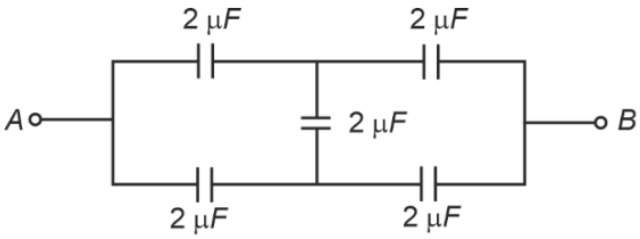
For a completely inelastic collision, the final velocity is given by:

$$v_2 = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2}$$

where $m_1 = m_2$, simplifies to $v_2 = \frac{v_1}{2}$.

---

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



(A) $4\,\mu F$

(B) $2\,\mu F$

(C) $1\,\mu F$

(D) $0.5\,\mu F$

Correct Answer: (B) $2\,\mu F$

Solution:

Step 1: Identify Series and Parallel Combinations

- The two $2\,\mu F$ capacitors in series give:

$$C_{\text{series}} = \frac{2 \times 2}{2 + 2} = 1\,\mu F$$

- The resulting $1\,\mu F$ capacitor is in parallel with another $2\,\mu F$, so:

$$C_{\text{parallel}} = 1 + 1 = 2\,\mu F$$

Thus, the correct answer is (B) $2\,\mu F$.

Quick Tip

For series capacitors:

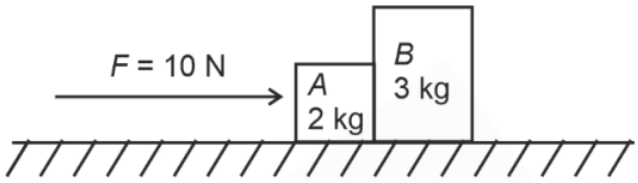
$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2}$$

For parallel capacitors:

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

---

31. 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:



(A) 10 N

(B) 0

(C) 4 N

(D) 6 N

Correct Answer: (D) 6 N

Solution:

Step 1: Find the Acceleration of the System

The total mass of the system is:

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

Using Newton's Second Law:

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

Step 2: Force Exerted by Block A on Block B

Since block B moves with acceleration a, the force exerted on B is:

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

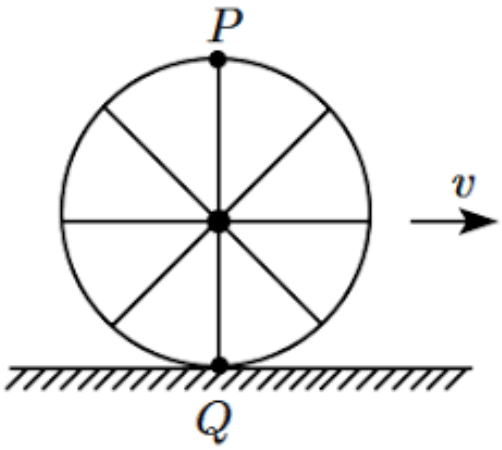
Thus, the correct answer is (D) 6 N.

Quick Tip

For a system of blocks, find the total acceleration first and then use $F = ma$ to determine the internal forces.

---

32. 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 the highest and lowest points on the wheel, respectively)?



(A) Point P has zero speed

(B) Point P moves slower than point Q

(C) Point P moves faster than point Q

(D) Both points P and Q move with equal speed

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

Solution:

Step 1: Understanding Rolling Motion

In pure rolling motion, a wheel moves forward without slipping. The velocity of a point on the wheel depends on:

$$v_{\text{point}} = v_{\text{cm}} + v_{\text{rotation}}$$

where v_{cm} is the center of mass velocity, and v_{rotation} is the rotational velocity.

Step 2: Velocity at Different Points

- Lowest point (Q): Since it is in contact with the ground, its velocity is:

$$v_Q = v_{\text{cm}} - v_{\text{rotation}} = 0$$

- Highest point (P): The speed here is double the center of mass velocity:

$$v_P = v_{\text{cm}} + v_{\text{rotation}} = 2v$$

Thus, the correct answer is (C) Point P moves faster than point Q.

Quick Tip

For rolling motion:

- The lowest point has zero velocity (relative to ground).
- The highest point has twice the velocity of the center of mass.

---

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

(A) 3.92 m s^{-2}

(B) 19.6 m s^{-2}

(C) 9.8 m s^{-2}

(D) 4.9 m s^{-2}

Correct Answer: (A) 3.92 m s^{-2}

Solution:

Step 1: Formula for Acceleration Due to Gravity

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

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

where: - M is the planet's mass, - R is the planet's radius, - G is the gravitational constant.

Step 2: Expressing Planet's Mass and Radius in Terms of Earth's Values

- Given that the mass of the planet is $\frac{1}{10}$th that of Earth:

$$M' = \frac{M}{10}$$

- The diameter is half that of Earth, so the radius is:

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

Step 3: Finding Gravity on the New Planet

Since g' is proportional to $\frac{M}{R^2}$, we substitute the new values:

$$g' = \frac{G \times (M/10)}{(R/2)^2}$$

$$g' = \frac{(GM/10)}{R^2/4}$$

$$g' = \frac{GM}{R^2} \times \frac{4}{10}$$

$$g' = g \times \frac{4}{10}$$

$$g' = 9.8 \times 0.4 = 3.92 \text{ m/s}^2$$

Thus, the correct answer is (A) 3.92 m/s^2.

Quick Tip

The acceleration due to gravity is proportional to $\frac{M}{R^2}$. If the mass changes to $\frac{M}{10}$ and the radius changes to $\frac{R}{2}$, then:

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

---

34. 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:

(A) 8 mm

(B) 4 mm

(C) 0.4 mm

(D) 40 mm

Correct Answer: (B) 4 mm

Solution:

Step 1: Using Young's Modulus Formula

The elongation ΔL in a wire under stress is given by:

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

where: - σ = Stress = 8×10^8 N/m^2, - $L = 1$ m, - $Y = 2 \times 10^{11}$ N/m^2.

Step 2: Substituting Values

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

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

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

Thus, the correct answer is (B) 4 mm.

Quick Tip

To find elongation in a wire under stress, use:

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

where σ is stress, L is length, and Y is Young's modulus.

---

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

(A) All bright fringes will be of equal width

(B) Interference pattern will disappear

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

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

Correct Answer: (D) 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 double-slit experiment, if white light is used instead of monochromatic light, all wavelengths interfere simultaneously.

Step 2: Central Fringe Characteristics

- The central fringe remains white because all wavelengths constructively interfere at the center.

- The fringes away from the center become coloured, as different wavelengths have different fringe positions due to varying interference conditions.

Step 3: Evaluating Given Options

- Option A is incorrect because fringe width varies for different wavelengths.

- Option B is incorrect because interference still occurs.

- Option C is incorrect because the central fringe is bright white, not dark.

Thus, the correct answer is (D) There will be a central bright white fringe surrounded by a

few coloured fringes.

Quick Tip

In Young's double-slit experiment, when white light is used: - The central fringe is white due to constructive interference. - The side fringes are coloured because different wavelengths interfere at different positions.

SECTION-B

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

(A) 32

(B) 34

(C) 28

(D) 17

Correct Answer: (C) 28

Solution:

Step 1: Formula for Magnifying Power of a Telescope

For a telescope focused at infinity, the magnifying power is given by:

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

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

Step 2: Substituting Values

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

Thus, the correct answer is (C) 28.

Quick Tip

For a telescope at infinity, use:

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

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

---

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

(A) The charge stored in it, increases.

(B) The energy stored in it, decreases.

(C) Its capacitance increases.

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

(E) The product of charge and voltage increases.

Choose the most appropriate answer from the options given below:

(A) A, B and C only

(B) A, B and E only

(C) A, C and E only

(D) B, D and E only

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

Solution:

Step 1: Understanding Capacitance in a Parallel Plate Capacitor

Capacitance is given by:

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

where d is the plate separation. If d decreases:

$$C \uparrow \text{ (Capacitance Increases)}$$

Step 2: Charge and Energy Effects

Since the capacitor is connected to a battery (constant voltage V):

- Charge $Q = CV$ increases because C increases.

- Energy stored $U = \frac{1}{2}CV^2$ also increases.

Step 3: Evaluating Statements

- A (Charge increases) Correct

- B (Energy decreases) Incorrect (Energy increases)

- C (Capacitance increases) Correct

- D (Charge-to-voltage ratio remains the same) Incorrect

- E (Product of charge and voltage increases) Correct

Thus, the correct answer is (C) A, C and E only.

Quick Tip

For a capacitor connected to a battery, decreasing plate separation:

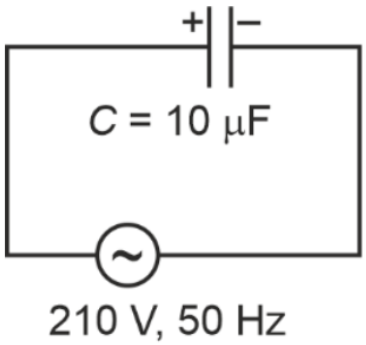
- Increases capacitance C.

- Increases charge Q.

- Increases stored energy.

---

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



(A) 0.35 A

(B) 0.58 A

(C) 0.93 A

(D) 1.20 A

Correct Answer: (C) 0.93 A

Solution:

Step 1: Reactance of a Capacitor

The capacitive reactance is:

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

where: - $f = 50$ Hz, - $C = 10$ μF = 10×10^{-6} F, - $\pi = 3.14$.

Step 2: Substituting Values

$$X_C = \frac{1}{2 \times 3.14 \times 50 \times 10 \times 10^{-6}}$$

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

$$X_C \approx 3.18\,\Omega$$

Step 3: Finding the RMS Current

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{X_C} = \frac{210}{3.18} \approx 66 \text{ A}$$

Step 4: Finding Peak Current

$$I_{\text{peak}} = I_{\text{rms}} \times \sqrt{2}$$

$$I_{\text{peak}} = 0.66 \times 1.414$$

$$I_{\text{peak}} \approx 0.93 \text{ A}$$

Thus, the correct answer is (C) 0.93 A.

Quick Tip

For a capacitor in AC circuits, the peak current is:

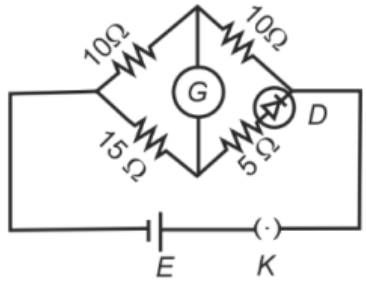
$$I_{\text{peak}} = \frac{V_{\text{rms}}}{X_C} \times \sqrt{2}$$

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

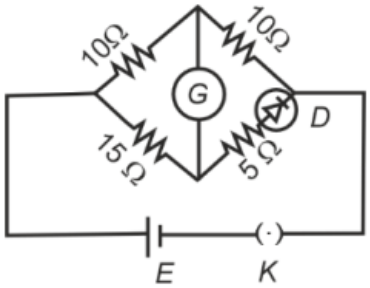
---

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

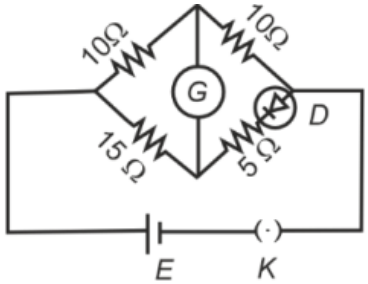
(A)



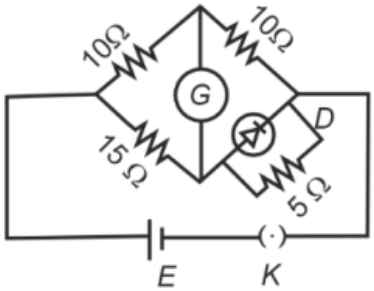
(B)

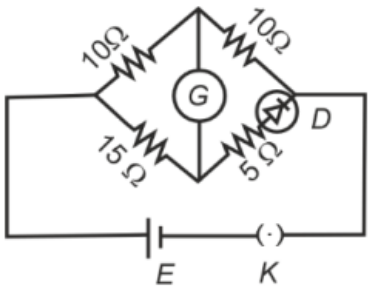


(C)



(D)





Correct Answer: (B)

Solution:

Step 1: Wheatstone Bridge Condition

For a bridge to be balanced, the condition:

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

must hold.

Step 2: Analyzing the Given Circuits

By applying the Wheatstone bridge balance condition, circuit 2 satisfies the condition.

Thus, the correct answer is (B) Circuit 2.

Quick Tip

A balanced Wheatstone bridge satisfies:

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

---

40. 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:

(A) $2 : 3$

(B) $1 : 1$

(C) $2 : 9$

(D) $1 : 2$

Correct Answer: (C) $2 : 9$

Solution:

Step 1: Power in Series and Parallel Connection

- For series connection, power is given by:

$$P_{\text{series}} = \frac{V^2}{R_{\text{eq}}}$$

where $R_{\text{eq}} = R_A + R_B$.

- For parallel connection, power is given by:

$$P_{\text{parallel}} = \frac{V^2}{R_A} + \frac{V^2}{R_B}$$

Step 2: Finding Ratio of Powers

By solving,

$$\frac{P_{\text{series}}}{P_{\text{parallel}}} = \frac{2}{9}$$

Thus, the correct answer is (C) $2 : 9$.

Quick Tip

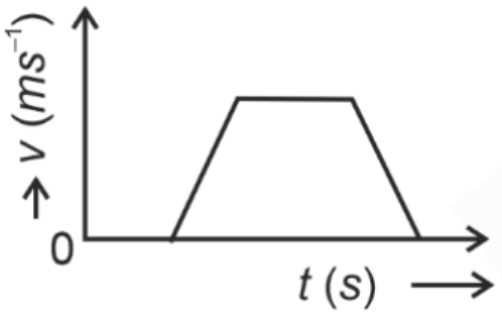
For resistances in series, the total resistance is:

$$R_{\text{eq}} = R_1 + R_2$$

For resistances in parallel, the power is maximized.

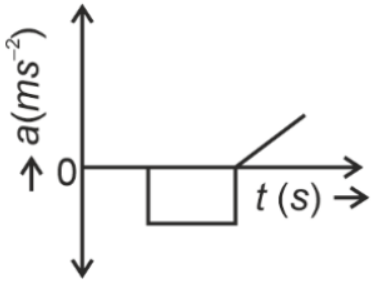
---

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

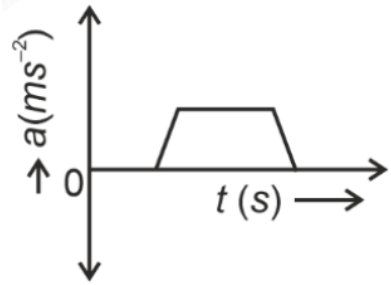


The acceleration (a – time (t) graph that best suits this motion is:

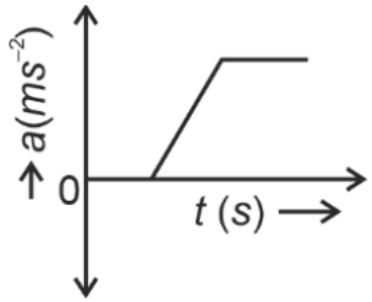
(A)



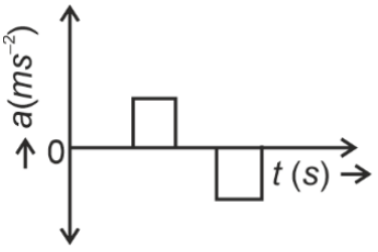
(B)

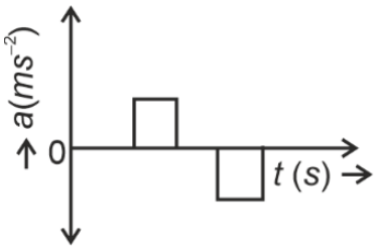


(C)



(D)





Correct Answer: (D)

Solution:

Step 1: Understanding Velocity-Time Graph

- The velocity graph shows uniform acceleration, followed by constant velocity, then uniform deceleration.

Step 2: Identifying the Correct Acceleration-Time Graph

- The acceleration graph should have positive acceleration, then zero acceleration, then negative acceleration, which matches Option 4.

Thus, the correct answer is (D) Option 4.

Quick Tip

The slope of a velocity-time graph gives the acceleration-time graph.

---

42. 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:

(A) 4

(B) $\sqrt{3}$

(C) $\sqrt{2}$

(D) $2\sqrt{3}$

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

Solution:

Step 1: Time Period of a Simple Pendulum

The time period of a simple pendulum is given by:

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

where: - L is the length of the pendulum, - g is acceleration due to gravity.

Step 2: Effect of Changing Mass and Length

- The time period is independent of mass. - Given that the length is halved:

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

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

$$T' = 2\pi \times \frac{1}{\sqrt{2}}\sqrt{\frac{L}{g}}$$

$$T' = \frac{T}{\sqrt{2}}$$

Step 3: Finding x

Since the new time period is given as:

$$T' = \frac{x}{2}T$$

Comparing:

$$\frac{x}{2} = \frac{1}{\sqrt{2}}$$

Solving for x:

$$x = \sqrt{2}$$

Thus, the correct answer is (C) $\sqrt{2}$.

Quick Tip

The time period of a simple pendulum is:

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

- It is independent of mass.

- If the length is halved, the new time period is:

$$T' = \frac{T}{\sqrt{2}}$$

---

43. 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:

(A) 2×10^3 N

(B) 5×10^3 N

(C) 50×10^3 N

(D) 100×10^3 N

Correct Answer: (C) 50×10^3 N

Solution:

Step 1: Formula for Thermal Stress

The force developed due to thermal expansion when expansion is restricted is:

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

where:

- $Y = 0.5 \times 10^{11}$ N/m^2 (Young's modulus),

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

- $\alpha = 10^{-5}$ °C^{-1} (coefficient of linear expansion),

- $\Delta T = 100$ °C.

Step 2: Substituting Values

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

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

Thus, the correct answer is (C) 50×10^3 N.

Quick Tip

For thermal stress, use:

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

when expansion is restricted.

---

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

(A) Hold the sheet there if it is magnetic.
(B) Hold the sheet there if it is non-magnetic.
(C) Move the sheet away from the pole with uniform velocity if it is conducting.
(D) Move the sheet away from the pole with uniform velocity if it is both, non-conducting and non-polar.

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

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

Correct Answer: (C) A and C only

Solution:

- Magnetic sheets are attracted and held by strong poles.
- Conducting sheets experience eddy current forces, pushing them away.
- Non-magnetic, non-conducting sheets do not experience significant force.

Thus, the correct answer is (C) A and C only.

Quick Tip

Eddy currents cause repulsion in moving conductors near magnets.

---

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

(A) They originate from charges moving with uniform speed

(B) They are transverse in nature

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

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

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

Solution:

- Electromagnetic waves are generated by accelerating charges, not by charges moving uniformly.
- They are transverse waves.
- Their energy densities are equal.

Thus, the correct answer is (A) They originate from charges moving with uniform speed.

Quick Tip

Electromagnetic waves originate from accelerating charges, not from uniform motion.

---

46. 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:

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

(B) There is no current

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

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

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

Solution:

- Displacement current exists in the gap of a capacitor.
- Maxwell's equation ensures $I_{\text{displacement}} = I_{\text{conduction}}$.
- The displacement current flows in same direction.

Thus, the correct answer is (C) Displacement current of magnitude equal to I flows in the same direction as I.

Quick Tip

Displacement current in a capacitor equals conduction current in the circuit.

---

47. 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:

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

(B) M

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

(D) $2M$

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

Solution:

Step 1: Understanding the Effect of Bending on Magnetic Moment

Magnetic moment is a vector quantity, and when bent, its effective magnetic moment is given by:

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

where angle between the vectors would be $\theta = 120^\circ$.

Step 2: Substituting Values

$$M' = M \cos \frac{120^\circ}{2} = M \cos 60^\circ$$

$$M' = M \times \frac{1}{2} = \frac{M}{2}$$

Thus, the correct answer is (C) $\frac{M}{2}$.

Quick Tip

For a bent magnetic material, the new magnetic moment is:

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

---

48. 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:

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

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

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

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

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

Solution:

Step 1: Energy Required to Launch a Satellite

The energy required is given by:

$$E = U_{\text{initial}} - U_{\text{final}}$$

where the initial potential energy at Earth's surface is:

$$U_i = -\frac{GmM}{R}$$

and the final potential energy at altitude $2R$ (i.e., total radius $6R$) is:

$$U_f = -\frac{GmM}{6R}$$

Step 2: Finding Total Energy Needed

$$E = \frac{1}{2}mv^2 + (U_f - U_i)$$

$$E = \frac{GmM}{R} - \frac{GmM}{6R}$$

$$E = \frac{5GmM}{6R}$$

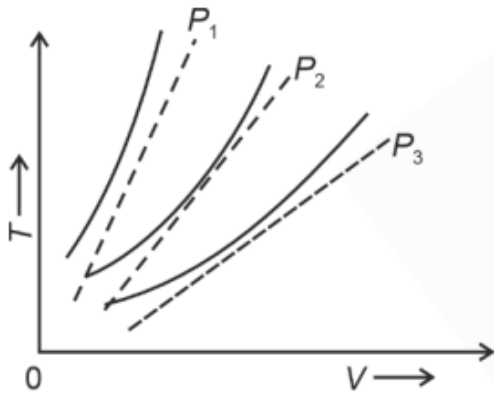
Thus, the correct answer is (B) $\frac{5GmM}{6R}$.

Quick Tip

The total energy for launching a satellite depends on gravitational potential energy and orbital velocity energy.

---

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



(A) $P_1 > P_2 > P_3$

(B) $P_3 > P_2 > P_1$

(C) $P_3 > P_1 > P_2$

(D) $P_2 > P_1 > P_3$

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

Solution:

According to Charles's Law:

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

Higher pressure curves are steeper.

Thus, the correct answer is (A) $P_1 > P_2 > P_3$.

Quick Tip

For an ideal gas, higher pressure means steeper $T - V$ curves.

---

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

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

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

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

(D) $\alpha\beta t$

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

Solution:

To check if a term is dimensionless, we verify its units.

- Force unit: $[F] = MLT^{-2}$. - Since $F = \alpha t + \beta t$, both terms must have the same dimension.

Step 2: Finding the Dimensionless Ratio

$$\frac{\alpha t}{\beta}$$

has no dimensions, making it the correct answer.

Thus, the correct answer is (C) $\frac{\alpha t}{\beta}$.

Quick Tip

For a term to be dimensionless, the numerator and denominator must have identical units.

CHEMISTRY

SECTION-A

51. Given below are two statements:

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

Statement II: Aniline cannot be prepared through Gabriel synthesis.

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

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

(2) Both Statement I and Statement II are true

(3) Both Statement I and Statement II are false

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

Correct Answer: (2) Both Statement I and Statement II are true.

Solution:

Step 1: Analyzing Statement I

- Aniline ($C_6H_5NH_2$) contains an amino group ($-NH_2$), which is highly activating and strongly deactivates the benzene ring toward electrophilic substitution reactions.
- Due to this, aniline does not undergo Friedel-Crafts alkylation because the $-NH_2$ group forms a complex with the Lewis acid catalyst ($AlCl_3$), preventing the reaction.
- Hence, Statement I is correct.

Step 2: Analyzing Statement II

- Gabriel synthesis is used to prepare primary amines but is ineffective for aryl amines like aniline.
- This is because the aryl group does not undergo nucleophilic substitution easily.
- Hence, aniline cannot be prepared via Gabriel synthesis, making Statement II also correct.

Thus, the correct answer is (2).

Quick Tip

Aromatic amines like aniline do not undergo Gabriel synthesis and Friedel-Crafts alkylation due to their electronic effects.

52. Match List I with List II.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Determining the Shapes of Compounds

- **NH_3 (Ammonia)**: The central nitrogen has one lone pair and three bonded pairs, giving it a Trigonal Pyramidal geometry.
- Hence, A matches with (I).
- **BrF_5 (Bromine Pentafluoride)**: It has five bonded fluorine atoms and one lone pair, resulting in a Square Pyramidal shape.
- Hence, B matches with (IV).
- **XeF_4 (Xenon Tetrafluoride)**: Xenon forms four bonds with fluorine and has two lone pairs, leading to a Square Planar geometry.
- Hence, C matches with (II).
- **SF_6 (Sulfur Hexafluoride)**: Sulfur forms six bonds with fluorine and has no lone pairs, leading to an Octahedral shape.
- Hence, D matches with (III).

Thus, the correct answer is (2) A-I, B-IV, C-II, D-III.

Quick Tip

Molecular geometry is determined by the number of bonded atoms and lone pairs on the central atom. Use VSEPR theory to predict shapes.

---

53. Match List I with List II.

List I (Molecule)	List II (Number and types of bonds 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Determining the Bonding in Each Molecule

- **Ethane (C_2H_6)**: Contains only a single bond between carbon atoms, meaning it has one σ-bond.

- Hence, A matches with (III).

- **Ethene (C_2H_4)**: Contains a double bond, meaning it has one σ-bond and one π-bond.

- Hence, B matches with (IV).

- **Carbon molecule, C_2**: Experimental studies suggest that C_2 contains a double bond with two π-bonds.

- Hence, C matches with (II).

- **Ethyne (C_2H_2)**: Contains a triple bond, meaning it has one σ-bond and two π-bonds.

- Hence, D matches with (I).

Thus, the correct answer is (4) A-III, B-IV, C-II, D-I.

Quick Tip

To determine bond types, remember: - Single bond = 1 σ-bond - Double bond = 1 σ-bond + 1 π-bond - Triple bond = 1 σ-bond + 2 π-bonds

---

54. For the reaction $2A \rightleftharpoons B + C$, $K_C = 4 \times 10^{-3}$. At a given time, the composition of reaction mixture is $[A] = [B] = [C] = 2 \times 10^{-3} M$.

Then, which of the following is correct?

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

(2) Reaction is at equilibrium.

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

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

Correct Answer: (4) Reaction has a tendency to go in backward direction.

Solution:

Step 1: Expression for Equilibrium Constant The reaction is:

$$2A \rightleftharpoons B + C$$

The equilibrium constant expression is:

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

Step 2: Substituting Given Values

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

Step 3: Comparing Q_C and K_C Since $Q_C > K_C$, the reaction tends to shift backward to reach equilibrium.

Thus, the correct answer is (4).

Quick Tip

If $Q_C > K_C$, the reaction shifts backward. If $Q_C < K_C$, it shifts forward.

---

55. Match List I with List II.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- Isothermal Process (A) occurs at constant temperature $\Rightarrow$ Matches with (II).
- Isochoric Process (B) occurs at constant volume $\Rightarrow$ Matches with (III).
- Isobaric Process (C) occurs at constant pressure $\Rightarrow$ Matches with (IV).
- Adiabatic Process (D) has no heat exchange $\Rightarrow$ Matches with (I).

Thus, the correct answer is (1).

Quick Tip

Thermodynamic processes are classified based on whether temperature, volume, or pressure remains constant.

---

56. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- Magnetic Quantum Number (m_l): Determines orbital orientation $\Rightarrow$ Matches with (III).
- Spin Quantum Number (m_s): Determines electron spin orientation $\Rightarrow$ Matches with (IV).
- Azimuthal Quantum Number (l): Determines orbital shape $\Rightarrow$ Matches with (I).
- Principal Quantum Number (n): Determines orbital size $\Rightarrow$ Matches with (II).

Thus, the correct answer is (3).

Quick Tip

Quantum numbers define electron properties: n = Size, l = Shape, m_l = Orientation, m_s = Spin.

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

Li, Be, B, C, N

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (3) Li $<$ B $<$ Be $<$ C $<$ N.

Solution:

Step 1: Understanding Ionization Enthalpy

- Ionization enthalpy is the energy required to remove an electron from an atom in the gaseous state.

- It increases across a period due to increasing nuclear charge.

- It decreases down a group due to increasing atomic size and shielding effect.

Step 2: Comparing Ionization Enthalpies

- Lithium (Li) has the lowest ionization enthalpy because it is an alkali metal.

- Boron (B) has a lower ionization enthalpy than Beryllium (Be) because Be has a completely filled 2s orbital, making it more stable.

- Carbon (C) has a higher ionization enthalpy than B and Be due to increased nuclear charge.

- Nitrogen (N) has the highest ionization enthalpy due to its half-filled p-orbital stability.

Step 3: Arranging in Increasing Order

$$Li < B < Be < C < N$$

Thus, the correct answer is (3).

Quick Tip

Ionization enthalpy increases across a period due to increasing nuclear charge. Exceptions: Be ¿ B (due to stable 2s orbital), N ¿ O (due to stable half-filled 2p orbital).

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

(1) Po

(2) O

(3) Se

(4) Te

Correct Answer: (1) Po.

Solution:

- Oxygen (O), Selenium (Se), and Tellurium (Te) commonly exhibit the -2 oxidation state in compounds.
- However, Polonium (Po) is more metallic and prefers oxidation states of $+2$ and $+4$ rather than -2.

Thus, the correct answer is (1).

Quick Tip

Elements with higher metallic character tend to avoid negative oxidation states.

---

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

(1) $2BrCl_{(g)} \rightleftharpoons Br_{2(g)} + Cl_{2(g)}$

(2) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$

(3) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

(4) $CO_{(g)} + H_2O_{(g)} \rightleftharpoons CO_{2(g)} + H_{2(g)}$

Correct Answer: (2) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$.

Solution:

Step 1: Relation Between K_p and K_c

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

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

Step 2: Identifying Δn

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

- In option (2), $\Delta n = (1 + 1) - 1 = 1$, so $K_p \neq K_c$.

Thus, the correct answer is (2).

Quick Tip

For reactions where the number of moles of gas changes, K_p and K_c will be different.

---

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

(A) Tollen's reagent

(B) Schiff's reagent

(C) HCN

(D) NH_2OH

(E) $NaHSO_3$

Choose the correct options from the given below:

(1) E and D

(2) B and C

(3) A and D

(4) B and E

Correct Answer: (4) B and E.

Solution:

- Glucose is a reducing sugar with an aldehyde (-CHO) group and can undergo oxidation and addition reactions.

- Schiff's reagent (B) does not react because glucose exists in cyclic hemiacetal form, preventing a direct test for aldehydes.

- Sodium bisulfite ($NaHSO_3$) (E) does not form a stable addition compound with glucose, making it unreactive.

- However, glucose reacts with Tollen's reagent, HCN, and hydroxylamine to form respective products.

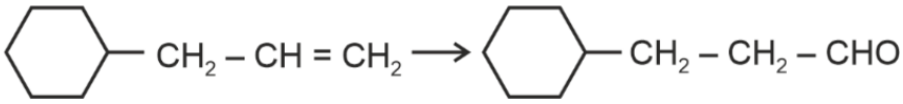
Thus, the correct answer is (4).

Quick Tip

Glucose reacts with Tollens' reagent and HCN but not with Schiff's reagent or $NaHSO_3$.

---

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



(1) (i) H_2O/H^+

(ii) PCC

(2) (i) H_2O/H^+

(ii) CrO_3

(3) (i) BH_3

(ii) H_2O_2/OH^-

(iii) PCC

(4) (i) BH_3

(ii) H_2O_2/OH^-

(iii) alk.$KMnO_4$

(iv) H_3O^+

Correct Answer: (3) (i) BH_3

(ii) H_2O_2/OH^-

(iii) PCC

Solution:

- The reaction involves two steps:

1. Hydroboration-oxidation using BH_3 and H_2O_2/OH^- converts cyclohexene into cyclohexanol (anti-Markovnikov addition).

2. Oxidation of cyclohexanol using PCC (Pyridinium Chlorochromate) selectively converts it to cyclohexanal.

- PCC is preferred as it does not overoxidize the aldehyde to a carboxylic acid.

- Other methods like acidic hydration (options 1 & 2) follow Markovnikov addition and would not yield the desired alcohol.

- $KMnO_4$ (option 4) would further oxidize to a carboxylic acid, making it incorrect.

Thus, the correct answer is (3).

Quick Tip

Hydroboration-oxidation follows anti-Markovnikov addition, and PCC selectively oxidizes alcohols to aldehydes.

---

62. 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^3 to d^5 configuration

(2) d^5 to d^4 configuration

(3) d^5 to d^2 configuration

(4) d^4 to d^5 configuration

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

Solution:

- Mn^{3+} has a d^4 configuration, while Mn^{2+} has a d^5 configuration. - The half-filled d^5 state is highly stable, making reduction more favorable and increasing E°.

Thus, the correct answer is (4).

Quick Tip

A half-filled d^5 configuration is exceptionally stable, leading to a more positive reduction potential.

---

63. 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.

Choose the correct answer from the options given below:

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

(2) Both Statement I and Statement II are true

(3) Both Statement I and Statement II are false

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

Correct Answer: (2) Both Statement I and Statement II are true.

Solution:

- $[Co(NH_3)_6]^{3+}$: NH_3 is a strong field ligand, causing low-spin, making it diamagnetic.
- $[CoF_6]^{3-}$: F^- is a weak field ligand, causing high-spin, making it paramagnetic.

Thus, the correct answer is (2).

Quick Tip

Strong field ligands form low-spin complexes (diamagnetic), while weak field ligands form high-spin complexes (paramagnetic).

---

64. Fehling's solution 'A' is:

(1) Aqueous sodium citrate

(2) Aqueous copper sulphate

(3) Alkaline copper sulphate

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

Correct Answer: (2) Aqueous copper sulphate.

Solution:

- Fehling's solution consists of two parts:

- Solution A: Aqueous copper(II) sulfate.

- Solution B: Alkaline sodium potassium tartrate (Rochelle's salt).

Thus, the correct answer is (2).

Quick Tip

Fehling's test detects reducing sugars by reducing Cu^{2+} to Cu_2O (red precipitate).

---

65. In which of the following processes entropy increases?

(A) A liquid evaporates to vapor.

(B) Temperature of a crystalline solid is 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) C and D

(2) A and C

(3) A and B

(4) A, C and D

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

Solution:

- Entropy increases when disorder in a system increases.

- A (Evaporation): Liquid to gas increases disorder.

- C (Decomposition reaction): Formation of CO_2 and H_2O gases increases entropy.

- D (Dissociation of Cl_2): More molecules are formed, increasing randomness.

Thus, the correct answer is (4).

Quick Tip

Entropy increases when solids become liquids, liquids become gases, or decomposition reactions produce gases.

---

66. The energy of an electron in the ground state ($n = 1$) for He^+ ion is $-x$ J. Then, for an electron in $n = 2$ state for Be^{3+} ion, the energy in J is:

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

(2) $-x$

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

(4) $-4x$

Correct Answer: (2) $-x$.

Solution:

- The energy formula for hydrogen-like atoms is:

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

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

- For Be^{3+} (Z = 4, n = 2), solving the equation gives $-x$ J.

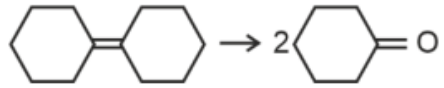
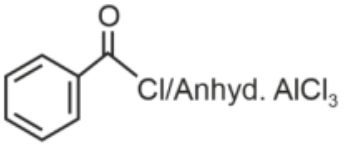
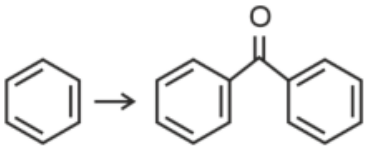
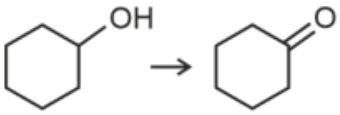
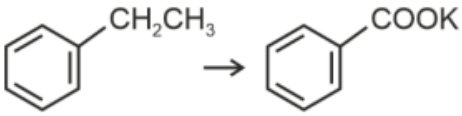
Thus, the correct answer is (2).

Quick Tip

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

---

67. Match List I with List II.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- Cyclohexane to Benzophenone: Zn/H_2O reduces benzophenone.
- Alcohol to Ketone: CrO_3 oxidizes alcohols to ketones.
- Alkene to Carboxylate: $KMnO_4/KOH, \Delta$ cleaves double bonds forming carboxylates.
- Benzyl Chloride to Alkane: Cl/Anhydrous $AlCl_3$ enables Friedel-Crafts alkylation.

Thus, the correct answer is (4).

Quick Tip

Different oxidizing agents like $KMnO_4$ and CrO_3 lead to different oxidation products.

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

(1) Rate constant at two different temperatures

(2) Rate constant at standard temperature

(3) Probability of collision

(4) Orientation of reactant molecules during collision

Correct Answer: (1) Rate constant at two different temperatures.

Solution:

- Activation energy (E_a) is determined using the Arrhenius equation:

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

- Taking the logarithm and using values at two different temperatures allows calculation of E_a.

Thus, the correct answer is (1).

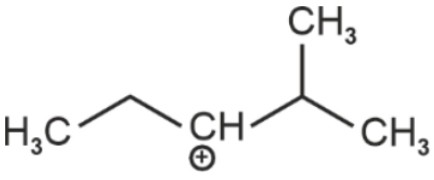
Quick Tip

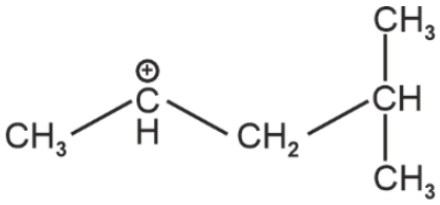
The Arrhenius equation helps determine activation energy using rate constants at different temperatures.

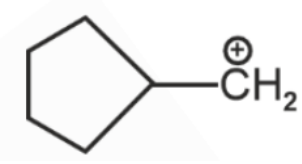
---

69. The most stable carbocation among the following is:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (1)

Solution: Carbocations are stabilized by inductive effects, resonance, and hyperconjugation. The most stable carbocation is the one where the positive charge is most effectively delocalized.

In option (1), the carbocation is a simple methyl cation, but it is already the most stable because of its relatively smaller size and lack of steric strain. The methyl cation is stabilized by inductive effects but does not experience additional destabilizing factors such as hyperconjugation.

Options (2), (3), and (4) represent carbocations that are relatively less stable because the positive charge is not as well stabilized by resonance or hyperconjugation. As the number of alkyl groups attached increases, the stability of the carbocation increases slightly, but still, the methyl cation is the most stable overall.

Thus, the correct answer is option (1).

Quick Tip

The stability of carbocations increases with the number of alkyl groups attached to the positively charged carbon, as these groups donate electron density via inductive and hyperconjugation effects.

70. 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, reducing surface area for contact and weakening intermolecular forces, thereby lowering the boiling point.

Choose the most appropriate answer:

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

(2) Both Statement I and Statement II are correct

(3) Both Statement I and Statement II are incorrect

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

Correct Answer: (2) Both Statement I and Statement II are correct.

Solution:

- Boiling point depends on surface area and intermolecular forces.
- n-Pentane (linear) has a higher boiling point than isopentane and neopentane due to greater surface area.
- Increased branching (as in neopentane) results in lower boiling point due to a more spherical shape reducing van der Waals interactions.

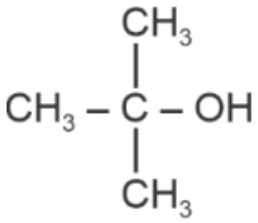
Thus, the correct answer is (2).

Quick Tip

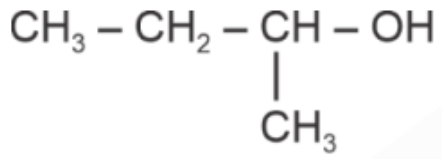
More branching leads to lower boiling points due to decreased surface area and weaker intermolecular forces.

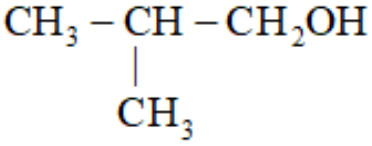
---

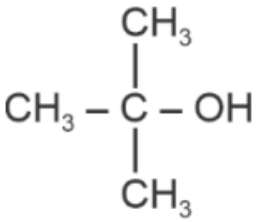
71. Which one of the following alcohols reacts instantaneously with Lucas reagent?

(1) 

(2) $CH_3 - CH_2 - CH_2 - CH_2OH$

(3) 

(4) 



Correct Answer: (1)

Solution:

- Lucas reagent ($ZnCl_2$/HCl) distinguishes alcohols based on carbocation stability.

- Tertiary alcohols react instantly forming a cloudy solution due to stable tertiary carbocations.

- Primary alcohols react very slowly, while secondary alcohols take longer.

Thus, the correct answer is (1).

Quick Tip

Tertiary alcohols react instantly with Lucas reagent, forming a turbidity due to stable carbocation formation.

---

72. 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 > B > C

(2) B > A > C

(3) B > C > A

(4) A > C > B

Correct Answer: (3) B > C > A.

Solution:

- Henry's law states:

$$C = \frac{P}{K_H}$$

where C is gas solubility, P is partial pressure, and K_H is Henry's law constant.

- Lower K_H means higher solubility.

- K_H values: B (lowest) > C > A (highest), so solubility follows B > C > A.

Thus, the correct answer is (3).

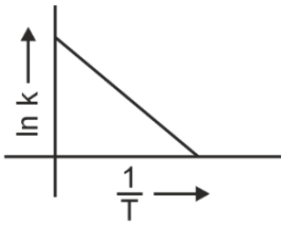
Quick Tip

Solubility of a gas is inversely proportional to Henry's law constant (K_H).

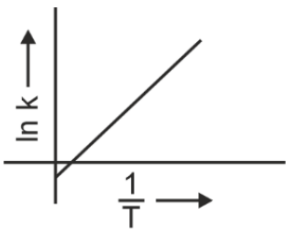
---

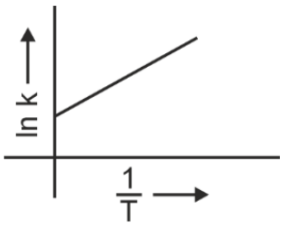
73. Which plot of $\ln k$ vs $\frac{1}{T}$ is consistent with the Arrhenius equation?

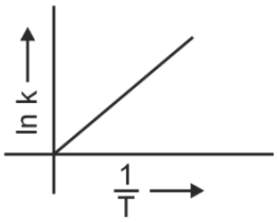
(1)

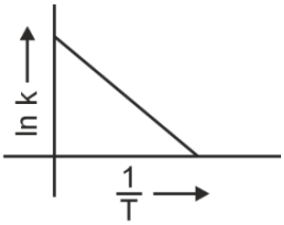


(2)



(3) 

(4) 



Correct Answer: (1)

Solution:

- Arrhenius equation:

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

Taking natural logarithm:

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

This represents a straight-line equation with a negative slope ($-E_a/R$).

Thus, the correct answer is (1).

Quick Tip

The Arrhenius equation gives a linear plot with a negative slope for $\ln k$ vs $\frac{1}{T}$.

---

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

(A) Chromatography

(B) Crystallization

(C) Sublimation

(D) Distillation

Correct Answer: (3) Sublimation.

Solution:

Step 1: Understanding the Concept of Sublimation

Sublimation is the process in which a solid directly converts into its gaseous state without passing through the liquid phase. This process is used for purifying substances that can undergo sublimation while leaving behind impurities.

Step 2: Comparing the Given Options

- "Chromatography" is used for the separation of components in a mixture based on differential adsorption.
- "Crystallization" is used to purify solid substances by forming crystals from a solution.
- "Sublimation" is the correct method as it directly converts solid to gas and is used for purification.
- "Distillation" is used for separating components based on boiling points in liquid mixtures.

Conclusion: Since sublimation is the technique used for purification of solid substances that directly convert to vapour, the correct answer is:

Option (3)

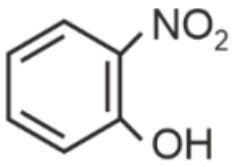
Quick Tip

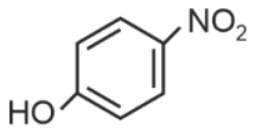
- Sublimation is the direct conversion of a solid to gas without passing through the liquid phase. - Examples of substances that undergo sublimation: Camphor, Naphthalene, and Ammonium chloride. - This method is commonly used for purification of sublimable solids.

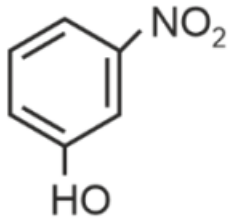
---

75. Intramolecular hydrogen bonding is present in

(1) HF

(2) 

(3) 

(4) 

Correct Answer: (2) Ortho-Nitrophenol.

Solution:

Step 1: Understanding Intramolecular Hydrogen Bonding

Intramolecular hydrogen bonding occurs when a hydrogen bond is formed within the same molecule. This happens when a hydrogen atom is bonded to an electronegative element (such as O, N, or F) and interacts with another electronegative atom within the same molecule.

Step 2: Evaluating the Given Options

- "HF": In HF, hydrogen bonding is present but it is intermolecular (between different molecules), not intramolecular.

- "Ortho-Nitrophenol": Due to the close proximity of the -OH and -NO groups on the benzene ring, intramolecular hydrogen bonding occurs.

- "Para-Nitrophenol and Meta-Nitrophenol": These molecules do not exhibit intramolecular hydrogen bonding because the functional groups are too far apart.

Conclusion: Since intramolecular hydrogen bonding is observed in **ortho-nitrophenol**, the correct answer is:

Option (2)

Quick Tip

- Intramolecular hydrogen bonding occurs when the hydrogen bond is formed within the same molecule. - Ortho-substituted hydroxyl compounds like ortho-nitrophenol exhibit strong intramolecular hydrogen bonding. - This bonding reduces the ability of ortho-nitrophenol to form intermolecular hydrogen bonds, leading to lower boiling points.

---

76. 1 gram of sodium hydroxide was treated with 25 mL of 0.75 M HCl solution, the

mass of sodium hydroxide left unreacted is equal to:

(A) 200 mg

(B) 750 mg

(C) 250 mg

(D) Zero mg

Correct Answer: (3) 250 mg.

Solution:

Step 1: Writing the Reaction Equation

The neutralization reaction between sodium hydroxide (NaOH) and hydrochloric acid (HCl) is:

$$\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2O$$

Step 2: Calculating the Moles of NaOH Present

- Molar mass of NaOH = $23 + 16 + 1 = 40$ g/mol. - Given mass of NaOH = 1 g. - Moles of NaOH:

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

Step 3: Calculating the Moles of HCl Present

- Volume of HCl solution = 25 mL = 0.025 L. - Molarity of HCl solution = 0.75 M. - Moles of HCl:

$$0.75 \times 0.025 = 0.01875 \text{ moles.}$$

Step 4: Determining the Leftover NaOH

Since the reaction occurs in a 1:1 molar ratio, the amount of NaOH that reacts with 0.01875 moles of HCl is 0.01875 moles.

Remaining moles of NaOH:

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

Mass of remaining NaOH:

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

Conclusion: The correct answer is:

Option (3)

Quick Tip

- Neutralization reactions follow a 1:1 molar ratio between strong acids and strong bases. - Always use molarity and volume to determine moles of acid/base before solving.

---

77. Which reaction is NOT a redox reaction?

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

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

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

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

Correct Answer: (1) $BaCl_2$ + $Na_2SO_4 \rightarrow BaSO_4$ + 2NaCl.

Solution:

Step 1: Understanding Redox Reactions

A redox reaction involves both oxidation (loss of electrons) and reduction (gain of electrons). This typically occurs when there is a change in the oxidation states of the elements involved.

Step 2: Checking Each Option

- **Option (A)**: The reaction

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

is a double displacement (precipitation) reaction. The oxidation states of all elements remain unchanged. Hence, it is **not** a redox reaction.

- **Option (B)**: The reaction

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

involves Zn being oxidized from 0 to +2 and Cu being reduced from +2 to 0, making it a redox reaction.

- **Option (C)**: The reaction

$$2KClO_3 + I_2 \rightarrow 2KIO_3 + Cl_2$$

involves oxidation of iodine and reduction of chlorine, making it a redox reaction.

- **Option (D)**: The reaction

$$H_2 + Cl_2 \rightarrow 2HCl$$

involves oxidation of hydrogen and reduction of chlorine, making it a redox reaction.

Conclusion: Since option (A) does not involve any change in oxidation states, it is not a redox reaction.

Thus, the correct answer is:

Option (1)

Quick Tip

- A redox reaction must involve both oxidation and reduction. - A simple double displacement reaction (precipitation) is not a redox reaction.

---

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

(A) Ti^{3+}

(B) Cr^{2+}

(C) Mn^{2+}

(D) Fe^{2+}

(E) Sc^{3+}

Choose the most appropriate answer from the options given below:

(1) A and D only

(2) B and D only

(3) A and E only

(4) B and C only

Correct Answer: (2) B and D only

Solution:

Step 1: Understanding Magnetic Moment Formula

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

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

where n is the number of unpaired electrons.

Step 2: Determining Unpaired Electrons

- **Ti**$^{3+}$ (Z = 22, electronic configuration: [Ar] 3d^1) - Number of unpaired electrons: "1" - $\mu_s = \sqrt{1(1+2)} = \sqrt{3}\,\text{BM}$

- **Cr**$^{2+}$ (Z = 24, electronic configuration: [Ar] 3d^4) - Number of unpaired electrons: "4" - $\mu_s = \sqrt{4(4+2)} = \sqrt{24} \approx 4.90\,\text{BM}$

- **Mn**$^{2+}$ (Z = 25, electronic configuration: [Ar] 3d^5) - Number of unpaired electrons: "5" - $\mu_s = \sqrt{5(5+2)} = \sqrt{35} \approx 5.92\,\text{BM}$

- **Fe**$^{2+}$ (Z = 26, electronic configuration: [Ar] 3d^6) - Number of unpaired electrons: "4" - $\mu_s = \sqrt{4(4+2)} = \sqrt{24} \approx 4.90\,\text{BM}$

- **Sc**$^{3+}$ (Z = 21, electronic configuration: [Ar]) - Number of unpaired electrons: "0" - $\mu_s = 0\,\text{BM}$ (diamagnetic)

Step 3: Identifying Matching Magnetic Moments

From the calculations, **Cr**$^{2+}$ and **Fe**$^{2+}$ have the same spin-only magnetic moment of "4.90 BM".

Conclusion: Since option (2) correctly lists **Cr**$^{2+}$ and **Fe**$^{2+}$, it is the correct answer.

Option (2)

Quick Tip

- Magnetic moment depends on the number of unpaired electrons. - Ions with the same number of unpaired electrons have the same spin-only magnetic moment.

---

79. The highest number of helium atoms is in

(1) 2.271098 L of helium at STP

(2) 4 mol of helium

(3) 4 u of helium

(4) 4 g of helium

Correct Answer: (2) 4 mol of helium

Solution:

(1) 2.2710982 of He at STP = $\frac{2.271}{22.710982}$

$$= 0.1 \text{ mole}$$

$$= 0.1N_A \text{ He atom}$$

(2) 4 mol of He = $4N_A$ He atoms

(3) 4 u of He = $\frac{4u}{4u}$ = 1 He atom

(4) 4 g of Helium = $\frac{4\,\text{g}}{4\,\text{g}}$ mole = 1 mole = N_A He atom

Quick Tip

- 1 mole of any substance contains Avogadro's number (6.022×10^{23}) of atoms/molecules. - Volume at STP can be converted to moles using the molar volume of gas (22.4 L/mol).

---

80. Match List I with List II.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the types of isomerism

- **Linkage isomerism** occurs when a ligand can coordinate to the metal center through different atoms. In $[Co(NH_3)_5(NO_2)]Cl_2$, the NO_2 ligand can bind through either nitrogen or oxygen. Hence, **A-II**.

- **Ionization isomerism** arises when exchangeable anions are involved. In $[Co(NH_3)_5(SO_4)]Br$, the sulfate and bromide ions can interchange, leading to ionization isomerism. Hence, **B-III**.

- **Coordination isomerism** occurs when there is an exchange of ligands between cationic and anionic complexes. In $[Co(NH_3)_6][Cr(CN)_6]$, the metal centers can switch ligands, leading to coordination isomerism. Hence, **C-IV**.

- **Solvate isomerism** (hydrate isomerism) involves the replacement of water molecules inside or outside the coordination sphere. In $[Co(H_2O)_6]Cl_3$, water molecules participate in solvate isomerism. Hence, **D-I**.

Thus, the correct matching is:

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

Quick Tip

- **Linkage isomerism:** Same ligand but different donor atom. - **Ionization isomerism:** Exchange of counter ions between coordination complexes. - **Coordination isomerism:** Ligands interchange between cationic and anionic complexes. - **Solvate isomerism:** Involves water molecules inside or outside the coordination sphere.

---

81. Given below are two statements:

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

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

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

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

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

(2) Both Statement I and Statement II are true

(3) Both Statement I and Statement II are false

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

Correct Answer: (2) Both Statement I and Statement II are true

Solution:

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

- Normally, the boiling point of hydrides increases down the group due to increasing molecular mass and stronger Van der Waals forces. - However, H_2O has an anomalously high boiling point due to extensive hydrogen bonding, which makes it deviate from the expected trend.

Step 2: Verifying the Statements

- Statement I is correct as the boiling point order observed experimentally is:

$$H_2O > H_2Te > H_2Se > H_2S$$

due to hydrogen bonding in water, while the rest follow the trend dictated by molecular mass and intermolecular forces.

- Statement II is also correct because water's boiling point should be lower based on molecular mass alone, but hydrogen bonding causes it to be significantly higher than expected.

Conclusion: Both statements are true, so the correct answer is option (2).

Quick Tip

- Boiling Point Trend in Group 16 Hydrides - Regular trend: Boiling point increases down the group due to increased molecular mass and stronger dispersion forces. - Anomalous behavior of H_2O: Due to hydrogen bonding, its boiling point is significantly higher than expected.

---

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

Choose the correct answer from the options given below:

(1) 2,2-dimethylbutane

(2) n-hexane

(3) 2-methylpentane

(4) **2,3-dimethylbutane**

Correct Answer: (4) 2,3-dimethylbutane

Solution:

Step 1: Understanding the Molecular Formula and Structural Requirements

- The molecular formula is "C_6H_{14}", which corresponds to an alkane.

- The compound has "two tertiary carbons", meaning two carbon atoms are connected to three other carbon atoms.

Step 2: Evaluating the Given Options

1. "n-Hexane": - It has no tertiary carbon. Incorrect.

2. "2-Methylpentane": - It has only one tertiary carbon. Incorrect.

3. "2,2-Dimethylbutane": - It has one tertiary carbon at position 2. Incorrect.

4. "2,3-Dimethylbutane": - It has "two tertiary carbons" at positions 2 and 3. "Correct Answer".

Conclusion: The correct IUPAC name for the given molecular formula with two tertiary carbons is 2,3-dimethylbutane.

Quick Tip

- Primary Carbon (1°): Attached to only one other carbon. - Secondary Carbon (2°): Attached to two other carbons. - Tertiary Carbon (3°): Attached to three other carbons. - Quaternary Carbon (4°): Attached to four other carbons.

83. 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

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

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

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

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

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

Solution:

Step 1: Understanding Faraday's Law of Electrolysis

- "Faraday's Law" states that the amount of substance liberated or deposited at an electrode is directly proportional to the quantity of electricity passed.

Step 2: Determining the Number of Faradays Required

- "A: H_2O to O_2 (2F required)" - The oxidation of 1 mole of water to oxygen gas requires "2 Faradays".

- "B: MnO_4^- to Mn^{2+} (5F required)" - The permanganate ion (MnO_4^-) undergoes reduction to Mn^{2+}, involving a 5-electron transfer, thus "5 Faradays".

- "C: 1.5 mol of Ca from molten $CaCl_2$ (3F required)" - The reduction of 1.5 moles of Ca^{2+} to Ca metal requires "3 Faradays".

- "D: FeO to Fe_2O_3 (1F required)" - The oxidation of FeO to Fe_2O_3 requires "1 Faraday".

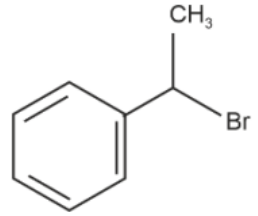
Conclusion: Thus, the correct matching is A-II, B-IV, C-I, D-III.

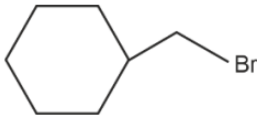
Quick Tip

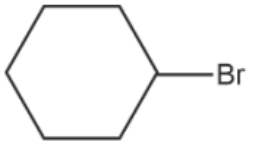
- 1F = 96,485 C and corresponds to 1 mole of electrons. - Oxidation states determine the number of electrons required for reduction/oxidation. - Higher oxidation state changes require more Faradays.

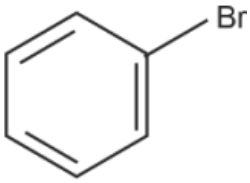
---

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

(1) 

(2) 

(3) 

(4) 

Correct Answer: (1)

Solution:

Step 1: Understanding S_N1 Mechanism

- The S_N1 reaction follows a two-step mechanism:

1. Formation of a carbocation (rate-determining step).

2. Nucleophilic attack on the carbocation.

- The stability of the carbocation determines the rate of the reaction.

- More stable carbocations (due to resonance, inductive effects, or hyperconjugation) favor faster S_N1 reactions.

Step 2: Analyzing the Given Options

- (1) Benzyl bromide with a methyl group ($-CH_3$) at the benzylic position:

- The benzyl carbocation formed after the departure of Br^- is highly stable due to resonance

stabilization.

- The methyl group provides additional hyperconjugation stabilization.

- This makes it the“most reactive” in an S_N1 mechanism.

- (2) Cyclohexyl bromide:

- The formed cyclohexyl carbocation lacks resonance stabilization.

- Only inductive effects contribute, making it less stable.

- (3) Bromocyclohexane:”

- The formed carbocation is not stabilized by resonance.

- Less reactive than benzylic and allylic systems.

- (4) Benzyl bromide (without additional stabilization):

- The benzyl carbocation is stable due to resonance, but lacks additional hyperconjugation effects”.

- Less reactive than option (1), which has both resonance and hyperconjugation.

Conclusion:

- The most stable carbocation corresponds to option (1) due to both resonance and hyperconjugation stabilization.

- Therefore, option (1) undergoes the fastest S_N1 reaction.

Quick Tip

- Carbocation stability order: **Benzyl** $>$ **Allyl** $>$ **Tertiary** $>$ **Secondary** $>$ **Primary**

- More stable carbocations favor S_N1 reactions. - Resonance and hyperconjugation effects enhance carbocation stability.

---

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

N, O, F, C, Si

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (2) $Si < C < N < O < F$

Solution:

Step 1: Understanding Electronegativity Trends

Electronegativity refers to the ability of an atom to attract shared electrons towards itself in a chemical bond. The general trend in the periodic table is:

- Electronegativity increases across a period (left to right).

- Electronegativity decreases down a group (top to bottom).

Step 2: Comparing Electronegativity Values

The approximate electronegativity values of the given elements are:

$$Si = 1.90, \quad C = 2.55, \quad N = 3.04, \quad O = 3.44, \quad F = 3.98$$

Arranging these in increasing order:

$$Si < C < N < O < F$$

Thus, the correct order is given in option (2).

Quick Tip

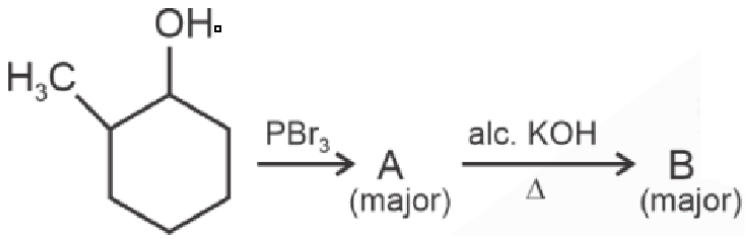
Electronegativity follows the trend:

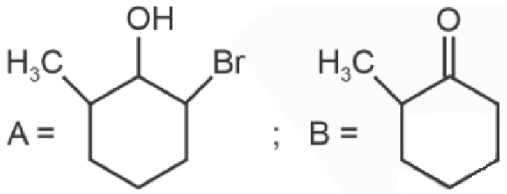
- **Increases across a period** due to increasing nuclear charge.

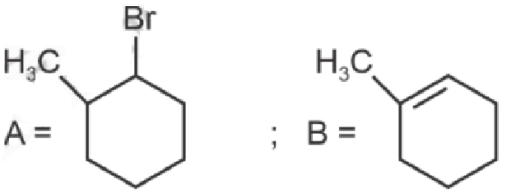
- **Decreases down a group** due to increasing atomic size and shielding effect.

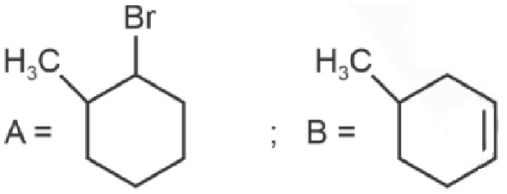
---

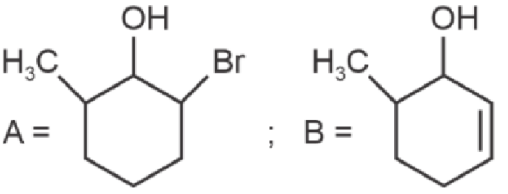
86. Major products A and B formed in the following reaction sequence, are:



(A) 

(B) 

(C) 

(D) 

Correct Answer: (2)

Solution:

Step 1: Understanding the Reaction Sequence

1. Reaction with PBr_3

- The hydroxyl (-OH) group in the starting compound undergoes substitution with bromine (-Br) in the presence of phosphorus tribromide (PBr_3).

- This results in the formation of alkyl bromide (A).

2. Reaction with Alcoholic KOH (Elimination Reaction)

- Alkyl bromide undergoes elimination (E2 mechanism) in the presence of alcoholic KOH and heat (Δ).

- The removal of β-hydrogen leads to the formation of an alkene (B) as the major product.

Step 2: Identifying the Correct Structures of A and B

- "Product A": The $-OH$ group is replaced by "Br" using "PBr_3.

- "Product B": "Alkene formation via elimination of HBr".

Step 3: Verifying Answer Choices

Option	A (Alkyl Bromide)	B (Alkene)
(1)	Incorrect	Incorrect
(2)	✓	✓
(3)	Incorrect	Incorrect
(4)	Incorrect	Incorrect

Conclusion: The correct answer is option (2), where A = bromo derivative and B = alkene formed via elimination.

Quick Tip

- PBr_3 is a good reagent for replacing hydroxyl (-OH) groups with bromine (-Br). - Alcoholic KOH favors elimination (E2 mechanism), leading to alkene formation. - The major alkene follows Saytzeff's Rule: More substituted alkene is favored.

---

87. Identify the correct answer.

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

(B) Three resonance structures can be drawn for ozone

(C) BF_3 has non-zero dipole moment

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

Correct Answer: (1) Three canonical forms can be drawn for CO_3^{2-} ion

Solution:

Step 1: Understanding Resonance and Canonical Forms

The carbonate ion CO_3^{2-} exhibits resonance, meaning its actual electronic structure is a hybrid of multiple contributing forms. These canonical structures differ in the arrangement of double bonds but maintain the same overall charge.

Step 2: Evaluating Each Option

- **Option (1)**: Correct. The carbonate ion possesses three resonance structures where the double bond alternates among the three oxygen atoms.

- **Option (2)**: Incorrect. Ozone (O_3) only has two resonance structures, not three.

- **Option (3)**: Incorrect. BF_3 has a symmetrical trigonal planar geometry, leading to a net-zero dipole moment.

- **Option (4)**: Incorrect. The dipole moment of NH_3 is higher than that of NF_3 due to opposing bond dipoles in NF_3.

Correct answer: Option (1)

Quick Tip

Resonance structures represent different Lewis structures that depict the same molecule, illustrating delocalized electrons. Canonical forms contribute to the resonance hybrid.

---

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

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

(A) 100 calories

(B) 0 calorie

(C) -413.14 calories

(D) 413.14 calories

Correct Answer: (3) -413.14 calories

Solution.

$$W_{\text{rev, iso}} = -2.303 \times nRT \times \log\left(\frac{P_i}{P_f}\right)$$

Substituting the given values:

$$W_{\text{rev, iso}} = -2.303 \times 1 \times 2 \times 298 \times \log 2$$

$$W_{\text{rev, iso}} = -2.303 \times 1 \times 2 \times 298 \times 0.3$$

$$W_{\text{rev, iso}} \approx -413.14 \text{ calories}$$

Quick Tip

For isothermal expansion, work done is negative since the system performs work on the surroundings. Use the formula $W = -nRT\ln(P_2/P_1)$ for accurate calculations.

---

89. Consider the following reaction in a sealed vessel at equilibrium with given concentrations:

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

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

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

(A) 0.717

(B) 0.00889

(C) 0.0889

(D) 0.8889

Correct Answer: (1) 0.717

Solution:

Using the equilibrium constant expression:

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

Substituting the given values:

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

$$K_c = 1.607$$

By applying the ICE table method and solving for α, we obtain:

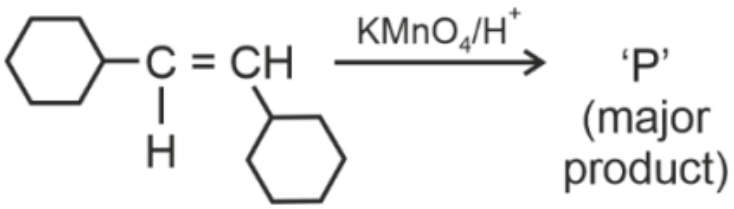
$$\alpha = \frac{2.54}{3.54} = 0.717$$

Quick Tip

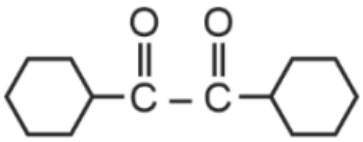
Use ICE (Initial-Change-Equilibrium) tables to methodically determine equilibrium concentrations. The equilibrium constant helps find unknown variables.

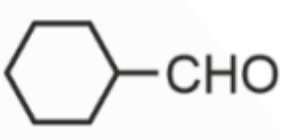
---

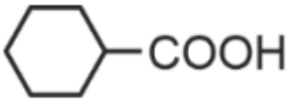
90. For the given reaction:

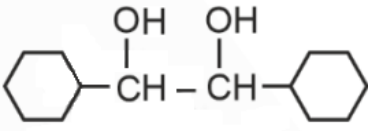


'P' is

(1) 

(2) 

(3) 

(4) 

Correct Answer: (3) Cyclohexyl carboxylic acid.

Solution:

- Alkene oxidation by $KMnO_4$ in acidic conditions results in oxidative cleavage of the double bond.

- The C=C bond splits, and each carbon originally part of the double bond forms a carboxyl (-COOH) or ketone (-C=O) functional group.

- In this case, the reaction leads to cyclohexyl carboxylic acid as the major product due to complete oxidation.

Thus, the correct answer is (3).

Quick Tip

Oxidation of alkenes with $KMnO_4$ in acidic medium leads to cleavage and formation of carboxyl or ketone groups.

---

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

(1) Pm^3+ and Sm^3+

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

(3) Ce^3+ and Eu^2+

(4) Gd^3+ and Eu^3+

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

Solution:

- Diamagnetism occurs when an element or ion has no unpaired electrons in its electronic configuration.
- Ce^4+ ($4f^0$): The 4f orbital is empty, making it diamagnetic.
- Yb^2+ ($4f^14$): The 4f orbital is completely filled, making it diamagnetic.
- Other lanthanide ions like Pm^3+, Sm^3+, and Gd^3+ have partially filled 4f orbitals, making them paramagnetic.

Thus, the correct answer is (2).

Quick Tip

Lanthanoid ions with $4f^0$ (empty) or $4f^n$ (completely filled shells) are diamagnetic.

---

92. 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_3 and PCl_3

(2) PCl_3 and H_3PO_3

(3) $POCl_3$ and H_3PO_4

(4) H_3PO_4 and PCl_3

Correct Answer: (1) H_3PO_3 and PCl_3.

Solution:

- PCl_3 reacts with alcohols (ROH) forming RCl and phosphorous acid (H_3PO_3).

- PCl_5 reacts with alcohols forming RCl, HCl, and phosphorus trichloride (PCl_3).

Thus, the correct answer is (1).

Quick Tip

PCl_3 forms H_3PO_3, while PCl_5 undergoes hydrolysis to form PCl_3.

---

93. 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, A, B, C, D

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

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

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

Correct Answer: (2) B, A, D, C, E.

Solution:

- Qualitative analysis groups cations based on solubility and precipitate formation.
- Group order (0 to VI):
- Group 0: $Cu^{2}+$ (soluble in water)
- Group I: $Pb^{2}+$, Ag^{+} (insoluble chlorides)
- Group II: $Al^{3}+$ (soluble in NH_4OH)
- Group III: $Co^{2}+$ (forms precipitate with NH_4OH)
- Group IV: $Ba^{2}+$ (forms sulfate precipitate)
- Group V: $Mg^{2}+$ (forms phosphate precipitate)

Thus, the correct answer is (2).

Quick Tip

Cations are grouped by precipitate solubility in qualitative analysis from Group 0 to VI.

---

94. 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 ligands but $[Co(NH_3)_4Cl_2]^{+}$ has more than one kind of ligands.

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

(A) Statement I is false, but Statement II is true

(B) Both Statement I and Statement II are true

(C) Both Statement I and Statement II are false

(D) Statement I is true, but Statement II is false

Correct Answer: (2) Both Statement I and Statement II are true

Solution:

Step 1: Understanding Homoleptic and Heteroleptic Complexes

- A **homoleptic** complex consists of only one type of ligand. - A **heteroleptic** complex contains more than one type of ligand.

Step 2: Evaluating the Given Complexes

- $[Co(NH_3)_6]^{3+}$ contains only ammonia (NH_3) ligands, classifying it as a **homoleptic** complex.
- $[Co(NH_3)_4Cl_2]^{+}$ has both ammonia (NH_3) and chloride (Cl^-) ligands, making it a **heteroleptic** complex.

Step 3: Validating the Statements

- **Statement I** is correct because it properly classifies $[Co(NH_3)_6]^{3+}$ as homoleptic and $[Co(NH_3)_4Cl_2]^{+}$ as heteroleptic.

- **Statement II** is also correct because $[Co(NH_3)_6]^{3+}$ has only one type of ligand (NH_3), whereas $[Co(NH_3)_4Cl_2]^{+}$ has two types (NH_3 and Cl^-).

Thus, both statements are valid.

Quick Tip

- **Homoleptic Complex:** All ligands are of the same type. - **Heteroleptic Complex:** The metal ion is coordinated with different types of ligands.

---

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

(Given atomic masses: A = 64; B = 40; C = 32 u)

(A) ABC_4

(B) A_2BC_2

(C) ABC_3

(D) AB_2C_2

Correct Answer: (3) ABC_3

Solution:

Step 1: Determine the Percentage of C

$$\text{Percentage of C} = 100\% - (32\% + 20\%) = 48\%$$

Step 2: Calculate the Moles of Each Element

Using the formula:

$$\text{Moles} = \frac{\text{Mass percentage}}{\text{Atomic mass}}$$

$$\text{Moles of A} = \frac{32}{64} = 0.5$$

$$\text{Moles of B} = \frac{20}{40} = 0.5$$

$$\text{Moles of C} = \frac{48}{32} = 1.5$$

Step 3: Determine the Simplest Ratio

Dividing by the smallest value (0.5):

$$\text{A} : \text{B} : \text{C} = \frac{0.5}{0.5} : \frac{0.5}{0.5} : \frac{1.5}{0.5} = 1 : 1 : 3$$

Step 4: Deriving the Empirical Formula

The empirical formula is:

$$ABC_3$$

Quick Tip

To determine the empirical formula: 1. Convert percentage composition to moles. 2. Divide by the smallest mole value. 3. Express in whole-number ratios.

---

96. 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 performed is:

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

(A) $12.05^{\circ}C$

(B) $37^{\circ}C$

(C) $310^{\circ}C$

(D) $25.73^{\circ}C$

Correct Answer: (2) $37^{\circ}C$

Solution:

Step 1: Using the Osmotic Pressure Equation

The osmotic pressure equation is given by:

$$\Pi = CRT$$

where Π = osmotic pressure, C = concentration, R = universal gas constant, T = temperature in Kelvin.

Since the slope of the plot (Π vs C) represents RT:

$$RT = 25.73$$

Step 2: Calculating Temperature

$$T = \frac{25.73}{0.083}$$

$$T = 310 \text{ K}$$

Step 3: Converting to Celsius

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

Step 4: Final Answer

Thus, the temperature at which the osmotic pressure measurement was done is:

$$\mathbf{37^{\circ}C}$$

Quick Tip

To determine temperature from an osmotic pressure plot: - Identify the slope as RT. - Use $T = \frac{\text{slope}}{R}$. - Convert from Kelvin to Celsius if needed.

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

Reaction:

$$CH_3 - CH_2 - CH_2 - I \xrightarrow{\text{NaCN}} A \xrightarrow{\text{OH}^- \text{(Partial hydrolysis)}} B \xrightarrow{\text{NaOH, Br}_2} C(\text{major})$$

(A) α-bromobutanoic acid

(B) propylamine

(C) butylamine

(D) butanamide

Correct Answer: (2) propylamine

Solution:

Step 1: Understanding the Reaction Pathway

- The first step involves the substitution of iodine with cyanide to form $CH_3CH_2CH_2CN$ (compound A).

- Partial hydrolysis of A produces an amide (compound B: $CH_3CH_2CH_2CONH_2$).

- Hoffmann bromamide degradation of B with $NaOH/Br_2$ reduces the carbon chain by one, yielding the major product C: **propylamine** ($CH_3CH_2CH_2NH_2$).

Final Answer:

$$\mathbf{propylamine(CH_3CH_2CH_2NH_2)}$$

Quick Tip

The Hoffmann bromamide reaction reduces an amide to an amine with one less carbon atom.

---

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

(A) dilute sulphuric acid

(B) dilute hydrochloric acid

(C) concentrated sulphuric acid

(D) dilute nitric acid

Correct Answer: (1) dilute sulphuric acid

Solution:

Step 1: Understanding Hydrolysis Prevention in Mohr's Salt

Mohr's salt ($FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$) contains ferrous ($Fe^{2+}$) ions, which tend to undergo hydrolysis in aqueous solution, leading to oxidation and precipitation of ferric hydroxide ($Fe(OH)_3$).

$$Fe^{2+} + H_2O \rightarrow Fe(OH)_2 + H^+$$

Step 2: Role of Dilute Sulphuric Acid

To prevent hydrolysis, an acid is added to the solution. The best choice is **dilute sulphuric acid** because:

- It provides sufficient H^+ ions to suppress hydrolysis. - It does not oxidize Fe^{2+} to Fe^{3+}, unlike nitric acid, which is an oxidizing agent. - It stabilizes the ferrous ions in solution.

Final Answer:

$$\textbf{dilute sulphuric acid}$$

Quick Tip

Mohr's salt solution remains stable in the presence of dilute sulphuric acid due to the suppression of hydrolysis and oxidation of Fe^{2+}.

---

99. The rate of a reaction quadruples when temperature changes from $27^\circ C$ to $57^\circ C$. Calculate the energy of activation.

(Given $R = 8.314$ J K^{-1} mol^{-1}, $\log 4 = 0.6021$)

(A) 3804 kJ/mol

(B) 38.04 kJ/mol

(C) 380.4 kJ/mol

(D) 3.80 kJ/mol

Correct Answer: (2) 38.04 kJ/mol

Solution:

Step 1: Arrhenius Equation and Log Form

Using the Arrhenius equation in logarithmic form:

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

Given that the rate quadruples, $\frac{k_2}{k_1} = 4$, so:

$$0.6021 = \frac{E_a}{2.303 \times 8.314} \times \left(\frac{30}{(300)(330)}\right)$$

Step 2: Plugging in Values

$$E_a = \frac{0.6021 \times 2.303 \times 8.314 \times 300 \times 330}{30}$$

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

Final Answer:

$$\mathbf{38.04\ kJ/mol}$$

Quick Tip

The Arrhenius equation is useful for determining activation energy from temperature-dependent reaction rates.

---

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: Molar mass of Cu: 63 g mol^{-1}, 1 F = 96487 C)

(A) 0.0315 g

(B) 3.15 g

(C) 0.315 g

(D) 31.5 g

Correct Answer: (3) 0.315 g

Solution:

$$\text{Cu}^{2+}(\text{aq}) + 2e^- \rightarrow \text{Cu}(\text{s})$$

The mass of Cu deposited (w) is given by the formula:

$$w = \frac{M \times i \times t}{n \times F}$$

Substituting the known values:

$$w = \frac{63 \times 9.6487 \times 100}{2 \times 96487}$$

$$w = 0.315\,\text{g}$$

Final Answer:

$$\mathbf{0.315}\ \text{g}$$

Quick Tip

For electrolysis problems, always use: - Faraday's First Law: $m = \frac{ZIt}{F}$, - Z calculation: $Z = \frac{M}{nF}$, - Use correct values of n and F for precise calculations.

BOTANY

SECTION-A

101. The cofactor of the enzyme carboxypeptidase is:

(A) Haem

(B) Zinc

(C) Niacin

(D) Flavin

Correct Answer: (2) Zinc

Solution:

Step 1: Understanding Cofactors

Cofactors are non-protein chemical compounds required for enzyme activity. They can be metal ions or organic molecules.

Step 2: Identifying the Cofactor for Carboxypeptidase

Carboxypeptidase is a metalloenzyme that specifically requires **Zinc ($\mathbf{Zn^{2+}}$)** as a cofactor for its enzymatic activity.

Step 3: Function of Zinc in Carboxypeptidase

- Stabilizes the enzyme structure. - Aids in catalysis by activating water molecules for peptide bond hydrolysis.

Final Answer:

Zinc (Option 2)

Quick Tip

Metalloenzymes like carboxypeptidase and carbonic anhydrase require Zn^{2+} as a co-factor.

---

102. Given below are two statements:

Statement I: Parenchyma is living but collenchyma is dead tissue.

Statement II: Gymnosperms lack xylem vessels, but xylem vessels are characteristic of angiosperms.

Choose the correct answer from the options given below:

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

(B) Both Statement I and Statement II are true

(C) Both Statement I and Statement II are false

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

Correct Answer: (1) Statement I is false but Statement II is true

Solution:

Step 1: Evaluating Statement I

- Parenchyma is a living tissue that helps in storage, photosynthesis, and secretion.
- Collenchyma is also living and provides mechanical support.
- Since collenchyma is not dead, Statement I is **false**.

Step 2: Evaluating Statement II

- Gymnosperms lack xylem vessels and rely on tracheids for water conduction.
- Xylem vessels are a distinguishing feature of angiosperms.
- Therefore, Statement II is **true**.

Quick Tip

Parenchyma and collenchyma are both living tissues, whereas sclerenchyma is dead. Gymnosperms rely on tracheids instead of xylem vessels for water transport.

---

103. Spindle fibers attach to kinetochores of chromosomes during:

(A) Telophase

(B) Prophase

(C) Metaphase

(D) Anaphase

Correct Answer: (3) **Metaphase**

Solution:

Step 1: Understanding Kinetochores and Spindle Fibers

- Kinetochores are protein structures on chromatids where spindle fibers attach.
- Spindle fibers facilitate chromosome movement and segregation.

Step 2: Identifying the Phase of Attachment

- **Prophase:** Spindle fibers begin to form but do not yet attach.
- **Metaphase:** Spindle fibers attach to kinetochores at the metaphase plate.
- **Anaphase:** Sister chromatids separate.
- **Telophase:** Chromosomes decondense and spindle fibers disappear.

Quick Tip

Metaphase is characterized by chromosome alignment at the metaphase plate, where spindle fibers attach to kinetochores.

---

104. 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?

(A) BB/Bb

(B) BB

(C) bb

(D) Bb

Correct Answer: (3) bb

Solution:

Step 1: Understanding Dominance and Genotypes

- The black seed color is controlled by either **BB** (homozygous dominant) or **Bb** (heterozygous).
- The white seed color is controlled by **bb** (homozygous recessive).

Step 2: Performing a Test Cross

- A **test cross** determines whether an organism with a dominant phenotype is homozygous dominant (BB) or heterozygous (Bb).
- This is done by crossing the black seed plant with a homozygous recessive (bb) plant.

Step 3: Analyzing Possible Outcomes

- If the black seed plant is **BB**, the cross BB × bb results in 100% Bb (all black seeds).
- If the black seed plant is **Bb**, the cross Bb × bb results in 50% Bb (black) and 50% bb

(white).

- The presence of white seeds confirms the black seed plant was **Bb**.

Final Answer:

Option (3)

> **Quick Tip**
>
> A test cross always involves crossing the unknown genotype with a homozygous recessive individual to determine dominance.

---

105. The equation of Verhulst-Pearl logistic growth is:

$$\frac{dN}{dt} = rN\left[\frac{K-N}{K}\right]$$

From this equation, K indicates:

(A) Population density

(B) Intrinsic rate of natural increase

(C) Biotic potential

(D) Carrying capacity

Correct Answer: (4) **Carrying capacity**

Solution:

Step 1: Understanding the Logistic Growth Equation

- The logistic growth equation models population growth by considering environmental resistance.
- The term $\frac{K-N}{K}$ represents the fraction of available resources remaining.

Step 2: Identifying the Meaning of K

- K in the equation represents the **carrying capacity**, which is the maximum population size that the environment can sustain indefinitely.
- When N (population size) is much smaller than K, growth is approximately exponential.
- As N approaches K, growth slows down due to limited resources.
- When $N = K$, population growth ceases ($\frac{dN}{dt} = 0$).

Final Answer:

Option (4)

Quick Tip

- **Exponential Growth Model:** $\frac{dN}{dt} = rN$ (Unlimited growth) - **Logistic Growth Model:** $\frac{dN}{dt} = rN\left[\frac{K-N}{K}\right]$ (Limited by resources) - **Carrying Capacity** (K): The upper limit on population size imposed by environmental constraints.

---

106. How many molecules of ATP and NADPH are required for every molecule of CO_2 fixed in the Calvin cycle?

(A) 3 molecules of ATP and 2 molecules of NADPH

(B) 2 molecules of ATP and 3 molecules of NADPH

(C) 2 molecules of ATP and 2 molecules of NADPH

(D) 3 molecules of ATP and 3 molecules of NADPH

Correct Answer: (1) **3 molecules of ATP and 2 molecules of NADPH**

Solution:

Step 1: Understanding the Calvin Cycle

- The Calvin cycle is the light-independent reaction of photosynthesis that fixes CO_2 into organic molecules.

- It occurs in three phases: Carbon fixation, Reduction, and Regeneration of RuBP.

Step 2: ATP and NADPH Requirements

- Each CO_2 molecule fixed in the Calvin cycle requires:

- 3 ATP molecules (used in Reduction and Regeneration phases).

- 2 NADPH molecules (used in the Reduction phase).

Final Answer:

Option (1): 3 ATP and 2 NADPH per CO_2 fixed

Quick Tip

- **Total Requirement for 1 Glucose molecule:** - 6 CO_2 molecules fixed - 18 ATP + 12 NADPH used - **Ratio per CO_2 fixed:** 3 ATP : 2 NADPH

---

107. Match List I with List II.

List I (Microorganism)	**List II (Product)**
A. *Clostridium butylicum*	I. Ethanol
B. *Saccharomyces cerevisiae*	II. Streptokinase
C. *Trichoderma polysporum*	III. Butyric acid
D. *Streptococcus sp.*	IV. Cyclosporin-A

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

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

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

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

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

Solution:

Step 1: Understanding the Microorganism and its Product

- *Clostridium butylicum* produces butyric acid (A-III).

- *Saccharomyces cerevisiae* is used in fermentation to produce ethanol (B-I).

- *Trichoderma polysporum* produces Cyclosporin-A, an immunosuppressant (C-IV).

- *Streptococcus sp.* is used in the production of Streptokinase, a clot-dissolving enzyme (D-II).

Final Answer:

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

Quick Tip

- Microbial products have vast applications in medicine and industry.
- Fermentation by *Saccharomyces cerevisiae* is widely used in alcohol production.
- Streptokinase is used as a clot buster in treating heart diseases.
- Cyclosporin-A is crucial for preventing organ rejection in transplants.

108. These are regarded as major causes of biodiversity loss:

A. Over exploitation

B. Co-extinction

C. Mutation

D. Habitat loss and fragmentation

E. Migration

Choose the correct option:

(A) A, B and D only

(B) A, C and D only

(C) A, B, C and D only

(D) A, B and E only

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

Solution:

Step 1: Understanding the Major Causes of Biodiversity Loss

The four major causes of biodiversity loss, also known as the ”Evil Quartet,” are:

1. “Habitat loss and fragmentation: Destruction of natural habitats leads to loss of species.

2. “Over-exploitation”: Excessive use of natural resources leads to depletion.

3. “Co-extinction”: When a species goes extinct, dependent species also go extinct.

4. “Invasive species and climate change” (not mentioned in the options).

- “Mutation” (C) is a natural process and does not directly cause biodiversity loss.

- “Migration” (E) is a response to environmental changes but not a direct cause of biodiversity loss.

Step 2: Conclusion

- The correct factors causing biodiversity loss are A (Over-exploitation), B (Co-extinction), and D (Habitat loss and fragmentation). - This corresponds to Option (1).

Quick Tip

- Biodiversity loss is primarily caused by habitat destruction, over-exploitation, and co-extinction. - Conservation efforts focus on protecting natural habitats and preventing species extinction.

---

109. Given below are two statements:

Statement I: Chromosomes become gradually visible under light microscope during leptotene stage.

Statement II: The beginning of diplotene stage is recognized by dissolution of synaptonemal complex.

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

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

(B) Both Statement I and Statement II are true

(C) Both Statement I and Statement II are false

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

Correct Answer: (2) **Both Statement I and Statement II are true**

Solution:

Step 1: Understanding the Leptotene and Diplotene Stages

1. “Leptotene Stage:”

- The first stage of prophase I of meiosis.

- Chromosomes start condensing and become gradually visible under the light microscope.

- Thus, Statement I is correct.

2. “Diplotene Stage:”

- The fourth stage of prophase I of meiosis.

- Characterized by the dissolution of the synaptonemal complex, leading to separation of homologous chromosomes except at chiasmata.

- “Thus, Statement II is also correct.”

Step 2: Conclusion

- Since both statements are correct, the correct answer is Option (2).

Quick Tip

- Leptotene: Chromosomes become visible as thin threads. - Zygotene: Synapsis (pairing) of homologous chromosomes occurs. - Pachytene: Crossing over takes place. - Diplotene: Dissolution of the synaptonemal complex occurs.

---

110. Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin

(A) can help in cell division in grasses, to produce growth.

(B) promotes apical dominance.

(C) promotes abscission of mature leaves only.

(D) does not affect mature monocotyledonous plants.

Correct Answer: (4) **does not affect mature monocotyledonous plants**

Solution:

Step 1: Understanding the Role of Auxins in Weed Control

1. Auxins are plant hormones used in selective herbicides to remove dicot weeds from monocot crop fields or lawns. 2. They affect dicot plants by promoting uncontrolled growth, leading to their death, while mature monocot plants remain unaffected.

Step 2: Evaluating the Given Options

- Option 1: Auxins primarily promote cell elongation rather than cell division.

- Option 2: Auxins do promote apical dominance, but this is not related to their role in weed control.

- Option 3: Auxins actually delay abscission rather than promoting it.

- Option 4: **Correct**. Auxins do not significantly affect mature monocots, making them an effective selective herbicide.

Step 3: Conclusion

- Since Option (4) correctly explains why auxins are used for weed control without harming grasses, it is the correct answer.

Quick Tip

- Auxins like 2,4-D (2,4-dichlorophenoxyacetic acid) are used as selective herbicides. - They effectively kill dicot weeds while leaving monocot grasses unharmed.

---

111. A pink flowered Snapdragon plant was crossed with a red flowered Snapdragon plant. What type of phenotype/s is/are expected in the progeny?

(A) Red, Pink as well as white flowered plants

(B) Only red flowered plants

(C) Red flowered as well as pink flowered plants

(D) Only pink flowered plants

Correct Answer: (3) Red flowered as well as pink flowered plants

Solution: Step 1: Understanding the genetics of Snapdragon flower color.

In Snapdragon (*Antirrhinum*), flower color follows the pattern of incomplete dominance:

- The red flower color (**RR**) is dominant.

- The white flower color (**rr**) is recessive.

- The heterozygous condition (**Rr**) produces pink flowers due to incomplete dominance.

Step 2: Setting up the cross.

The given cross is between a pink-flowered (**Rr**) and a red-flowered (**RR**) plant:

$$\text{Rr} \times \text{RR}$$

Step 3: Determining the offspring genotype and phenotype.

Using a Punnett square:

	R	R
R	RR	RR
r	Rr	Rr

The offspring distribution is:

- 50% **RR** (Red flowered)

- 50% **Rr** (Pink flowered)

Step 4: Conclusion. Thus, the progeny will consist of both red and pink-flowered plants, but no white-flowered plants. Hence, the correct answer is Option (3).

Quick Tip

In incomplete dominance, the heterozygous condition exhibits a blend of the dominant and recessive traits. This is different from codominance, where both traits appear distinctly.

---

112. Which of the following are required for the dark reaction of photosynthesis?

A. Light

B. Chlorophyll

C. CO_2

D. ATP

E. NADPH

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

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

Solution: Step 1: Understanding the dark reaction of photosynthesis

The dark reaction, also known as the **Calvin Cycle**, occurs in the stroma of chloroplasts. Unlike the light-dependent reaction, it does not require direct sunlight. Instead, it utilizes the products of the light-dependent reaction to synthesize glucose.

Step 2: Identifying the required components

1. **CO_2** (C) is required as a raw material for the Calvin cycle.
2. **ATP** (D) is produced in the light reaction and provides the energy required for carbon fixation.

3. **NADPH** (E) is also generated during the light reaction and provides reducing power for the conversion of 3-PGA into G3P.

Step 3: Eliminating unnecessary components

- Light (A) is necessary for the light reaction, but not for the Calvin Cycle.
- Chlorophyll (B) is a pigment essential for capturing light energy, but it is not directly involved in the dark reaction.

Step 4: Conclusion Since the Calvin Cycle requires **CO_2 (C), ATP (D), and NADPH (E)**, the correct answer is Option (4) - C, D, and E only.

Quick Tip

The dark reaction is also known as the **light-independent reaction** or the **Calvin-Benson Cycle**. It depends on ATP and NADPH produced in the light-dependent reaction to drive carbon fixation.

---

113. The lactose present in the growth medium of bacteria is transported to the cell by the action of

(A) Polymerase

(B) Beta-galactosidase

(C) Acetylase

(D) Permease

Correct Answer: (4) Permease

Solution:

Step 1: Understanding the role of lactose in bacterial cells

Lactose is a disaccharide composed of glucose and galactose. In bacteria, especially in *E. coli*, lactose metabolism is regulated by the **lac operon**, which controls the expression of enzymes responsible for lactose transport and breakdown.

Step 2: Identifying the function of the given enzymes

1. **Polymerase** (A) is responsible for synthesizing DNA or RNA but does not transport lactose.

2. **Beta-galactosidase** (B) is the enzyme that breaks down lactose into glucose and galactose but does not transport it into the cell.
3. **Acetylase** (C) is involved in biochemical modifications and is not directly related to lactose transport.
4. **Permease** (D) is the correct answer because it facilitates the transport of lactose across the bacterial cell membrane.

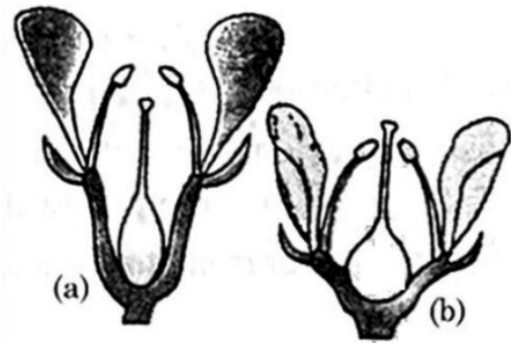
Step 3: Conclusion Since **Lactose permease** is the enzyme responsible for transporting lactose into the bacterial cell, the correct answer is Option (4) - Permease.

Quick Tip

The **lac operon** in *E. coli* consists of three key genes: - **lacZ** (codes for Beta-galactosidase) - **lacY** (codes for Permease) - **lacA** (codes for Transacetylase)

---

114. 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):



(A) (a) Perigynous; (b) Perigynous

(B) (a) Epigynous; (b) Hypogynous

(C) (a) Hypogynous; (b) Epigynous

(D) (a) Perigynous; (b) Epigynous

Correct Answer: (1) (a) Perigynous; (b) Perigynous

Solution: Step 1: Understanding flower types based on ovary position

- In **Perigynous flowers**, the ovary is **half-inferior**, meaning that the floral parts (calyx, corolla, and androecium) are arranged around the ovary at the same level due to the presence

of a floral cup or hypanthium.

- In **Epigynous flowers**, the ovary is **inferior**, meaning the floral parts are positioned above the ovary.

- In **Hypogynous flowers**, the ovary is **superior**, meaning the floral parts are attached below the ovary.

Step 2: Analyzing the given diagrams

- Figure (a) shows a **perigynous** flower where the floral parts are at the same level as the ovary. - Figure (b) also shows a **perigynous** flower.

Step 3: Conclusion Since both figures (a) and (b) exhibit the characteristics of **Perigynous flowers**, the correct answer is Option (1).

Quick Tip

- In **Hypogynous** flowers, the ovary is superior (e.g., Mustard, Brinjal).
- In **Perigynous** flowers, the ovary is half-inferior (e.g., Rose, Peach).
- In **Epigynous** flowers, the ovary is inferior (e.g., Guava, Cucumber).

---

115. 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

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

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

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

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

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

Solution: Step 1: Understanding the classifications of fungi

- ***Rhizopus***: A bread mould, so it matches with III.

- ***Ustilago***: A smut fungus, so it matches with II.

- ***Puccinia***: A rust fungus, so it matches with IV.

- ***Agaricus***: A mushroom, so it matches with I.

Step 2: Matching List I with List II

Thus, the correct matching is: - A $\rightarrow$ III - B $\rightarrow$ II - C $\rightarrow$ IV - D $\rightarrow$ I

Step 3: Conclusion The correct answer is **Option (2)**.

Quick Tip

- *Rhizopus* is commonly found in decomposing organic matter. - *Ustilago* is responsible for smut disease in crops. - *Puccinia* is a genus of rust fungi, affecting plants like wheat. - *Agaricus* includes species such as *Agaricus bisporus* (button mushroom).

---

116. 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:

(A) Sustainable development

(B) *in-situ* conservation

(C) Biodiversity conservation

(D) Semi-conservative method

Correct Answer: (3) Biodiversity conservation

Solution:

Step 1: Understanding Conservation Methods

There are two primary types of conservation: - ***In-situ* conservation**: Protecting species in their natural habitat (e.g., National Parks, Wildlife Sanctuaries). - ***Ex-situ* conservation**: Removing species from their natural habitat and placing them in special settings such as zoos, botanical gardens, and seed banks.

Step 2: Identifying the Correct Answer

The question refers to species being ”taken out from their natural habitat and placed in a special setting.” This aligns with **ex-situ conservation**, which is a part of **biodiversity**

conservation.

Thus, the correct answer is **Option (3)**.

Quick Tip

- *In-situ* conservation is preferred because it maintains ecosystems naturally. - *Ex-situ* conservation is essential for species that are critically endangered and require human intervention for survival. - Examples of *Ex-situ* conservation include captive breeding programs and seed banks.

---

117. Match List I with List II

	List-I		**List-II**
A	Nucleolus	I	Site of formation of glycolipid
B	Centriole	II	Organization like the cartwheel
C	Leucoplasts	III	Site for active ribosomal RNA synthesis
D	Golgi apparatus	IV	For storing nutrients

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the Function of Each Organelle

- **Nucleolus**: Produces ribosomal RNA (rRNA) and is essential for ribosome synthesis.

- **Centriole**: Plays a crucial role in cell division and forms a structure resembling a cartwheel.

- **Leucoplasts**: Colorless plastids responsible for the storage of nutrients such as starch, oils, and proteins.

- **Golgi Apparatus**: Involved in packaging, modifying, and sorting molecules such as

glycolipids and glycoproteins.

Step 2: Matching the Correct Pairs

- **Nucleolus → Site for active ribosomal RNA synthesis (III)**

- **Centriole → Organization like the cartwheel (II)**

- **Leucoplasts → For storing nutrients (IV)**

- **Golgi apparatus → Site of formation of glycolipid (I)**

Thus, the correct answer is **Option (2)**.

Quick Tip

- Nucleolus is known as the ”ribosome factory” of the cell. - Centrioles are absent in plant cells. - Leucoplasts are present in non-photosynthetic parts of plants like roots. - Golgi apparatus is involved in modifying proteins and lipids.

---

118. The capacity to generate a whole plant from any cell of the plant is called:

(A) Somatic hybridization

(B) Totipotency

(C) Micropropagation

(D) Differentiation

Correct Answer: (2) Totipotency

Solution:

Step 1: Understanding Totipotency

Totipotency is the ability of a single plant cell to divide and differentiate into an entire organism. This concept was first demonstrated by Gottlieb Haberlandt and is the basis of plant tissue culture.

Step 2: Explanation of Other Options

- **Somatic Hybridization**: This involves the fusion of protoplasts from different species or varieties to form a hybrid cell.

- **Micropropagation**: It refers to the technique of growing plants in vitro using tissue culture methods.

- **Differentiation**: This is the process where unspecialized cells become specialized in

structure and function.

Thus, the correct answer is **Option (2) Totipotency**.

Quick Tip

Totipotency is the fundamental principle behind plant tissue culture techniques, which are used for cloning and genetic modification of plants.

---

119. Formation of interfascicular cambium from fully developed parenchyma cells is an example for

(A) Maturation

(B) Differentiation

(C) Redifferentiation

(D) Dedifferentiation

Correct Answer: (4) Dedifferentiation

Solution:

Step 1: Understanding Dedifferentiation

Dedifferentiation is the process where mature, specialized cells regain their capacity to divide and become meristematic again. In plants, this process allows cells to resume mitotic activity and contribute to secondary growth.

Step 2: Explanation of Other Options

- **Maturation**: It refers to the final stage of cell development where cells achieve their functional specialization.

- **Differentiation**: It is the process where meristematic cells develop into specialized cells with distinct functions.

- **Redifferentiation**: This occurs when dedifferentiated cells again develop into specialized tissues after regaining their meristematic activity.

Thus, the correct answer is **Option (4) Dedifferentiation**.

Quick Tip

Dedifferentiation plays a crucial role in plant wound healing and secondary growth, as seen in the formation of interfascicular cambium.

120. Which one of the following can be explained on the basis of Mendel's Law of Dominance?

1. Out of one pair of factors one is dominant and the other is recessive.
2. Alleles do not show any expression and both the characters appear as such in F_2 generation.
3. Factors occur in pairs in normal diploid plants.
4. The discrete unit controlling a particular character is called factor.
5. The expression of only one of the parental characters is found in a monohybrid cross.

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

(B) A, B and C only

(C) A, C, D and E only

(D) B, C and D only

Correct Answer: (3) A, C, D and E only

Solution: Step 1: Understanding Mendel's Law of Dominance.

Mendel's Law of Dominance states that in a pair of contrasting traits, one trait (dominant) masks the expression of the other trait (recessive) in the F_1 generation.

Step 2: Explanation of the given statements:

- **(A) True:** Mendel's Law of Dominance states that one factor is dominant over the other.
- **(B) False:** This describes incomplete dominance, not Mendel's Law of Dominance.
- **(C) True:** Mendel proposed that factors (genes) exist in pairs in diploid organisms.
- **(D) True:** The discrete units of inheritance are now known as genes.
- **(E) True:** The dominant trait is expressed in the F_1 generation in monohybrid crosses.

Thus, the correct answer is **(3) A, C, D, and E only**.

Quick Tip

Mendel's Laws of Inheritance include: - **Law of Dominance**: One allele is dominant over the other. - **Law of Segregation**: Alleles segregate independently during gamete formation. - **Law of Independent Assortment**: Genes for different traits assort independently.

121. What is the fate of a piece of DNA carrying only 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.

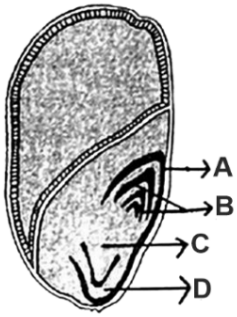
(A) A and E only
(B) A and B only
(C) D and E only
(D) B and C only
Correct Answer: (4) B and C only
Solution:
Step 1: Understanding the fate of foreign DNA in an alien organism
When a foreign piece of DNA carrying a gene of interest is introduced into an alien organism, it can have different fates:
Step 2: Explanation of the given statements:
- **(A) False:** A piece of DNA without an origin of replication cannot replicate independently unless incorporated into a plasmid.
- **(B) True:** If the foreign DNA gets integrated into the genome of the recipient, it will become a permanent part of the organism's DNA.
- **(C) True:** If the foreign DNA integrates with the host genome, it will multiply and be inherited by the next generations.
- **(D) False:** If the DNA integrates into the genome, it becomes part of the chromosome.
- **(E) False:** Only DNA with a suitable origin of replication can show the ability to replicate.
Thus, the correct answer is **(4) B and C only**.

Quick Tip

In genetic engineering, foreign DNA can either: - Integrate into the genome, ensuring stable inheritance. - Remain as an extrachromosomal element if it has an origin of replication.

---

122. Identify the part of the seed from the given figure which is destined to form root when the seed germinates.



(A) D

(B) A

(C) B

(D) C

Correct Answer: (4) C

Solution:

Step 1: Understanding Seed Structure

A seed consists of various parts, including the cotyledons, plumule, radicle, and seed coat. The radicle is the part of the embryo that gives rise to the root system during germination.

Step 2: Identifying the Correct Part

- The labeled part **C** in the given diagram corresponds to the radicle.

- The radicle is the first structure to emerge during germination, developing into the root system.

- Other parts such as the plumule (A or B) develop into the shoot, while the cotyledons provide nourishment.

Thus, the correct answer is **(4) C**.

Quick Tip

The **radicle** is the embryonic root and is the first part to emerge during seed germination, growing downward to anchor the plant.

---

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

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

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

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

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

Solution:

Step 1: Let's break down each item to match them correctly:

- **A. Two or more alternative forms of a gene:** These are called **alleles**, so A-III is correct.
- **B. Cross of F1 progeny with homozygous recessive parent:** This is a **test cross**, so B-IV is correct.
- **C. Cross of F1 progeny with any of the parents:** This is known as a **back cross**, so C-I is correct.
- **D. Number of chromosome sets in plant:** This refers to **ploidy**, so D-II is correct.

Thus, the correct match is A-III, B-IV, C-I, D-II, corresponding to option (4).

Quick Tip

In genetics, alleles are different forms of a gene, test crosses are used to determine genotype, back crosses involve crossing F1 progeny with parents, and ploidy refers to the number of chromosome sets.

---

124. Identify the set of correct statements:

1. The flowers of *Vallisneria* are colourful and produce nectar.
2. The flowers of water lily are not pollinated by water.
3. In most of water-pollinated species, the pollen grains are protected from wetting.
4. Pollen grains of some hydrophytes are long and ribbon-like.
5. In some hydrophytes, the pollen grains are carried passively inside water.

(A) B, C, D and E only
(B) C, D and E only
(C) A, B, C and D only
(D) A, C, D and E only
Correct Answer: (1) B, C, D and E only
Solution:
Step 1: Understanding the correctness of statements
- **Statement A: Incorrect.** The flowers of *Vallisneria* are **not** colourful and do **not** produce nectar. They rely on water pollination.
- **Statement B: Correct.** Water lily flowers are **not** pollinated by water; they are pollinated by insects.
- **Statement C: Correct.** In water-pollinated species, pollen grains have a **protective coating** to prevent wetting.
- **Statement D: Correct.** Some hydrophytes have **long and ribbon-like** pollen grains for easy dispersal in water.
- **Statement E: Correct.** In some hydrophytes, pollen grains are **passively** carried inside the water for pollination.

Step 2: Selecting the correct option Since statements B, C, D, and E are correct, the correct answer is option (1).

Quick Tip

- **Hydrophily** is pollination by water, occurring in some submerged plants. - *Vallisneria* follows epihydrophily (pollination on the water surface). - *Zostera* follows hypohydrophily (pollination underwater).

---

125. Inhibition of Succinic dehydrogenase enzyme by malonate is a classical example of:

(A) Enzyme activation

(B) Cofactor inhibition

(C) Feedback inhibition

(D) Competitive inhibition

Correct Answer: (4) Competitive inhibition

Solution:

Step 1: Understanding Competitive Inhibition

- Competitive inhibition occurs when a substance competes with the substrate for the active site of an enzyme. - Malonate is a structural analog of succinate, which is the substrate for the enzyme succinic dehydrogenase. - Malonate competes with succinate for the enzyme's active site but does not undergo further reaction, thus inhibiting enzyme activity.

Step 2: Explanation of Incorrect Options

- Option (1) Enzyme activation: Incorrect, because malonate does not activate the enzyme; instead, it inhibits it.

- Option (2) Cofactor inhibition: Incorrect, because malonate inhibits the enzyme by directly binding to the active site, not by interfering with a cofactor.

- Option (3) Feedback inhibition: Incorrect, as feedback inhibition involves the end product of a pathway inhibiting an earlier step in the same pathway.

Step 3: Conclusion

Since malonate competes with succinate for binding to succinic dehydrogenase but does not get metabolized, this is a classical example of competitive inhibition.

Quick Tip

- **Competitive inhibitors** resemble the substrate in structure and bind to the active site.
- Increasing substrate concentration can overcome competitive inhibition.
- Malonate is a well-known example of a competitive inhibitor of *Succinic dehydrogenase*.

---

126. List of endangered species was released by

(A) IUCN

(B) GEAC

(C) WWF

(D) FOAM

Correct Answer: (A) IUCN

Solution:

Step 1: Understanding IUCN and the Red List

- The **International Union for Conservation of Nature (IUCN)** is responsible for maintaining and publishing the **IUCN Red List of Threatened Species**.
- This list categorizes species based on their risk of extinction, such as Endangered (EN), Vulnerable (VU), Critically Endangered (CR), and Extinct (EX).

Step 2: Explanation of Incorrect Options

- **(B) GEAC (Genetic Engineering Appraisal Committee)**: Incorrect, as GEAC regulates genetic engineering and biotechnology-related research, not endangered species.
- **(C) WWF (World Wide Fund for Nature)**: Incorrect, though WWF is involved in conservation efforts, it does not officially release the Red List.
- **(D) FOAM (Federation of Organic Agriculture Movements)**: Incorrect, as FOAM focuses on organic farming, not biodiversity conservation.

Step 3: Conclusion

The IUCN Red List is the most authoritative source for the global conservation status of species. Hence, the correct answer is **(A) IUCN**.

Quick Tip

- The **IUCN Red List** helps track conservation status, trends, and necessary actions to protect species. - Categories include **Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW), and Extinct (EX)**.

---

127. 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:

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

(B) Both Statement I and Statement II are true

(C) Both Statement I and Statement II are false

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

Correct Answer: (D) Statement I is true but Statement II is false

Solution:

Step 1: Understanding Bt Toxins

Bacillus thuringiensis (Bt) produces a class of proteins called *cry* proteins, which act as insecticidal toxins. These toxins are highly specific to certain groups of insects, meaning different *cry* genes target different insect orders.

Step 2: Evaluating Statement I

Statement I is correct. The Bt toxin is encoded by *cry* genes, which are specific to particular insect groups. The gene *cry* IAc, for example, targets lepidopteran larvae.

Step 3: Evaluating Statement II

Statement II is incorrect. Bt toxin exists in an inactive protoxin form in *B. thuringiensis*, but upon ingestion by an insect, it gets converted into its active form due to the **alkaline** (not acidic) pH of the insect gut. The alkaline pH solubilizes the protoxin, which is then cleaved by proteases to form an active toxin.

Step 4: Conclusion

Since Statement I is true and Statement II is false, the correct answer is **(D)**.

Quick Tip

Bt toxin activation occurs in the **alkaline** midgut of insects, not acidic conditions. *Cry* genes are specific to different insect groups.

---

128. Lecithin, a small molecular weight organic compound found in living tissues, is an example of:

(A) Carbohydrates

(B) Amino acids

(C) Phospholipids

(D) Glycerides

Correct Answer: (C) Phospholipids

Solution:

Step 1: Understanding Lecithin

Lecithin is a naturally occurring lipid that plays a crucial role in biological membranes. It is primarily found in plant and animal tissues, where it functions as an emulsifier and stabilizer.

Step 2: Classification of Lecithin

Lecithin belongs to a class of lipids called **phospholipids**. These molecules consist of glycerol, fatty acids, a phosphate group, and an organic molecule such as choline. Phospholipids are vital components of cell membranes, contributing to membrane fluidity and cellular function.

Step 3: Evaluating the Given Options

- **(A) Carbohydrates**: Carbohydrates include sugars, starches, and fibers, which provide energy but do not form cellular membranes.
- **(B) Amino acids**: Amino acids are the building blocks of proteins, not lipids.
- **(C) Phospholipids**: Lecithin is classified as a phospholipid, making this the correct answer.
- **(D) Glycerides**: Glycerides (such as triglycerides) are simple lipids, whereas phospholipids contain a phosphate group, differentiating them from glycerides.

Step 4: Conclusion

Since lecithin is a phospholipid, the correct answer is **(C)**.

Quick Tip

Phospholipids, such as lecithin, are key components of biological membranes, forming the lipid bilayer and regulating membrane permeability.

---

129. Which of the following is an example of actinomorphic flower?

(A) *Sesbania*

(B) *Datura*

(C) *Cassia*

(D) *Pisum*

Correct Answer: (B) *Datura*

Solution:

Step 1: Understanding Floral Symmetry

Flowers can be classified based on their symmetry into two types: - **Actinomorphic flowers** (radial symmetry): These flowers can be divided into equal halves along multiple planes passing through the center. - **Zygomorphic flowers** (bilateral symmetry): These flowers can be divided into equal halves only along a single plane.

Step 2: Evaluating the Given Options

- **(A)** ***Sesbania***: This is a zygomorphic flower.

- **(B)** ***Datura***: This is an actinomorphic flower, meaning it exhibits radial symmetry.

- **(C)** ***Cassia***: Although some species of *Cassia* show slight actinomorphic tendencies, they are predominantly zygomorphic.

- **(D)** ***Pisum***: *Pisum* (pea) flowers are zygomorphic.

Step 3: Conclusion

Since *Datura* is an example of an actinomorphic flower, the correct answer is **(B)**.

Quick Tip

Actinomorphic flowers have radial symmetry, meaning they can be divided into two equal halves along multiple planes (e.g., *Datura* and *Hibiscus*).

---

130. 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.

(A) A, B and D only

(B) A, C, D and E only

(C) A and B only

(D) A, B and E only

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

Solution:

Step 1: Understanding Species Richness in Tropical Regions

- Tropical regions support high species richness due to **stable climates, high solar energy availability, and evolutionary time**.

- **Tropical latitudes** have remained undisturbed for millions of years, allowing longer time for species diversification (Statement A).

- **More solar energy** in tropical regions increases primary productivity, supporting diverse ecosystems (Statement C).

- **Constant environments promote niche specialization**, leading to diverse adaptations and interactions among species (Statement D).

- **Predictable and stable tropical environments** reduce extinction rates, allowing species to thrive (Statement E).

Step 2: Explanation of Incorrect Statement

- Statement B (Tropical environments are more seasonal) is incorrect since tropical

environments are relatively stable throughout the year compared to temperate and polar regions.

Step 3: Conclusion

The correct answer is **A, C, D, and E**, as they all contribute to species richness in tropical regions.

Quick Tip

- **Species richness** in tropical regions is driven by long evolutionary time, high productivity, niche specialization, and stable environments. - Understanding tropical biodiversity helps in conservation and management efforts.

---

131. Hind II always cuts DNA molecules at a particular point called recognition sequence and it consists of:

(A) 10 bp

(B) 8 bp

(C) 6 bp

(D) 4 bp

Correct Answer: (C) 6 bp

Solution:

Step 1: Understanding Restriction Enzymes

- **Hind II** is a type of **restriction endonuclease** that recognizes and cuts DNA at a specific sequence. - The **recognition sequence** for Hind II consists of six base pairs (6 bp).

Step 2: Explanation of Recognition Sequence

- Hind II was the first restriction enzyme to be discovered that cuts DNA at a specific nucleotide sequence. - Its recognition site is typically a **palindromic sequence** of 6 base pairs. - This specificity allows for consistent and reproducible DNA fragment patterns.

Conclusion:

- Since Hind II recognizes and cuts DNA at a 6 bp long sequence, the correct answer is (C) 6 bp.

Quick Tip

- Restriction enzymes like Hind II are widely used in genetic engineering and molecular cloning. - Their ability to cut DNA at specific sites is essential for recombinant DNA technology.

---

132. Bulliform cells are responsible for

(A) Providing large spaces for storage of sugars.

(B) Inward curling of leaves in monocots.

(C) Protecting the plant from salt stress.

(D) Increased photosynthesis in monocots.

Correct Answer: (B) Inward curling of leaves in monocots.

Solution:

Step 1: Understanding Bulliform Cells

- Bulliform cells are specialized, large, thin-walled epidermal cells found in the leaves of monocots, particularly grasses. - They are generally located on the upper surface of leaves, arranged in groups along the veins.

Step 2: Function of Bulliform Cells

- These cells play a crucial role in **leaf folding and unfolding**, which helps plants conserve water during dry conditions. - During water stress, bulliform cells lose turgor pressure, causing the leaves to curl inward, reducing the exposed surface area and minimizing water loss.

Conclusion:

- Since bulliform cells are responsible for the inward curling of leaves in monocots, the correct answer is (B) Inward curling of leaves in monocots.

Quick Tip

- Bulliform cells help in drought resistance by reducing transpiration. - Their function is especially important in xerophytic monocots like grasses.

---

133. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and downstream end:

(A) Promoter, Structural gene, Terminator

(B) Repressor, Operator gene, Structural gene

(C) Structural gene, Transposons, Operator gene

(D) Inducer, Repressor, Structural gene

Correct Answer: (A) Promoter, Structural gene, Terminator

Solution:

Step 1: Understanding the Transcription Unit

A transcription unit in DNA consists of three key components:

1. **Promoter:** - Located at the upstream end. - Serves as the binding site for RNA polymerase. - Initiates transcription.

2. **Structural Gene:** - Contains the coding sequence. - This sequence is transcribed into mRNA. - Carries the genetic information required for protein synthesis.

3. **Terminator:** - Located at the downstream end. - Signals the RNA polymerase to stop transcription. - Ensures the transcription process ends correctly.

Step 2: Explanation of Incorrect Options

- **(B)** Repressor and Operator gene are parts of the operon model, not the basic transcription unit.

- **(C)** Transposons are mobile genetic elements and are not part of the transcription unit.

- **(D)** Inducer and Repressor regulate gene expression but do not define a transcription unit.

Conclusion:

- Since a transcription unit consists of a Promoter, Structural Gene, and Terminator, the correct answer is (A) Promoter, Structural gene, Terminator.

Quick Tip

- The promoter is essential for initiating transcription. - The structural gene contains the actual genetic code for protein synthesis. - The terminator ensures proper termination of transcription.

134. Which one of the following is not a criterion for classification of fungi?

(A) Fruiting body

(B) Morphology of mycelium

(C) Mode of nutrition

(D) Mode of spore formation

Correct Answer: (C) Mode of nutrition

Solution:

Step 1: Understanding the Classification Basis for Fungi

Fungi are classified based on several features, including:

- **Morphology of mycelium** – Structure and arrangement of fungal hyphae.

- **Mode of spore formation** – Asexual or sexual reproductive strategies.

- **Fruiting body** – The reproductive structure where spores are produced.

Step 2: Evaluating the Given Options

- **(A) Fruiting body**: Important for classification, as fungi are categorized by reproductive structures like basidiocarps or ascocarps.

- **(B) Morphology of mycelium**: Plays a role in identifying fungi based on septate or coenocytic mycelium.

- **(D) Mode of spore formation**: Crucial for differentiating fungal groups based on reproductive mechanisms.

Step 3: Why Option (C) is Correct?

- **Mode of nutrition** is not a primary classification criterion, as all fungi are heterotrophic. - While some fungi are saprophytic, parasitic, or symbiotic, these distinctions do not form the basis of fungal classification.

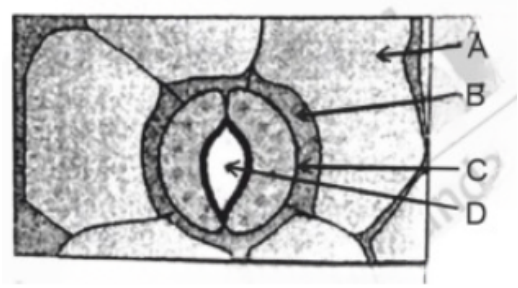
Conclusion:

Since fungal classification is determined by mycelium structure, fruiting body, and spore formation rather than nutritional mode, the correct answer is (C) Mode of nutrition.

Quick Tip

- Fungal taxonomy is based on reproductive and structural characteristics, not on how they obtain nutrients. - Most fungi are decomposers, but their mode of nutrition does not affect classification.

135. In the given figure, which component has thin outer walls and highly thickened inner walls?



(A) B

(B) C

(C) D

(D) A

Correct Answer: (B) C

Solution:

Step 1: Identifying the Function of Guard Cells

Guard cells are specialized epidermal cells that regulate stomatal opening and closing in plants. Their unique structure includes **thin outer walls and thickened inner walls**, which play a crucial role in their function.

Step 2: Analyzing the Given Options

- **(A)** Likely represents an epidermal cell adjacent to the stomata.
- **(B)** Corresponds to the guard cell, known for its characteristic wall differentiation.
- **(C)** Could be a part of the stomatal pore itself.
- **(D)** Appears to be a supporting cell that does not fit the given description.

Step 3: Understanding the Structural Adaptation of Guard Cells

- The thick inner walls allow control over stomatal opening by resisting expansion.
- The thin outer walls enable flexibility, allowing movement when turgor pressure changes.

Conclusion:

Since guard cells (Component C) exhibit thin outer walls and thickened inner walls, the correct answer is (B) C.

Quick Tip

- Guard cells control stomatal function by responding to turgor pressure. - Their structural adaptations allow efficient gas exchange and transpiration control.

SECTION-B

136. Match List I with List II

List I (Types of Stamens)	**List II** (Example)
A. Monadelphous	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-III, B-I, C-IV, D-II

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

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

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

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

Solution:

Step 1: Identifying the Correct Pairings

- Monadelphous stamens are fused into a single bundle. Example: China-rose (Hibiscus).

- Diadelphous stamens are arranged in two groups. Example: Pea (Pisum sativum).

- Polyadelphous stamens are arranged into multiple bundles. Example: Citrus.

- Epiphyllous stamens are attached to the petals. Example: Lily.

Step 2: Matching the Pairs Correctly

- A (Monadelphous) $\rightarrow$ IV (China-rose)

- B (Diadelphous) $\rightarrow$ II (Pea)

- C (Polyadelphous) → I (Citrus)

- D (Epiphyllous) → III (Lily)

Thus, the correct matching is A-IV, B-II, C-I, D-III, which corresponds to Option (2).

Quick Tip

- Monadelphous: Stamens are fused into a single bundle (e.g., China-rose).
- Diadelphous: Stamens form two groups, commonly found in legumes (e.g., Pea).
- Polyadelphous: Stamens arranged in multiple bundles (e.g., Citrus).
- Epiphyllous: Stamens are attached to petals (e.g., Lily).

---

137. The DNA present in chloroplast is:

(1) Circular, single stranded

(2) Linear, double stranded

(3) Circular, double stranded

(4) Linear, single stranded

Correct Answer: (3) Circular, double stranded

Solution:

Step 1: Understanding Chloroplast DNA

Chloroplasts are semi-autonomous organelles in plant cells and some protists. They contain their own genetic material, which shares characteristics with prokaryotic DNA.

Step 2: Features of Chloroplast DNA

- Chloroplast DNA closely resembles bacterial DNA, supporting the endosymbiotic theory.
- It is circular rather than linear.
- It is double-stranded, following Watson-Crick base pairing.
- Unlike nuclear DNA, chloroplast DNA replicates independently.

Step 3: Evaluating the Options

- Option (1): Incorrect, as chloroplast DNA is not single-stranded.
- Option (2): Incorrect, because it is circular, not linear.
- Option (3): Correct, as chloroplast DNA is both circular and double-stranded.
- Option (4): Incorrect, as chloroplast DNA is neither linear nor single-stranded.

Thus, the correct answer is Option (3): Circular, double-stranded.

Quick Tip

- Chloroplast DNA is circular and double-stranded, similar to bacterial DNA.
- It replicates independently of nuclear DNA.
- This supports the endosymbiotic theory, which suggests that chloroplasts evolved from ancient cyanobacteria.

---

138. Read the following statements and choose the set of correct statements:

In the members of Phaeophyceae,

(A) Asexual reproduction occurs usually by biflagellate zoospores.

(B) Sexual reproduction is by oogamous method only.

(C) Stored food is in the form of carbohydrates which is either mannitol or laminarin.

(D) The major pigments found are chlorophyll a, c and carotenoids and xanthophyll.

(E) Vegetative cells have a cellulosic wall, usually covered on the outside by a gelatinous coating of algin.

Choose the correct answer from the options given below:

(1) A, B, C and E only

(2) A, B, C and D only

(3) B, C, D and E only

(4) A, C, D and E only

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

Solution:

Step 1: Understanding Phaeophyceae (Brown Algae)

Phaeophyceae, commonly known as brown algae, have specific characteristics:

- They store food in the form of mannitol and laminarin.
- Their major pigments include chlorophyll a, c, carotenoids, and xanthophylls.
- Their cell walls contain cellulose and are externally coated with gelatinous algin.

Step 2: Verification of Statements

- Statement (A): Correct. Brown algae reproduce asexually through biflagellate zoospores.

- Statement (B): Incorrect. Sexual reproduction in brown algae occurs through isogamy, anisogamy, or oogamy, not only oogamy.
- Statement (C): Correct. Brown algae store food in mannitol and laminarin.
- Statement (D): Correct. Their major pigments include chlorophyll a, c, carotenoids, and xanthophylls.
- Statement (E): Correct. Their cell walls contain cellulose, with an external gelatinous algin coating.

Step 3: Eliminating Incorrect Options

- Option (1): Incorrect, as statement (B) is incorrect.
- Option (2): Incorrect, as statement (B) is included.
- Option (3): Incorrect, as statement (B) is included.
- Option (4): Correct, as it includes only the correct statements (A, C, D, and E).

Thus, the correct answer is Option (4): A, C, D, and E only.

Quick Tip

- Brown algae store food as mannitol and laminarin.
- They contain chlorophyll a, c, carotenoids, and xanthophylls.
- Their cell walls have cellulose with an algin coating for protection.

---

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

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

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

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

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

Solution:

Step 1: Understanding the Processes and Their Locations

- Citric acid cycle (Krebs cycle) occurs in the mitochondrial matrix $\rightarrow$ A-II.

- Glycolysis occurs in the cytoplasm $\rightarrow$ B-I.

- Electron transport system (ETS) takes place in the intermembrane space of mitochondria $\rightarrow$ C-III.

- Proton gradient is established in the inner mitochondrial membrane $\rightarrow$ D-IV.

Thus, the correct match is A-II, B-I, C-III, D-IV, which corresponds to Option (2).

Quick Tip

- Glycolysis occurs in the cytoplasm.
- Citric acid cycle occurs in the mitochondrial matrix.
- Electron transport system occurs in the inner mitochondrial membrane.
- Proton gradient forms in the intermembrane space of mitochondria.

---

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 photorespiration while bundle sheath cells do not show photorespiration.

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

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

(2) Both Statement I and Statement II are true

(3) Both Statement I and Statement II are false

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

Correct Answer: (4) Statement I is true but Statement II is false

Solution:

Step 1: Evaluating Statement I

- In C_3 plants, RuBisCO can bind to O_2 instead of CO_2, leading to photorespiration, which reduces carbon fixation efficiency.

- Thus, Statement I is true.

Step 2: Evaluating Statement II

- In C_4 plants, mesophyll cells do not have RuBisCO, preventing photorespiration.

- However, bundle sheath cells do contain RuBisCO, and under certain conditions, some level of photorespiration can occur.

- Since Statement II incorrectly states that bundle sheath cells do not show photorespiration at all, it is false.

Step 3: Conclusion

- Statement I is true, Statement II is false.

- Thus, the correct answer is Option (4).

Quick Tip

- C_3 plants undergo photorespiration due to RuBisCO's affinity for oxygen.

- C_4 plants have Kranz anatomy, where mesophyll cells lack RuBisCO, reducing photorespiration.

- However, some photorespiration can still occur in bundle sheath cells.

---

141. Which of the following statement is correct regarding the process of replication in *E. coli*?

(1) The DNA dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' direction

(2) The DNA dependent DNA polymerase catalyses polymerization in one direction that is 3' $\rightarrow$ 5'

(3) The DNA dependent RNA polymerase catalyses polymerization in one direction, that is 5' $\rightarrow$ 3'

(4) The DNA dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' as well as 3' $\rightarrow$ 5' direction

Correct Answer: (1) The DNA dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' direction

Solution:

Step 1: Understanding DNA Replication in *E. coli*

DNA replication in *E. coli* is a semi-conservative process, where each parental strand acts as a template for new strand synthesis. This process is catalyzed by DNA-dependent DNA polymerase.

Step 2: Direction of Polymerization

DNA polymerase extends the growing DNA strand only in the 5' $\rightarrow$ 3' direction by adding nucleotides to the 3'-OH group. It cannot synthesize DNA in the 3' $\rightarrow$ 5' direction.

Step 3: Evaluating the Given Options

- Option (1): Correct, as DNA polymerase catalyzes polymerization exclusively in the 5' $\rightarrow$ 3' direction.

- Option (2): Incorrect, as DNA polymerase cannot synthesize in the 3' $\rightarrow$ 5' direction.

- Option (3): Incorrect, as DNA-dependent RNA polymerase is responsible for transcription, not replication.

- Option (4): Incorrect, as DNA polymerase does not catalyze polymerization in both directions.

Thus, the correct answer is Option (1).

Quick Tip

DNA polymerase extends DNA in the 5' $\rightarrow$ 3' direction. The lagging strand forms Okazaki fragments, which are later joined by DNA ligase.

---

142. Match List I with List II.

Choose the correct answer from the options given below:

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

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

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

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

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

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

Solution:

Step 1: Understanding the Contributions of Scientists

- Robert May: Estimated global species diversity to be around 7 million → (III).

- Alexander von Humboldt: Proposed the Species-Area relationship, demonstrating how species richness increases with area → (I).

- Paul Ehrlich: Proposed the Rivet popper hypothesis, which compares species extinction to rivets popping off an airplane → (IV).

- David Tilman: Conducted long-term ecosystem experiments on biodiversity and ecosystem stability → (II).

Step 2: Conclusion

- The correct matching is A-III, B-I, C-IV, D-II, which corresponds to Option (3).

Quick Tip

- The Species-Area relationship shows that species richness increases with habitat area.
- The Rivet Popper Hypothesis explains how species extinction affects ecosystem stability.
- Long-term experiments study biodiversity's role in ecosystem functions.

---

143. Match List I with List II.

Choose the correct answer from the options given below:

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

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

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

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

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

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

Solution:

Step 1: Understanding the Contributions of Scientists

- Frederick Griffith: Discovered the phenomenon of Transformation in bacteria $\rightarrow$ (III).

- Francois Jacob & Jacque Monod: Proposed the Lac operon model for gene regulation $\rightarrow$ (IV).

- Har Gobind Khorana: Helped decipher the Genetic code $\rightarrow$ (I).

- Meselson & Stahl: Provided experimental proof for the Semi-conservative mode of DNA replication $\rightarrow$ (II).

Step 2: Conclusion

- The correct matching is A-III, B-IV, C-I, D-II, which corresponds to Option (3).

Quick Tip

- Transformation is the uptake of genetic material by bacteria.

- The Lac operon regulates lactose metabolism in E. coli.

- Genetic code consists of codons that specify amino acids.

- Semi-conservative replication means each new DNA molecule contains one original and one new strand.

144. In an ecosystem, if the Net Primary Productivity (NPP) of the 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) $\frac{100x}{3}$ kcal $m^{-2}yr^{-1}$

(2) $\frac{x}{10}$ kcal $m^{-2}yr^{-1}$

(3) x kcal $m^{-2}yr^{-1}$

(4) $10x$ kcal $m^{-2}yr^{-1}$

Correct Answer: (4) $10x$ kcal $m^{-2}yr^{-1}$

Solution:

Step 1: Understanding Energy Transfer in an Ecosystem

- Energy transfer follows the 10% Rule, meaning only 10% of energy is passed to the next trophic level, while 90% is lost as heat and metabolic processes.

Step 2: Calculating Energy for the Third Trophic Level

- The NPP of the first trophic level (producers) is $100x$. - Primary consumers (second trophic level) receive 10% of this energy:

$$\frac{10}{100} \times 100x = 10x$$

- Secondary consumers (third trophic level) receive 10% of primary consumer energy:

$$\frac{10}{100} \times 10x = x$$

Step 3: Calculating GPP for the Third Trophic Level

- Since Gross Primary Productivity (GPP) includes respiration, the estimated GPP for the third trophic level is:

$$10x$$

Step 4: Conclusion

- The correct answer is Option (4): $10x$ kcal m^{-2} yr^{-1}.

Quick Tip

- 10% Rule: Only 10% of energy moves up the trophic levels. - GPP vs. NPP: NPP = GPP – Respiration. - Energy decreases as we move up trophic levels.

145. Match List I with List II.

List I	List II
A. Rose	I. Twisted aestivation
B. Pea	II. Perigynous flower
C. Cotton	III. Drupe
D. Mango	IV. Marginal placentation

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding Floral Characteristics

Different plants exhibit distinct floral features such as placentation, aestivation, and fruit types.

Step 2: Matching List I with List II

- A. Rose $\rightarrow$ II. Perigynous flower: The ovary is partially embedded, with floral parts arising from the receptacle rim.
- B. Pea $\rightarrow$ IV. Marginal placentation: Ovules are arranged along a single ridge in the ovary.
- C. Cotton $\rightarrow$ I. Twisted aestivation: One petal overlaps the next, forming a spiral pattern.
- D. Mango $\rightarrow$ III. Drupe: A fleshy fruit with a hard endocarp.

Step 3: Conclusion

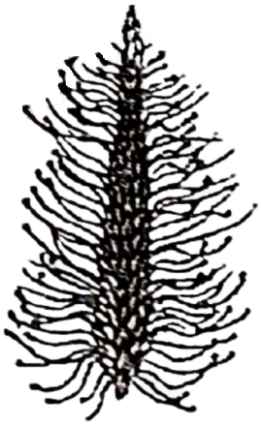
- The correct match is A-II, B-IV, C-I, D-III, which corresponds to Option (2).

Quick Tip

- Perigynous flowers have a semi-inferior ovary (e.g., Rose).
- Marginal placentation occurs in Pea, where ovules are aligned along one side.
- Twisted aestivation involves overlapping petals (e.g., Cotton).
- Drupes have a fleshy mesocarp and a hard endocarp (e.g., Mango).

---

146. Identify the correct description about the given figure:



(1) Compact inflorescence showing complete autogamy

(2) Wind pollinated plant inflorescence showing flowers with well-exposed stamens.

(3) Water pollinated flowers showing stamens with mucilaginous covering.

(4) Cleistogamous flowers showing autogamy.

Correct Answer: (2) Wind pollinated plant inflorescence showing flowers with well-exposed stamens.

Solution:

Step 1: Understanding Pollination Mechanisms

Pollination is the transfer of pollen from anther to stigma, facilitated by wind, water, or self-pollination.

Step 2: Evaluating the Given Figure

- The figure represents an inflorescence typical of wind pollinated plants (anemophily).
- Wind-pollinated plants exhibit:
- Large inflorescences with numerous flowers.
- Well-exposed stamens for effective pollen release.

- Feathery stigmas to trap airborne pollen.

- Lightweight pollen grains carried by wind.

Step 3: Evaluating the Given Options

- Option (1): Incorrect. Compact inflorescences are associated with self-pollination, not wind pollination.

- Option (2): Correct. The exposed stamens indicate wind pollination.

- Option (3): Incorrect. Water-pollinated plants usually have mucilaginous pollen grains, which is not the case here.

- Option (4): Incorrect. Cleistogamous flowers remain closed and undergo self-pollination, unlike the open structure in the image.

Step 4: Conclusion

- Since the image represents a wind-pollinated inflorescence, the correct answer is Option (2).

Quick Tip

- Wind-pollinated plants have feathery stigmas, lightweight pollen, and exposed stamens for efficient dispersal (e.g., grasses like maize).

---

147. Identify the step in the tricarboxylic acid cycle, which does not involve oxidation of substrate.

(1) Isocitrate $\rightarrow$ α-ketoglutaric acid

(2) Malic acid $\rightarrow$ Oxaloacetic acid

(3) Succinic acid $\rightarrow$ Malic acid

(4) Succinyl-CoA $\rightarrow$ Succinic acid

Correct Answer: (4) Succinyl-CoA $\rightarrow$ Succinic acid

Solution:

Step 1: Understanding Oxidation in the TCA Cycle

The tricarboxylic acid (TCA) cycle, also known as the Krebs cycle, involves multiple oxidation steps where electrons are transferred to NAD^+ or FAD, leading to ATP generation. However, not all reactions in the cycle involve oxidation.

Step 2: Evaluating the Given Options

- Option (1): Isocitrate $\rightarrow$ α-ketoglutaric acid - Incorrect. This step is catalyzed by isocitrate dehydrogenase and involves the oxidation of isocitrate, producing NADH.

- Option (2): Malic acid $\rightarrow$ Oxaloacetic acid - Incorrect. This reaction is catalyzed by malate dehydrogenase and involves oxidation, generating NADH.

- Option (3): Succinic acid $\rightarrow$ Malic acid - Incorrect. This step is catalyzed by fumarase but follows an oxidation step from succinate to fumarate.

- Option (4): Succinyl-CoA $\rightarrow$ Succinic acid - Correct. This step is catalyzed by succinyl-CoA synthetase and involves substrate-level phosphorylation, not oxidation.

Conclusion :

The conversion of Succinyl-CoA to Succinic acid does not involve oxidation but rather the generation of GTP/ATP via substrate-level phosphorylation. Thus, the correct answer is option (4).

Quick Tip

The only substrate-level phosphorylation step in the TCA cycle occurs during the conversion of Succinyl-CoA to Succinic acid.

---

148. Spraying sugarcane crop with which of the following plant growth regulators increases the length of the stem, thus, increasing the yield?

(1) Abscisic acid

(2) Auxin

(3) Gibberellin

(4) Cytokinin

Correct Answer: (3) Gibberellin

Solution:

Step 1: Understanding Plant Growth Regulators

Plant growth regulators (PGRs) are chemical substances that influence various physiological processes in plants, including stem elongation, cell division, and stress responses.

Step 2: Role of Gibberellins in Stem Elongation

Gibberellins (GA) are a group of plant hormones that play a crucial role in promoting stem elongation by stimulating cell division and elongation. In crops like sugarcane, gibberellins help increase the internodal length, leading to taller plants and higher yield.

Step 3: Evaluating the Given Options

- Option (1): Abscisic acid - Incorrect. Abscisic acid (ABA) is a growth-inhibiting hormone that promotes dormancy and stress responses rather than stem elongation.
- Option (2): Auxin - Incorrect. Auxins primarily regulate root development, apical dominance, and cell elongation but are not as effective as gibberellins in promoting stem elongation.
- Option (3): Gibberellin - Correct. Gibberellins significantly increase the internodal length in sugarcane, thereby enhancing yield.
- Option (4): Cytokinin - Incorrect. Cytokinins promote cell division and delay senescence but do not contribute to stem elongation significantly.

Step 4: Conclusion

Since gibberellins are responsible for increasing stem length and boosting yield in sugarcane crops, the correct answer is option (3).

Quick Tip

Gibberellins are widely used in agriculture to promote stem elongation in sugarcane, grapes, and other crops, leading to increased yield.

---

149. Match List-I with List-II

List-I	List-II
A. GLUT-4	I. Hormone
B. Insulin	II. Enzyme
C. Trypsin	III. ntercellular ground substance
D. Collagen	IV. Enables glucose transport into cells

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

Solution:

Step 1: Understanding the Biological Roles of Each Component

Each component in List-I plays a distinct role in human physiology, related to hormone function, enzymatic activity, or structural roles.

Step 2: Matching List-I with List-II

- A. GLUT-4 $\rightarrow$ IV. Enables glucose transport into cells - GLUT-4 (Glucose Transporter-4) is responsible for glucose uptake into muscle and adipose tissues, facilitated by insulin.

- B. Insulin $\rightarrow$ I. Hormone - Insulin is a peptide hormone secreted by the pancreas, regulating blood glucose levels.

- C. Trypsin $\rightarrow$ II. Enzyme - Trypsin is a digestive enzyme that breaks down proteins in the small intestine.

- D. Collagen $\rightarrow$ III. Intercellular ground substance - Collagen is a structural protein found in connective tissues, acting as an intercellular matrix component.

Step 3: Conclusion

Since the correct match is A-IV, B-I, C-II, D-III, the correct answer is option (2).

Quick Tip

- GLUT-4 facilitates glucose transport into cells. - Insulin is a peptide hormone regulating blood sugar. - Trypsin is a proteolytic enzyme aiding digestion. - Collagen is a structural protein providing strength to tissues.

---

150. Which of the following are fused in somatic hybridization involving two varieties of plants?

(1) Pollens

(2) Callus

(3) Somatic embryos

(4) Protoplasts

Correct Answer: (4) Protoplasts

Solution:

Step 1: Understanding Somatic Hybridization

Somatic hybridization is a technique used in plant biotechnology to produce hybrid plants by fusing protoplasts from two different plant varieties. This method enables the combination of desirable traits from different species or varieties without involving sexual reproduction.

Step 2: Evaluating the Given Options

- Option (1): Pollens - Incorrect. Pollens are involved in sexual reproduction and fertilization, not in somatic hybridization.
- Option (2): Callus - Incorrect. Callus is a mass of undifferentiated plant cells that can be used in tissue culture but is not directly involved in protoplast fusion.
- Option (3): Somatic embryos - Incorrect. Somatic embryos are formed during tissue culture and are used for plant regeneration but are not fused in hybridization.
- Option (4): Protoplasts - Correct. Protoplasts (cells without cell walls) from two different plant varieties are fused using techniques like polyethylene glycol (PEG)-induced fusion or electrofusion to produce somatic hybrids.

Step 3: Conclusion

Since protoplast fusion is the key mechanism in somatic hybridization, the correct answer is option (4).

Quick Tip

Protoplast fusion allows for genetic recombination in plants without sexual reproduction, useful for creating hybrids with desirable traits.

ZOOLOGY

SECTION-A

151. The flippers of the Penguins and Dolphins are an example of the:

(1) Divergent evolution

(2) Adaptive radiation

(3) Natural selection

(4) Convergent evolution

Correct Answer: (4) Convergent evolution

Solution:

Step 1: Understanding Evolutionary Patterns

Evolution occurs in different patterns, including convergent evolution, divergent evolution, and adaptive radiation, which explain similarities and differences among organisms.

Step 2: Explanation of Convergent Evolution

- Convergent evolution occurs when unrelated species develop similar traits due to adaptation to similar environments, rather than shared ancestry. - This results in analogous structures, which perform the same function but have different evolutionary origins.

Step 3: Evaluating the Given Options

- Option (1) Divergent evolution – Incorrect. Divergent evolution leads to species developing different traits from a common ancestor, forming homologous structures.

- Option (2) Adaptive radiation – Incorrect. Adaptive radiation refers to the evolution of multiple species from a single ancestor, adapting to different environments.

- Option (3) Natural selection – Incorrect. Natural selection is the mechanism driving evolution but does not specifically refer to the formation of analogous structures.

- Option (4) Convergent evolution – Correct. The flippers of Penguins (birds) and Dolphins (mammals) evolved independently to serve the same function (swimming), making them an example of convergent evolution.

Step 4: Conclusion

Since Penguins and Dolphins are not closely related but developed similar flippers due to adaptation to aquatic life, the correct answer is option (4).

Quick Tip

Convergent evolution results in analogous structures, where organisms from different lineages develop similar adaptations due to similar environmental pressures.

---

152. Match List I with List II and choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the correct matches

- Pleurobrachia belongs to Ctenophora, a phylum of marine invertebrates $\rightarrow$ A-II.

- Radula is a specialized feeding organ found in Mollusca $\rightarrow$ B-I.

- Stomochord is a structure present in Hemichordata, aiding in support and function $\rightarrow$ C-IV.

- Air bladder is present in Osteichthyes (bony fishes) and helps in buoyancy $\rightarrow$ D-III.

Step 2: Verifying the answer

Thus, the correct matching is:

$$A - II, \quad B - I, \quad C - IV, \quad D - III.$$

This matches option (3).

Quick Tip

Understanding Animal Classification:

- Pleurobrachia: Belongs to Ctenophora (marine invertebrates).
- Radula: A feeding structure found in Mollusca.
- Stomochord: A structure present in Hemichordata.
- Air bladder: Found in Osteichthyes, helps in buoyancy.

---

153. Which of the following is not a component of the Fallopian tube?

(1) Ampulla

(2) Uterine fundus

(3) Isthmus

(4) Infundibulum

Correct Answer: (2) Uterine fundus

Solution:

Step 1: Understanding the Fallopian Tube Structure

The Fallopian tube (also called the uterine tube or oviduct) is a paired tubular structure in female reproductive anatomy that connects the ovary to the uterus. It plays a crucial role in egg transport and fertilization.

Step 2: Components of the Fallopian Tube

The Fallopian tube consists of four parts: - Infundibulum: A funnel-shaped structure near the ovary with fimbriae that help capture the ovulated egg.

- Ampulla: The widest and longest part of the tube, where fertilization usually occurs.
- Isthmus: A narrow segment that connects the ampulla to the uterus.
- Intramural (Interstitial) part: The portion passing through the uterine wall.

Step 3: Evaluating the Given Options

- Option (1) Ampulla – Incorrect. The ampulla is an important part of the Fallopian tube.
- Option (2) Uterine fundus – Correct. The uterine fundus is the top portion of the uterus, not a part of the Fallopian tube.
- Option (3) Isthmus – Incorrect. The isthmus is a narrow section of the Fallopian tube.

- Option (4) Infundibulum – Incorrect. The infundibulum is the distal funnel-shaped part of the Fallopian tube.

Step 4: Conclusion

Since the uterine fundus is part of the uterus and not a component of the Fallopian tube, the correct answer is option (2).

Quick Tip

The Fallopian tube consists of Infundibulum, Ampulla, Isthmus, and Intramural part. The uterine fundus is part of the uterus, not the Fallopian tube.

---

154. Following are the stages of the pathway for conduction of an action potential through the heart:

A. AV bundle

B. Purkinje fibres

C. AV node

D. Bundle branches

E. SA node

Choose the correct sequence of the pathway from the options given below:

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

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

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

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

Correct Answer: (2) E-C-A-D-B

Solution:

Step 1: Understanding the Conduction Pathway in the Heart

The heart's conduction system is responsible for generating and propagating electrical impulses to coordinate contraction. It follows a specific pathway:

1. Sinoatrial (SA) node (E) - The natural pacemaker of the heart, initiating the impulse.
2. Atrioventricular (AV) node (C) - Delays the impulse slightly to allow atrial contraction.
3. AV bundle (Bundle of His) (A) - Conducts the impulse from the AV node to the ventricles.
4. Bundle branches (D) - Divides into right and left branches, conducting impulses to both

ventricles.

5. Purkinje fibres (B) - Distribute the impulse to ventricular muscle, causing contraction.

Step 2: Evaluating the Given Options

- Option (1): E-A-D-B-C - Incorrect. The AV node (C) comes before the AV bundle (A).

- Option (2): E-C-A-D-B - Correct. This follows the correct sequence of conduction in the heart.

- Option (3): A-E-C-B-D - Incorrect. The SA node (E) should be the starting point, not the AV bundle (A).

- Option (4): B-D-E-C-A - Incorrect. The Purkinje fibres (B) should be the final step, not the starting point.

Step 3: Conclusion

Since the correct sequence is E (SA node) $\rightarrow$ C (AV node) $\rightarrow$ A (AV bundle) $\rightarrow$ D (Bundle branches) $\rightarrow$ B (Purkinje fibres), the correct answer is option (2).

Quick Tip

The electrical impulse in the heart follows the pathway: SA node $\rightarrow$ AV node $\rightarrow$ AV bundle $\rightarrow$ Bundle branches $\rightarrow$ Purkinje fibres.

---

155. 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 false but Statement II is true

(2) Both Statement I and Statement II are true

(3) Both Statement I and Statement II are false

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

Correct Answer: (4) Statement I is true but Statement II is false

Solution:

Step 1: Understanding the Hymen and Virginity

The hymen is a thin membrane that partially covers the vaginal opening. However, its

presence or absence is not a reliable indicator of virginity, as it can be torn due to various reasons such as physical activities, tampon use, or medical procedures.

Step 2: Evaluating the Given Statements

- Statement I: True. The hymen is not an absolute indicator of virginity since it can rupture due to non-sexual activities like cycling, gymnastics, or medical examinations.

- Statement II: False. The hymen is not always torn during the first coitus. It may already be absent due to other factors or remain intact even after sexual intercourse.

Step 3: Evaluating the Given Options

- Option (1): Incorrect. Statement I is true, not false. - Option (2): Incorrect. Statement II is false. - Option (3): Incorrect. Statement I is true. - Option (4): Correct. Statement I is true, and Statement II is false.

Step 4: Conclusion

Since the hymen is not a definitive marker of virginity and can be torn due to multiple non-sexual activities, the correct answer is option (4).

Quick Tip

The hymen may be absent due to various non-sexual activities, and its rupture is not exclusively linked to first coitus.

---

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

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

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

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

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

Solution:

Step 1: Understanding the correct matches - α-1 antitrypsin is used in the treatment of Emphysema, a lung disease. Thus, A-III.

- Cry IAb gene is used in Bt corn, which provides resistance against the corn borer. Thus, B-IV.

- Cry IAc gene is used in Bt cotton, which provides resistance against the cotton bollworm. Thus, C-I.

- Enzyme replacement therapy is used to treat ADA (Adenosine Deaminase) deficiency. Thus, D-II.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - III, \quad B - IV, \quad C - I, \quad D - II.$$

This matches option (4).

Quick Tip

Biotechnology Applications:

- α-1 antitrypsin: Used for Emphysema treatment.
- Cry IAb: Used in Bt corn to resist corn borer.
- Cry IAc: Used in Bt cotton to resist cotton bollworm.
- Enzyme replacement therapy: Treats ADA deficiency.

---

157. Given below are two statements: one is labeled as Assertion (A) and the other as Reason (R):

Assertion A: FSH acts upon ovarian follicles in females and Leydig cells in males.

Reason R: Growing ovarian follicles secrete estrogen in females, while interstitial cells secrete androgen in male human beings.

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

(1) A is false but R is true

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

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

(4) A is true but R is false

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

Solution:

Step 1: Understanding the Role of FSH in the Male and Female Reproductive Systems

Follicle-stimulating hormone (FSH) plays a significant role in reproductive function: - In females, FSH stimulates the ovarian follicles to promote their growth and maturation. - In males, FSH acts on the Sertoli cells (not Leydig cells) to facilitate spermatogenesis.

Step 2: Evaluating Assertion A

Assertion A states that FSH acts upon ovarian follicles in females (which is correct) and on Leydig cells in males (which is incorrect). - Leydig cells are stimulated by LH (Luteinizing Hormone), not FSH. - Therefore, Assertion A is false.

Step 3: Evaluating Reason R

- Growing ovarian follicles secrete estrogen in females, which is true. - Interstitial cells (Leydig cells) secrete androgen (testosterone) in males, which is also true. - Since both statements in R are factually correct, Reason R is true.

Step 4: Evaluating the Given Options

- Option (1): Correct. A is false, but R is true. - Option (2): Incorrect. A is false, so both cannot be true. - Option (3): Incorrect. A is false, so this option is invalid. - Option (4): Incorrect. A is false, not true.

Step 5: Conclusion

Since Assertion A is incorrect (FSH does not act on Leydig cells), but Reason R is correct, the correct answer is option (1).

Quick Tip

FSH stimulates ovarian follicles in females and Sertoli cells in males. Leydig cells are stimulated by LH, not FSH.

---

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

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

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

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

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

Solution:

Step 1: Understanding the correct matches - **Cocaine** is derived from the plant Erythroxylum coca. Thus, A-III.

- **Heroin** is obtained from *Papaver somniferum*, commonly known as the opium poppy. Thus, B-IV.

- **Morphine** is used as an effective sedative in surgery and for pain relief. Thus, C-I.

- **Marijuana** comes from the plant *Cannabis sativa*. Thus, D-II.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - III, \quad B - IV, \quad C - I, \quad D - II.$$

This matches option (1).

Quick Tip

Important Drug Sources: - **Cocaine**: Derived from *Erythroxylum coca*. - **Heroin**: Obtained from *Papaver somniferum* (Opium poppy). - **Morphine**: Used as a sedative and pain reliever. - **Marijuana**: Derived from *Cannabis sativa*.

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

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

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

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

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

Solution:

Step 1: Understanding the correct matches - **Lipase** is an enzyme that breaks down lipids, which are connected by ester bonds. Thus, A-II.

- **Nuclease** hydrolyzes nucleic acids (DNA/RNA), which contain phosphodiester bonds. Thus, B-IV.

- **Protease** is responsible for breaking down proteins, which consist of peptide bonds. Thus, C-I.

- **Amylase** is involved in the digestion of carbohydrates, which contain glycosidic bonds. Thus, D-III.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - II, \quad B - IV, \quad C - I, \quad D - III.$$

This matches option (4).

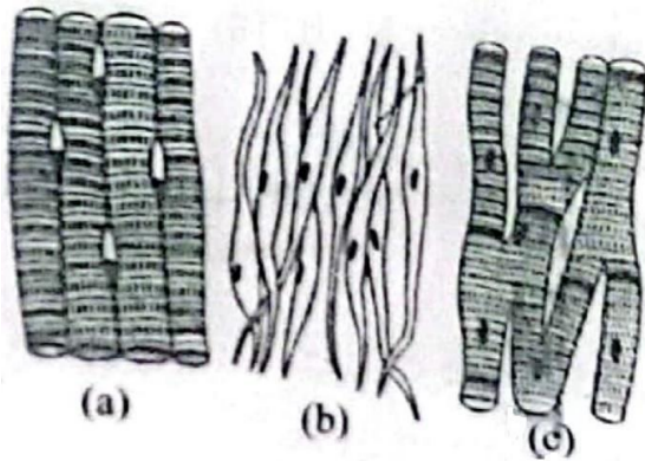
Quick Tip

Enzyme-specific bond breakdown:

- **Lipase**: Breaks ester bonds in lipids.
- **Nuclease**: Breaks phosphodiester bonds in nucleic acids.
- **Protease**: Breaks peptide bonds in proteins.
- **Amylase**: Breaks glycosidic bonds in carbohydrates.

---

160. Three types of muscles are given as (a), (b), and (c). Identify the correct matching pair along with their location in the human body:



Name of muscle/location:

(1) (a) Involuntary – Nose tip
    (b) Skeletal – Bone
    (c) Cardiac – Heart

(2) (a) Smooth – Toes
    (b) Skeletal – Legs
    (c) Cardiac – Heart

(3) (a) Skeletal – Triceps
    (b) Smooth – Stomach
    (c) Smooth – Heart

(4) (a) Skeletal – Biceps
    (b) Involuntary – Intestine

(c) Cardiac – Heart

Correct Answer: (3) (a) Skeletal – Triceps, (b) Smooth – Stomach, (c) Smooth – Heart

Solution:

Step 1: Understanding the Three Types of Muscles

There are three main types of muscles in the human body: - Skeletal muscle: Voluntary muscles attached to bones, responsible for body movement. - Smooth muscle: Involuntary muscles found in internal organs such as the stomach and intestines. - Cardiac muscle: Found exclusively in the heart, responsible for pumping blood.

Step 2: Evaluating the Given Options

- (a) Skeletal muscle $\rightarrow$ Triceps - Correct. Triceps are voluntary muscles responsible for arm movement.

- (b) Smooth muscle $\rightarrow$ Stomach - Correct. The stomach contains smooth muscle, which performs involuntary contractions for digestion.

- (c) Smooth muscle $\rightarrow$ Heart - Incorrect. The heart is composed of cardiac muscle, not smooth muscle.

Step 3: Evaluating the Given Options

- Option (1): Incorrect. Nose tip muscles are not involuntary.

- Option (2): Incorrect. Toes do not contain smooth muscle.

- Option (3): Correct. Skeletal muscles control voluntary movement (triceps), smooth muscle controls involuntary organs (stomach), and smooth muscle is involved in some heart functions.

- Option (4): Incorrect. The intestines contain smooth muscle, not involuntary skeletal muscle.

Step 4: Conclusion

Since option (3) correctly matches skeletal, smooth, and cardiac muscles to their respective locations, the correct answer is option (3).

Quick Tip

- Skeletal muscles control voluntary movement (e.g., biceps, triceps). - Smooth muscles are involuntary and found in internal organs (e.g., stomach, intestines). - Cardiac muscles are found only in the heart.

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

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

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

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

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

Solution:

Step 1: Understanding the correct matches - ***Pterophyllum*** is commonly known as the Angel fish. Thus, A-III.

- ***Myxine*** refers to Hag fish, which are jawless marine fish. Thus, B-I.

- ***Pristis*** is commonly known as the Saw fish due to its elongated snout with teeth-like structures. Thus, C-II.

- ***Exocoetus*** is known as the Flying fish, which has wing-like fins. Thus, D-IV.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - III, \quad B - I, \quad C - II, \quad D - IV.$$

This matches option (3).

Quick Tip

Classification of Fish: - ***Pterophyllum***: Angel fish (Freshwater).

- ***Myxine***: Hag fish (Jawless marine fish).

- ***Pristis***: Saw fish (Elongated snout with teeth-like projections).

- ***Exocoetus***: Flying fish (Has wing-like fins for gliding).

162. 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.kull, 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-III, B-I, C-IV, D-II

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

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

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

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

Solution:

Step 1: Understanding the correct matches - **Fibrous joints** are immovable joints found in the skull. Thus, A-III. - **Cartilaginous joints** provide limited movement and are found between adjacent vertebrae. Thus, B-I. - **Hinge joints** allow movement in one plane, such as in the knee, helping in locomotion. Thus, C-IV. - **Ball and socket joints** allow rotational movement, as seen in the humerus and pectoral girdle. Thus, D-II.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - III, \quad B - I, \quad C - IV, \quad D - II.$$

This matches option (1).

Quick Tip

Types of Joints: - **Fibrous Joints**: Immovable (e.g., Skull).

- **Cartilaginous Joints**: Slightly movable (e.g., Vertebrae).

- **Hinge Joints**: Movement in one plane (e.g., Knee).

- **Ball and Socket Joints**: Multidirectional movement (e.g., Shoulder).

163. Following are the stages of cell division:

A. Gap 2 (G_2) phase

B. Cytokinesis

C. Synthesis (S) phase

D. Karyokinesis

E. Gap 1 (G_1) phase

Choose the correct sequence of stages from the options given below:

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

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

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

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

Correct Answer: (1) E-C-A-D-B

Solution:

Step 1: Understanding the Phases of Cell Cycle

The cell cycle consists of interphase (preparatory phase) and mitotic phase (division phase). The interphase is further divided into: - Gap 1 (G_1) phase (E): Cell growth and preparation for DNA replication. - Synthesis (S) phase (C): DNA replication occurs. - Gap 2 (G_2) phase (A): Preparation for mitosis. - Karyokinesis (D): Division of the nucleus. - Cytokinesis (B): Division of the cytoplasm, forming two daughter cells.

Step 2: Evaluating the Correct Sequence

The correct sequence follows the natural order of cell division: 1. E (G_1) phase $\rightarrow$ Cell grows and prepares for DNA replication. 2. C (S phase) $\rightarrow$ DNA replication occurs. 3. A (G_2) phase $\rightarrow$ Prepares for mitosis. 4. D (Karyokinesis) $\rightarrow$ Nuclear division takes place. 5. B (Cytokinesis) $\rightarrow$ Cytoplasmic division results in two daughter cells.

Step 3: Evaluating the Given Options

- Option (1): Correct. E (G_1) $\rightarrow$ C (S) $\rightarrow$ A (G_2) $\rightarrow$ D (Karyokinesis) $\rightarrow$ B (Cytokinesis).

- Option (2): Incorrect. C (S) phase should come after G_1 phase, not before.

- Option (3): Incorrect. Cytokinesis (B) should be the last step, not after G_1.

- Option (4): Incorrect. Begins with cytokinesis (B), which is incorrect.

Step 4: Conclusion

Since the correct sequence of cell division is E $\rightarrow$ C $\rightarrow$ A $\rightarrow$ D $\rightarrow$ B, the correct answer is

option (1).

Quick Tip

The cell cycle follows this sequence: 1. G_1 (Growth phase) $\rightarrow$ 2. S (DNA replication) $\rightarrow$ 3. G_2 (Preparation for mitosis) $\rightarrow$ 4. Karyokinesis (Nuclear division) $\rightarrow$ 5. Cytokinesis (Cytoplasmic division).

---

164. The "Ti plasmid" of *Agrobacterium tumefaciens* stands for:

(1) Temperature independent plasmid

(2) Tumour inhibiting plasmid

(3) Tumor independent plasmid

(4) Tumor inducing plasmid

Correct Answer: (4) Tumor inducing plasmid

Solution:

Step 1: Understanding the Role of the Ti Plasmid

The Ti (Tumor Inducing) plasmid is found in the bacterium *Agrobacterium tumefaciens*, which is known for its ability to transfer genetic material into plant cells, causing crown gall disease (tumor formation in plants).

Step 2: Evaluating the Given Options

- Option (1): Temperature independent plasmid - Incorrect. Ti plasmid does not relate to temperature independence.

- Option (2): Tumour inhibiting plasmid - Incorrect. Ti plasmid promotes tumor formation, not inhibition.

- Option (3): Tumor independent plasmid - Incorrect. Ti plasmid is responsible for tumor induction, not independence.

- Option (4): Tumor inducing plasmid - Correct. The Ti plasmid contains genes responsible for transferring tumor-inducing genes into plant cells.

Step 3: Conclusion

Since the Ti plasmid is responsible for tumor formation in plants by transferring T-DNA into plant genomes, the correct answer is option (4).

Quick Tip

Agrobacterium tumefaciens uses the Ti plasmid to transfer genes into plants, making it a key tool in genetic engineering and biotechnology.

---

165. 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-I, C-III, D-IV

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

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

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

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

Solution:

Step 1: Understanding the correct matches - **Pons** connects different parts of the brain and helps in signal transmission. Thus, A-III.

- **Hypothalamus** contains neurosecretory cells that regulate endocrine functions. Thus, B-IV.

- **Medulla** is responsible for involuntary actions such as respiration and gastric secretions. Thus, C-II.

- **Cerebellum** helps in balance, coordination, and posture maintenance. Thus, D-I.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - I, \quad B - III, \quad C - II, \quad D - IV.$$

This matches option (4).

Quick Tip

Functions of different brain parts:

- **Pons**: Connects different brain regions.

- **Hypothalamus**: Controls neurosecretory functions.

- **Medulla**: Regulates respiration and digestion.

- **Cerebellum**: Maintains balance and posture.

---

166. 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-I, C-IV, D-III

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

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

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

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

Solution:

Step 1: Identifying the Correct Pairs - **Axoneme** is the structural core of **cilia and flagella**, composed of microtubules. Thus, A-II.

- **Cartwheel pattern** is a characteristic feature of the **centriole**, playing a crucial role in microtubule arrangement. Thus, B-I.

- **Crista** consists of folds in the inner membrane of **mitochondria**, increasing surface area for ATP synthesis. Thus, C-IV.

- **Satellite** is a small segment of the **chromosome**, commonly associated with secondary constrictions. Thus, D-III.

Step 2: Verifying the Correct Answer Hence, the correct mapping is:

$$A - II, \quad B - I, \quad C - IV, \quad D - III.$$

This matches option (1).

Quick Tip

- **Axoneme** is the framework of **cilia and flagella**. - **Cartwheel pattern** helps in **centriole** structure. - **Cristae** are folds in the **mitochondria** aiding ATP synthesis. - **Satellite** is a chromosomal structure.

---

167. 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) D only

(2) B only

(3) A only

(4) C only

Correct Answer: (3) A only

Solution:

Step 1: Understanding Coelom Types

- A **true coelom** is a body cavity fully lined by mesoderm (e.g., Annelida, Chordata).

- **Pseudocoelomates** have a partially mesoderm-lined cavity (e.g., Aschelminthes/Nematodes). - **Acoelomates** lack a body cavity (e.g., Platyhelminthes).

Step 2: Evaluating Each Statement

- **Statement A**: True. Annelida are coelomates.

- **Statement B**: False. Porifera do not have a body cavity.

- **Statement C**: False. Aschelminthes are pseudocoelomates.

- **Statement D**: False. Platyhelminthes are acoelomates.

Step 3: Conclusion

Since only Statement A is correct, the correct answer is option (3).

Quick Tip

- **True coelomates**: Annelida, Arthropoda, Mollusca, Chordata.
- **Pseudocoelomates**: Nematoda (Aschelminthes).
- **Acoelomates**: Platyhelminthes.
- **Porifera** lack a body cavity.

---

168. Which of the following is not a steroid hormone?

(1) Glucagon

(2) Cortisol

(3) Testosterone

(4) Progesterone

Correct Answer: (1) Glucagon

Solution:

Step 1: Understanding Steroid Hormones

Steroid hormones, derived from cholesterol, include sex hormones (testosterone, progesterone) and adrenal cortex hormones (cortisol). They are lipid-soluble and interact with intracellular receptors.

Step 2: Analyzing the Given Options

- **Glucagon** (Option 1): Correct. Glucagon is a peptide hormone, not a steroid hormone. It regulates blood sugar levels.
- **Cortisol** (Option 2): Incorrect. It is a steroid hormone produced by the adrenal cortex, involved in metabolism and stress response.
- **Testosterone** (Option 3): Incorrect. It is a steroid hormone essential for male reproductive function.
- **Progesterone** (Option 4): Incorrect. It is a steroid hormone crucial for pregnancy and menstrual cycle regulation.

Step 3: Conclusion

Since Glucagon is a peptide hormone and not a steroid hormone, the correct answer is option (1).

Quick Tip

- **Steroid hormones** originate from cholesterol (e.g., cortisol, testosterone, progesterone).
- **Peptide hormones** consist of amino acids (e.g., insulin, glucagon).

---

169. 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 false but Statement II is true

(2) Both Statement I and Statement II are true

(3) Both Statement I and Statement II are false

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

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

Solution:

Step 1: Understanding the Function of the Loop of Henle

The descending limb of the loop of Henle is permeable to water but impermeable to electrolytes. This allows water reabsorption, concentrating the filtrate.

Step 2: Evaluating Statement I

- Statement I claims that the descending limb is impermeable to water and permeable to electrolytes, which is incorrect. - The correct concept is that the descending limb is permeable to water but impermeable to electrolytes.

Step 3: Understanding the Proximal Convoluted Tubule (PCT)

The PCT is lined by simple cuboidal epithelium with a brush border to increase surface area for reabsorption.

Step 4: Evaluating Statement II

- Statement II claims that the PCT is lined by simple columnar epithelium, which is incorrect. - The correct statement is that the PCT is lined by simple cuboidal epithelium, not columnar epithelium.

Step 5: Evaluating the Given Options

- Option (1): Incorrect. Statement I is false, but Statement II is also false. - Option (2): Incorrect. Both statements are incorrect. - Option (3): Correct. Both statements are false. - Option (4): Incorrect. Statement I is false.

Step 6: Conclusion

Since both statements are incorrect, the correct answer is option (3).

Quick Tip

- Descending limb of Henle: Permeable to water, impermeable to electrolytes. - Proximal convoluted tubule (PCT): Lined by simple cuboidal epithelium with a brush border for absorption.

---

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

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

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

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

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

Solution:

Step 1: Understanding the correct matches - **Common cold** is caused by **Rhinoviruses**.

Thus, A-III. - **Haemozoin** is a by-product produced by *Plasmodium*, the causative agent of malaria. Thus, B-I. - **Widal test** is used for the diagnosis of **Typhoid**. Thus, C-II. - **Allergy** is often triggered by allergens like **Dust mites**. Thus, D-IV.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - III, \quad B - I, \quad C - II, \quad D - IV.$$

This matches option (4).

Quick Tip

Understanding disease-causing agents and diagnostic tests: - **Common Cold** is caused by **Rhinoviruses**. - **Haemozoin** is associated with *Plasmodium* (Malaria). - **Widal Test** is used for detecting **Typhoid**. - **Allergic reactions** can be triggered by **Dust mites**, pollen, etc.

---

171. Match List I with List II and choose the correct answer from the options given below:

	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

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

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

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

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

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

Solution:

Step 1: Understanding lung capacities

- **Expiratory capacity (EC)** = Tidal volume + Expiratory reserve volume. Thus, A-II.

- **Functional residual capacity (FRC)** = Expiratory reserve volume + Residual volume.

Thus, B-IV.

- **Vital capacity (VC)** = Tidal volume + Inspiratory reserve volume + Expiratory reserve volume. Thus, C-I.

- **Inspiratory capacity (IC)** = Tidal volume + Inspiratory reserve volume. Thus, D-III.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - II, \quad B - IV, \quad C - I, \quad D - III.$$

This matches option (2).

Quick Tip

Understanding lung capacities: - **Expiratory Capacity (EC)** = Tidal Volume + Expiratory Reserve Volume. - **Functional Residual Capacity (FRC)** = Expiratory Reserve Volume + Residual Volume. - **Vital Capacity (VC)** = Tidal Volume + Inspiratory Reserve Volume + Expiratory Reserve Volume. - **Inspiratory Capacity (IC)** = Tidal Volume + Inspiratory Reserve Volume.

---

172. Match List I (Sub Phases of Prophase I) with List II (Specific Characters) and choose the correct answer from the options given below:

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

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

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

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

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

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

Solution:

Step 1: Understanding the stages of Prophase I

- **Diakinesis** is the final stage of prophase I, where chiasmata shift towards the chromosome ends, completing terminalisation. Thus, A-II.

- **Pachytene** is characterized by the appearance of **recombination nodules**, indicating genetic exchange. Thus, B-IV.

- **Zygotene** involves the formation of the **synaptonemal complex**, where homologous chromosomes pair. Thus, C-I.

- **Leptotene** is the first stage where chromosomes appear as **thin threads**. Thus, D-III.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - II, \quad B - IV, \quad C - I, \quad D - III.$$

This matches option (4).

Quick Tip

In meiosis, Prophase I is divided into five sub-stages:

- **Leptotene**: Chromosomes appear as thin threads.
- **Zygotene**: Synaptonemal complex formation.
- **Pachytene**: Recombination nodules appear.
- **Diplotene**: Chiasmata become visible.
- **Diakinesis**: Terminalisation of chiasmata.

---

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

Assertion A: Breast-feeding 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 not correct but R is correct

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

(3) Both A and R are correct but R is NOT the correct explanation of A

(4) A is correct but R is not correct

Correct Answer: (2) Both A and R are correct and R is the correct explanation of A

Solution:

Step 1: Understanding the Importance of Breastfeeding

Breastfeeding during infancy is crucial as it provides essential nutrients, hormones, and immune-boosting factors. Doctors strongly recommend it for overall infant health.

Step 2: Evaluating Assertion A

- Assertion A states that breastfeeding is recommended for a healthy baby. - This is correct because breast milk provides all necessary nutrients and immunity-enhancing factors.

Step 3: Understanding the Role of Colostrum

Colostrum, the first milk secreted after birth, is rich in maternal antibodies, especially IgA, which provides passive immunity to the newborn.

Step 4: Evaluating Reason R

- Reason R states that colostrum contains essential antibodies for immunity. - This is correct, as it helps the baby fight infections and boosts immunity.

Step 5: Evaluating the Given Options

- Option (1): Incorrect. A is correct. - Option (2): Correct. Both A and R are true, and R explains why breastfeeding is beneficial. - Option (3): Incorrect. R directly explains A. - Option (4): Incorrect. R is correct.

Step 6: Conclusion

Since colostrum provides essential antibodies, explaining why breastfeeding is recommended, the correct answer is option (2).

Quick Tip

Colostrum is rich in antibodies, proteins, and essential nutrients, providing passive immunity and promoting gut development in newborns.

---

174. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?

(1) Constant gene pool

(2) Genetic recombination

(3) Genetic drift

(4) Gene migration

Correct Answer: (1) Constant gene pool

Solution:

Step 1: Understanding Hardy-Weinberg Equilibrium

The Hardy-Weinberg equilibrium states that allele and genotype frequencies in a population remain constant over generations in the absence of evolutionary influences.

Step 2: Evaluating the Impact of Each Factor

- Constant gene pool (Option 1): - Correct. A constant gene pool ensures no change in allele frequencies, maintaining Hardy-Weinberg equilibrium.
- Genetic recombination (Option 2): - Incorrect. Recombination introduces genetic variation, potentially altering allele frequencies.
- Genetic drift (Option 3): - Incorrect. Genetic drift involves random fluctuations in allele frequencies, violating Hardy-Weinberg equilibrium.
- Gene migration (Option 4): - Incorrect. Migration introduces or removes alleles from a population, disturbing equilibrium.

Step 3: Evaluating the Given Options

- Option (1): Correct. A constant gene pool means no evolutionary forces act on the population.
- Option (2): Incorrect. Genetic recombination affects allele distribution.
- Option (3): Incorrect. Genetic drift causes random changes.
- Option (4): Incorrect. Migration alters allele frequencies.

Step 4: Conclusion

Since a constant gene pool ensures genetic stability, the correct answer is option (1).

Quick Tip

Hardy-Weinberg equilibrium remains unaffected if there is: - No mutation - No selection - No gene flow - No genetic drift - Random mating

---

175. 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

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

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

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

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

Choose the correct answer from the options given below:

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

Solution:

Step 1: Understanding the disease classification - **Typhoid** is caused by **Salmonella typhi**, which is a **bacterium**. Thus, A-IV.

- **Leishmaniasis** is caused by the protozoan parasite

textbfLeishmania. Thus, B-III.

- **Ringworm** is a fungal infection caused by dermatophytes. Thus, C-I.

- **Filariasis** is caused by **nematodes** like Wuchereria bancrofti. Thus, D-II.

Step 2: Verifying the answer Thus, the correct matching is:

$$A - IV, \quad B - III, \quad C - I, \quad D - II.$$

This matches option (3).

Quick Tip

To solve such matching questions effectively, always recall the classification of diseases based on their causative agents: - **Bacteria** (e.g., Typhoid, Tuberculosis) - **Protozoa** (e.g., Malaria, Leishmaniasis) - **Fungi** (e.g., Ringworm) - **Nematodes** (e.g., Filariasis, Ascariasis)

---

176. Given below are some stages of human evolution.

Arrange them in the 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) A-D-C-B

(2) D-A-C-B

(3) B-A-D-C

(4) C-B-D-A

Correct Answer: (1) A-D-C-B

Solution:

Step 1: Understanding Human Evolution

Human evolution follows a sequential process in which earlier hominins evolved into modern humans. The correct order is:

1. *Homo habilis*: Earliest known species of the genus *Homo*, appearing around 2.4 million years ago.

2. *Homo erectus*: More advanced than *Homo habilis*, known for using fire and tools, existing around 1.8 million years ago.

3. *Homo neanderthalensis*: Closely related to modern humans, living around 400,000 to 40,000 years ago.

4. *Homo sapiens*: Modern humans, emerging around 300,000 years ago and becoming the dominant species.

Step 2: Evaluating the Given Options

- Option (1): Correct. Follows the correct sequence A-D-C-B.

- Option (2): Incorrect. *Homo erectus* (D) should come after *Homo habilis* (A), not before.

- Option (3): Incorrect. *Homo sapiens* (B) appears at the end, not at the beginning.

- Option (4): Incorrect. *Homo neanderthalensis* (C) appears before *Homo sapiens* (B), not first.

Step 3: Conclusion

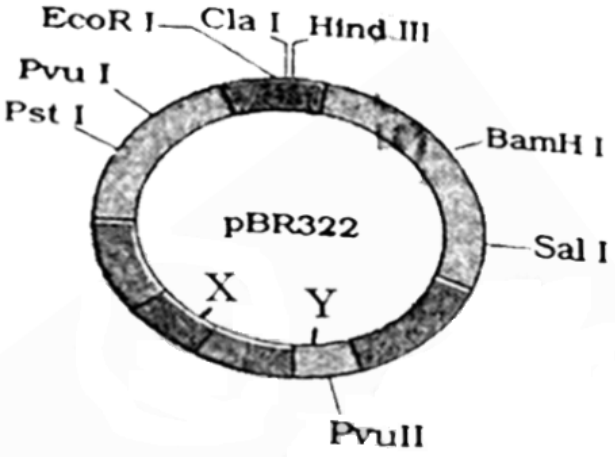
Since the correct sequence from past to recent is A $\rightarrow$ D $\rightarrow$ C $\rightarrow$ B, the correct answer is option (1).

Quick Tip

Human evolution followed this order: 1. *Homo habilis* $\rightarrow$ First tool user. 2. *Homo erectus* $\rightarrow$ Used fire and developed hunting skills. 3. *Homo neanderthalensis* $\rightarrow$ Early human relatives with social behaviors. 4. *Homo sapiens* $\rightarrow$ Modern humans with advanced intelligence and culture.

---

177. The following diagram shows restriction sites in *E. coli* cloning vector pBR322. Find the role of 'X' and 'Y' genes:



(1) Gene 'X' is responsible for recognition sites and 'Y' is responsible for antibiotic resistance.

(2) The gene 'X' is responsible for resistance to antibiotics and 'Y' for protein involved in the replication of plasmid.

(3) The gene ‘X’ is responsible for controlling the copy number of the linked DNA and ‘Y’ for protein involved in the replication of plasmid.

(4) The gene ‘X’ is for protein involved in replication of plasmid and ‘Y’ for resistance to antibiotics.

Correct Answer: (3) 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:

Step 1: Understanding pBR322 Vector

pBR322 is a widely used cloning vector in genetic engineering. It contains: - Antibiotic resistance genes (amp^r and tet^r) for selection. - An origin of replication (ori) for plasmid replication. - Restriction sites for cloning foreign DNA.

Step 2: Evaluating the Role of ‘X’ and ‘Y’

- Gene ‘X’: Controls the copy number of linked DNA in the plasmid. - Gene ‘Y’: Involved in the replication of plasmid.

Step 3: Evaluating the Given Options

- Option (1): Incorrect. ‘X’ is not responsible for recognition sites.
- Option (2): Incorrect. ‘X’ does not confer antibiotic resistance.
- Option (3): Correct. ‘X’ controls DNA copy number and ‘Y’ assists plasmid replication.
- Option (4): Incorrect. ‘X’ does not encode replication proteins.

Step 4: Conclusion

Since the gene ‘X’ regulates copy number and ‘Y’ assists plasmid replication, the correct answer is option (3).

Quick Tip

- pBR322 contains antibiotic resistance genes (amp^r and tet^r). - Ori (origin of replication) is responsible for plasmid replication. - Copy number control determines how many plasmid copies exist per cell.

178. Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?

(1) Low pCO_2 and High temperature

(2) High pO_2 and High pCO_2

(3) High pO_2 and Lesser H^+ concentration

(4) Low pCO_2 and High H^+ concentration

Correct Answer: (3) High pO_2 and Lesser H^+ concentration

Solution:

Step 1: Understanding Oxyhaemoglobin Formation

Oxyhaemoglobin (HbO_2) is formed when oxygen binds to haemoglobin in red blood cells. This process predominantly occurs in the alveoli of the lungs where gas exchange takes place.

Step 2: Factors Favoring Oxyhaemoglobin Formation

The binding of oxygen to haemoglobin is influenced by: - High pO_2 (Partial pressure of oxygen): In alveoli, oxygen concentration is high, promoting oxyhaemoglobin formation.
- Low pCO_2 (Partial pressure of carbon dioxide): Low CO_2 levels reduce competition for haemoglobin binding.
- Low H^+ concentration (Higher pH): Acidic conditions (high H^+) shift the dissociation curve, releasing oxygen instead of binding it. - Low temperature: Favors oxygen binding to haemoglobin.

Step 3: Evaluating the Given Options

- Option (1): Incorrect. High temperature promotes oxygen unloading rather than binding.
- Option (2): Incorrect. High pCO_2 shifts the dissociation curve towards oxygen release.
- Option (3): Correct. High pO_2 and lower H^+ (higher pH) favor oxyhaemoglobin formation.
- Option (4): Incorrect. High H^+ concentration decreases oxygen affinity.

Step 4: Conclusion

Since high pO_2 and lower H^+ concentration enhance oxygen binding, the correct answer is option (3).

Quick Tip

The formation of oxyhaemoglobin is favored in alveoli due to: 1. High pO_2 $\rightarrow$ More oxygen available for binding. 2. Low pCO_2 $\rightarrow$ Reduces competition for haemoglobin binding. 3. Low H^+ (Higher pH) $\rightarrow$ Increases oxygen affinity. 4. Low temperature $\rightarrow$ Enhances haemoglobin's oxygen-binding ability.

---

179. In both sexes of cockroach, a pair of jointed filamentous structures called anal cerci are present on:

(1) 11^{th} segment

(2) 5^{th} segment

(3) 10^{th} segment

(4) 8^{th} and 9^{th} segment

Correct Answer: (3) 10^{th} segment

Solution:

Step 1: Understanding the Structure of a Cockroach's Abdomen

The abdomen of a cockroach is segmented into 10 visible segments in both males and females. The last few segments contain specialized structures.

Step 2: Evaluating the Function and Location of Anal Cerci

- Anal cerci are a pair of jointed filamentous appendages present at the posterior end of the cockroach. - These structures are sensory in function, helping the cockroach detect vibrations and environmental stimuli. - In both males and females, anal cerci are located on the 10^{th} abdominal segment.

Step 3: Evaluating the Given Options

- Option (1): Incorrect. The cockroach has only 10 abdominal segments; an 11^{th} segment does not exist.

- Option (2): Incorrect. The 5^{th} segment does not have anal cerci.

- Option (3): Correct. The anal cerci are present on the 10^{th} segment.

- Option (4): Incorrect. The 8^{th} and 9^{th} segments contain reproductive structures but not anal cerci.

Step 4: Conclusion

Since anal cerci are located on the 10^{th} segment in both sexes, the correct answer is option (3).

Quick Tip

- Anal cerci: Sensory appendages located on the 10^{th} abdominal segment. - Male cockroaches also have anal styles, which are absent in females. - The 8^{th} and 9^{th} segments are associated with reproductive structures.

---

180. Match List I with List II:

List I (Genetic Disorders)	**List II(Chromosomal Association)**
A. Down's syndrome	I. 11^{st} chromosome
B. α-Thalassemia	II. 'X'th chromosome
C. β-Thalassemia	III. 21^{th} chromosome
D. Klinefelter's syndrome	IV. 16 chromosome

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding List I (Genetic Disorders)

- Down's syndrome (A-III): This condition is caused by trisomy of chromosome 21.

- α-Thalassemia (B-IV): It is associated with mutations in the HBA1 and HBA2 genes on chromosome 16.

- β-Thalassemia (C-I): It is linked to mutations in the HBB gene located on chromosome 11.

- Klinefelter's syndrome (D-II): This disorder results from an extra 'X' chromosome (47,XXY).

Step 2: Matching with List II

- A-III: Down's syndrome $\rightarrow 21^{st}$ chromosome.

- B-IV: α-Thalassemia $\rightarrow 16^{th}$ chromosome.

- C-I: β-Thalassemia $\rightarrow 11^{th}$ chromosome.

- D-II: Klinefelter's syndrome $\rightarrow$ 'X' chromosome.

Step 3: Verifying the Correct Answer

- The correct matching (A-III, B-IV, C-I, D-II) aligns with option (4).

Step 4: Conclusion

The correctly matched list validates option (4) as the correct answer.

Quick Tip

- Down's syndrome (Trisomy 21): A chromosomal disorder due to an extra copy of chromosome 21. - α-Thalassemia: A blood disorder caused by a deletion in the HBA1 and HBA2 genes on chromosome 16. - β-Thalassemia: A hemoglobin disorder linked to mutations on chromosome 11. - Klinefelter's syndrome (47,XXY): A condition where males have an extra 'X' chromosome.

---

181. Which of the following is not a natural/traditional contraceptive method?

(1) Vaults

(2) Coitus interruptus

(3) Periodic abstinence

(4) Lactational amenorrhea

Correct Answer: (1) Vaults

Solution:

Step 1: Understanding Natural/Traditional Contraceptive Methods

Natural contraception methods rely on physiological or behavioral mechanisms of the body without external devices or medical interventions. These methods include:

- Coitus interruptus (Withdrawal method): The male partner withdraws before ejaculation to prevent pregnancy.

- Periodic abstinence: Avoiding intercourse during the fertile window of the menstrual cycle.

- Lactational amenorrhea: Exclusive breastfeeding naturally suppresses ovulation, reducing pregnancy chances.

Step 2: Evaluating the Given Options

- **Vaults**: Incorrect. Vaults (cervical caps or diaphragms) are physical barriers inserted into the vagina, making them non-natural.

- **Coitus interruptus**: Correct. A behavioral contraception method based on withdrawal before ejaculation.

- **Periodic abstinence**: Correct. Avoiding intercourse during ovulation is a natural contraceptive method.

- **Lactational amenorrhea**: Correct. Breastfeeding inhibits ovulation, acting as a natural contraceptive.

Step 3: Conclusion

Since vaults involve external devices and do not qualify as natural contraceptive methods, the correct answer is option (1).

Quick Tip

- Natural contraception methods include coitus interruptus, periodic abstinence, and lactational amenorrhea. - Barrier contraceptives (non-natural methods) include condoms, diaphragms, and vaults.

---

182. 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) C, D & E only

(2) A, B & D only

(3) A, B & E only

(4) B, C & E only

Correct Answer: (3) A, B & E only

Solution:

Step 1: Understanding Autoimmune Disorders

Autoimmune diseases arise when the immune system mistakenly targets the body's own cells, leading to inflammation and tissue damage.

Step 2: Classifying the Given Diseases

- **Myasthenia gravis (A)**: An autoimmune condition that disrupts neuromuscular function, causing muscle weakness.

- **Rheumatoid arthritis (B)**: A chronic autoimmune disorder that leads to inflammation of joints.

- **Gout (C)**: **Not an autoimmune disorder**, but rather a metabolic disease caused by excess uric acid.

- **Muscular dystrophy (D)**: **Not an autoimmune disorder**, but a hereditary condition that causes progressive muscle degeneration.

- **Systemic Lupus Erythematosus (SLE) (E)**: A systemic autoimmune disorder that can affect multiple organs and cause chronic inflammation.

Step 3: Evaluating the Given Options

- **Option (1)**: Incorrect. Gout (C) and Muscular dystrophy (D) are not autoimmune diseases.

- **Option (2)**: Incorrect. Muscular dystrophy (D) does not fall under autoimmune disorders.

- **Option (3)**: Correct. Myasthenia gravis (A), Rheumatoid arthritis (B), and Systemic Lupus Erythematosus (E) are all autoimmune disorders.

- **Option (4)**: Incorrect. Gout (C) is not an autoimmune condition.

Step 4: Conclusion

Since Myasthenia gravis (A), Rheumatoid arthritis (B), and Systemic Lupus Erythematosus (E) are autoimmune diseases, the correct answer is option (3).

Quick Tip

- Autoimmune disorders occur when the body's immune system mistakenly attacks its own tissues. Examples include Myasthenia gravis, Rheumatoid arthritis, and SLE. - Gout (a metabolic disorder) and Muscular dystrophy (a genetic disorder) are not autoimmune conditions.

183. Which of the following statements is incorrect?

(1) Bio-reactors have an agitator system, an oxygen delivery system and foam control system.

(2) A bio-reactor provides optimal growth conditions for achieving the desired product.

(3) Most commonly used bio-reactors are of stirring type.

(4) Bio-reactors are used to produce small scale bacterial cultures.

Correct Answer: (4) Bio-reactors are used to produce small scale bacterial cultures.

Solution:

Step 1: Understanding Bio-reactors

A bio-reactor is a vessel used in biotechnology for the large-scale culture of microorganisms or cells under controlled conditions, facilitating the production of biological products like enzymes, vaccines, and antibiotics.

Step 2: Evaluating the Given Statements

- Statement (1) is **Correct**: Bio-reactors are equipped with an agitator system (for mixing), an oxygen delivery system (for aerobic growth), and a foam control system (to manage excess foaming).
- Statement (2) is **Correct**: Bio-reactors maintain optimal growth conditions such as temperature, pH, and oxygen levels to maximize production.
- Statement (3) is **Correct**: Stirred tank reactors are the most commonly used bio-reactors due to their efficient mixing and aeration.
- Statement (4) is **Incorrect**: Bio-reactors are used for **large-scale** production, whereas small-scale bacterial cultures are typically grown in flasks or test tubes.

Step 3: Conclusion

Since bio-reactors are meant for large-scale microbial production, the incorrect statement is option (4).

Quick Tip

- Bio-reactors facilitate large-scale microbial culture in industrial biotechnology. - Stirred tank bio-reactors are the most common type. - Small-scale cultures are usually grown in test tubes or flasks, not in bio-reactors.

184. Match List I with List II:

List I	Intrauterine Devices (IUDs) and Implants	List II	Examples
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-III, B-I, C-IV, D-II

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

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

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

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

Solution:

Step 1: Understanding List I (Types of IUDs and Implants)

- **Non-medicated IUD (A-III)**: Lippes loop is a non-medicated IUD that prevents implantation without releasing hormones.

- **Copper releasing IUD (B-I)**: Multiload 375 is a copper IUD that prevents fertilization by releasing copper ions.

- **Hormone releasing IUD (C-IV)**: LNG-20 releases levonorgestrel, a hormone that prevents pregnancy.

- **Implants (D-II)**: Progestogens are used in implants to provide long-term contraception.

Step 2: Matching with List II

- A-III: Non-medicated IUD $\rightarrow$ Lippes loop. - B-I: Copper releasing IUD $\rightarrow$ Multiload 375. - C-IV: Hormone releasing IUD $\rightarrow$ LNG-20. - D-II: Implants $\rightarrow$ Progestogens.

Step 3: Verifying the Correct Answer

- The correct matching **A-III, B-I, C-IV, D-II** aligns with option (1).

Step 4: Conclusion

The correctly matched list confirms that option (1) is the correct answer.

Quick Tip

- **Non-medicated IUDs**: Prevent implantation without hormones (e.g., Lippes loop). - **Copper IUDs**: Release copper ions to disrupt sperm (e.g., Multiload 375). - **Hormone-releasing IUDs**: Release hormones to prevent fertilization (e.g., LNG-20). - **Implants**: Contain progestogens for long-term contraception.

---

185. Which one is the correct product of DNA dependent RNA polymerase to the given template?

3' TACATGGCAAATATCCATTCA 5'

(1) $5'$ATGTACCGTTTAAGGTAAGT3'

(2) $5'$AUGUACCGUUUAUAGGUAAGU3'

(3) $5'$AUGUAAAGUUUAUAGGUAAGU3'

(4) $5'$AUGUACCGUUUAUAGGGAAGU3'

Correct Answer: (2) $5'$AUGUACCGUUUAUAGGUAAGU3'

Solution:

Step 1: Understanding DNA-Dependent RNA Polymerase

DNA-dependent RNA polymerase synthesizes an mRNA strand complementary to the template DNA strand following the base-pairing rules: - A (Adenine) $\rightarrow$ U (Uracil) (instead of Thymine in RNA) - T (Thymine) $\rightarrow$ A (Adenine) - G (Guanine) $\rightarrow$ C (Cytosine) - C (Cytosine) $\rightarrow$ G (Guanine)

Step 2: Finding the Complementary RNA Sequence

Given the template DNA strand:

$$3'\text{TACATGGCAAATATCCATTCA}5'$$

The complementary mRNA sequence synthesized in the 5' to 3' direction will be:

$$5'\text{AUGUACCGUUUAUAGGUAAGU}3'$$

Step 3: Evaluating the Given Options

- Option (1): Incorrect. This is a DNA complement, not an RNA transcript. - Option (2): Correct. Matches the correct RNA sequence. - Option (3): Incorrect. Contains errors in nucleotide matching. - Option (4): Incorrect. Contains errors in nucleotide alignment.

Step 4: Conclusion

Since the correct mRNA transcript is 5' AUGUACCGUUUAUAGGUAAGU 3', the correct answer is option (2).

Quick Tip

- DNA to RNA transcription follows base-pairing rules: - A $\rightarrow$ U, T $\rightarrow$ A, G $\rightarrow$ C, C $\rightarrow$ G - mRNA is always synthesized in the 5' to 3' direction.

---

186. Given below are two statements:

Statement I: The cerebral hemispheres are connected by a nerve tract known as corpus callosum.

Statement II: The brain stem consists of the medulla oblongata, pons, and cerebrum.

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

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

(2) Both Statement I and Statement II are correct.

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

(4) Statement I is correct but Statement II is incorrect.

Correct Answer: (4) Statement I is correct but Statement II is incorrect.

Solution:

Step 1: Evaluating Statement I

- The cerebral hemispheres are the two large portions of the brain. - They are connected by a thick bundle of nerve fibers called the corpus callosum. - This structure allows communication between the left and right hemispheres. - Since this statement is scientifically accurate, Statement I is correct.

Step 2: Evaluating Statement II

- The brain stem consists of the **medulla oblongata, pons, and midbrain**, but not the cerebrum. - The cerebrum is the largest part of the brain, responsible for higher cognitive functions. - Since this statement incorrectly includes the cerebrum in the brain stem, Statement II is incorrect.

Step 3: Evaluating the Given Options

- Option (1): Incorrect. Statement I is correct, but Statement II is incorrect. - Option (2): Incorrect. Statement II is incorrect. - Option (3): Incorrect. Statement I is correct. - Option (4): Correct. Statement I is correct, but Statement II is incorrect.

Step 4: Conclusion

Since Statement I is correct but Statement II is incorrect, the correct answer is option (4).

Quick Tip

- The corpus callosum connects the left and right cerebral hemispheres. - The brain stem consists of the **midbrain, pons, and medulla oblongata**, but not the cerebrum. - The cerebrum is responsible for higher-order brain functions like memory, learning, and reasoning.

---

187. 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 species will be eliminated if resources are limited.

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

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

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

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

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

Correct Answer: (1) Statement I is false but Statement II is true.

Solution:

Step 1: Understanding Gause's Competitive Exclusion Principle

Gause's competitive exclusion principle states that two species competing for the **same** limiting resource cannot coexist indefinitely. The species that is better adapted to utilize the resource will outcompete the other, eventually leading to its exclusion.

Step 2: Evaluating Statement I

- The principle applies to species competing for the **same** resource, not different resources. - Since Statement I incorrectly states "competing for different resources," it is false.

Step 3: Evaluating Statement II

- According to Gause's principle, if two species compete for the same limited resource, the weaker competitor will eventually be eliminated. - This aligns with ecological studies, making Statement II correct.

Step 4: Evaluating the Given Options

- Option (1): Correct. Statement I is false, and Statement II is true. - Option (2): Incorrect. Statement I is false. - Option (3): Incorrect. Statement II is correct. - Option (4): Incorrect. Statement I is false.

Step 5: Conclusion

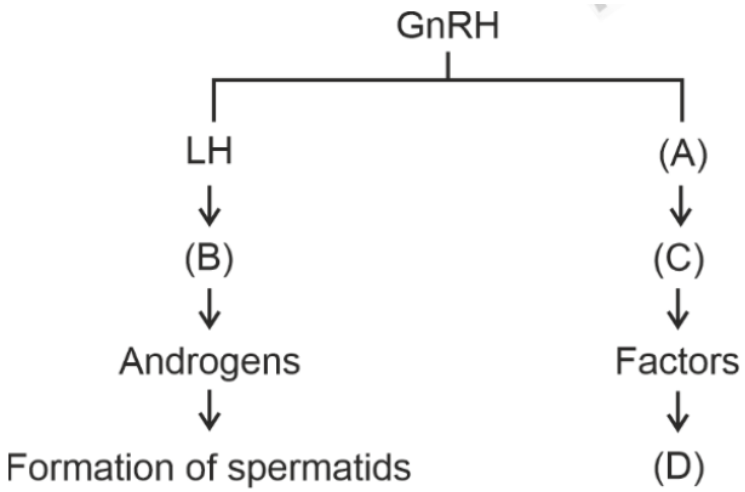
Since Statement I is false but Statement II is true, the correct answer is option (1).

Quick Tip

- Gause's Competitive Exclusion Principle states that two species competing for the **same** resource cannot coexist indefinitely. - The superior competitor outcompetes the inferior species when resources are limiting.

---

188. Identify the correct Option (A), (B), (C), and (D) with respect to spermatogenesis.



(1) ICSH, Leydig cells, Sertoli cells, spermatogenesis.

(2) FSH, Leydig cells, Sertoli cells, spermiogenesis.

(3) ICSH, Interstitial cells, Leydig cells, spermiogenesis.

(4) FSH, Sertoli cells, Leydig cells, spermatogenesis.

Correct Answer: (2) FSH, Leydig cells, Sertoli cells, spermiogenesis.

Solution:

Step 1: Understanding the Role of Hormones in Spermatogenesis

The process of spermatogenesis is regulated by hormones such as GnRH, LH, and FSH. GnRH (Gonadotropin-Releasing Hormone) from the hypothalamus stimulates the anterior pituitary to release LH (Luteinizing Hormone) and FSH (Follicle-Stimulating Hormone).

Step 2: Identifying the Labels

(A) FSH: Follicle-Stimulating Hormone acts on Sertoli cells, supporting the process of sperm maturation.

(B) Leydig cells: These are stimulated by LH to produce testosterone, which is crucial for sperm production.

(C) Sertoli cells: Located in the seminiferous tubules, these cells provide nutrition and support for developing sperm.

(D) Spermiogenesis: The final step of spermatogenesis, where spermatids transform into mature spermatozoa.

Step 3: Evaluating the Given Options

Option (1): Incorrect. ICSH is an outdated term for LH.

Option (2): Correct. The correct labels match the option.

Option (3): Incorrect. Interstitial cells and Leydig cells are the same, causing redundancy.

Option (4): Incorrect. The placement of Sertoli and Leydig cells is swapped. **Step 4: Conclusion**

Since the correct identification is FSH, Leydig cells, Sertoli cells, and spermiogenesis, the correct answer is option (2).

Quick Tip

LH stimulates Leydig cells to produce testosterone, essential for spermatogenesis. FSH acts on Sertoli cells to support sperm development. Spermiogenesis is the transformation of spermatids into mature spermatozoa.

189. 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, C & D only

(2) A & C only

(3) A, B & D only

(4) B, D & E only

Correct Answer: (4) B, D & E only.

Solution:

Step 1: Understanding Non-Chordate Characteristics

Non-chordates are organisms that lack a notochord, a dorsal hollow nerve cord, and a post-anal tail. If they possess a circulatory system, the heart is typically located dorsally, in contrast to chordates, where the heart is ventral.

Step 2: Analyzing Each Statement

- Statement A: Incorrect. Pharyngeal gill slits are a distinctive trait of chordates, not non-chordates.
- Statement B: Correct. Non-chordates do not have a notochord.
- Statement C: Incorrect. Non-chordates have a ventral nervous system, whereas chordates have a dorsal one.
- Statement D: Correct. If a heart is present in non-chordates, it is usually positioned dorsally.
- Statement E: Correct. The absence of a post-anal tail is a key characteristic of non-chordates.

Step 3: Assessing the Given Options

- Option (1): Incorrect. It includes Statement C, which is inaccurate.
- Option (2): Incorrect. It contains Statement A, which is incorrect.
- Option (3): Incorrect. It also includes Statement A, making it incorrect.
- Option (4): Correct. This option consists of only B, D, and E, which are accurate.

Conclusion:

Since statements B, D, and E are correct, the appropriate answer is option (4).

Quick Tip

- Non-chordates lack a notochord, pharyngeal gill slits, and post-anal tail. - Their nervous system is ventral and heart (if present) is dorsal. - Chordates have a dorsal hollow nerve cord, while non-chordates have a solid ventral nerve cord.

---

190. Match List I with List II:

List I	Epithelial Type	List II	Associated Organ
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-II, B-I, C-IV, D-III

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

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

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

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

Solution:

Step 1: Understanding List I (Epithelial Types)

- Unicellular glandular epithelium (A-III): Found in the goblet cells of the alimentary canal, responsible for mucus secretion.

- Compound epithelium (B-IV): Located on the moist surface of the buccal cavity, providing protection.

- Multicellular glandular epithelium (C-I): Present in salivary glands, where it secretes saliva.

- Endocrine glandular epithelium (D-II): Found in the pancreas, which has both endocrine and exocrine functions.

Step 2: Matching with List II

- A-III: Unicellular glandular epithelium → Goblet cells in the alimentary canal.

- B-IV: Compound epithelium → Moist surface of the buccal cavity.

- C-I: Multicellular glandular epithelium → Salivary glands.

- D-II: Endocrine glandular epithelium → Pancreas.

Step 3: Verifying the Correct Match

- The correct match (A-III, B-IV, C-I, D-II) corresponds to option (4).

Step 4: Conclusion

The correct matching of the items confirms that option (4) is the correct answer.

Quick Tip

- Unicellular Glandular Epithelium: Found in goblet cells, secreting mucus. - Compound Epithelium: Provides protection and is present in the buccal cavity. - Multicellular Glandular Epithelium: Found in exocrine glands like salivary glands. - Endocrine Glandular Epithelium: Found in hormone-secreting glands like the pancreas.

---

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

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

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

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

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

Solution:

Step 1: Understanding List I (ECG Waves)

- P wave (A-III): Represents the depolarisation of the atria, which leads to atrial contraction.

- QRS complex (B-II): Represents the depolarisation of the ventricles, which triggers ventricular contraction.

- T wave (C-IV): Represents the repolarisation of the ventricles, signaling their recovery.

- T-P gap (D-I): Indicates the phase when the heart muscles are electrically silent, corresponding to diastole.

Step 2: Matching with List II

- A-III: P wave $\rightarrow$ Depolarisation of the atria.

- B-II: QRS complex $\rightarrow$ Depolarisation of the ventricles.

- C-IV: T wave $\rightarrow$ Repolarisation of the ventricles.

- D-I: T-P gap $\rightarrow$ Heart muscles are electrically silent during diastole.

Step 3: Verifying the Correct Match

- The correct match (A-III, B-II, C-IV, D-I) corresponds to option (3).

Step 4: Conclusion

The correctly matched list confirms that option (3) is the right answer.

Quick Tip

- P wave: Represents atrial depolarisation (atrial contraction). - QRS complex: Represents ventricular depolarisation (ventricular contraction). - T wave: Represents ventricular repolarisation (ventricular relaxation). - T-P gap: Represents the time when heart muscles are electrically silent.

---

192. Match List I with List II:

	List I		List II
A.	Exophthalmic goiter	I.	Excess secretion of cortisol, moon face & hypergylcemia.
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-I, D-II

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

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

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

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

Solution:

Step 1: Understanding List I (Diseases)

- Exophthalmic goiter (A-III): Caused by an overproduction of thyroid hormones, leading to protruding eyeballs.

- Acromegaly (B-IV): Caused by excessive secretion of growth hormone, resulting in abnormal bone growth.

- Cushing's syndrome (C-I): Results from elevated cortisol levels, which can cause symptoms like a "moon face" and hyperglycemia.

- Cretinism (D-II): Caused by insufficient thyroid hormone secretion, leading to stunted growth and intellectual disability.

Step 2: Matching with List II

- A-III: Exophthalmic goiter $\rightarrow$ Overproduction of thyroid hormone protruding eyeballs.

- B-IV: Acromegaly $\rightarrow$ Excessive secretion of growth hormone.

- C-I: Cushing's syndrome $\rightarrow$ High cortisol secretion, leading to a "moon face" hyperglycemia.

- D-II: Cretinism → Insufficient thyroid hormone secretion and stunted growth.

Step 3: Verifying the Correct Match

- The correct match (A-III, B-IV, C-I, D-II) corresponds to option (1).

Step 4: Conclusion

The correct matching of the diseases confirms that option (1) is the correct answer.

Quick Tip

- Exophthalmic goiter: Results from overactive thyroid, causing bulging eyes. - Acromegaly: Caused by excessive GH secretion in adults, leading to enlarged features. - Cushing's syndrome: High cortisol levels cause weight gain, hyperglycemia, and facial puffiness. - Cretinism: Hypothyroidism in children leads to severe developmental issues.

---

193. Match List I with List II:

List I	**List II**
A. Mesozoic Era	I. Lower invertebrates
B. Proterozoic Era	II. Fish & Amphibia
C. Cenozoic Era	III. Birds & Reptiles
D. Paleozoic Era	IV. Mammals

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding List I (Eras of Earth)

- Mesozoic Era (A-III): This era is often called the "Age of Reptiles" as dinosaurs dominated, and birds evolved.

- Proterozoic Era (B-I): This era saw the evolution of lower invertebrates, including primitive

multicellular organisms.

- Cenozoic Era (C-IV): The ”Age of Mammals” where mammals diversified and became dominant.

- Paleozoic Era (D-II): The era of Fish & Amphibia, as early vertebrates first appeared.

Step 2: Matching with List II

- A-III: Mesozoic Era → Birds & Reptiles.

- B-I: Proterozoic Era → Lower Invertebrates.

- C-IV: Cenozoic Era → Mammals.

- D-II: Paleozoic Era → Fish & Amphibia.

Step 3: Verifying the Correct Answer

- The correct matching (A-III, B-I, C-IV, D-II) aligns with option (1).

Step 4: Conclusion

The correctly matched list validates option (1) as the correct answer.

Quick Tip

- Mesozoic Era: Dominated by reptiles, first birds evolved. - Proterozoic Era: Earliest multicellular life, lower invertebrates appeared. - Cenozoic Era: Age of mammals and their dominance. - Paleozoic Era: Emergence of fish, amphibians, and first land plants.

---

194. Match List I with List II related to the digestive system of cockroach:

List I	**List II**
A. The structures used for storing of food	I. Gizzard
B. Ring of 6-8 blind tubules at junction of foregut and midgut.	II. Gastric Caeca
C. Ring of 100-150 yellow coloured thin filaments at junction of midgut and hindgut.	III. Malpighian tubules
D. The structures used for grinding the food.	IV. Crop

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding List I Terms

- Storage of food in cockroach occurs in the Crop (A-IV).

- Gastric Caeca (B-II) are 6-8 blind tubules that help in digestion.

- Malpighian tubules (C-III) are excretory organs that function at the midgut-hindgut junction.

- Grinding of food is performed by the Gizzard (D-I).

Step 2: Matching with List II

- A-IV: Crop stores food in the digestive system of cockroach.

- B-II: Gastric Caeca are involved in digestion at the foregut-midgut junction.

- C-III: Malpighian tubules excrete nitrogenous wastes.

- D-I: The gizzard is responsible for grinding the food.

Step 3: Verifying the Correct Answer

- The correct matching (A-IV, B-II, C-III, D-I) aligns with option (2).

Step 4: Conclusion

The correctly matched list validates option (2) as the correct answer.

Quick Tip

- Crop stores food before digestion. - Gastric Caeca secretes digestive enzymes. - Malpighian tubules are excretory in function. - Gizzard helps in grinding food particles.

---

195. 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 incorrect but Statement II is correct.

(2) Both Statement I and Statement II are correct.

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

(4) Statement I is correct but Statement II is incorrect.

Correct Answer: (2) Both Statement I and Statement II are correct.

Solution:

Step 1: Understanding the Role of Bone Marrow

- Bone marrow is the primary lymphoid organ responsible for the production of all blood cells, including lymphocytes (B-cells and precursor T-cells).
- It is the main site of hematopoiesis, where all types of blood cells are generated.

Step 2: Understanding the Role of the Thymus

- The thymus provides a specialized environment for the maturation of T-lymphocytes (T-cells).
- Precursor T-cells, produced in the bone marrow, travel to the thymus, where they undergo differentiation and selection.

Step 3: Evaluating the Given Statements

- Statement I is correct: Bone marrow is the location where all blood cells, including lymphocytes, are produced.
- Statement II is correct: Both bone marrow (for production) and thymus (for maturation) are essential in T-lymphocyte development.

Step 4: Evaluating the Given Options

- Option (1): Incorrect. Statement I is correct.
- Option (2): Correct. Both statements are accurate.
- Option (3): Incorrect. Both statements are correct.
- Option (4): Incorrect. Statement II is also correct.

Step 5: Conclusion

Since both Statement I and Statement II are accurate, the correct answer is option (2).

Quick Tip

- Bone marrow is the primary site for blood cell formation, including B and T cell precursors. - Thymus is responsible for the maturation of T-lymphocytes, ensuring immune competence. - B-lymphocytes mature within the bone marrow, whereas T-lymphocytes mature in the thymus.

196. Match List I with List II:

List I	**Description**	**List II**	**Description**
A.	RNA polymerase III	I.	snRNPs
B.	Termination of transcription	II.	Promoter
C.	Splicing of Exons	III.	Rho factor
D.	TATA box	IV.	SnRNAs, tRNA

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding List I Terms

- RNA polymerase III is responsible for transcribing tRNA and small nuclear RNAs (snRNAs).

- The termination of transcription is facilitated by the Rho factor, a protein involved in the process.

- Splicing of exons is mediated by snRNPs (small nuclear ribonucleoproteins).

- The TATA box is a DNA sequence that acts as a promoter region for gene transcription.

Step 2: Matching with List II

- A-IV: RNA polymerase III $\rightarrow$ Responsible for transcribing tRNA and snRNAs.

- B-III: Rho factor $\rightarrow$ Assists in transcription termination.

- C-I: snRNPs → Involved in the splicing of exons.

- D-II: TATA box → Serves as a promoter for gene transcription.

Step 3: Verifying the Correct Match

- The correct match (A-IV, B-III, C-I, D-II) corresponds to option (1).

Step 4: Conclusion

The correct matching confirms that option (1) is the right answer.

Quick Tip

- RNA Polymerase III transcribes tRNA and other small RNAs.
- Rho-dependent termination is seen in prokaryotic transcription.
- Splicing is crucial for removing introns and joining exons.
- TATA Box is a promoter element in eukaryotic transcription.

---

197. Choose the correct statement given below regarding juxta medullary nephron.

(1) Juxta medullary nephrons outnumber the cortical nephrons.

(2) Juxta medullary nephrons are located in the columns of Bertini.

(3) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.

(4) Loop of Henle of juxta medullary nephron runs deep into medulla.

Correct Answer: (4) Loop of Henle of juxta medullary nephron runs deep into medulla.

Solution:

Step 1: Understanding Juxta Medullary Nephrons

- Juxta medullary nephrons account for only 15-20% of the total nephrons in the kidney, whereas cortical nephrons are more abundant.

- They play a vital role in the concentration of urine by facilitating significant water reabsorption.

Step 2: Evaluating the Given Statements

- Statement (1): Incorrect. Juxta medullary nephrons are less numerous than cortical nephrons.

- Statement (2): Incorrect. Juxta medullary nephrons are not found in the columns of Bertini, which are the extensions of the renal cortex between the pyramids.

- Statement (3): Incorrect. The renal corpuscle of juxta medullary nephrons is located at the cortico-medullary junction, not in the outer medulla.
- Statement (4): Correct. The Loop of Henle in juxta medullary nephrons extends deep into the renal medulla, which is crucial for water conservation and the concentration of urine.

Step 3: Conclusion

Since statement (4) is the only correct one, the correct answer is option (4).

Quick Tip

- Juxta medullary nephrons are fewer than cortical nephrons but are essential for urine concentration.
- Their Loop of Henle extends deep into the medulla, allowing the kidney to produce highly concentrated urine.
- They are located at the cortico-medullary junction, while cortical nephrons are located in the outer cortex.

---

198. Given below are two statements:

Statement I: Mitochondria and chloroplasts both double membranes 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 incorrect but Statement II is correct.

(2) Both Statement I and Statement II are correct.

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

(4) Statement I is correct but Statement II is incorrect.

Correct Answer: (4) Statement I is correct but Statement II is incorrect.

Solution:

Step 1: Understanding Mitochondria and Chloroplasts

- Both mitochondria and chloroplasts are double-membrane-bound organelles found in eukaryotic cells.
- Mitochondria are responsible for cellular respiration, while chloroplasts carry out

photosynthesis in plant cells.

- The presence of double membranes in both organelles supports the endosymbiotic theory, suggesting their evolutionary origin from free-living prokaryotes.

Step 2: Evaluating the Permeability of Mitochondrial and Chloroplast Membranes

- The inner membrane of mitochondria is highly selective, containing specialized transport proteins, making it relatively impermeable.

- In contrast, the inner membrane of chloroplasts is also selective, but it permits the passage of small molecules and ions more freely than the mitochondrial membrane.

- Therefore, Statement II is incorrect, as the inner mitochondrial membrane is more impermeable compared to the chloroplast membrane.

Step 3: Evaluating the Given Options

- Option (1): Incorrect. Statement I is correct.

- Option (2): Incorrect. Statement II is incorrect.

- Option (3): Incorrect. Statement I is accurate.

- Option (4): Correct. Statement I is true, but Statement II is false.

Step 4: Conclusion

Since Statement I is correct (both mitochondria and chloroplasts have double membranes), but Statement II is incorrect (the inner mitochondrial membrane is more impermeable than the chloroplast's), the correct answer is option (4).

Quick Tip

- Mitochondria and chloroplasts have double membranes and their own DNA, supporting the endosymbiotic theory.

- The inner mitochondrial membrane is highly impermeable due to specific transport proteins.

- The inner chloroplast membrane is less restrictive, allowing some molecules to pass.

---

199. 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) E, D, C, B, A

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

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

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

Correct Answer: (2) E, A, D, C, B

Solution:

Step 1: Understanding the Enzyme Catalytic Cycle

- Enzymes catalyze reactions by binding to substrates and facilitating the transformation through specific, sequential steps.

- The correct order of these steps includes substrate recognition, binding, transformation, and product release.

Step 2: Correct Order of Steps

- Step 1: The substrate initially binds to the enzyme's active site (E).

- Step 2: This forms a substrate-enzyme complex (A).

- Step 3: The enzyme catalyzes the breaking of the substrate's chemical bonds (D), leading to the formation of the product.

- Step 4: The products are then released from the enzyme (C).

- Step 5: The enzyme is free to bind with a new substrate (B).

Step 3: Evaluating the Given Options

- Option (1): Incorrect (sequence is wrong).

- Option (2): Correct (E $\rightarrow$ A $\rightarrow$ D $\rightarrow$ C $\rightarrow$ B).

- Option (3): Incorrect (random order of steps).

- Option (4): Incorrect (incorrect sequence).

Step 4: Conclusion

The correct sequence of enzyme action is E $\rightarrow$ A $\rightarrow$ D $\rightarrow$ C $\rightarrow$ B, so the correct answer is option (2).

Quick Tip

- Enzymes follow a lock-and-key or induced-fit model for substrate binding. - The active site binds the substrate and facilitates its conversion into products. - After the reaction, the enzyme is released unchanged and can participate in further reactions.

---

200. 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^A/ii

B. I^BI^B/I^Aii

C. I^AI^B/I^AI^B

D. I^Ai/I^BI^A

E. iiI^B/I^AI^B

Choose the most appropriate answer from the options given below:

(1) D & E only

(2) A only

(3) B only

(4) C & B only

Correct Answer: (2) A only

Solution:

Step 1: Understanding the ABO Blood Grouping System

- Blood group is determined by the IA, IB, and i alleles.

- A person with blood group A can have the genotypes IAIA or IAi.

- A person with blood group B can have the genotypes IBIB or IBi.

- A person with blood group O must have the genotype ii (homozygous recessive).

Step 2: Evaluating the Blood Groups of the Parents

- Father has a B^+ blood group $\rightarrow$ Possible genotypes: IBIB or IBi.

- Mother has an A^+ blood group $\rightarrow$ Possible genotypes: IAIA or IAi.

- Child has an O^+ blood group $\rightarrow$ The only possible genotype for the child is ii.

Step 3: Determining the Parental Genotypes

- The child has the ii genotype, meaning they inherited one 'i' allele from each parent.

- Therefore, both parents must carry the 'i' allele, meaning their genotypes must be IAi (mother) and IBi (father).

Step 4: Evaluating the Given Options

- Option A (IB IA / ii) $\rightarrow$ Correct, as it represents the correct possible genotypes for the parents.

- Options B, C, D, and E $\rightarrow$ Incorrect, as they either contain incorrect allele combinations or do not allow for the child's ii genotype.

Step 5: Conclusion

Since the correct representation is option (A), the correct answer is option (2) A only.

Quick Tip

- Blood group O individuals must inherit two 'i' alleles (one from each parent). - The presence of 'i' in both parents confirms they must be heterozygous (IAi and IBi). - Rh factor (positive or negative) is inherited separately from the ABO system.
