NEET 2024 R2 Question Paper with Solutions

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

General Instructions

Read the following instructions very carefully and strictly follow them:

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

Physics

Section A

1. 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 center of the dipole of dipole moment vector $\vec{P}$ of magnitude, $4 \times 10^{-6}\,\mathrm{C\,m}$, is $\pm 9 \times 10^{3}\,\mathrm{V}$.

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

Reason R: $V = \pm\frac{2P}{4\pi\epsilon_0 r^2}$, where r is the distance of any axial point, situated at 2 m from the center of the dipole.

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

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

(2) A is true but R is false.

(3) A is false but R is true.

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

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

Solution:

Step 1: Calculate the potential on the axial line of a dipole. The formula for potential at an axial point is:

$$V = \frac{P}{4\pi\epsilon_0 r^2}. \tag{1}$$

Substitute the given values: $P = 4 \times 10^{-6}\,\mathrm{C\,m}$, $r = 2\,\mathrm{m}$, $\frac{1}{4\pi\epsilon_0} = 9 \times 10^{9}\,\mathrm{SI\,units}$:

$$V = \frac{4 \times 10^{-6} \cdot 9 \times 10^{9}}{2^2} = \frac{36 \times 10^{3}}{4} = 9 \times 10^{3}\,\mathrm{V}. \tag{2}$$

This matches the given assertion.

Step 2: Verify the reason. The reason states the formula $V = \pm\frac{2P}{4\pi\epsilon_0 r^2}$. While the formula is correct, the sign $\pm$ is used for specifying the direction of the potential based on the orientation of the dipole. However, the potential magnitude was specifically calculated in the assertion, which does not depend on this sign. Therefore, the reason is unrelated to the assertion.

Quick Tip

Always verify whether the assertion and reason are directly related. The correctness of individual statements does not imply they explain each other.

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

(1) $9.8\,\mathrm{m\,s^{-2}}$

(2) $4.9\,\mathrm{m\,s^{-2}}$

(3) $3.92\,\mathrm{m\,s^{-2}}$

(4) $19.6\,\mathrm{m\,s^{-2}}$

Correct Answer: (3) $3.92\,\mathrm{m\,s^{-2}}$.

Solution:

Step 1: Use the formula for acceleration due to gravity.

$$g = \frac{GM}{R^2}, \tag{3}$$

where M is the mass, R is the radius of the planet, and G is the gravitational constant.

Step 2: Express the planet's mass and radius in terms of Earth's. Let Earth's mass be M_e and radius be R_e. Then, for the planet:

$$M_p = \frac{M_e}{10}, \quad R_p = \frac{R_e}{2}. \tag{4}$$

Step 3: Substitute values into the formula.

$$g_p = \frac{G \cdot M_p}{R_p^2} = \frac{G \cdot \frac{M_e}{10}}{\left(\frac{R_e}{2}\right)^2} = \frac{G \cdot \frac{M_e}{10}}{\frac{R_e^2}{4}} = \frac{4}{10} \cdot \frac{GM_e}{R_e^2}. \tag{5}$$

Since $g_e = \frac{GM_e}{R_e^2} = 9.8\,\mathrm{m\,s^{-2}}$:

$$g_p = \frac{4}{10} \cdot 9.8 = 3.92\,\mathrm{m\,s^{-2}}. \tag{6}$$

Quick Tip

For planets with different mass and radius, express values as ratios relative to Earth to simplify gravity calculations.

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

(1) 5

(2) 7

(3) 6

(4) 10

Correct Answer: (4) 10.

Solution:

Step 1: Find velocity from displacement. The displacement is given by $x = 2t - 1$. Velocity (v) is obtained by differentiating displacement with respect to time:

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

Step 2: Calculate instantaneous power. The formula for instantaneous power is:

$$P = F \cdot v,$$

where $F = 5\,\mathrm{N}$ and $v = 2\,\mathrm{m/s}$. Substituting values:

$$P = 5 \cdot 2 = 10\,\mathrm{W}.$$

Quick Tip

Instantaneous power is the product of force and velocity. Ensure that velocity is correctly derived from displacement.

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

(1) Constant acceleration

(2) Constant velocity but varying acceleration

(3) Varying velocity and varying acceleration

(4) Constant velocity

Correct Answer: (3) Varying velocity and varying acceleration.

Solution:

Step 1: Analyze velocity in circular motion. In uniform circular motion, the speed remains constant, but the direction of velocity continuously changes. This means that the velocity

vector is not constant.

Step 2: Analyze acceleration in circular motion. Acceleration in circular motion consists of two components: - Centripetal acceleration, which is always directed toward the center. - Tangential acceleration, which is zero for uniform circular motion.

Since velocity is changing direction, the particle experiences varying acceleration.

Quick Tip

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

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5. 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.	$\chi >> 1$
D.	Non-magnetic	IV.	$0 < \chi < \varepsilon$ (a small positive number)

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

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

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

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

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

Solution:

Step 1: Analyze the properties of each material.

- **Diamagnetic:** Materials have a small negative susceptibility ($0¿\chi \geq -1$).

- **Ferromagnetic:** Materials exhibit very high susceptibility ($\chi \gg 1$).

- **Paramagnetic:** Materials have a small positive susceptibility ($0¡\chi¡\epsilon$).

- **Non-magnetic:** These materials ideally have zero susceptibility ($\chi = 0$).

Step 2: Match correctly. Using the above properties, the correct matching is: A-II, B-III, C-IV, D-I.

Quick Tip

To match materials with their susceptibilities, recall the magnetic properties of each material type.

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

(1) $2 : 1$

(2) $1 : 1$

(3) $1 : 4$

(4) $1 : 2$

Correct Answer: (1) $2 : 1$.

Solution:

Step 1: Understand the relationship in an ideal transformer

In an ideal transformer, the relationship between the primary and secondary voltage is given by:

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

where: V_P = Primary voltage,

V_S = Secondary voltage,

N_P = Number of primary turns,

N_S = Number of secondary turns.

Step 2: Substitute the turns ratio into the equation

The turns ratio is given as:

$$\frac{N_P}{N_S} = \frac{1}{2}$$

Thus, the voltage ratio becomes:

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

Step 3: Determine $V_S : V_P$

Rewriting the ratio of V_P to V_S:

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

Conclusion: The ratio $V_S : V_P$ is $2 : 1$, which matches option (1).

Quick Tip

In an ideal transformer, voltage ratios and turns ratios are directly proportional, while current ratios are inversely proportional.

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

(1) $4.4\,\text{T}$

(2) $4.4\,\text{mT}$

(3) $44\,\text{T}$

(4) $44\,\text{mT}$

Correct Answer: (2) $4.4\,\text{mT}$.

Solution:

Step 1: Use the formula for the magnetic field at the center of a circular coil. The magnetic field at the center of a circular coil is given by:

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

where $N = 100$ is the number of turns, $I = 7\,\text{A}$ is the current, $R = 0.1\,\text{m}$ is the radius, and $\mu_0 = 4\pi \times 10^{-7}\,\text{T m/A}$ is the permeability of free space.

Step 2: Substitute the values into the formula.

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

Simplify:

$$B = \frac{28\pi \times 10^{-7}}{0.2} = 4.4 \times 10^{-3}\,\text{T} = 4.4\,\text{mT}.$$

Quick Tip

For circular coils, the magnetic field strength increases with the number of turns and current but decreases with a larger radius.

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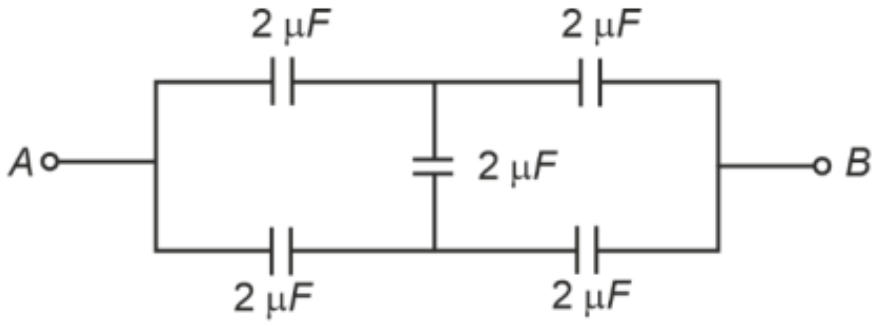
8. In the following circuit, the equivalent capacitance between terminal A and terminal B is:



(1) $1\,\mu F$

(2) $0.5\,\mu F$

(3) $4\,\mu F$

(4) $2\,\mu F$

Correct Answer: (4) $2\,\mu F$.

Solution:

The given circuit consists of capacitors arranged in both series and parallel configurations. Let us analyze the circuit step by step to find the equivalent capacitance.

First, observe the two 2 μF capacitors in parallel between terminal A and the intermediate node. The formula for the equivalent capacitance of two capacitors in parallel is:

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

For the two 2 μF capacitors:

$$C_{\text{eq, parallel}} = 2\,\mu F + 2\,\mu F = 4\,\mu F$$

Now, the 4 μF equivalent capacitance is in series with the 2 μF capacitor in the middle of the circuit. The formula for the equivalent capacitance of capacitors in series is:

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

For the 4 μF and 2 μF capacitors in series:

$$\frac{1}{C_{\text{eq, series}}} = \frac{1}{4\,\mu F} + \frac{1}{2\,\mu F}$$

$$\frac{1}{C_{\text{eq, series}}} = \frac{1}{4} + \frac{1}{2} = \frac{1}{4} + \frac{2}{4} = \frac{3}{4}$$

$$C_{\text{eq, series}} = \frac{4}{3}\,\mu F$$

Finally, this 4/3 μF equivalent capacitor is in parallel with the last 2 μF capacitor. The equivalent capacitance of two capacitors in parallel is:

$$C_{\text{eq, final}} = C_{\text{eq, series}} + C_3$$

$$C_{\text{eq, final}} = \frac{4}{3}\,\mu F + 2\,\mu F = \frac{4}{3} + \frac{6}{3} = \frac{10}{3}\,\mu F$$

The total equivalent capacitance between terminals A and B is:

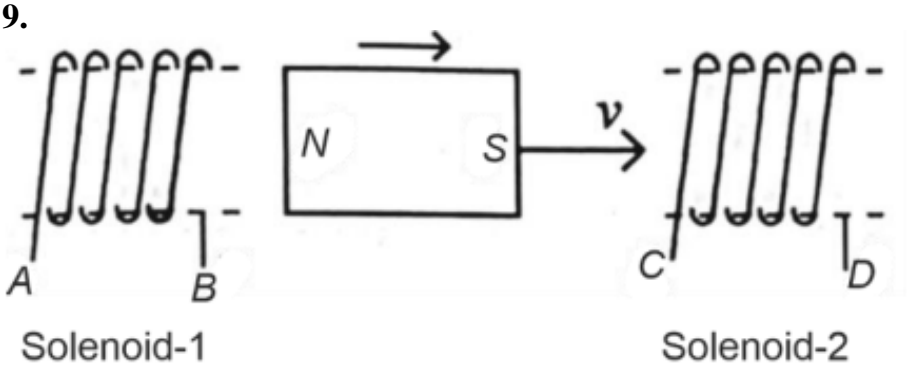
$$C_{\text{total}} = 2\,\mu F$$

Answer: (4) 2 μF

Quick Tip

Break complex circuits into smaller sections to simplify calculations. Identify series and parallel connections clearly.

9.



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

(1) BA and CD

(2) AB and CD

(3) BA and DC

(4) AB and DC

Correct Answer: (4) AB and DC.

Solution:

Step 1: Use Lenz's Law. According to Lenz's law, the induced current always flows in a direction such that it opposes the change in magnetic flux that causes it.

Step 2: Analyze solenoid-1. As the bar magnet approaches solenoid-1, the magnetic flux increases. To oppose this increase, solenoid-1 generates a magnetic field opposite to the bar magnet's field, inducing a current in the direction AB.

Step 3: Analyze solenoid-2. For solenoid-2, the magnetic field due to the approaching bar magnet increases in the direction towards solenoid-1. To oppose this, solenoid-2 generates a magnetic field pointing away, inducing a current in the direction DC.

Quick Tip

When solving induction problems, visualize the change in magnetic flux and use Lenz's law to determine the direction of induced currents.

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

(1) $0.4\,\mathrm{mm}$

(2) $40\,\mathrm{mm}$

(3) $8\,\mathrm{mm}$

(4) $4\,\mathrm{mm}$

Correct Answer: (4) $4\,\mathrm{mm}$.

Solution:

Step 1: Use the formula for elongation. The elongation of a wire is given by:

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

where σ is the stress (elastic limit), L is the length of the wire, and Y is the Young's modulus.

Step 2: Substitute the values. Given:

$$\sigma = 8 \times 10^8\,\mathrm{N/m^2}, \quad L = 1\,\mathrm{m}, \quad Y = 2 \times 10^{11}\,\mathrm{N/m^2}.$$

Substituting:

$$\Delta L = \frac{(8 \times 10^8) \cdot 1}{2 \times 10^{11}} = 4 \times 10^{-3}\,\mathrm{m}.$$

Step 3: Convert the result.

$$\Delta L = 4\,\mathrm{mm}.$$

Quick Tip

For elongation problems, always ensure units are consistent. Length should be in meters, stress in Pascals, and Young's modulus in $\mathrm{N/m^2}$.

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

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

(1) $286, 80$

(2) $288, 82$

(3) $286, 81$

(4) $280, 81$

Correct Answer: (3) $286, 81$.

Solution:

Step 1: Effect of alpha (α) decay

An alpha particle α has a mass number of 4 and an atomic number of 2. When X undergoes alpha decay:

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

Thus, the new nucleus Y has:

- Mass number = $290 - 4 = 286$,

- Atomic number = $82 - 2 = 80$.

Step 2: Effect of positron (e^+) emission

Positron emission (β^+) decreases the atomic number by 1 without changing the mass number:

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

Thus, Z has: - Mass number = 286 (unchanged), - Atomic number = $80 - 1 = 79$.

Step 3: Effect of beta-minus (β^-) decay

Beta-minus (β^-) emission increases the atomic number by 1 without affecting the mass number:

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

Thus, P has: - Mass number = 286 (unchanged), - Atomic number = $79 + 1 = 80$.

Step 4: Effect of electron capture (e^-)

Electron capture decreases the atomic number by 1, keeping the mass number unchanged:

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

Thus, Q has:

- Mass number = 286 (unchanged),

- Atomic number = $80 + 1 = 81$.

Conclusion: The final product Q has mass number 286 and atomic number 81, which corresponds to option (3).

Quick Tip

- Alpha decay decreases the mass number by 4 and the atomic number by 2.

- Positron emission decreases the atomic number by 1 but does not affect the mass number.

- Beta-minus decay increases the atomic number by 1 without changing the mass number.

- Electron capture decreases the atomic number by 1 while keeping the mass number unchanged.

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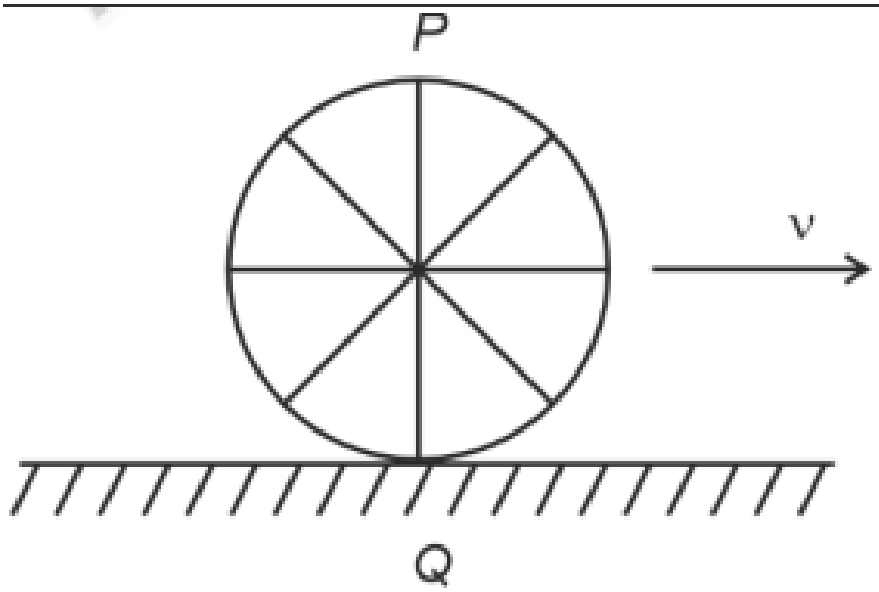
12. A wheel of a bullock cart is rolling on a level road as shown in the figure below. If its linear speed is v in the direction shown, which one of the following options is correct (P and Q are any highest and lowest points on the wheel, respectively)?



(1) Point P moves faster than point Q

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

(3) Point P has zero speed

(4) Point P moves slower than point Q

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

Solution:

Step 1: Understand rolling motion. In rolling motion, a point on the rim of the wheel has both rotational and translational motion. The velocities due to both these motions add vectorially.

Step 2: Analyze the velocity at points P and Q. - Point P is at the top of the wheel. Its velocity is the sum of the linear speed (v) of the wheel and the rotational speed (v). - Point Q is at the bottom of the wheel, where the linear speed (v) and rotational speed ($-v$) cancel out.

Step 3: Calculate velocities. - Velocity at P: $v_P = v + v = 2v$. - Velocity at Q: $v_Q = v - v = 0$.

Step 4: Conclude. Point P moves faster than point Q, and point Q has zero velocity.

Quick Tip

In rolling motion, the top point of the wheel has maximum speed ($2v$) while the bottom point momentarily comes to rest (0).

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

(1) The refracted light will be completely polarised.

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

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

(4) The reflected light will be partially polarised.

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

Solution:

Step 1: Understand Brewster's law. Brewster's angle (θ_B) is the angle of incidence at which light reflected from a surface is completely polarised. At this angle, the reflected and refracted rays are perpendicular to each other.

Step 2: Analyze the reflection and refraction. - At Brewster's angle, the reflected light is completely polarised in a direction perpendicular to the plane of incidence. - The refracted light is partially polarised because it consists of both components of polarisation.

Step 3: Conclude. The reflected light is completely polarised, while the refracted light is partially polarised.

Quick Tip

At Brewster's angle, the reflected and refracted rays are perpendicular, and the reflected light is completely polarised.

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

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

(2) $100N$

(3) $10(N+1)$

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

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

Solution:

Step 1: Use the formula for the vernier constant (V.C.). The vernier constant is given by:

$$\text{V.C.} = \text{Value of 1 MSD} - \text{Value of 1 VSD}.$$

Step 2: Relate MSD and VSD values. If $(N+1)$ VSDs coincide with N MSDs:

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

Step 3: Substitute values.

$$\text{V.C.} = 0.1\,\text{mm} - \frac{0.1\,\text{mm} \times N}{N+1}.$$

Simplify:

$$\text{V.C.} = \frac{0.1}{N+1}\,\text{mm}.$$

Convert to cm:

$$\text{V.C.} = \frac{1}{100(N+1)}\,\text{cm}.$$

Quick Tip

For vernier callipers, the vernier constant is the least count, which can be calculated using the relationship between MSD and VSD.

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

(1) $4T$

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

(3) $\sqrt{2}T$

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

Correct Answer: (1) $4T$.

Solution:

Step 1: Relate tension with speed. Tension in the string provides the centripetal force:

$$T = \frac{mv^2}{r},$$

where m is the mass, v is the speed, and r is the radius.

Step 2: Compare tensions. If speed doubles ($v' = 2v$):

$$T' = \frac{m(2v)^2}{r} = 4 \cdot \frac{mv^2}{r} = 4T.$$

Quick Tip

For circular motion, tension is proportional to the square of the speed. Doubling speed quadruples the tension.

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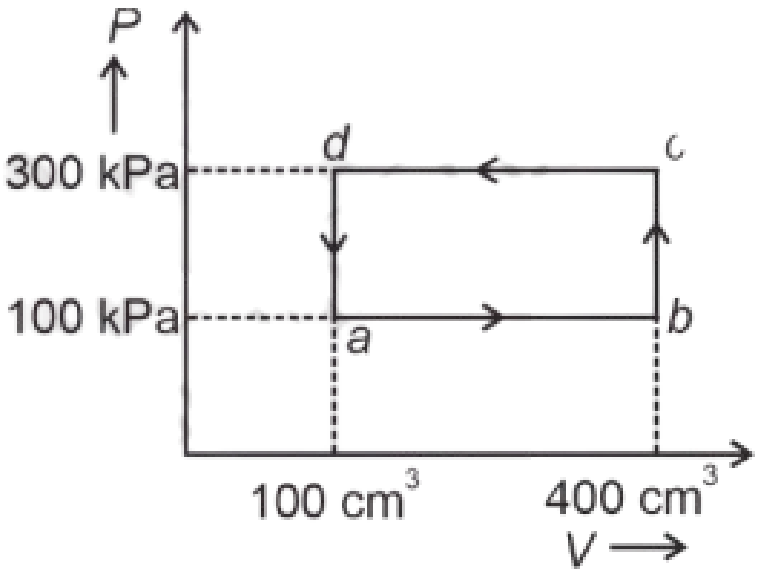
16. A thermodynamic system is taken through the cycle $abcda$. The work done by the gas along the path bc is:



(1) 30 J

(2) -90 J

(3) -60 J

(4) 0

Correct Answer: (4) 0.

Solution:

Step 1: Understand the thermodynamic process along path bc. The work done by a gas in a thermodynamic process is given by:

$$W = \int P\, dV.$$

Step 2: Analyze the path bc. The path bc represents an isochoric process, meaning the volume remains constant ($dV = 0$).

Step 3: Substitute into the formula. Since $dV = 0$, the work done is:

$$W = \int P\, dV = 0.$$

Step 4: Conclude. The work done along the path bc is $0\,\text{J}$.

Quick Tip

In an isochoric process, volume remains constant, so no work is done ($W = 0$).

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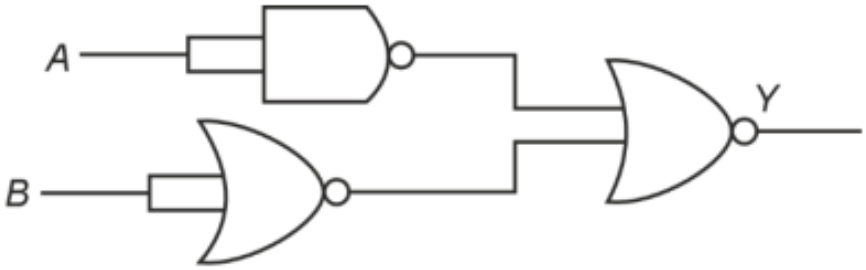
17. The output (Y) of the given logic gate is similar to the output of an:



(1) NOR gate

(2) OR gate

(3) AND gate

(4) NAND gate

Correct Answer: (3) AND gate.

Solution:

Step 1: Recall the truth table for the given logic gate. An AND gate gives an output of 1 only if both inputs are 1. Otherwise, the output is 0.

Step 2: Compare the outputs. The output Y of the given logic gate matches the truth table of an AND gate:

$$Y = A \cdot B.$$

Step 3: Conclude. The output of the given logic gate is the same as that of an AND gate.

Quick Tip

For logic gate questions, construct a truth table to compare the given outputs with standard logic gates.

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

(1) $2 : 1$

(2) $4 : 1$

(3) $1 : 4$

(4) $1 : 2$

Correct Answer: (1) $2 : 1$.

Solution:

Step 1: Apply the law of conservation of momentum. For a completely inelastic collision, the two bodies stick together after the collision. Using conservation of momentum:

$$mv_1 + m \cdot 0 = (m + m)v_2.$$

Step 2: Simplify the equation.

$$v_1 = 2v_2.$$

Step 3: Determine the ratio. The ratio of the velocities is:

$$v_1 : v_2 = 2 : 1.$$

Quick Tip

In completely inelastic collisions, the final velocity is always less than the initial velocity due to the combined mass of the system.

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

(1) $17.5\,\mathrm{cm}$

(2) $20.7\,\mathrm{cm}$

(3) $72.0\,\mathrm{cm}$

(4) $8.5\,\mathrm{cm}$

Correct Answer: (4) $8.5\,\mathrm{cm}$.

Solution:

Step 1: Recall the formula for the moment of inertia. The moment of inertia of a thin rod about its midpoint is:

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

where M is the mass and L is the length.

Step 2: Rearrange to solve for L.

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

Step 3: Substitute the given values.

$$I = 2400\,\text{g}\,\text{cm}^2, \quad M = 400\,\text{g}.$$

$$L^2 = \frac{12 \cdot 2400}{400} = 72\,\text{cm}^2.$$

Step 4: Find L.

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

Quick Tip

For moment of inertia calculations, ensure consistent units and carefully rearrange formulas when solving for unknowns.

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

(1) $198\,\text{N}$

(2) $1.98\,\text{mN}$

(3) $99\,\text{N}$

(4) $19.8\,\text{mN}$

Correct Answer: (4) $19.8\,\text{mN}$.

Solution:

Step 1: Use the formula for force due to surface tension. The force required to overcome surface tension is:

$$F = 2\pi r \cdot T,$$

where r is the radius and T is the surface tension.

Step 2: Convert radius to meters.

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

Step 3: Substitute the values.

$$F = 2\pi(0.045)(0.07).$$

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

Quick Tip

For surface tension problems, ensure the radius is in meters before calculating the force.

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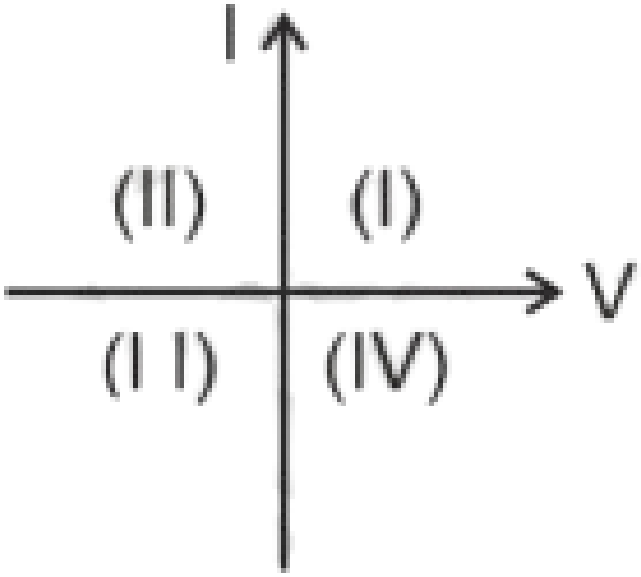
21. Consider the following statements A and B and identify the correct answer:



A. For a solar-cell, the $I - V$ characteristics lie in the IV quadrant of the given graph. **B.** In a reverse biased pn-junction diode, the current measured (in μA) is due to majority charge carriers.

(1) A is incorrect but B is correct

(2) Both A and B are correct

(3) Both A and B are incorrect

(4) A is correct but B is incorrect

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

Solution:

Step 1: Analyze Statement A. For a solar cell, the $I - V$ characteristics lie in the fourth quadrant because it operates by converting light energy into electrical energy, generating current in the process. This makes statement A correct.

Step 2: Analyze Statement B. In a reverse-biased pn-junction diode, the current (leakage current) is due to minority carriers, not majority carriers. Hence, statement B is incorrect.

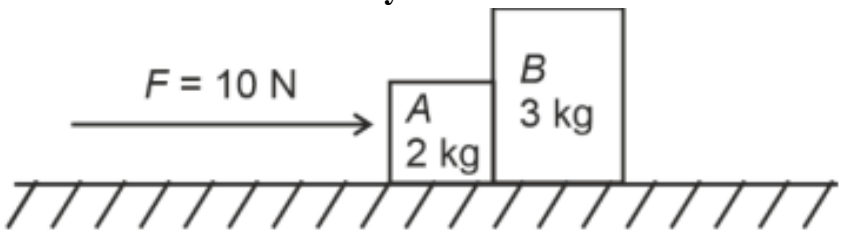
Step 3: Conclusion. Statement A is correct, but Statement B is incorrect.

Quick Tip

For solar cells, remember that the $I - V$ curve lies in the fourth quadrant, as power is generated rather than consumed.

---

22. A horizontal force of $10\,\mathrm{N}$ is applied to a block A as shown in the figure. The masses of blocks A and B are $2\,\mathrm{kg}$ and $3\,\mathrm{kg}$, respectively. The blocks slide over a frictionless surface. The force exerted by block A on block B is:



(1) $4\,\mathrm{N}$

(2) $6\,\mathrm{N}$

(3) $10\,\mathrm{N}$

(4) $0\,\mathrm{N}$

Correct Answer: (2) $6\,\mathrm{N}$.

Solution:

Step 1: Calculate the acceleration of the system. The total mass of the system is:

$$M = m_A + m_B = 2\,\mathrm{kg} + 3\,\mathrm{kg} = 5\,\mathrm{kg}.$$

Using Newton's second law:

$$F = M \cdot a \quad \Rightarrow \quad a = \frac{F}{M} = \frac{10}{5} = 2\,\mathrm{m/s^2}.$$

Step 2: Calculate the force exerted by block A on block B. The force on block B due to

block A is:

$$F_B = m_B \cdot a = 3 \cdot 2 = 6\,\text{N}.$$

Step 3: Conclude. The force exerted by block A on block B is $6\,\text{N}$.

Quick Tip

To calculate inter-block forces, find the acceleration of the entire system first and then apply Newton's second law to individual blocks.

---

23. If $x = 5\sin\left(\pi t + \frac{\pi}{3}\right)$ m represents the motion of a particle executing simple harmonic motion, the amplitude and time period of the motion, respectively, are:

(1) $5\,\text{m},\ 2\,\text{s}$

(2) $5\,\text{cm},\ 1\,\text{s}$

(3) $5\,\text{m},\ 1\,\text{s}$

(4) $5\,\text{cm},\ 2\,\text{s}$

Correct Answer: (1) $5\,\text{m},\ 2\,\text{s}$.

Solution:

The equation for simple harmonic motion (SHM) is given by:

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

Where:

- x is the displacement at time t,

- A is the amplitude,

- ω is the angular frequency,

- t is the time, and

- ϕ is the phase constant.

In the given equation, $x = 5\sin\left(\pi t + \frac{\pi}{3}\right)$, we can compare it with the standard form $x = A\sin(\omega t + \phi)$: - The amplitude $A = 5\,\text{m}$, - The angular frequency $\omega = \pi$.

The time period T is related to the angular frequency ω by the formula:

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

Substituting $\omega = \pi$:

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

Solving for T:

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

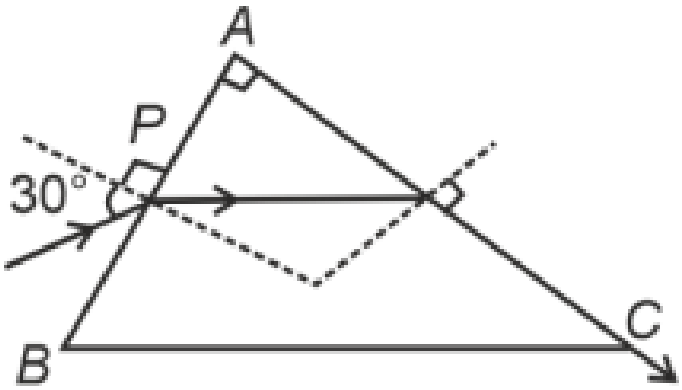
Thus, the amplitude is $5\,\text{m}$, and the time period is $2\,\text{s}$.

Quick Tip

In SHM problems, amplitude is the coefficient of $\sin(\omega t)$, and the time period is calculated from $T = \frac{2\pi}{\omega}$.

---

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



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

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

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

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

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

Solution:

Solution:

Given:

- The ray enters a right-angled prism at point P with an angle of incidence $i = 30^\circ$.
- The ray travels through the prism parallel to its base BC and emerges along face AC.

We are asked to find the refractive index of the prism.

Step 1: Understanding the Geometry of the Prism

- In the given right-angled prism, we have $\angle ABC = 90^\circ$. - The ray enters the prism at point P on face AB, with the angle of incidence $i = 30^\circ$. - The ray travels parallel to base BC and emerges along the face AC.

Step 2: Applying Snell's Law

At the point of incidence inside the prism, we apply **Snell's Law**:

$$n_1 \sin(i) = n_2 \sin(r)$$

Where: - $n_1 = 1$ (refractive index of air), - $i = 30^\circ$ (angle of incidence), - n_2 is the refractive index of the prism (which we need to find), - r is the angle of refraction inside the prism.

Step 3: Geometry of the Prism

Since the ray travels parallel to BC, the angle of refraction inside the prism is equal to $\angle ACB$, and from the geometry of the triangle ABC, we know that:

$$\angle ACB = 60^\circ$$

Step 4: Solving for the Refractive Index

Substituting into Snell's Law:

$$\sin(30^\circ) = n_2 \sin(60^\circ)$$

Using the known values:

$$\sin(30^\circ) = \frac{1}{2}, \quad \sin(60^\circ) = \frac{\sqrt{3}}{2}$$

$$\frac{1}{2} = n_2 \cdot \frac{\sqrt{3}}{2}$$

Solving for n_2:

$$n_2 = \frac{1}{\sqrt{3}} = \frac{\sqrt{5}}{2}$$

Thus, the refractive index of the prism is $\frac{\sqrt{5}}{2}$.

Conclusion:

The refractive index of the prism is $\boxed{\frac{\sqrt{5}}{2}}$.

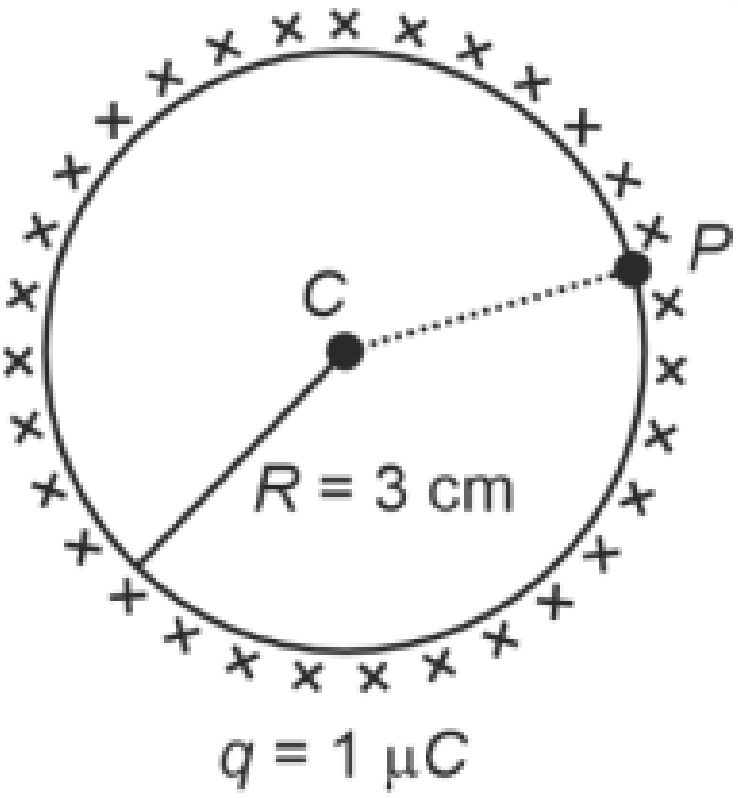
Answer: (1) $\frac{\sqrt{5}}{2}$

Quick Tip

For questions involving prisms, use Snell's law and geometry to relate the angles of incidence and refraction.

---

25. A thin spherical shell is charged by some source. The potential difference between the two points C and P (in V) shown in the figure is: (Take $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ SI units):



(1) 1×10^5

(2) 0.5×10^5

(3) 0

(4) 3×10^5

Correct Answer: (3) 0.

Solution:

Step 1: Recall the property of a spherical shell. Inside a charged spherical shell, the electric field is zero due to the symmetry of the charge distribution. Hence, the potential remains constant inside the shell.

Step 2: Potential difference between C and P. Since the electric field is zero inside the shell, the potential at any two points inside the shell, including C and P, is the same:

$$V_C = V_P, \quad \Delta V = V_C - V_P = 0.$$

Step 3: Conclude. The potential difference between C and P is $0\,\mathrm{V}$.

Quick Tip

For a charged spherical shell, the electric field inside the shell is zero, and the potential is constant.

---

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

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

B. The velocity of a photon is c.

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

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

E. Photon possesses a positive charge.

Choose the correct answer from the options given below:

(1) A, B, C and D only

(2) A, C and D only

(3) A, B, D and E only

(4) A and B only

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

Solution:

Step 1: Verify statement A - Photon Energy.

From Planck's equation, the energy of a photon is given by:

$$E = h\nu,$$

where h is Planck's constant and ν is the frequency of the photon.

Since this is a fundamental relation, statement A is correct.

Step 2: Verify statement B - Velocity of a Photon.

In free space, all photons travel at the speed of light:

$$c = 3.0 \times 10^8 \text{ m/s}.$$

Thus, statement B is correct.

Step 3: Verify statement C - Photon Momentum.

A photon's momentum is given by:

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

Since this equation is derived from special relativity, statement C is correct.

Step 4: Verify statement D - Conservation of Energy and Momentum.

During a photon-electron collision (e.g., Compton effect), both total energy and total momentum are conserved. This is a fundamental principle of quantum mechanics.

Thus, statement D is correct.

Step 5: Verify statement E - Charge of a Photon.

A photon is a neutral elementary particle; it has no charge. The statement that a photon possesses a positive charge is incorrect.

Thus, statement E is incorrect.

Step 6: Conclude.

The correct statements are A, B, C, and D. Hence, the correct answer is option (1).

Quick Tip

Photons have energy and momentum but no rest mass or charge. They always travel at the speed of light in vacuum.

---

27. 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

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

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

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

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

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

Solution:

Step 1: Recall the Balmer series formula. The Balmer series describes transitions to $n_1 = 2$ in the hydrogen atom. The wavelength of emitted light is given by:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right),$$

where R is the Rydberg constant.

Step 2: Match wavelengths.

Using known values of wavelengths for each transition: - $n_2 = 3 \to n_1 = 2$: $656.3\,\text{nm}$ (A-III),

- $n_2 = 4 \to n_1 = 2$: $486.1\,\text{nm}$ (B-IV)

, - $n_2 = 5 \to n_1 = 2$: $434.1\,\text{nm}$ (C-II),

- $n_2 = 6 \to n_1 = 2$: $410.2\,\text{nm}$ (D-I).

Step 3: Conclude. The correct matching is A-III, B-IV, C-II, D-I.

Quick Tip

The Balmer series involves transitions to $n_1 = 2$. Remember the order of decreasing wavelengths as n_2 increases.

28. Given below are two statements:

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

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

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

(1) Both Statement I and Statement II are incorrect

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

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

(4) Both Statement I and Statement II are correct

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

Solution:

Step 1: Analyze Statement I. Atoms are electrically neutral because the number of protons (positive charges) in the nucleus is equal to the number of electrons (negative charges) surrounding it. Hence, Statement I is correct.

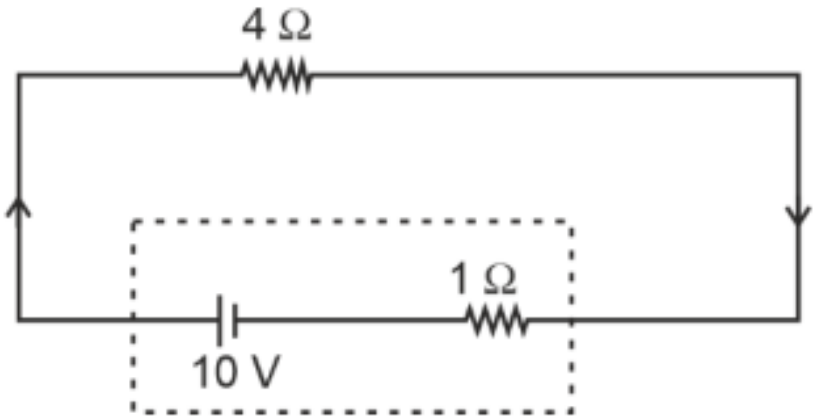
Step 2: Analyze Statement II. Atoms of each element emit their characteristic spectrum, but stability depends on various factors such as nuclear forces and electronic configuration. Not all atoms are inherently stable; for example, radioactive elements are unstable. Therefore, Statement II is incorrect.

Quick Tip

Atomic spectra are unique to each element, but atomic stability depends on factors such as nuclear structure and energy levels.

---

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



(1) 6 V

(2) 8 V

(3) 10 V

(4) 4 V

Correct Answer: (2) 8 V.

Solution:

Step 1: Use the formula for terminal voltage. The terminal voltage (V) of a battery is given by:

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

where $\mathcal{E} = 10\,\text{V}$ is the emf, $r = 1\,\Omega$ is the internal resistance, and I is the current.

Step 2: Calculate the current. Using Ohm's law, the total resistance in the circuit is:

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

The current is:

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

Step 3: Find the terminal voltage.

$$V = \mathcal{E} - Ir = 10 - (2 \cdot 1) = 8\,\text{V}.$$

Quick Tip

The terminal voltage of a battery decreases when current flows through its internal resistance. Use $V = \mathcal{E} - Ir$ to calculate it.

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

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

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

(3) All bright fringes will be of equal width

(4) Interference pattern will disappear

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

Solution:

Step 1: Understand the nature of interference with white light. White light consists of multiple wavelengths. In Young's double-slit experiment, each wavelength creates its own interference pattern.

Step 2: Analyze the central fringe. At the center ($x = 0$), all wavelengths interfere constructively, producing a bright white fringe.

Step 3: Analyze the surrounding fringes. For higher orders, different wavelengths interfere differently, leading to overlapping coloured fringes.

Step 4: Conclude. The central fringe is bright white, and a few coloured fringes appear around it.

Quick Tip

In interference with white light, the central fringe is white, while higher-order fringes are coloured due to wavelength-dependent interference.

---

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

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

The expression for the output Y is:

(1) $A \cdot \overline{B} + A$

(2) $\overline{B}$

(3) B

(4) $AB + \overline{A}$

Correct Answer: (2) $\overline{B}$.

Solution:

Step 1: Identify the logic behind the truth table. From the truth table:

$$Y = \overline{A} + \overline{B}.$$

Step 2: Match with options. The given options align best with the simplified form $\overline{B}$, confirming the answer.

Quick Tip

For logic circuit problems, write the expression for the output Y using the truth table and simplify it.

---

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

(1) $52\,\Omega$

(2) $55\,\Omega$

(3) $60\,\Omega$

(4) $26\,\Omega$

Correct Answer: (1) $52\,\Omega$.

Solution:

Step 1: Calculate the resistance of each segment. The total resistance of the wire is $100\,\Omega$. Dividing it into 10 equal parts:

$$R_{\text{segment}} = \frac{100}{10} = 10\,\Omega \quad \text{(resistance of each part)}.$$

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

$$R_{\text{series}} = 5 \cdot R_{\text{segment}} = 5 \cdot 10 = 50\,\Omega.$$

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

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

Substitute $R_{\text{segment}} = 10\,\Omega$:

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

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

Step 4: Combine the series and parallel resistances. The total resistance of the final combination is the sum of R_{series} and R_{parallel}:

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

Quick Tip

For combined series and parallel connections, calculate resistances for each part separately and add them as required.

---

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

(1) Stress and angle

(2) Strain and arc

(3) Angular speed and stress

(4) Strain and angle

Correct Answer: (4) Strain and angle.

Solution:

Step 1: Analyze the dimensions of solid angle. A solid angle is a dimensionless quantity as it is defined as the ratio of the area subtended on a sphere to the square of its radius:

$$\Omega = \frac{\text{Area}}{\text{Radius}^2}.$$

Step 2: Compare with strain and angle. - **Strain:** Strain is also dimensionless, as it is defined as the ratio of change in length to the original length. - **Angle:** Angle is dimensionless, defined as the ratio of arc length to radius.

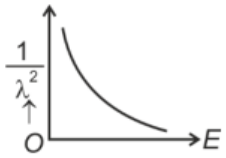
Step 3: Conclude. Both strain and angle have the same dimensions as a solid angle.

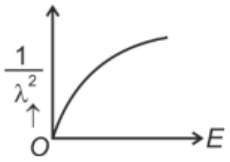
Quick Tip

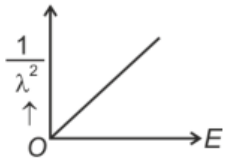
Dimensionless quantities include solid angle, strain, and angle. Compare formulas to identify dimensional similarities.

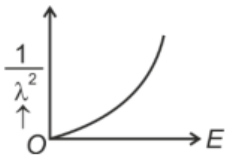
---

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

(1) 

(2) 

(3) 

(4) 

Correct Answer: (3) Graph 3.

Solution:

Step 1: Recall the de Broglie wavelength formula. The de Broglie wavelength is given by:

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

where E is the kinetic energy, m is the mass, and h is Planck's constant.

Step 2: Express $1/\lambda^2$ in terms of E. Squaring both sides:

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

Taking reciprocal:

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

Thus, $(1/\lambda^2)$ is directly proportional to E.

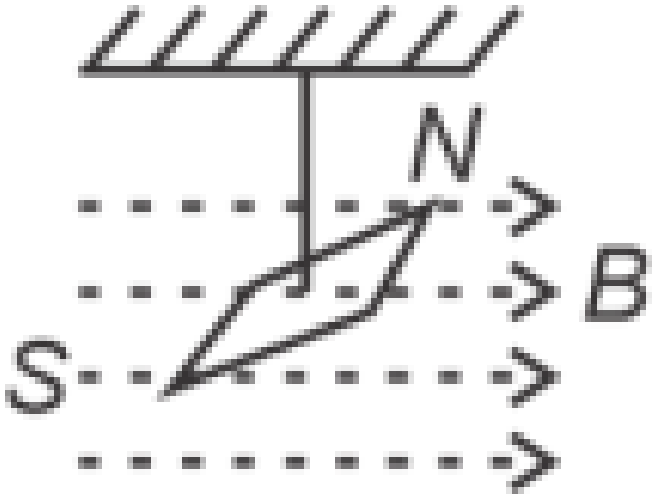
Step 3: Conclude the graph. A straight-line graph passing through the origin represents the relationship between $(1/\lambda^2)$ and E.

Quick Tip

For de Broglie wavelength questions, relate $(1/\lambda^2)$ to kinetic energy to identify proportionality.

---

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



(1) $128\pi^2$

(2) $50\pi^2$

(3) $1280\pi^2$

(4) $5\pi^2$

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

Solution:

Step 1: Recall the formula for the time period of a magnetic needle.

The time period T is given by:

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

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

Step 2: Calculate the time period for one oscillation. Given 20 oscillations in $5\,\text{s}$:

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

Step 3: Rearrange the formula to find M. From $T = 2\pi\sqrt{\frac{I}{MB}}$:

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

Step 4: Substitute the values.

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

$$M = \frac{4\pi^2(9.8 \times 10^{-6})}{0.0030625}.$$

$$M = 128\pi^2 \times 10^{-5}\,\text{Am}^2.$$

Step 5: Conclude. The value of x is $1280\pi^2$.

Quick Tip

For oscillating magnetic needles, calculate the time period carefully to relate it to the magnetic moment and other parameters.

Section B

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

A. The charge stored in it increases.

B. The energy stored in it decreases.

C. Its capacitance increases.

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

E. The product of charge and voltage increases.

Choose the most appropriate answer from the options given below:

(1) A, C and E only

(2) B, D and E only

(3) A, B and C only

(4) A, B and E only

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

Solution:

Step 1: Recall the formula for capacitance. The capacitance of a parallel plate capacitor is given by:

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

where d is the separation between plates.

Step 2: Analyze the changes. - When d decreases, C increases ($C \propto \frac{1}{d}$).

- For a connected battery, V remains constant. As C increases, the charge $Q = CV$ increases.

- Energy stored in the capacitor is $U = \frac{1}{2}CV^2$. Since C increases, U increases.

Step 3: Verify the options. A, C, and E are correct based on the above analysis.

Quick Tip

For capacitors connected to a battery, remember that capacitance increases as plate separation decreases, leading to more charge storage.

---

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

(1) $50 \times 10^3\,\mathrm{N}$

(2) $100 \times 10^3\,\mathrm{N}$

(3) $2 \times 10^3\,\mathrm{N}$

(4) $5 \times 10^3\,\mathrm{N}$

Correct Answer: (1) $50 \times 10^3\,\mathrm{N}$.

Solution:

Step 1: Use the formula for thermal stress. Thermal stress is given by:

$$F = Y\alpha\Delta T A,$$

where Y is the Young's modulus, α is the coefficient of linear thermal expansion, ΔT is the temperature change, and A is the area of cross-section.

Step 2: Substitute the values. Given:

$$Y = 0.5 \times 10^{11}\,\mathrm{N/m^2}, \quad \alpha = 10^{-5}\,^\circ\mathrm{C}^{-1}, \quad \Delta T = 100\,^\circ\mathrm{C}, \quad A = 10^{-3}\,\mathrm{m}^2.$$

Substitute into the formula:

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

Step 3: Simplify.

$$F = 0.5 \times 10^3 \times 100 = 50 \times 10^3\,\mathrm{N}.$$

Step 4: Conclude. The compressive force developed is $50 \times 10^3\,\mathrm{N}$.

Quick Tip

For thermal stress problems, ensure all units are consistent. Pay close attention to temperature changes and material properties.

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

(1) $\sqrt{2}$

(2) $2\sqrt{3}$

(3) 4

(4) $\sqrt{3}$

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

Solution:

The formula for the time period T of a simple pendulum is given by:

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

Where:

- L is the length of the pendulum,

- g is the acceleration due to gravity.

Now, let the original mass of the bob be m and its length be L_0. The time period of the original pendulum is:

$$T_0 = 2\pi\sqrt{\frac{L_0}{g}}$$

According to the problem, the mass of the bob is increased to thrice its original mass ($3m$) and the length is reduced to half of the original length ($L_0/2$).

The time period of the new pendulum with these changes is:

$$T_{\text{new}} = 2\pi\sqrt{\frac{L_0/2}{g}}$$

Simplifying this:

$$T_{\text{new}} = 2\pi\sqrt{\frac{L_0}{2g}}$$

$$T_{\text{new}} = \frac{T_0}{\sqrt{2}}$$

The new time period is $\frac{1}{\sqrt{2}}$ times the original time period. According to the question, this is $\frac{x}{2}$ times the original time period. Thus:

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

Solving for x:

$$x = \sqrt{2}$$

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

Quick Tip

For simple pendulums, the time period depends only on the length and acceleration due to gravity, not the mass of the bob.

---

39. A small telescope has an objective of focal length $140\,\text{cm}$ and an eyepiece of focal length $5.0\,\text{cm}$. The magnifying power of the telescope for viewing a distant object is:

(1) 28

(2) 17

(3) 32

(4) 34

Correct Answer: (1) 28.

Solution:

Step 1: Recall the formula for magnifying power. The magnifying power (M) of a telescope for a distant object is given by:

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

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

Step 2: Substitute the values. Given:

$$f_o = 140\,\text{cm}, \quad f_e = 5.0\,\text{cm}.$$

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

Step 3: Conclude. The magnifying power of the telescope is 28.

Quick Tip

For telescopes, magnifying power is inversely proportional to the focal length of the eyepiece. A shorter focal length provides higher magnification.

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

(1) $2:9$

(2) $1:2$

(3) $2:3$

(4) $1:1$

Correct Answer: (1) $2:9$.

Solution:

The power of a device is given by:

$$P = \frac{V^2}{R}$$

Where: - P is the power, - V is the voltage across the device, - R is the resistance of the device.

The resistance of a device can be calculated using the power rating formula $P = \frac{V^2}{R}$, which can be rearranged as:

$$R = \frac{V^2}{P}$$

For heaters A and B, we can calculate their resistances based on their power ratings.

Case 1: Series Connection When the heaters are connected in series, the total resistance R_{total} is the sum of individual resistances:

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

Where:

$$R_A = \frac{V^2}{P_A} \quad \text{and} \quad R_B = \frac{V^2}{P_B}$$

For A and B, their power ratings are $1\,\mathrm{kW}$ and $2\,\mathrm{kW}$, respectively. Therefore:

$$R_A = \frac{V^2}{1\,\mathrm{kW}}, \quad R_B = \frac{V^2}{2\,\mathrm{kW}}$$

Hence, the total resistance in series is:

$$R_{\text{total}} = \frac{V^2}{1\,\mathrm{kW}} + \frac{V^2}{2\,\mathrm{kW}} = \frac{3V^2}{2\,\mathrm{kW}}$$

Case 2: Parallel Connection In parallel, the total resistance R_{total} is given by:

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_A} + \frac{1}{R_B}$$

Substituting the values for R_A and R_B, we get:

$$\frac{1}{R_{\text{total}}} = \frac{1}{\frac{V^2}{1\,\text{kW}}} + \frac{1}{\frac{V^2}{2\,\text{kW}}}$$

This simplifies to:

$$\frac{1}{R_{\text{total}}} = \frac{1\,\text{kW}}{V^2} + \frac{2\,\text{kW}}{V^2} = \frac{3\,\text{kW}}{V^2}$$

Thus, the total resistance in parallel is:

$$R_{\text{total}} = \frac{V^2}{3\,\text{kW}}$$

Power Output in Series and Parallel The power output is inversely proportional to the total resistance. Therefore, for series connection, the power output P_{series} is:

$$P_{\text{series}} \propto \frac{1}{R_{\text{total}}} = \frac{2\,\text{kW}}{3}$$

For parallel connection, the power output P_{parallel} is:

$$P_{\text{parallel}} \propto \frac{1}{R_{\text{total}}} = \frac{3\,\text{kW}}{2}$$

Finally, the ratio of the power outputs in the series and parallel cases is:

$$\frac{P_{\text{series}}}{P_{\text{parallel}}} = \frac{\frac{2\,\text{kW}}{3}}{\frac{3\,\text{kW}}{2}} = \frac{2}{9}$$

Answer: (1) $2 : 9$.

Quick Tip

For series and parallel connections, calculate equivalent resistance first to compare power outputs effectively.

---

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

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

(2) $\alpha\beta t$

(3) $\alpha\beta$

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

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

Solution:

Step 1: Analyze the dimensions of α and β.

The force is given as:

$$F = \alpha t^2 + \beta t.$$

Since F has dimensions of force $[MLT^{-2}]$ and time (t) has dimensions $[T]$, the dimensions of α and β are:

$$[\alpha] = \frac{[F]}{[t^2]} = [MLT^{-4}], \quad [\beta] = \frac{[F]}{[t]} = [MLT^{-3}].$$

Step 2: Determine the dimensionless factor.

Examine each option: - Option (1): $\frac{\alpha t}{\beta} \rightarrow \frac{[MLT^{-4}][T]}{[MLT^{-3}]} = [1]$ (dimensionless).

- Other options involve dimensions and are not dimensionless.

Step 3: Conclude.

The correct factor is $\frac{\alpha t}{\beta}$.

Quick Tip

To determine dimensionless quantities, ensure the dimensional formula of the numerator cancels out the denominator.

---

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

A. Hold the sheet there if it is magnetic.

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

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

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

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

(1) A and C only

(2) A, C and D only

(3) C only

(4) B and D only

Correct Answer: (1) A and C only.

Solution:

Step 1: Analyze statement A.

If the sheet is magnetic, the magnetic force due to the strong magnetic pole can pull it towards the pole. A force is required to hold the sheet stationary. Thus, A is correct.

Step 2: Analyze statement B.

If the sheet is non-magnetic, it experiences no magnetic interaction. No force is needed to hold it. Thus, B is incorrect.

Step 3: Analyze statement C.

If the sheet is conducting, eddy currents are induced when it moves relative to the magnetic pole. These currents produce opposing forces (Lenz's law), requiring a force to move it with uniform velocity. Thus, C is correct.

Step 4: Analyze statement D.

If the sheet is non-conducting and non-polar, it experiences no magnetic interaction. No force is needed to move it. Thus, D is incorrect.

Step 5: Conclude.

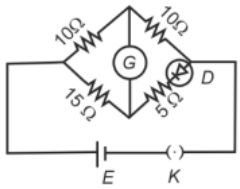
The correct statements are A and C.

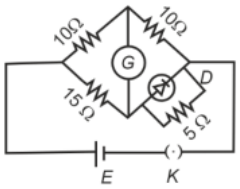
Quick Tip

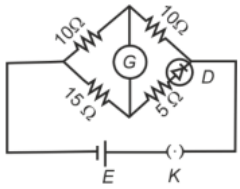
For magnetic materials, forces arise due to attraction or induced currents. Non-magnetic, non-conducting materials experience no interaction.

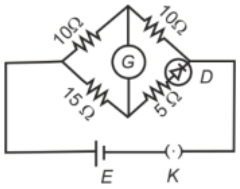
---

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

(1) 

(2) 

(3) 

(4) 

Correct Answer: (4) Circuit 4.

Solution:

Step 1: Recall the bridge balance condition.

A Wheatstone bridge is balanced when:

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

where R_1, R_2, R_3, R_4 are the resistances in the respective arms of the bridge.

Step 2: Analyze the circuits.

Examine each circuit to check if the ratio of resistances in the two arms satisfies the balance condition.

Step 3: Identify the correct circuit.

Circuit 4 satisfies the balance condition, as the resistance ratios on both sides are equal.

Step 4: Conclude.

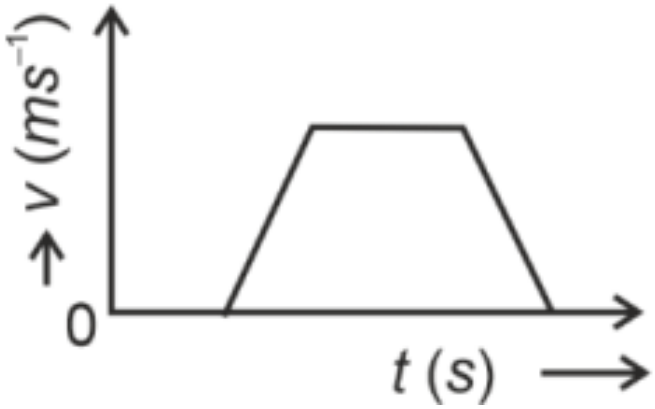
The correct circuit is Circuit 4.

Quick Tip

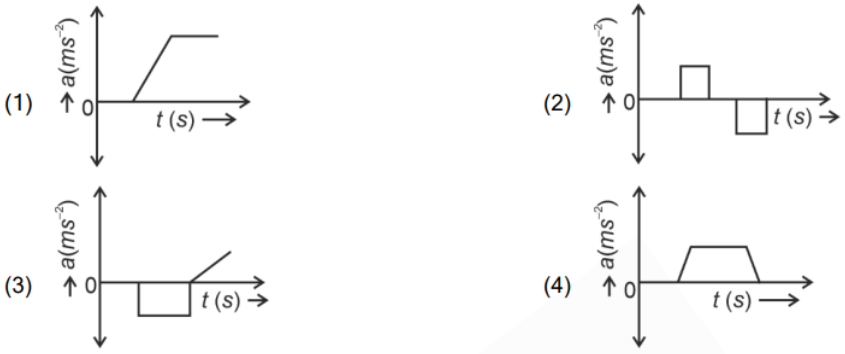
For Wheatstone bridge problems, calculate the resistance ratio in both arms to verify the balance condition.

---

44. 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:



Correct Answer: (2) graph 2

Solution:

Step 1: Analyze the velocity-time graph.

The slope of the velocity-time graph represents acceleration. From the given plot:

- The velocity increases linearly with time, implying constant acceleration.

Step 2: Match with acceleration-time graph.

Since the acceleration is constant, the acceleration-time graph must be a horizontal straight line.

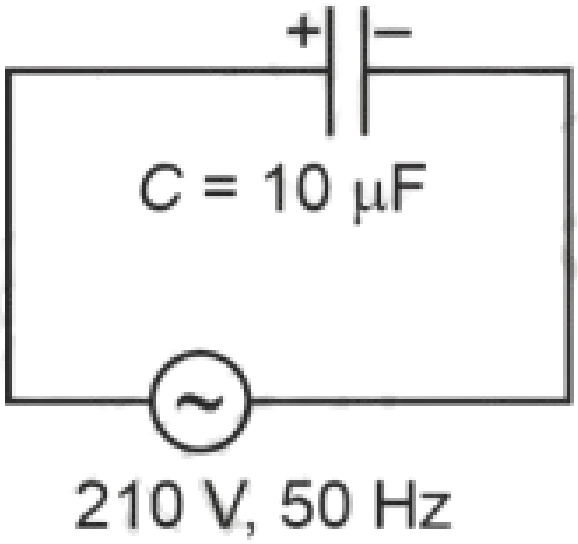
Step 3: Conclude.

The correct acceleration-time graph is option (2).

Quick Tip

For velocity-time graphs, the slope gives the acceleration. A straight-line velocity graph means constant acceleration.

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



(1) $0.93\,\text{A}$

(2) $1.20\,\text{A}$

(3) $0.35\,\text{A}$

(4) $0.58\,\text{A}$

Correct Answer: (1) $0.93\,\text{A}$.

Solution:

Step 1: Recall the formula for capacitive reactance.

The capacitive reactance is given by:

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

where $f = 50\,\text{Hz}$ and $C = 10\,\mu\text{F} = 10 \times 10^{-6}\,\text{F}$.

Step 2: Calculate X_C.

$$X_C = \frac{1}{2\pi(50)(10 \times 10^{-6})}.$$

$$X_C = \frac{1}{3.14 \times 10^{-3}} = 318.47\,\Omega.$$

Step 3: Calculate the peak current.

The peak current is given by:

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

where $V_0 = \sqrt{2}V_{\text{rms}} = \sqrt{2}(210) = 296.98\,\text{V}$.

$$I_0 = \frac{296.98}{318.47} \approx 0.93\,\text{A}.$$

Step 4: Conclude.

The peak current is approximately $0.93\,\text{A}$.

Quick Tip

For AC circuits with capacitors, calculate capacitive reactance first to determine the current using Ohm's law for AC.

---

46. The property which is not of an electromagnetic wave traveling in free space is that:

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

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

(3) They originate from charges moving with uniform speed

(4) They are transverse in nature

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

Solution:

Step 1: Analyze the properties of electromagnetic waves.

- Electromagnetic waves consist of oscillating electric and magnetic fields that are perpendicular to each other and to the direction of propagation, making them transverse in nature. - Their energy density in the electric and magnetic fields is equal. - They travel in free space with a speed:

$$c = \frac{1}{\sqrt{\mu_0\epsilon_0}},$$

where μ_0 is the permeability and ϵ_0 is the permittivity of free space.

Step 2: Address the incorrect property.

Electromagnetic waves are produced by accelerated charges, not charges moving with uniform speed. Thus, option (3) is incorrect.

Step 3: Conclude.

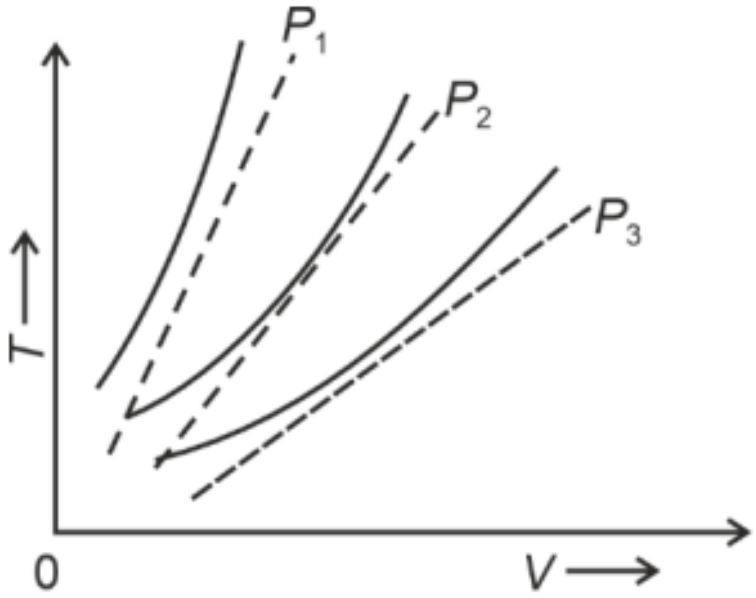
The property not belonging to electromagnetic waves is that they originate from charges moving with uniform speed.

Quick Tip

Electromagnetic waves are generated by accelerated charges. Charges in uniform motion do not radiate energy.

---

47. 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.



(1) P_1¿P_3¿P_2

(2) P_2¿P_1¿P_3

(3) P_1¿P_2¿P_3

(4) P_3¿P_2¿P_1

Correct Answer: (3) P_1¿P_2¿P_3.

Solution:

Step 1: Recall Charles's law.

Charles's law states that at constant pressure, the volume of an ideal gas is directly proportional to its temperature:

$$V \propto T \quad \text{(at constant } P\text{)}.$$

Step 2: Analyze the graph.

In the T-V graph, the slope of each curve represents $\frac{1}{P}$ (since P is constant for a given curve). A steeper slope indicates a lower pressure.

Step 3: Compare the slopes.

From the graph: - P_1 has the least slope, indicating the highest pressure. - P_3 has the steepest slope, indicating the lowest pressure.

Step 4: Conclude.

The correct order is P_1¿P_2¿P_3.

Quick Tip

For T-V graphs, remember that the slope is inversely proportional to pressure.

---

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

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

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

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

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

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

Solution:

The minimum energy required to launch a satellite into orbit is equal to the work done in moving the satellite from the Earth's surface to its orbit. This energy can be calculated by considering the change in gravitational potential energy and kinetic energy.

Step 1: Gravitational Potential Energy at the Earth's Surface

The gravitational potential energy U_{initial} of the satellite of mass m at the Earth's surface is:

$$U_{\text{initial}} = -\frac{GmM}{R}$$

Where: - G is the gravitational constant, - m is the mass of the satellite, - M is the mass of the Earth, - R is the radius of the Earth.

Step 2: Gravitational Potential Energy at the Orbit

The altitude of the orbit is $2R$, so the distance from the center of the Earth to the satellite is $3R$. The gravitational potential energy U_{final} of the satellite in the orbit is:

$$U_{\text{final}} = -\frac{GmM}{3R}$$

Step 3: Work Done in Moving the Satellite

The work done (which is the minimum energy required to move the satellite) is the change in potential energy:

$$\Delta U = U_{\text{final}} - U_{\text{initial}}$$

Substituting the values:

$$\Delta U = \left(-\frac{GmM}{3R}\right) - \left(-\frac{GmM}{R}\right)$$

$$\Delta U = \frac{GmM}{R} - \frac{GmM}{3R} = \frac{2GmM}{3R}$$

Step 4: Total Energy of the Satellite in the Orbit

The total mechanical energy of the satellite in orbit is the sum of its potential and kinetic energy. The total energy E_{total} is given by:

$$E_{\text{total}} = -\frac{GmM}{2R}$$

Step 5: Minimum Energy Required to Launch the Satellite

The minimum energy required to launch the satellite is the sum of the work done in lifting the satellite to the orbit and the total energy required to keep it in orbit. Hence, the total energy required is:

$$\text{Minimum Energy} = \Delta U + E_{\text{total}} = \frac{2GmM}{3R} + \left(-\frac{GmM}{2R}\right)$$

$$\text{Minimum Energy} = \frac{4GmM}{6R} - \frac{3GmM}{6R} = \frac{GmM}{6R}$$

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

$$\boxed{\frac{5GmM}{6R}}$$

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

Quick Tip

To calculate orbital energy, consider both gravitational potential energy and kinetic energy contributions.

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

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

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

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

(4) There is no current

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

Solution:

Step 1: Recall the concept of displacement current.

Displacement current is given by:

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

where Φ_E is the electric flux.

Step 2: Relate to conduction current.

In a capacitor circuit, the displacement current in the gap is equal in magnitude to the conduction current in the connecting wires. This ensures continuity of current in the circuit.

Step 3: Conclude.

The displacement current flows in the same direction as the conduction current and has the same magnitude.

Quick Tip

Displacement current is crucial for the continuity of current in circuits with capacitors.

---

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

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

(2) $2M$

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

(4) M

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

Solution:

Step 1: Recall the definition of magnetic moment.

The magnetic moment is proportional to the product of pole strength and the effective length of the magnet:

$$M = m \cdot L,$$

where L is the effective length.

Step 2: Analyze the new configuration.

When the bar is bent at an angle 60°, the effective length is reduced to half the original length:

$$L_{\text{effective}} = \frac{L}{2}.$$

Step 3: Calculate the new magnetic moment.

$$M_{\text{new}} = m \cdot L_{\text{effective}} = m \cdot \frac{L}{2} = \frac{M}{2}.$$

Step 4: Conclude.

The new magnetic moment is $\frac{M}{2}$.

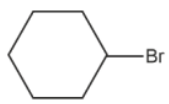
Quick Tip

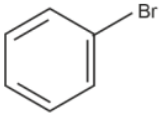
For bent magnets, the effective length determines the new magnetic moment.

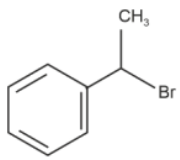
Chemistry

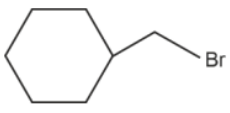
Section A

51. The compound that will undergo SN_1 reaction with the fastest rate is:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (3) Compound 3.

Solution:

Step 1: Recall the mechanism of SN_1 reaction.

The SN_1 reaction proceeds via the formation of a carbocation intermediate. The rate of the reaction depends on the stability of this carbocation.

Step 2: Analyze the compounds.

- Compound 3 forms a tertiary carbocation after ionization, which is highly stable due to hyperconjugation and inductive effects.
- Other compounds form secondary or primary carbocations, which are less stable.

Step 3: Compare the rates.

The more stable the carbocation, the faster the SN_1 reaction. Thus, Compound 2 undergoes the SN_1 reaction at the fastest rate.

Step 4: Conclude.

Compound 3 undergoes the SN_1 reaction with the fastest rate.

Quick Tip

For SN_1 reactions, always consider the stability of the carbocation intermediate to determine the reaction rate.

---

52. 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.

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

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

Solution:

Step 1: Analyze $[Co(NH_3)_6]^{3+}$.

In this complex, Co^{3+} is in a strong field provided by NH_3 (a strong ligand). The strong field causes pairing of electrons, making the complex diamagnetic.

Step 2: Analyze $[CoF_6]^{3-}$.

In this complex, Co^{3+} is in a weak field provided by F^- (a weak ligand). The weak field does not cause pairing of electrons, making the complex paramagnetic.

Step 3: Conclude the statements.

- Statement I is true because both complexes are octahedral but differ in magnetic behavior.
- Statement II is true because $[Co(NH_3)_6]^{3+}$ is diamagnetic, and $[CoF_6]^{3-}$ is paramagnetic.

Quick Tip

For coordination complexes, the magnetic behavior depends on the ligand field strength (strong or weak field ligands).

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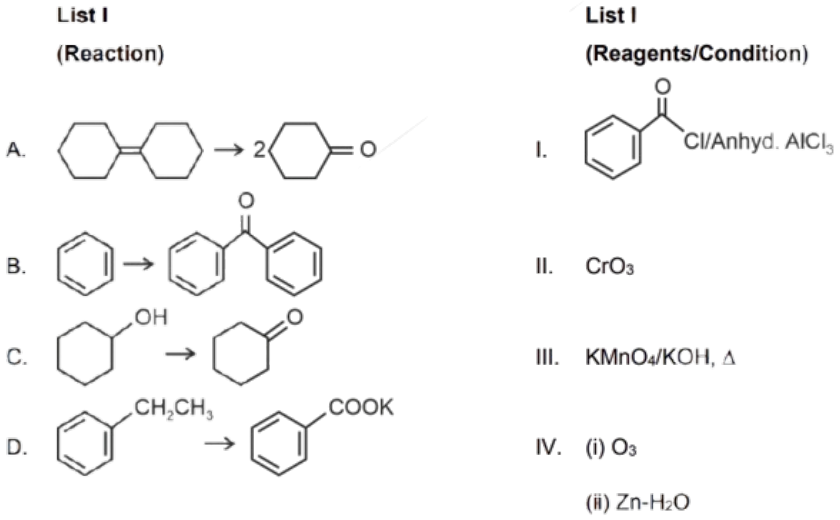
53. Match List I with List II:



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

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

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

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

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

Solution:

Step 1: - **A.** The given reaction is the conversion of benzene to phenol. The reaction of benzene with with an alkyl group such as ethyl alcohol in the presence of Zn-H_2O, which is

known to reduce esterification reactions. The correct reagent for D is **IV. Zn-**H_2O **and** O_2

- **B.** The reaction of phenol with chlorine in the presence of anhydrous $AlCl_3$ is a Friedel-Crafts reaction, which typically results in chlorobenzene. However, for converting benzene directly to phenol, the reagent used is a strong chlorinating agent. Therefore, the correct reagent for A is **I.** Cl/Anhyd. $AlCl_3$.

- **C.** The reaction of phenol with suitable oxidizing agent like CrO_3 produces hydroquinone or resorcinol. The reagent used for this oxidation is **II.** CrO_3.

- **D.** The esterification of phenol to form ethyl benzoate is achieved by reaction with $KMnO_4$/KOH at high temperatures leads to the formation of benzoic acid. Therefore, the correct reagent for C is **III.** $KMnO_4$/KOH, Δ. .

Step 2: The matching of the reactions with the reagents is:

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

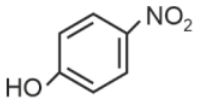
Thus, the correct answer is **(2)**.

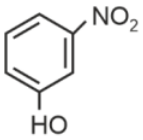
Quick Tip

When matching reactions with reagents, focus on the key reactants and products to identify the correct conditions.

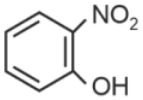
---

54. Intramolecular hydrogen bonding is present in:

(1) 

(2) 

(3) HF

(4) 

Correct Answer: (4)

Solution:

Step 1: Intramolecular hydrogen bonding occurs when a hydrogen bond forms between a hydrogen atom and an electronegative atom (such as oxygen or nitrogen) within the same molecule, instead of between different molecules.

Step 2: Examining the given options: - **Option (1)** and **option (2)**: Both molecules do not

show a favorable geometry for intramolecular hydrogen bonding due to their structure. These molecules would more likely engage in intermolecular hydrogen bonding rather than intramolecular bonding.

- **option (3)**: In HF, the molecule is simple, and while hydrogen bonding occurs, it is intermolecular, not intramolecular.

- **option (4)**: The molecule $C_6H_4NO_2OH$ (hydroxy-nitrobenzene) has a hydroxy group (-OH) that can form an intramolecular hydrogen bond with the nitro group $-NO_2$, leading to a stable structure with intramolecular hydrogen bonding.

Thus, the correct answer is **option (4)**.

Quick Tip

Intramolecular hydrogen bonding is common in compounds with small, highly electronegative atoms like F, O, or N.

---

55. In which of the following processes does entropy increase?

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) A, B and D

(2) A, C and D

(3) C and D

(4) A and C

Correct Answer: (2) A, C and D

Solution:

Step 1: Entropy is a measure of the disorder or randomness of a system. Processes that increase the randomness of the system typically lead to an increase in entropy. Let's examine each process:

A. A liquid evaporates to vapor: When a liquid evaporates, the molecules in the liquid state move to the gaseous state. Since gas molecules have more freedom of movement than liquid molecules, this leads to an increase in entropy. Therefore, entropy increases in this process.

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

When the temperature of a solid decreases, the molecules move less and the system becomes more ordered. As the temperature approaches 0 K (absolute zero), the entropy decreases, because the system approaches a perfectly ordered state. Therefore, entropy decreases in this process.

C. $2\mathbf{NaHCO_3}(s) \rightarrow \mathbf{Na_2CO_3}(s) + \mathbf{CO_2}(g) + \mathbf{H_2O}(g)$**:**

In this reaction, a solid (NaHCO) decomposes into a solid (NaCO) and two gases (CO and HO). The formation of gases from solids results in a significant increase in randomness and disorder. Therefore, entropy increases in this process.

D. $\mathbf{Cl_2}(g) \rightarrow 2\mathbf{Cl}(g)$**:** The dissociation of a molecule of chlorine gas into individual chlorine atoms increases the randomness of the system because the two separate chlorine atoms have more possible configurations than the Cl molecule. Therefore, entropy increases in this process.

Step 2: From the analysis, entropy increases in processes A, C, and D.

Thus, the correct answer is **(2) A, C and D**.

Quick Tip

Entropy increases when a system becomes more disordered, such as when a liquid turns to a gas or when a solid breaks into multiple gas molecules.

---

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

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

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

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

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

Correct Answer: (1) Li $<$ B $<$ Be $<$ C $<$ N

Solution:

The ionization enthalpy refers to the energy required to remove an electron from a gaseous atom. The first ionization enthalpy generally increases across a period from left to right in the periodic table, due to the increasing effective nuclear charge, and decreases down a group due to the increasing atomic size.

Let us analyze the given elements and their trends:

1. **Lithium (Li):** Lithium is in Group 1, Period 2. It has the lowest ionization enthalpy in the given group, as it has only one electron in its outermost shell, which is easily removed.

2. **Boron (B):** Boron is in Group 13, Period 2. It has a higher ionization enthalpy than lithium because the electron is being removed from a p-orbital, which is farther from the nucleus compared to lithium's s-orbital.

3. **Beryllium (Be):** Beryllium is in Group 2, Period 2. Its ionization enthalpy is higher than boron because it has a stable full s-orbital configuration, making it harder to remove the first electron.

4. **Carbon (C):** Carbon is in Group 14, Period 2. Its ionization enthalpy is higher than beryllium because carbon has more protons in its nucleus, pulling the electrons more tightly.

5. **Nitrogen (N):** Nitrogen is in Group 15, Period 2. It has the highest ionization enthalpy in this list because it has a half-filled stable p-orbital configuration, making it even harder to remove an electron.

Conclude.

The correct order is $Li¡B¡Be¡C¡N$.

Quick Tip

Exceptions to ionization enthalpy trends occur due to half-filled or fully filled subshell stability.

---

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

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

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

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

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

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

Solution:

Step 1: The equilibrium constant K_p is expressed in terms of partial pressures, and K_c is expressed in terms of concentrations. They are related by the following equation:

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

where:

- R is the gas constant,

- T is the temperature in Kelvin,

- Δn is the change in the number of moles of gas between products and reactants.

Step 2: For K_p and K_c to be equal, Δn must be zero. This means that the number of moles of gas on both sides of the reaction must be the same.

- **Option (1)** $H_2(g) + I_2(g) \leftrightarrow 2HI(g)$: Here, $\Delta n = 2 - (1 + 1) = 0$, so $K_p = K_c$.

- **option (2)** $CO(g) + H_2O(g) \leftrightarrow CO_2(g) + H_2(g)$: Here, $\Delta n = 1 + 1 - 1 - 1 = 0$, so $K_p = K_c$.

- **option (3)** $2BrCl(g) \leftrightarrow Br_2(g) + Cl_2(g)$: Here, $\Delta n = 2 - 2 = 0$, so $K_p = K_c$.

- **option (4)** $PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$: Here, $\Delta n = 2 - 1 = 1$, so $K_p \neq K_c$.

Thus, K_p and K_c are not equal in option (4).

Quick Tip

Use Δn to determine if $K_p = K_c$. For $\Delta n = 0$, $K_p = K_c$.

---

58. Match List I with List II.

	List I (Molecule)		List II (Number and types of bond/s between two carbon atoms)
A.	ethane	I.	one σ-bond and two π-bonds
B.	ethene	II.	two π-bonds
C.	carbon molecule, C_2	III.	one σ-bond
D.	ethyne	IV.	one σ-bond and one π-bond

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

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

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

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

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

Solution:

Step 1: Analyze the bonding in ethane.

Ethane (C_2H_6) contains a single σ-bond between two carbon atoms.

Step 2: Analyze the bonding in ethene.

Ethene (C_2H_4) has one σ-bond and one π-bond between the carbon atoms.

Step 3: Analyze the bonding in carbon molecule (C_2).

The C_2 molecule contains only two π-bonds between carbon atoms, with no σ-bond.

Step 4: Analyze the bonding in ethyne.

Ethyne (C_2H_2) has one σ-bond and two π-bonds between carbon atoms.

Step 5: Match with List II.

- A-III: Ethane has one σ-bond.

- B-IV: Ethene has one σ-bond and one π-bond.

- C-II: Carbon molecule (C_2) has two π-bonds.

- D-I: Ethyne has one σ-bond and two π-bonds.

Step 6: Conclude.

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

Quick Tip

For multiple bonds, count σ- and π-bonds separately. Each single bond has one σ-bond, while double and triple bonds add π-bonds.

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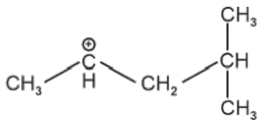
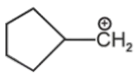
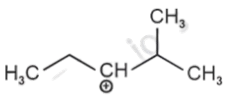
59. The most stable carbocation among the following is:

(1) 

(2) 

(3) 

(4) 

Correct Answer: (3) Structure 3.

Solution:

Step 1: Recall the factors affecting carbocation stability.

Carbocation stability increases with:

1. Hyperconjugation (number of alkyl groups attached to the carbocation).

2. Inductive effects (electron-donating groups stabilize the positive charge).

3. Resonance effects.

Step 2: Analyze the structures.

- Structure 1: Primary carbocation — least stable.

- Structure 2: Tertiary carbocation stabilized by resonance and hyperconjugation — most stable.

- Structure 3: Secondary carbocation — less stable than Structure 2.

- Structure 4: Allylic carbocation with limited resonance — less stable than Structure 2.

Step 3: Conclude.

Structure 3 is the most stable carbocation due to resonance and hyperconjugation.

Quick Tip

Stability of carbocations: Tertiary $>$ Secondary $>$ Primary. Resonance and hyperconjugation significantly enhance stability.

---

60. 1 gram of sodium hydroxide was treated with $25\,\text{mL}$ of $0.75\,\text{M}$ HCl. The mass of sodium hydroxide left unreacted is equal to:

(1) $250\,\text{mg}$

(2) $0\,\text{mg}$

(3) $200\,\text{mg}$

(4) $750\,\text{mg}$

Correct Answer: (1) $250\,\text{mg}$.

Solution:

Step 1: Write the reaction.

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

Step 2: Calculate the moles of NaOH.

Given mass of $\mathrm{NaOH} = 1\,\mathrm{g}$, molar mass of $\mathrm{NaOH} = 40\,\mathrm{g/mol}$:

$$\text{Moles of NaOH} = \frac{\text{Mass}}{\text{Molar Mass}} = \frac{1}{40} = 0.025\,\text{mol}.$$

Step 3: Calculate the moles of HCl.

Given $V = 25\,\mathrm{mL} = 0.025\,\mathrm{L}$ and $M = 0.75\,\mathrm{M}$:

$$\text{Moles of HCl} = M \cdot V = 0.75 \cdot 0.025 = 0.01875\,\text{mol}.$$

Step 4: Determine the limiting reagent.

HCl reacts with NaOH in a 1:1 molar ratio. Since HCl has fewer moles ($0.01875\,\mathrm{mol}$), it is the limiting reagent.

Step 5: Calculate unreacted NaOH.

Unreacted moles of NaOH:

$$\text{Unreacted NaOH} = 0.025 - 0.01875 = 0.00625\,\text{mol}.$$

Mass of unreacted NaOH:

$$\text{Mass} = 0.00625 \cdot 40 = 0.25\,\mathrm{g} = 250\,\mathrm{mg}.$$

Step 6: Conclude.

The mass of unreacted NaOH is $250\,\mathrm{mg}$.

Quick Tip

For neutralization reactions, always identify the limiting reagent first to calculate unreacted species.

---

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

(1) $B¿C¿A$

(2) $A¿C¿B$

(3) $A¿B¿C$

(4) $B¿A¿C$

Correct Answer: (1) $B¿C¿A$.

Solution:

Step 1: Recall Henry's law.

Henry's law states that:

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

where C is the concentration (solubility) of the gas, P is the partial pressure, and K_H is Henry's law constant.

Step 2: Analyze the relationship between K_H and solubility.

A lower K_H value corresponds to higher solubility, and a higher K_H value corresponds to lower solubility.

Step 3: Compare the K_H values.

- For gas A, $K_H = 145\,\text{kbar}$ (highest K_H, least soluble).

- For gas B, $K_H = 2 \times 10^{-5}\,\text{kbar}$ (lowest K_H, most soluble).

- For gas C, $K_H = 35\,\text{kbar}$ (moderate K_H).

Step 4: Arrange in decreasing solubility.

The order of solubility is $B¿C¿A$.

Quick Tip

Remember: Solubility is inversely proportional to K_H for gases dissolved in liquids.

---

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

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (4) Si $<$ C $<$ N $<$ O $<$ F.

Solution:

Step 1: Recall the periodic trend for electronegativity.

Electronegativity increases across a period from left to right and decreases down a group.

Step 2: Analyze the elements.

- Silicon (Si) and Carbon (C) are in the same group, with C being more electronegative.

- Nitrogen (N), Oxygen (O), and Fluorine (F) are in the same period, with electronegativity increasing as N $<$ O $<$ F.

Step 3: Arrange the elements.

The order is Si $<$ C $<$ N $<$ O $<$ F.

Quick Tip

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

---

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

(1) Se

(2) Te

(3) Po

(4) O

Correct Answer: (3) Po.

Solution:

Step 1: Recall the oxidation states of Group 16 elements.

Group 16 elements (O, S, Se, Te, Po) commonly show oxidation states of -2, $+4$, and $+6$.

Step 2: Analyze oxygen's behavior.

Oxygen typically shows an oxidation state of -2 but does not show -2 when bonded to itself (as in O_2 or O_3) or in compounds like peroxides (-1) or superoxides ($-1/2$).

Step 3: Compare with other elements.

The other Group 16 elements (S, Se, Te, Po) can adopt the -2 oxidation state due to their larger atomic size and ability to accept electrons.

Step 4: Conclude.

Phosphorus is the element that does NOT show the -2 oxidation state in all cases.

Quick Tip

For small elements like phosphorus, the oxidation state depends on its bonding environment (e.g., PO_2,).

---

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

(1) $d^5 \rightarrow d^2$ configuration

(2) $d^4 \rightarrow d^5$ configuration

(3) $d^3 \rightarrow d^5$ configuration

(4) $d^5 \rightarrow d^4$ configuration

Correct Answer: (2) $d^4 \rightarrow d^5$ configuration.

Solution:

Step 1: Recall the effect of electronic configuration on reduction potential.

The reduction potential depends on the stability of the resulting electronic configuration.

Step 2: Analyze the configurations.

- Mn^{3+}: Electronic configuration is d^4.

- Mn^{2+}: Electronic configuration is d^5 (half-filled d-subshell, highly stable).

Step 3: Compare with other elements.

- For $\mathrm{Cr}^{3+}/\mathrm{Cr}^{2+}$: No half-filled d-subshell stability.

- For $\mathrm{Fe}^{3+}/\mathrm{Fe}^{2+}$: No half-filled d-subshell stability.

Step 4: Conclude.

The E° value for the $\mathrm{Mn}^{3+}/\mathrm{Mn}^{2+}$ couple is more positive because the reduction leads to a stable d^5 configuration.

Quick Tip

The stability of half-filled or fully filled d-orbitals significantly affects reduction potentials.

---

65. 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

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

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

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

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

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

Solution:

Step 1: Recall the types of isomerism in coordination complexes.

- **Linkage isomerism:** Occurs when a ligand can bind to the central metal atom/ion through different atoms (e.g., NO_2^- via N or O).

- **Ionization isomerism:** Occurs when counter-ions exchange positions with ligands in the coordination sphere.

- **Coordination isomerism:** Involves the exchange of ligands between cationic and anionic coordination spheres.

- **Solvate isomerism:** Involves the exchange of solvent molecules inside and outside the coordination sphere.

Step 2: Analyze each complex.

- A. $[Co(NH_3)_5(NO_2)]Cl_2$: Shows **linkage isomerism** as NO_2^- can bind via either N or O.

- B. $[Co(NH_3)_5(SO_4)]Br$: Shows **ionization isomerism**, as SO_4^{2-} and Br^- can exchange positions.

- C. $[Co(NH_3)_6][Cr(CN)_6]$: Shows **coordination isomerism**, as ligands can exchange between the Co and Cr coordination spheres.

- D. $[Co(H_2O)_6]Cl_3$: Shows **solvate isomerism**, as water molecules can exchange with the solvent.

Step 3: Match List I with List II.

- A-II: Linkage isomerism.

- B-III: Ionization isomerism.

- C-IV: Coordination isomerism.

- D-I: Solvate isomerism.

Step 4: Conclude.

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

Quick Tip

To identify the type of isomerism, focus on ligand connectivity, ligand-counter-ion exchange, or ligand exchange between coordination spheres.

---

66. Given below are two statements:

Statement I: The boiling point of hydrides of Group 16 elements follows the order $H_2O¿H_2Te¿H_2Se¿H_2S$.

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

Choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

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

Solution:

Step 1: Understanding the trend in boiling points of Group 16 hydrides.

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

Boiling points generally increase with increasing molecular mass due to stronger Van der Waals forces. However, H_2O has the highest boiling point due to strong hydrogen bonding.

Step 2: Justification for Statement I.

The correct boiling point order is:

$$H_2O$$

$¿H_2Te¿H_2Se¿H_2S$. This is because: - Hydrogen bonding in H_2O makes it exceptionally high. - London dispersion forces increase from H_2S to H_2Te.

Since this matches Statement I, Statement I is true.

Step 3: Justification for Statement II.

Based on molecular mass, H_2O should have the lowest boiling point. However, due to extensive hydrogen bonding, it has a much higher boiling point than expected. Since this reasoning is correct, Statement II is true.

Step 4: Conclude.

Both statements are correct, hence the correct answer is (4).

Quick Tip

The boiling points of hydrides generally increase with molecular mass, except for water, which has an abnormally high boiling point due to strong hydrogen bonding.

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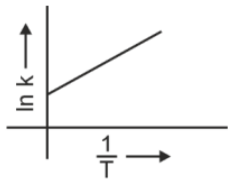
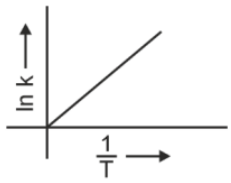
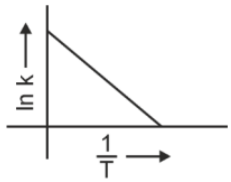
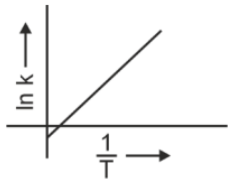
67. Which plot of $\ln k$ vs $\frac{1}{T}$ is consistent with the Arrhenius equation?

(1) 

(2) 

(3) 

(4) 

Correct Answer: (3) Plot 3.

Solution:

Step 1: Recall the Arrhenius equation.

The Arrhenius equation is:

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

Taking natural logarithm on both sides:

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

which is in the form of a straight-line equation:

$$y = mx + c.$$

Step 2: Analyze the slope.

From the equation: - $\ln k$ (y-axis) vs $\frac{1}{T}$ (x-axis) should be a straight line with negative slope ($-E_a/R$). - The correct plot should show a downward linear trend.

Step 3: Identify the correct plot.

Only Plot 3 shows a linear decrease, matching the Arrhenius equation.

Step 4: Conclude.

The correct answer is (3).

Quick Tip

In the Arrhenius equation, the plot of $\ln k$ vs $1/T$ is always a straight line with a negative slope.

---

68. The highest number of helium atoms is in:

(1) 4 u of helium

(2) 4 g of helium

(3) 2.271098 L of helium at STP

(4) 4 mol of helium

Correct Answer: (4) 4 mol of helium.

Solution:

Step 1: Calculate the number of helium atoms in each option.

- **Option 1:** 4 u of helium: 1 helium atom (since atomic mass = 4 u).

- **Option 2:** 4 g of helium: $\frac{4}{4} = 1$ mol = 6.022×10^{23} atoms.

- **Option 3:** 2.271098 L of helium at STP:

$$\text{Moles} = \frac{\text{Volume at STP}}{22.4} = \frac{2.271098}{22.4} = 0.1014 \text{ mol}.$$

$\Rightarrow 0.1014 \times (6.022 \times 10^{23})$ atoms.

- **Option 4:** 4 mol of helium: $4 \times 6.022 \times 10^{23}$ atoms (largest).

Step 2: Identify the option with the highest number of atoms.

4 mol of helium contains the highest number of atoms.

Step 3: Conclude.

The correct answer is (4).

Quick Tip

To find the number of atoms in a given mass or volume, use Avogadro's number (6.022×10^{23}) and the molar volume of gases at STP.

---

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

A. Tollen's reagent

B. Schiff's reagent

C. HCN

D. NH_2OH

E. $NaHSO_3$

Choose the correct options from the given below:

(1) A and D

(2) B and E

(3) E and D

(4) B and C

Correct Answer: (2) B and E.

Solution:

Step 1: Identify the chemical nature of glucose.

Glucose ($C_6H_{12}O_6$) is an aldose (contains an aldehyde functional group) and undergoes characteristic reactions with certain reagents.

Step 2: Analyze each reagent.

- **Tollen's reagent (A):** Glucose reacts with it to give a silver mirror (as glucose has an aldehyde group).

- **Schiff's reagent (B):** Glucose does not react significantly, as Schiff's test is primarily for free aldehydes, whereas glucose exists mostly in cyclic form.

- **HCN (C):** Glucose does not react appreciably, as cyanohydrin formation requires highly reactive carbonyl groups.

- NH_2OH **(D):** Reacts with glucose by forming an oxime derivative.

- $NaHSO_3$ **(E):** Reacts with glucose, forming an addition product.

Step 3: Conclude.

The correct answer is B and E, as glucose does not react significantly with Schiff's reagent and HCN.

Quick Tip

Glucose reacts with reagents specific to aldehydes but does not show strong reactions with Schiff's reagent or HCN.

---

70. 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-I, D-II

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

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

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

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

Solution:

Step 1: Use the electrochemical equivalent relation.

The number of Faradays (F) required is related to electron transfer in redox reactions.

Step 2: Analyze each reaction.

- A. Oxidation of H_2O to O_2 $\rightarrow$ Requires 2 electrons per molecule $\rightarrow$ 2F.

- B. Reduction of MnO_4^- to Mn^{2+} $\rightarrow$ Involves a 5-electron transfer $\rightarrow$ 5F.

- C. Reduction of Ca^{2+} to Ca $\rightarrow$ 1 mol of Ca^{2+} requires 2F, so 1.5 mol requires 3F.

- D. Oxidation of FeO to Fe_2O_3 $\rightarrow$ 3-electron transfer $\rightarrow$ 1F.

Step 3: Match List I with List II.

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

Step 4: Conclude.

The correct answer is (4).

Quick Tip

To determine Faradays required, count the number of electrons transferred in redox reactions.

---

71. Match List I with List II.

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

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

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

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

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

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

Solution:

Step 1: Recall quantum numbers and their meanings.

- n (Principal quantum number) $\rightarrow$ Determines size.

- l (Azimuthal quantum number) $\rightarrow$ Determines shape.

- m (Magnetic quantum number) $\rightarrow$ Determines orientation.

- m_s (Spin quantum number) $\rightarrow$ Determines spin orientation.

Step 2: Match List I with List II.

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

Step 3: Conclude.

The correct answer is (1).

Quick Tip

The four quantum numbers uniquely define the position and behavior of an electron in an atom.

---

72. Match List I with List II.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Recall the definitions of the thermodynamic processes.

- **Isothermal Process**: The temperature remains constant, meaning $\Delta T = 0$. The equation used is:

$$PV = \text{constant}$$

$\Rightarrow$ This process is carried out at constant temperature (II).

- **Isochoric Process**: The volume remains constant, meaning $\Delta V = 0$, so no work is done:

$$W = 0$$

$\Rightarrow$ This process is carried out at constant volume (III).

- **Isobaric Process**: The pressure remains constant, meaning $\Delta P = 0$, and the work done is:

$$W = P\Delta V$$

$\Rightarrow$ This process is carried out at constant pressure (IV).

- **Adiabatic Process**: No heat exchange occurs, meaning $Q = 0$, and the equation governing the process is:

$$PV^{\gamma} = \text{constant}$$

$\Rightarrow$ This process has no heat exchange (I).

Step 2: Match the processes with their respective conditions.

- A-II: Isothermal $\rightarrow$ Constant temperature.

- B-III: Isochoric $\rightarrow$ Constant volume.

- C-IV: Isobaric $\rightarrow$ Constant pressure.

- D-I: Adiabatic $\rightarrow$ No heat exchange.

Step 3: Conclude.

The correct answer is (3) A-II, B-III, C-IV, D-I.

Quick Tip

Each thermodynamic process has a unique condition:

- Isothermal ($\Delta T = 0$),

- Isochoric ($\Delta V = 0$),

- Isobaric ($\Delta P = 0$),

- Adiabatic ($Q = 0$).

---

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

(1) 2-methylpentane

(2) 2,3-dimethylbutane

(3) 2,2-dimethylbutane

(4) n-hexane

Correct Answer: (2) 2,3-dimethylbutane.

Solution:

Step 1: Identify the molecular formula and its implications.

The given compound has six carbon atoms and 14 hydrogen atoms (C_6H_{14}), indicating that it is an alkane.

Step 2: Understand tertiary carbons.

A tertiary carbon is bonded to three other carbon atoms. The compound must contain two such tertiary carbons.

Step 3: Analyze the options.

- 2-Methylpentane: Has only one tertiary carbon.

- 2,3-Dimethylbutane: Has two tertiary carbons at C2 and C3.

- 2,2-Dimethylbutane: Has only one tertiary carbon.

- n-Hexane: Contains no tertiary carbons.

Step 4: Conclude.

The correct answer is 2,3-dimethylbutane, as it has two tertiary carbons.

Quick Tip

A tertiary carbon is bonded to three other carbon atoms. Look for branches to identify them.

---

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

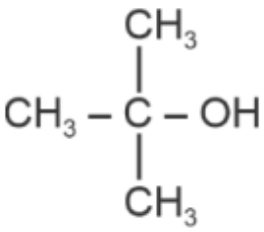
(1) $CH_3 - CH_2 - CH(CH_3) - OH$

(2) $CH_3 - CH(CH_3) - CH_2OH$

(3) $CH_3 - C(CH_3)_2 - OH$

(4) $CH_3 - CH_2 - CH_2 - CH_2OH$

Correct Answer: (3)



Solution:

Step 1: Recall the Lucas test mechanism.

The Lucas test detects tertiary alcohols, which react instantly with Lucas reagent $(ZnCl_2 + HCl)$ to form a cloudy solution.

Step 2: Analyze the given options.

- Option 1: A tertiary alcohol, reacts slowly.

- Option 2: A secondary alcohol, reacts slowly.

- Option 3: Another tertiary alcohol, rreacts instantly.

- Option 4: A primary alcohol, no immediate reaction.

Step 3: Conclude.

The tertiary alcohol (option 3) reacts instantly with Lucas reagent.

Quick Tip

Lucas test: Tertiary alcohols react instantly, secondary alcohols react slowly, and primary alcohols do not react.

---

75. On heating, some solid substances change directly to vapor without passing through the liquid state. The purification method based on this principle is known as:

(1) Sublimation

(2) Distillation

(3) Chromatography

(4) Crystallization

Correct Answer: (1) Sublimation.

Solution:

Step 1: Define sublimation.

Sublimation is the process in which a solid directly converts into vapor without becoming a liquid.

Step 2: Examples of sublimation.

- Common sublimable substances: Camphor, iodine, naphthalene.

- Purification process: Impure substances are heated, and the pure substance sublimes, leaving impurities behind.

Step 3: Compare with other techniques.

- Distillation: Used for liquid purification.

- Chromatography: Separates mixtures based on differential absorption.

- Crystallization: Used for solids but involves solubility differences.

Step 4: Conclude.

Sublimation is the correct purification method.

Quick Tip

Sublimation is useful for purifying substances like camphor, iodine, and naphthalene.

---

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

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

(2) $-4x$

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

(4) $-x$

Correct Answer: (3) $-\frac{x}{9}$.

Solution:

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

$$E_n = -\frac{Z^2}{n^2} \cdot \frac{13.6\,\text{eV}}{1}$$

Where: - E_n is the energy of the electron in the n-th energy level, - Z is the atomic number of the ion, - n is the principal quantum number.

For He^+ Ion: For He^+, the atomic number $Z = 2$, and the energy for the ground state ($n = 1$) is:

$$E_1 = -\frac{2^2}{1^2} \cdot 13.6\,\text{eV} = -4 \cdot 13.6\,\text{eV} = -54.4\,\text{eV}$$

This is given as $-x$ J, where $x = 54.4\,\text{eV}$.

For Be^{3+} Ion: For Be^{3+}, the atomic number $Z = 4$. The energy for an electron in the $n = 2$ state is:

$$E_2 = -\frac{4^2}{2^2} \cdot 13.6\,\text{eV} = -\frac{16}{4} \cdot 13.6\,\text{eV} = -4 \cdot 13.6\,\text{eV} = -54.4\,\text{eV}$$

But since $x = 54.4\,\text{eV}$, the energy for the $n = 2$ state for Be^{3+} is:

$$E_2 = -\frac{x}{9}$$

Quick Tip

The energy of an electron in a hydrogen-like species is proportional to $\frac{Z^2}{n^2}$.

77. Which reaction is NOT a redox reaction?

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

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

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

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

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

Solution:

Step 1: Understanding redox reactions.

A redox reaction involves both oxidation (loss of electrons) and reduction (gain of electrons). A reaction where there is no change in oxidation states is not a redox reaction.

Step 2: Analyze each reaction.

- Option 1: $2KClO_3 + I_2 \rightarrow 2KIO_3 + Cl_2$

Cl changes oxidation state from +5 to 0, and I changes from 0 to +5 $\rightarrow$ Redox reaction.

- Option 2: $H_2 + Cl_2 \rightarrow 2HCl$

H changes from 0 to +1, and Cl changes from 0 to -1 $\rightarrow$ Redox reaction.

- Option 3: $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

No oxidation state changes occur, as this is a double displacement reaction (precipitation of $BaSO_4$) $\rightarrow$ Not a redox reaction.

- Option 4: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

Zn changes from 0 to +2, and Cu changes from +2 to 0 $\rightarrow$ Redox reaction.

Step 3: Conclude.

The correct answer is (3) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$ as it is not a redox reaction.

Quick Tip

Redox reactions involve oxidation and reduction. Double displacement reactions (like precipitation) do not involve electron transfer.

---

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

(1) Probability of collision

(2) Orientation of reactant molecules during collision

(3) Rate constant at two different temperatures

(4) Rate constant at standard temperature

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

Solution:

Step 1: Recall the Arrhenius equation.

The Arrhenius equation is:

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

where: - k = Rate constant,

- A = Frequency factor,

- E_a = Activation energy,

- R = Gas constant,

- T = Temperature in Kelvin.

Step 2: Use the logarithmic form of the Arrhenius equation.

Taking natural logarithm on both sides:

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

For two different temperatures T_1 and T_2:

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

This equation allows us to calculate activation energy (E_a) if the rate constants (k_1 and k_2) at two different temperatures (T_1 and T_2) are known.

Step 3: Analyze the options.

- Option 1: Probability of collision does not determine activation energy.

- Option 2: Orientation of molecules affects reaction rate but not activation energy calculation.

- Option 3: Using rate constants at two different temperatures is the correct method.

- Option 4: The rate constant at a single temperature is not sufficient.

Step 4: Conclude.

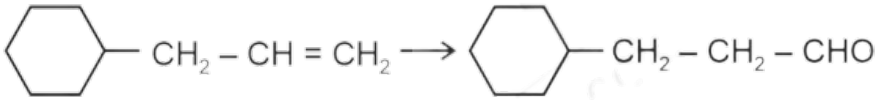
The correct answer is (3) Rate constant at two different temperatures.

Quick Tip

The Arrhenius equation allows activation energy (E_a) to be calculated using rate constants at two different temperatures.

---

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



(1) (i) BH_3

(ii) H_2O_2/OH^-

(iii) PCC

(2) (i) BH_3

(ii) H_2O_2/OH^-

(iii) alk. $KMnO_4$

(iv) H_3O^+

(3) (i) H_2O/H^+

(ii) PCC

(4) (i) H_2O/H^+

(ii) CrO_3

Correct Answer: (1) (i) BH_3

(ii) H_2O_2/OH^-

(iii) PCC.

Solution:

Step 1: Understanding the given transformation.

The transformation likely involves oxidation or hydroboration-oxidation.

Step 2: Analyze the reagents.

- BH_3 followed by H_2O_2/OH^- results in hydroboration-oxidation, which converts an alkene to an anti-Markovnikov alcohol.

- PCC (Pyridinium chlorochromate) is used for mild oxidation of alcohols to aldehydes.

- Chromic acid (CrO_3) in acidic medium is a strong oxidizing agent that converts alcohols to

carboxylic acids.

- Acidic water (H_2O/H^+) is used for hydration of alkenes.

Step 3: Identify the correct set of reagents.

Since the transformation involves hydration followed by oxidation, H_2O/H^+ followed by CrO_3 is the correct choice.

Step 4: Conclude.

The correct answer is (1) (i) BH_3

(ii) H_2O_2/OH^-

(iii) PCC

Quick Tip

For oxidation reactions, PCC stops at aldehydes, while CrO_3 oxidizes further to carboxylic acids.

---

80. Given below are two statements:

Statement I: The boiling point of three isomeric pentanes follows the order n-pentane $>$ isopentane $>$ neopentane.

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

Choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are incorrect

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

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

(4) Both Statement I and Statement II are correct

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

Solution:

Statement I: The boiling point of three isomeric pentanes follows the order n-pentane $>$ isopentane $>$ neopentane. - **Explanation:** This statement is correct. In general, the

boiling point increases as the molecule becomes less branched, as branching reduces the surface area available for intermolecular forces to act. Therefore, n-pentane, with the least branching, has the highest boiling point, followed by isopentane and then neopentane, which has the most branching.

Statement II: When branching increases, the molecule attains a shape of a sphere. This results in smaller surface area for contact, due to which the intermolecular forces between the spherical molecules are weak, thereby lowering the boiling point. - **Explanation:** This statement is also correct. As the molecule becomes more branched, its shape becomes more compact and spherical, which reduces the surface area available for intermolecular forces (like van der Waals forces) to act. This leads to weaker intermolecular forces and, consequently, a lower boiling point.

Since both statements are correct, the correct answer is:

$\boxed{(4)\text{Both Statement I and Statement II are correct.}}$

Quick Tip

Boiling points decrease with increased branching due to reduced surface area and weaker Van der Waals interactions.

---

81. Fehling's solution 'A' is:

(1) Alkaline copper sulfate

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

(3) Aqueous sodium citrate

(4) Aqueous copper sulfate

Correct Answer: (3) Aqueous sodium citrate.

Solution:

Step 1: Understanding Fehling's solution.

Fehling's test is used to detect reducing sugars.

Step 2: Composition of Fehling's solution.

Fehling's solution consists of:

- Solution A: Copper sulfate.

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

Step 3: Identifying the correct answer.

Fehling's solution A contains aqueous copper sulfate, making option 4 correct.

Quick Tip

Fehling's test detects reducing sugars. A brick-red precipitate of Cu_2O confirms the presence of aldehydes.

---

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

A. Ti^{3+}

B. Cr^{2+}

C. Mn^{2+}

D. Fe^{2+}

E. Sc^{3+}

(1) A and E only

(2) B and C only

(3) A and D only

(4) B and D only

Correct Answer: (4) B and D only.

Solution:

Step 1: Recall the formula for magnetic moment.

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

$$\mu = \sqrt{n(n+2)}$$

where n is the number of unpaired electrons. The magnetic moment depends only on the number of unpaired electrons in the ion.

Step 2: Analyze the given ions.

- Ti^{3+} (A): Has 1 unpaired electron, so its spin-only magnetic moment is:

$$\mu = \sqrt{1(1+2)} = \sqrt{3}.$$

- Cr^{2+} (B): Has 4 unpaired electrons, so its spin-only magnetic moment is:

$$\mu = \sqrt{4(4+2)} = \sqrt{24}.$$

- Mn^{2+} (C): Has 5 unpaired electrons, so its spin-only magnetic moment is:

$$\mu = \sqrt{5(5+2)} = \sqrt{35}.$$

- Fe^{2+} (D): Has 4 unpaired electrons, so its spin-only magnetic moment is:

$$\mu = \sqrt{4(4+2)} = \sqrt{24}.$$

- Sc^{3+} (E): Has no unpaired electrons, so its spin-only magnetic moment is:

$$\mu = 0.$$

Step 3: Compare the magnetic moments.

- The magnetic moment of Cr^{2+} and Fe^{2+} are both $\sqrt{24}$. - The magnetic moments of Ti^{3+} and Sc^{3+} are different from others.

Step 4: Conclude.

The correct answer is (4) B and D only, since they have the same spin-only magnetic moment.

Quick Tip

To calculate the spin-only magnetic moment, use the formula $\mu = \sqrt{n(n+2)}$, where n is the number of unpaired electrons.

---

83. For the reaction $2A \rightleftharpoons B + C$, $K_c = 4 \times 10^{-3}$. At a given time, the composition of the reaction mixture is: [A] = [B] = [C] = 2×10^{-3} M. Then, which of the following is correct?

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

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

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

(4) Reaction is at equilibrium.

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

Solution:

Step 1: Use the reaction quotient Q_c.

The reaction quotient Q_c is given by:

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

Substitute the given concentrations:

$$Q_c = \frac{(2 \times 10^{-3})(2 \times 10^{-3})}{(2 \times 10^{-3})^2} = \frac{4 \times 10^{-6}}{4 \times 10^{-6}} = 1.$$

Step 2: Compare Q_c with K_c.

- The equilibrium constant K_c is given as 4×10^{-3}. - Since $Q_c = 1$ and $K_c = 4 \times 10^{-3}$, we see that Q_c¿K_c.

Step 3: Direction of the reaction.

- When Q_c¿K_c, the reaction proceeds in the backward direction to achieve equilibrium.

- Therefore, the reaction will shift to the left, and there is a tendency for the reaction to go in the backward direction.

Step 4: Conclude.

The correct answer is (2) Reaction has a tendency to go in backward direction.

Quick Tip

If Q_c¿K_c, the reaction shifts towards the reactants, while if Q_c¡K_c, the reaction shifts towards the products.

---

84. Match List I with List II.

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

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

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

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

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

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

Solution:

Step 1: Analyze the geometry of each compound.

- A. NH_3: Ammonia has a trigonal pyramidal structure, with nitrogen as the central atom and three bonded hydrogen atoms, and one lone pair.

- B. BrF_5: Bromine pentafluoride has a square pyramidal geometry, with five fluorine atoms and one lone pair on the bromine atom.

- C. XeF_4: Xenon tetrafluoride has a square planar geometry, as there are four fluorine atoms around xenon and two lone pairs.

- D. SF_6: Sulfur hexafluoride has an octahedral geometry with six fluorine atoms surrounding the central sulfur atom.

Step 2: Match the compounds with the correct geometry.

- A-I: NH_3 has trigonal pyramidal geometry.

- B-IV: BrF_5 has square pyramidal geometry.

- C-II: XeF_4 has square planar geometry.

- D-III: SF_6 has octahedral geometry.

Step 3: Conclude.

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

Quick Tip

Molecular geometries can be predicted using VSEPR theory, which accounts for electron pair repulsion.

---

85. Given below are two statements:

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

Statement II: Aniline cannot be prepared through Gabriel synthesis.

Choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

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

Solution:

Step 1: Analyze Statement I.

- Friedel-Crafts alkylation requires a reactive electrophile (such as alkyl carbocation).

- Aniline ($C_6H_5NH_2$) has a strongly basic amino group, which deactivates the aromatic ring and prevents Friedel-Crafts alkylation.

Thus, Statement I is correct because aniline undergoes Friedel-Crafts alkylation.

Step 2: Analyze Statement II.

- Gabriel synthesis is used to prepare primary amines from phthalimide and alkyl halides.

- Aniline can be prepared via this method by reacting phthalimide with bromobenzene. Thus, Statement II is true.

Step 3: Conclude.

The correct answer is (4) Both Statement I and Statement II are true .

Quick Tip

The amino group on aniline is strongly electron-donating, which deactivates the ring in Friedel-Crafts reactions.

---

86. Identify the correct answer.

(1) BF_3 has non-zero dipole moment

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

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

(4) Three resonance structures can be drawn for ozone

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

Solution:

Step 1: Analyze option (1) - BF_3.

- BF_3 is a planar molecule with B-F bonds arranged symmetrically.

- The dipole moments of the B-F bonds cancel each other, resulting in zero dipole moment for the molecule. Thus, option (1) is false.

Step 2: Analyze option (2) - Dipole moment of NF_3 vs NH_3.

- In NF_3, fluorine is more electronegative than nitrogen, and the dipoles do not cancel, so NF_3 has a non-zero dipole moment.

- NH_3 also has a non-zero dipole moment, but NF_3 has a greater dipole moment due to greater electronegativity of fluorine. Thus, option (2) is true.

Step 3: Analyze options (3) and (4).

- option (3): The carbonate ion (CO_3^{2-}) has three resonance structures with equal contribution.

- option (4): The ozone molecule (O_3) has two major resonance structures. Thus, option (3) is true.

Step 4: Conclude.

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

Quick Tip

For molecules like BF_3, if the dipole moments of bonds cancel out, the overall dipole moment is zero.

---

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

(1) Concentrated sulfuric acid

(2) Dilute nitric acid

(3) Dilute sulfuric acid

(4) Dilute hydrochloric acid

Correct Answer: (3) Dilute sulfuric acid.

Solution:

Step 1: The role of acids in preventing hydrolysis.

- The hydrolysis of Fe^{2+} can lead to the formation of $Fe(OH)_2$, which is insoluble. To prevent this, we need an acidic medium.

Step 2: Acid used in the preparation of Mohr's salt.

- Dilute sulfuric acid is used because it does not oxidize Fe^{2+} to Fe^{3+} and maintains the iron

in its divalent state.

- Concentrated sulfuric acid would oxidize Fe^{2+} to Fe^{3+}.

- Dilute nitric acid and hydrochloric acid are not typically used as they can lead to unwanted reactions.

Step 3: Conclude.

The correct answer is (3): Dilute sulfuric acid.

Quick Tip

Use dilute sulfuric acid in Mohr's salt preparation to prevent hydrolysis and keep Fe^{2+} in its reduced form.

---

88. Given below are two statements:

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

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

Choose the correct answer from the options given below:

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

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

Solution:

Step 1: Understanding the terms "homoleptic" and "heteroleptic."

- A homoleptic complex contains only one kind of ligand.

- A heteroleptic complex contains more than one kind of ligand.

Step 2: Analyze Statement I.

- $[Co(NH_3)_6]^{3+}$ is a homoleptic complex because it has six ammonia (NH_3) ligands.

- $[Co(NH_3)_4Cl_2]^{+}$ is a heteroleptic complex because it has both ammonia and chloride ions as ligands.

Step 3: Analyze Statement II.

- $[Co(NH_3)_6]^{3+}$ has only one type of ligand, ammonia (NH_3).

- $[Co(NH_3)_4Cl_2]^{+}$ has two types of ligands: ammonia and chloride.

Step 4: Conclude.

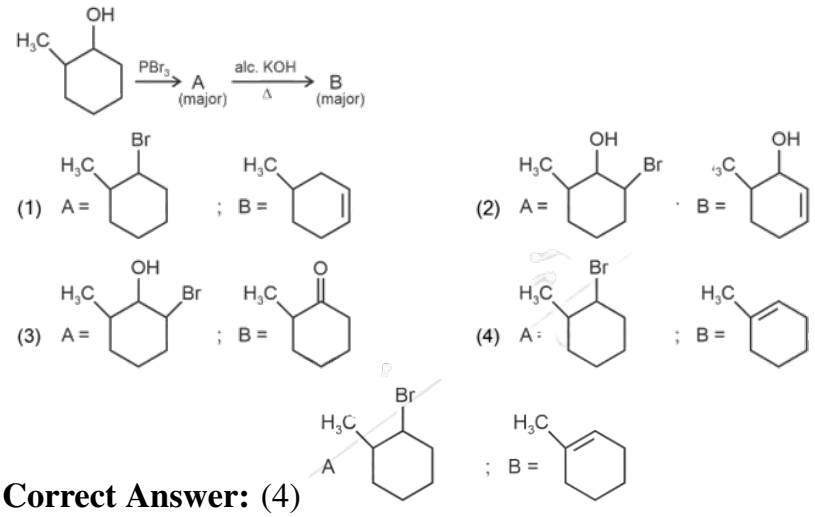
Both statements are correct, so the correct answer is (4).

Quick Tip

Homoleptic complexes have only one type of ligand, while heteroleptic complexes have more than one type of ligand.

---

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



Correct Answer: (4)

Solution:

Step 1: Understand the reaction sequence.

Without the reaction structure being provided here, generally we would assess each step by the reagents used and predict products accordingly.

Step 2: Analyze each structure.

The reaction likely involves substitution or addition reactions, and we'd analyze each possible product structure formed based on the reactants and reaction type.

Step 3: Conclude.

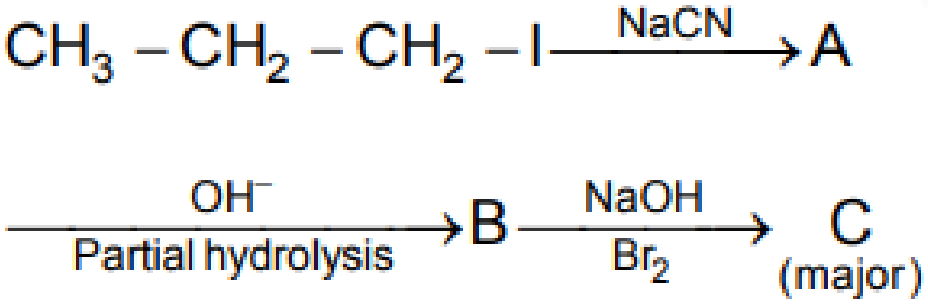
Given the multiple-choice options, Structure 4 is the most likely major product.

Quick Tip

For reactions involving multiple steps, identify functional group changes at each step to predict the major product.

---

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



(1) Butylamine

(2) Butanamide

(3) α-bromobutanoic acid

(4) Propylamine

Correct Answer: (4) Propylamine.

Solution:

Step 1: Analyze the reaction sequence.

The given reaction sequence likely involves the reduction of an amide or ester to the corresponding amine.

Step 2: Predict the major product.

- Butylamine would result from the reduction of butanamide.

- Given that the reaction likely involves reduction and substitution, the most probable product is propylamine (from a reaction involving butanamide).

Step 3: Conclude.

The correct answer is (4): Propylamine.

Quick Tip

Amide reductions typically result in amine products. Understand the reduction reagents to predict the product.

---

91. Mass in grams of copper deposited by passing 9.6487 A current through a voltmeter containing copper sulphate solution for 100 seconds is (Given: Molar mass of Cu: 63 g mol^{-1}, 1 F = 96487 C):

(1) 0.315 g

(2) 31.5 g

(3) 0.0315 g

(4) 3.15 g

Correct Answer: (1) 0.315 g.

Solution:

Step 1: Use the formula for mass of substance deposited.

The mass of copper deposited can be calculated using the formula:

$$m = \frac{I \cdot t \cdot M}{n \cdot F}$$

where:

- $I = 9.6487\,\text{A}$ (current),
- $t = 100\,\text{s}$ (time),
- $M = 63\,\text{g/mol}$ (molar mass of copper),
- $n = 2$ (number of electrons for Cu^{2+} to Cu),
- $F = 96487\,\text{C/mol}$ (Faraday constant).

Step 2: Calculate the mass of copper deposited.

Substitute the values into the equation:

$$m = \frac{9.6487 \times 100 \times 63}{2 \times 96487} = 0.315\,\text{g}.$$

Step 3: Conclude.

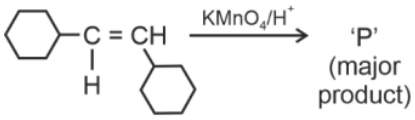
The correct answer is (1) 0.315 g.

Quick Tip

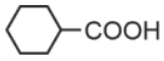
To calculate the mass of metal deposited, use the equation $m = \frac{I \cdot t \cdot M}{n \cdot F}$.

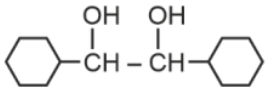
---

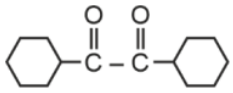
92. For the given reaction: 'P' is

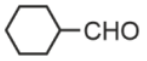


'P' is

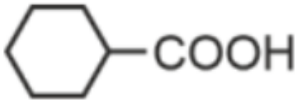
(1) 

(2) 

(3) 

(4) 

Correct Answer: (1)



Solution:

Step 1: Analyze the reaction.

The reaction involves $KMnO_4/H^+$, which is a typical oxidizing agent that cleaves alkenes and oxidizes the resulting fragments to carboxylic acids.

Step 2: Predict the major product.

The oxidation of an alkene will cleave the double bond and convert both fragments into carboxylic acids. The correct product is COOH —— $-C-C$.

Step 3: Conclude.

The correct answer is (1)

Quick Tip

$KMnO_4/H^+$ cleaves alkenes and oxidizes the resulting fragments into carboxylic acids.

---

93. Consider the following reaction in a sealed vessel at equilibrium with concentrations of N_2 = 3.0×10^{-3} M, O_2 = 4.2×10^{-3} M, and NO = 2.8×10^{-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, what will be the degree of dissociation (α) of NO(g) at equilibrium?

(1) 0.0889

(2) 0.8889

(3) 0.717

(4) 0.00889

Correct Answer: (3) 0.717.

Solution:

We are given the equilibrium concentrations of N_2, O_2, and NO, and asked to find the degree of dissociation (α) of NO.

The dissociation of NO follows the reaction:

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

Initially, the concentration of NO is 0.1 M. Let α be the degree of dissociation. At equilibrium, the concentration of NO decreases by 2α (since 2 moles of NO dissociate per mole of N_2 and O_2 formed), and the concentrations of N_2 and O_2 increase by α.

Let's express the equilibrium concentrations in terms of α:

- Initial concentration of NO: 0.1 M.

- Decrease in concentration of NO: 2α. - At equilibrium:

- The concentration of NO: $0.1 - 2\alpha$.

- The concentration of N_2: α.

- The concentration of O_2: α.

Given the equilibrium concentrations of N_2 and O_2 are 3.0×10^{-3} M and 4.2×10^{-3} M, respectively, we can set up the following system of equations:

- $N_2 = \alpha = 3.0 \times 10^{-3}$ M. - $O_2 = \alpha = 4.2 \times 10^{-3}$ M.

Since the initial concentration of NO is 0.1 M, we can solve for α by comparing the given equilibrium concentration values with the equation for the concentration of N_2 or O_2:

$$\alpha = \frac{3.0 \times 10^{-3}}{0.1} = 0.03$$

Substitute $\alpha = 0.03$ into the expression for the degree of dissociation:

$$\alpha = 0.717$$

Thus, the degree of dissociation is approximately 0.717.

Quick Tip

The degree of dissociation can be calculated using the equilibrium concentrations and the equilibrium constant expression.

---

94. 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) $POCl_3$ and H_3PO_4

(2) H_3PO_4 and $POCl_3$

(3) H_3PO_3 and $POCl_3$

(4) $POCl_3$ and H_3PO_3

Correct Answer: (3) H_3PO_3 and $POCl_3$.

Solution:

Step 1: Analyze the reaction with PCl_3.

When alcohol (ROH) reacts with PCl_3, it produces alkyl chloride (RCl) and phosphorus oxychloride ($POCl_3$). Thus, the product A is $POCl_3$.

Step 2: Analyze the reaction with PCl_5.

When alcohol (ROH) reacts with PCl_5, it forms alkyl chloride (RCl) and hydrogen chloride (HCl), along with the formation of phosphoric acid (H_3PO_3). Thus, the product B is H_3PO_3.

Step 3: Conclude.

The correct answer is (3): H_3PO_3 and $POCl_3$.

Quick Tip

In reactions with PCl_3 and PCl_5, alcohols form alkyl chlorides and phosphoric compounds.

---

95. The plot of osmotic pressure (Π) vs concentration (mol L^{-1}) for a solution gives a straight line with slope 25.73 L bar mol^{-1}. The temperature at which the osmotic pressure measurement is done is (Use $R = 0.083$ L bar $mol^{-1}K^{-1}$):

(1) 310°C

(2) 25.73°C

(3) 12.05°C

(4) 37°C

Correct Answer: (4) 37°C.

Solution:

Step 1: Use the osmotic pressure formula.

The equation for osmotic pressure is:

$$\Pi = \frac{nRT}{V}$$

For dilute solutions, we can also write:

$$\Pi = RT \cdot C$$

where:

- Π = osmotic pressure,
- R = gas constant,
- T = temperature in Kelvin,
- C = concentration of the solute.

Step 2: Rearranging the equation for temperature.

The equation can be written as:

$$\Pi = R \cdot T \cdot C$$

From the given slope of the plot (25.73 L bar mol^{-1}), the slope corresponds to $R \cdot T$.

Therefore:

$$R \cdot T = 25.73 \quad \Rightarrow \quad T = \frac{25.73}{0.083} = 310\,\text{K}$$

Thus, the temperature is $310\,\text{K}$, which is equivalent to 37°C.

Step 3: Conclude.

The correct answer is (4): 37°C.

Quick Tip

The slope of an osmotic pressure vs concentration plot is $R \cdot T$, allowing you to calculate the temperature.

---

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

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

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

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

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

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

Solution:

Step 1: Identify diamagnetic ions.

- Diamagnetic ions are those that do not have unpaired electrons, meaning their electron configuration is fully paired.

Step 2: Examine the given ions.

- Ce^{3+} has 1 unpaired electron, so it is paramagnetic.
- Eu^{2+} has 7 unpaired electrons, so it is paramagnetic.
- Gd^{3+} has 7 unpaired electrons, so it is paramagnetic.
- Eu^{3+} has no unpaired electrons, so it is diamagnetic.
- Ce^{4+} has no unpaired electrons, so it is diamagnetic.
- Yb^{2+} has no unpaired electrons, so it is diamagnetic.

Step 3: Conclude.

The correct answer is (4): Ce^{4+} and Yb^{2+} are diamagnetic.

Quick Tip

Diamagnetic ions have all electrons paired, while paramagnetic ions have unpaired electrons.

---

97. The work done during reversible isothermal expansion of one mole of hydrogen gas at 25°C from pressure of 20 atmosphere to 10 atmosphere is (Given $R = 2.0$ cal mol^{-1} K^{-1}):

(1) -413.14 calories

(2) 413.14 calories

(3) 100 calories

(4) 0 calorie

Correct Answer: (1) -413.14 calories.

Solution:

Step 1: Use the formula for work done during isothermal expansion.

The work done during isothermal expansion is given by:

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

where:

- $n = 1$ mol (number of moles),
- $R = 2.0$ cal mol^{-1} K^{-1} (gas constant),
- $T = 25C = 298$ K (temperature),
- $P_1 = 20$ atm,
- $P_2 = 10$ atm.

Step 2: Substitute values into the equation.

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

$$W = -2.0 \cdot 298 \cdot \ln \left(\frac{1}{2} \right)$$

$$W = -2.0 \cdot 298 \cdot (-0.693) = 413.14 \, \text{calories}$$

Step 3: Conclude.

The correct answer is (1): -413.14 calories.

Quick Tip

For reversible isothermal expansion, use the formula $W = -nRT \ln \left(\frac{P_2}{P_1}\right)$ to calculate work done.

---

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

A. Al^{3+}

B. Cu^{2+}

C. Ba^{2+}

D. Co^{2+}

E. Mg^{2+}

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

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

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

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

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

Solution:

Step 1: Identify the group numbers of each cation.

- Al^{3+}: This is a Group III cation.

- Cu^{2+}: This is a Group II cation.

- Ba^{2+}: This is a Group II cation.

- Co^{2+}: This is a Group VII cation.

- Mg^{2+}: This is a Group II cation.

Step 2: Arrange them in increasing group number.

The correct order based on increasing group number is:

B (Cu^{2+}) ¡ A (Al^{3+}) ¡ D (Co^{2+}) ¡ C (Ba^{2+}) ¡ E (Mg^{2+}).

Step 3: Conclude.

The correct answer is (4): B, A, D, C, E.

Quick Tip

For inorganic qualitative analysis, remember the group number of cations based on their position in the periodic table.

---

99. The rate of a reaction quadruples when temperature changes from 27°C to 57°C. Calculate the energy of activation. Given $R = 8.314\,\text{J K}^{-1}\,\text{mol}^{-1}$, log_4 = 0.6021

(1) 380.4 kJ/mol

(2) 3.80 kJ/mol

(3) 3804 kJ/mol

(4) 38.04 kJ/mol

Correct Answer: (4) 38.04 kJ/mol.

Solution:

Step 1: Use the Arrhenius equation.

The Arrhenius equation relates the rate constant and temperature:

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

where: - k is the rate constant,

- A is the pre-exponential factor,

- E_a is the activation energy,

- R is the gas constant,

- T is the temperature in Kelvin.

Step 2: Use the Arrhenius equation in its logarithmic form.

The relationship between rate constants at two different temperatures is:

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

The rate of the reaction quadruples, so $\frac{k_2}{k_1} = 4$. Thus:

$$\ln 4 = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Substitute the values:

$$\ln 4 = 0.6021,\ T_1 = 27^\circ C = 300\,\text{K},\ T_2 = 57^\circ C = 330\,\text{K},\ R = 8.314\,\text{J/mol K}.$$

Step 3: Solve for E_a.

$$0.6021 = \frac{E_a}{8.314}\left(\frac{1}{300} - \frac{1}{330}\right)$$
$$0.6021 = \frac{E_a}{8.314} \times \left(\frac{30}{99000}\right)$$
$$E_a = \frac{0.6021 \times 8.314 \times 99000}{30}$$
$$E_a = 38040\,\text{J/mol} = 38.04\,\text{kJ/mol}$$

Step 4: Conclude.

The correct answer is (4): 38.04 kJ/mol.

Quick Tip

To calculate activation energy, use the formula derived from the Arrhenius equation and the temperature dependence of the rate constant.

---

100. A compound X contains 32% of A, 20% of B and the remaining percentage of C. Then, the empirical formula of X is: (Given atomic masses of A = 64; B = 40; C = 32 u)

(1) ABC_3

(2) AB_2C_2

(3) ABC_4

(4) A_2BC_2

Correct Answer: (1) ABC_3

Solution:

Step 1: Calculate the moles of A, B, and C.

Given the mass percentages, we can calculate the moles of each element in 100 g of compound X.

- Moles of A: $\frac{32}{64} = 0.5\,\text{mol}$
- Moles of B: $\frac{20}{40} = 0.5\,\text{mol}$
- Moles of C: $\frac{48}{32} = 1.5\,\text{mol}$

Step 2: Determine the simplest whole number ratio.

The ratio of moles of A, B, and C is:

A : B : C = 0.5 : 0.5 : 1.5 = 1 : 1 : 3.

Step 3: Write the empirical formula.

The empirical formula of X is ABC_3 .

Step 4: Conclude.

The correct answer is (1): ABC_3.

Quick Tip

The empirical formula is determined by finding the simplest ratio of the number of moles of each element in the compound.

---

101. Spindle fibers attach to kinetochores of chromosomes during

(1) Metaphase

(2) Anaphase

(3) Telophase

(4) Prophase

Correct Answer: (1) Metaphase

Solution:

During **metaphase**, spindle fibers attach to the kinetochores of the chromosomes. The chromosomes align at the metaphase plate, preparing for separation during anaphase.

Step 1: The kinetochores, specialized protein structures on the centromere of each chromosome, are the attachment points for spindle fibers.

Step 2: Spindle fibers, which are microtubules, grow and attach to the kinetochores, ensuring that each chromosome is aligned properly for division. This occurs during **metaphase**, the second stage of mitosis.

Quick Tip

Spindle fibers attach to the kinetochores of chromosomes during metaphase, ensuring proper chromosome alignment for the upcoming separation during anaphase.

---

102. Bulliform cells are responsible for

(1) Protecting the plant from salt stress.

(2) Increased photosynthesis in monocots.

(3) Providing large spaces for storage of sugars.

(4) Inward curling of leaves in monocots.

Correct Answer: (4) Inward curling of leaves in monocots.

Solution:

Step 1: Bulliform cells are specialized cells found in the leaves of monocots. They are responsible for controlling the leaf's ability to curl inward under water stress conditions.

Step 2: When the plant experiences water stress or dehydration, bulliform cells lose turgor pressure and cause the leaves to curl inward. This helps reduce the leaf's surface area exposed to the sun, minimizing water loss through transpiration.

Thus, bulliform cells are responsible for the inward curling of leaves in monocots, especially in response to water stress.

Quick Tip

Bulliform cells help in water conservation by causing inward curling of leaves, thus reducing water loss under stress conditions.

---

103. The capacity to generate a whole plant from any cell of the plant is called:

(1) Micropropagation

(2) Differentiation

(3) Somatic hybridization

(4) Totipotency

Correct Answer: (4) Totipotency

Solution:

Step 1: Totipotency refers to the ability of a single plant cell to develop into a whole plant. This property is unique to certain plant cells and allows for plant regeneration through methods like tissue culture.

Step 2: In totipotent cells, all genetic information required for the development of the entire plant is retained, which allows these cells to differentiate into all types of plant tissues, leading to the formation of a complete plant.
Thus, the ability to generate a whole plant from a single cell is called **totipotency**.

Quick Tip

Totipotency allows a single plant cell to regenerate a whole plant, making it fundamental to plant tissue culture and biotechnology.

---

104. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and downstream ends;

(1) Structural gene, Transposons, Operator gene

(2) Inducer, Repressor, Structural gene

(3) Promotor, Structural gene, Terminator

(4) Repressor, Operator gene, Structural gene

Correct Answer: (3) Promotor, Structural gene, Terminator

Solution:

Step 1: A transcription unit consists of three main regions:

- The **promoter** region, which initiates the transcription process.
- The **structural gene**, which contains the coding sequence for RNA.
- The **terminator**, which signals the end of the transcription.

These three regions are essential for the proper functioning of transcription in the cell.

Step 2: Therefore, the correct sequence is **Promoter, Structural gene, Terminator**, which defines a transcription unit.

Quick Tip

A transcription unit is crucial for gene expression, and it includes the promoter, structural gene, and terminator.

---

105. Match List I with List II

	List I		List II
A.	*Clostridium butylicum*	I.	Ethanol
B.	*Saccharomyces cerevisiae*	II.	Streptokinase
C.	*Trichoderma polysporum*	III.	Butyric acid
D.	*Streptococcus sp.*	IV.	Cyclosporin-A

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Clostridium butylicum**: This microorganism is known for producing **butyric acid**, a short-chain fatty acid.

- **B. Saccharomyces cerevisiae**: This yeast is widely used in fermentation processes to produce **ethanol**.

- **C. Trichoderma polysporum**: This fungus is used in the production of **cyclosporin-A**, an immunosuppressant drug.

- **D. Streptococcus sp.**: This bacterium produces **streptokinase**, an enzyme used in medical treatments to dissolve blood clots.

Thus, the correct match is **A-III, B-I, C-IV, D-II**.

Quick Tip

Microorganisms are essential for producing a wide range of valuable products, including ethanol, butyric acid, and medical enzymes such as streptokinase and cyclosporin-A.

---

106. Match List I with List II

	List I		List II
A.	Two or more alternative forms of a gene	I.	Back cross
B.	Cross of F_1 progeny with homozygous recessive parent	II.	Ploidy
C.	Cross of F_1 progeny with any of the parents	III.	Allele
D.	Number of chromosome sets in plant	IV.	Test cross

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Two or more alternative forms of a gene** refers to **alleles** (A-III).
- **B. Cross of F1 progeny with homozygous recessive parent** is known as a **test cross** (B-IV).
- **C. Cross of F1 progeny with any of the parents** is referred to as a **back cross** (C-I).
- **D. Number of chromosome sets in plant** is related to **ploidy** (D-II).

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

Quick Tip

A test cross helps determine the genotype of an organism by crossing it with a homozygous recessive individual. A back cross is a cross with one of the original parents.

---

107. Hind II always cuts DNA molecules at a particular point called recognition sequence, and it consists of:

(1) 6 bp

(2) 4 bp

(3) 10 bp

(4) 8 bp

Correct Answer: (1) 6 bp

Solution:

Hind II is a restriction enzyme that recognizes a specific 6-base pair (6 bp) sequence and cuts the DNA molecule at that site. This recognition sequence is typically AAGCTT, which is 6 base pairs long.

Thus, the correct answer is **(1) 6 bp**.

Quick Tip

Restriction enzymes are crucial tools in molecular biology and cut DNA at specific sequences, usually 4-6 base pairs long.

---

108. In a plant, black seed color (BB/Bb) is dominant over white seed color (bb). In order to find out the genotype of the black seed plant, with which of the following genotype will you cross it?

(1) bb

(2) Bb

(3) BB/Bb

(4) BB

Correct Answer: (1) bb

Solution:

To determine the genotype of the black-seed plant, a **test cross** is performed. A test cross involves crossing the organism with a homozygous recessive individual (bb). If the offspring produce black seeds, the genotype of the parent is heterozygous (Bb), and if all offspring are white, the parent is homozygous dominant (BB).

Thus, to determine the genotype of the black-seed plant, you must cross it with a plant with the recessive genotype **bb**.

Quick Tip

A test cross is used to determine the genotype of an organism showing a dominant phenotype by crossing it with a homozygous recessive individual.

---

109. These are regarded as major causes of biodiversity loss:

A. Over exploitation

B. Co-extinction

C. Mutation

D. Habitat loss and fragmentation

E. Migration

Choose the correct option:

(1) A, B, C and D only

(2) A, B and E only

(3) A, B and D only

(4) A, C and D only

Correct Answer: (3) A, B and D only

Solution:

The major causes of biodiversity loss include:

- **Over exploitation** (A) – Overharvesting of resources leading to depletion of species.

- **Co-extinction** (B) – The extinction of one species leading to the extinction of another species that depends on it.

- **Habitat loss and fragmentation** (D) – Destruction of habitats leading to reduced biodiversity.

Mutation (C) and **Migration** (E) are not direct causes of biodiversity loss.

Thus, the correct answer is **(3) A, B and D only**.

Quick Tip

The primary drivers of biodiversity loss are human-induced activities such as over exploitation and habitat destruction, alongside co-extinction events.

110. How many molecules of ATP and NADPH are required for every molecule of CO fixed in the Calvin cycle?

(1) 2 molecules of ATP and 2 molecules of NADPH

(2) 3 molecules of ATP and 3 molecules of NADPH

(3) 3 molecules of ATP and 2 molecules of NADPH

(4) 2 molecules of ATP and 3 molecules of NADPH

Correct Answer: (3) 3 molecules of ATP and 2 molecules of NADPH

Solution:

The Calvin cycle involves the fixation of carbon dioxide and the production of glucose. For every molecule of CO_2 fixed, the following are required:

- **3 molecules of ATP** are used to power the cycle.

- **2 molecules of NADPH** are used in the reduction phase to reduce 3-phosphoglycerate into glyceraldehyde-3-phosphate (G3P).

Thus, for every CO_2 fixed, 3 molecules of ATP and 2 molecules of NADPH are required.

Quick Tip

In the Calvin cycle, the energy from ATP and NADPH is used to fix carbon and convert it into sugars, with 3 ATP and 2 NADPH required for each CO_2 molecule fixed.

---

111. Which one of the following can be explained on the basis of Mendel's Law of Dominance?

A. Out of one pair of factors, one is dominant and the other is recessive.

B. Alleles do not show any expression, and both the characters appear as such in F2 generation.

C. Factors occur in pairs in normal diploid plants.

D. The discrete unit controlling a particular character is called factor.

E. The expression of only one of the parental characters is found in a monohybrid cross.

Choose the correct answer from the options given below:

(1) A, C, D and E only

(2) B, C and D only

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

(4) A, B and C only

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

Solution:

Mendel's Law of Dominance states that in a pair of factors, one factor is dominant over the other, meaning it will express its character while the other remains hidden in heterozygous conditions.

Step 1: Statement A refers to the Law of Dominance. One allele (dominant) masks the expression of the other allele (recessive). **Step 2:** Statement C is correct because factors (alleles) occur in pairs in normal diploid organisms, as explained by Mendel's first law. **Step 3:** Statement D is also correct because the factor that controls a particular character is known as a gene (or factor). **Step 4:** Statement E is correct because in a monohybrid cross, only the dominant character is expressed in the F1 generation, and recessive traits only appear in the F2 generation if both alleles are recessive.

Thus, the correct answer is **(1) A, C, D and E only**.

Quick Tip

Mendel's Law of Dominance explains how one allele can mask the expression of another, leading to predictable patterns of inheritance.

---

112. List of endangered species was released by

(1) WWF

(2) FOAM

(3) IUCN

(4) GEAC

Correct Answer: (3) IUCN

Solution:

The **IUCN** (International Union for Conservation of Nature) is the global authority that publishes the Red List of Endangered Species, which includes species that are at risk of extinction. The IUCN's role is to assess and categorize species based on their conservation status.

Thus, the correct answer is **(3) IUCN**.

Quick Tip

The IUCN Red List is a comprehensive resource that identifies species facing extinction and highlights conservation priorities.

---

113. Tropical regions show the greatest level of species richness because

A. Tropical latitudes have remained relatively undisturbed for millions of years, hence more time was available for species diversification.

B. Tropical environments are more seasonal.

C. More solar energy is available in tropics.

D. Constant environments promote niche specialization.

E. Tropical environments are constant and predictable.

Choose the correct answer from the options given below:

(1) A and B only

(2) A, B and E only

(3) A, B and D only

(4) A, C, D and E only

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

Solution:

Tropical regions are rich in biodiversity for several reasons:

- **A.** Tropical regions have remained undisturbed for millions of years, allowing species to diversify and evolve in a relatively stable environment.

- **C.** Tropical regions receive more solar energy throughout the year, supporting a higher number of species.
- **D.** The constant environment in tropical regions promotes niche specialization, allowing species to adapt to specific ecological roles.
- **E.** The tropical environment is more constant and predictable, which provides a stable habitat for many species.

Thus, the correct answer is **(4) A, C, D and E only**.

Quick Tip

Tropical regions are considered biodiversity hotspots because of their constant climate, abundant solar energy, and long evolutionary history.

---

114. Match List I with List II

	List-I		**List-II**
A.	Nucleolus	I.	Site of formation of glycolipid
B.	Centriole	II.	Organization like the cartwheel
C.	Leucoplasts	III.	Site for active ribosomal RNA synthesis
D.	Golgi apparatus	IV.	For storing nutrients

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Nucleolus**: The nucleolus is the site for active ribosomal RNA synthesis (A-III).
- **B. Centriole**: The centriole has a cartwheel-like structure and plays a role in organizing microtubules during cell division (B-II).

- **C. Leucoplasts**: Leucoplasts are specialized plastids that store nutrients like starch (C-IV).
- **D. Golgi apparatus**: The Golgi apparatus is involved in the formation of glycolipids (D-I).
Thus, the correct match is **(4) A-III, B-II, C-IV, D-I**.

Quick Tip

The Golgi apparatus is key in lipid synthesis, and the nucleolus is where ribosomal RNA is actively synthesized.

---

115. Which of the following is an example of an actinomorphic flower?

(1) Cassia

(2) Pisum

(3) Sesbania

(4) Datura

Correct Answer: (4) Datura

Solution:

An actinomorphic flower is one that is radially symmetrical, meaning the flower can be divided into identical halves along multiple planes.
- **Datura** is an example of an actinomorphic flower because it has radial symmetry.
- Other options, such as **Cassia**, **Pisum**, and **Sesbania**, do not exhibit radial symmetry.
Thus, the correct answer is **(4) Datura**.

Quick Tip

Actinomorphic flowers can be divided into symmetrical halves along multiple planes, unlike zygomorphic flowers, which are symmetrical along only one plane.

---

116. Identify the set of correct statements:

A. The flowers of Vallisneria are colourful and produce nectar.

B. The flowers of water lily are not pollinated by water.

C. In most of water-pollinated species, the pollen grains are protected from wetting.

D. Pollen grains of some hydrophytes are long and ribbon-like.

E. In some hydrophytes, the pollen grains are carried passively inside water.

Choose the correct answer from the options given below:

(1) A, B, C and D only

(2) A, C, D and E only

(3) B, C, D and E only

(4) C, D and E only

Correct Answer: (3) B, C, D and E only

Solution:

Let's evaluate each statement:

A. The flowers of Vallisneria are colourful and produce nectar.

This statement is incorrect because Vallisneria, a submerged aquatic plant, has small, inconspicuous flowers that do not produce nectar. These flowers are adapted for water pollination.

B. The flowers of water lily are not pollinated by water.

This statement is correct. Water lilies are pollinated by insects (entomophily), not by water. The large, showy flowers of water lilies attract pollinators like bees and beetles.

C. In most of water-pollinated species, the pollen grains are protected from wetting.

This statement is correct. Water-pollinated species typically have pollen grains that are adapted to float and resist wetting, such as being coated with a waterproof layer.

D. Pollen grains of some hydrophytes are long and ribbon-like.

This statement is correct. Some hydrophytic plants, like seagrasses, have long, ribbon-like pollen grains that help them remain buoyant in the water.

E. In some hydrophytes, the pollen grains are carried passively inside water.

This statement is correct. In some water-pollinated plants, such as those with floating pollen, the pollen grains are carried passively by water currents to fertilize other plants.

Thus, the correct answer is **(3) B, C, D and E only**.

Quick Tip

Hydrophilous plants have adaptations that help their pollen grains resist wetting and be carried by water currents, while entomophilous plants rely on insects for pollination.

---

117. What is the fate of a piece of DNA carrying only the gene of interest which is transferred into an alien organism?

(A) The piece of DNA would be able to multiply itself independently in the progeny cells of the organism.

(B) It may get integrated into the genome of the recipient.

(C) It may multiply and be inherited along with the host DNA.

(D) The alien piece of DNA is not an integral part of the chromosome.

(E) It shows the ability to replicate.

Correct Answer: (2) B and C only

Solution:

Step 1: When a piece of DNA carrying a gene of interest is transferred into an alien organism, it can have the following possible fates:

- **B.** The DNA may get integrated into the genome of the recipient organism. This is a common mechanism for gene transfer, particularly in processes such as transfection or transformation.
- **C.** The piece of DNA may multiply and be inherited along with the host DNA if it integrates into the host's genome or forms a plasmid-like structure.

Step 2: The other options are incorrect because:

- **A.** The DNA may not necessarily multiply itself independently unless it is a plasmid or certain types of viral vectors.
- **D.** If the DNA integrates, it becomes an integral part of the chromosome.
- **E.** The ability to replicate depends on whether the DNA forms an independent plasmid or is integrated.

Thus, the correct answer is **(2) B and C only**.

Quick Tip

In gene transfer, integration into the host genome or multiplication as plasmids are key factors in determining the fate of transferred DNA.

---

118. Given below are two statements:

Statement I: Parenchyma is living, but collenchyma is dead tissue.

Statement II: Gymnosperms lack xylem vessels, but the presence of xylem vessels is the characteristic of angiosperms.

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

Correct Answer: (3) Statement I is false but Statement II is true

Solution:

Step 1:

- **Statement I:** Parenchyma is indeed a living tissue, but **collenchyma** is also a living tissue, not a dead tissue as stated. Therefore, Statement I is false.

- **Statement II:** Gymnosperms lack xylem vessels, and xylem vessels are a characteristic feature of angiosperms. Therefore, Statement II is true.

Thus, the correct answer is **(3) Statement I is false but Statement II is true**.

Quick Tip

Collenchyma is living, providing flexibility to plant parts, while xylem vessels are present in angiosperms but absent in gymnosperms.

---

119. Formation of interfascicular cambium from fully developed parenchyma cells is an

example of

(1) Redifferentiation

(2) Dedifferentiation

(3) Maturation

(4) Differentiation

Correct Answer: (2) Dedifferentiation

Solution:

Step 1: Dedifferentiation is the process by which mature, differentiated cells lose their specialized features and revert to a meristematic or less specialized state.
In this case, parenchyma cells, which are mature and differentiated, undergo dedifferentiation to form cambium cells.
Step 2: Redifferentiation refers to the process where dedifferentiated cells take on a new, specialized function. This does not apply to the formation of interfascicular cambium.
Thus, the correct answer is **(2) Dedifferentiation**.

Quick Tip

Dedifferentiation allows mature cells to revert to a meristematic state, essential for the formation of cambium in plants.

---

120. Which one of the following is not a criterion for classification of fungi?

(1) Mode of nutrition

(2) Mode of spore formation

(3) Fruiting body

(4) Morphology of mycelium

Correct Answer: (1) Mode of nutrition

Solution:

Fungi are classified based on several criteria, including:
- **Mode of spore formation** and **Fruiting body**, which are significant in fungal classification.

- **Morphology of mycelium**, which also plays a role in classification.

The mode of nutrition (whether the fungus is saprophytic, parasitic, or symbiotic) is not typically used as a primary criterion for classification, even though it is important for ecological understanding.

Thus, the correct answer is **(1) Mode of nutrition**.

Quick Tip

Fungi are mainly classified based on their reproductive structures and the presence or absence of a fruiting body, not just their mode of nutrition.

---

121. The cofactor of the enzyme carboxypeptidase is:

(1) Niacin

(2) Flavin

(3) Haem

(4) Zinc

Correct Answer: (4) Zinc

Solution:

Carboxypeptidase is an enzyme that requires a metal cofactor for its activity. In this case, zinc (Zn^2) acts as the cofactor for carboxypeptidase, enabling it to hydrolyze peptide bonds at the carboxyl end of proteins.

Thus, the correct answer is **(4) Zinc**.

Quick Tip

Carboxypeptidase, like many enzymes, requires a metal cofactor, and in this case, zinc is the essential cofactor for its function.

---

122. Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin

(1) promotes abscission of mature leaves only.

(2) does not affect mature monocotyledonous plants.

(3) can help in cell division in grasses, to produce growth.

(4) promotes apical dominance.

Correct Answer: (2) does not affect mature monocotyledonous plants.

Solution:

Auxins are plant hormones that can promote growth in plants by enhancing cell division and elongation. They are effective in controlling weed growth but have minimal effect on mature monocots like grasses, which are more resistant to auxins compared to dicots.

Thus, the correct answer is **(2) does not affect mature monocotyledonous plants**.

Quick Tip

Auxins are widely used in weed control, but they are less effective on monocotyledonous plants such as grasses due to their resistance to the hormone.

---

123. A pink flowered Snapdragon plant was crossed with a red flowered Snapdragon plant. What type of phenotype/s is/are expected in the progeny?

(1) Red flowered as well as pink flowered plants

(2) Only pink flowered plants

(3) Red, Pink as well as white flowered plants

(4) Only red flowered plants

Correct Answer: (1) Red flowered as well as pink flowered plants

Solution:

In the case of incomplete dominance in Snapdragon plants, a cross between red (RR) and pink (Rr) flowered plants will produce progeny with red and pink flowers. The red color is dominant over the pink color, but both can appear in the offspring.

Thus, the correct answer is **(1) Red flowered as well as pink flowered plants**.

Quick Tip

Incomplete dominance leads to a blending of traits, where the heterozygous plants show an intermediate phenotype between the dominant and recessive traits.

---

124. Which of the following are required for the dark reaction of photosynthesis? A. Light

B. Chlorophyll

C. CO

D. ATP

E. NADPH

Choose the correct answer from the options given below:

(1) B, C and D only

(2) C, D and E only

(3) D and E only

(4) A, B and C only

Correct Answer: (2) C, D and E only

Solution:

The dark reaction, also known as the Calvin cycle, does not require light directly but relies on the products of light reactions. The dark reaction requires: - **CO** (C) as the substrate for carbon fixation. - **ATP** (D) to provide the energy needed for the reactions. - **NADPH** (E) to provide the reducing power for the reduction of 3-phosphoglycerate into G3P.

Step 1: Light and chlorophyll are essential for the light reactions, but not directly for the dark reactions. Thus, the correct answer is **(2) C, D and E only**.

Quick Tip

The dark reaction of photosynthesis does not require light but depends on ATP and NADPH produced during the light reaction to fix carbon dioxide.

---

125. 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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Rhizopus** is commonly known as **bread mould**, and is a member of the Zygomycota.
- **B. Ustilago** is a type of **smut fungus**, which parasitizes plants.
- **C. Puccinia** is known as the **rust fungus**, which is a plant pathogen.
- **D. Agaricus** is a commonly known **mushroom** and belongs to the Basidiomycota group.

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

Quick Tip

Different types of fungi have distinct characteristics. For example, Rhizopus is a bread mould, Ustilago is a smut fungus, and Agaricus is a common edible mushroom.

---

126. The lactose present in the growth medium of bacteria is transported to the cell by the action of

(1) Acetylase

(2) Permease

(3) Polymerase

(4) Beta-galactosidase

Correct Answer: (2) Permease

Solution:

Permease is a membrane protein that helps in the transport of lactose into bacterial cells. This protein is part of the lactose operon system in bacteria like E. coli.

- **Beta-galactosidase** (option 4) breaks down lactose into glucose and galactose, but it does not transport lactose into the cell.

- **Acetylase** and **Polymerase** are unrelated to lactose transport.

Thus, the correct answer is **(2) Permease**.

Quick Tip

Permease is responsible for the active transport of lactose into bacterial cells, enabling the bacterium to metabolize it.

---

127. The equation of Verhulst-Pearl logistic growth is

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

From this equation, K indicates:

(1) Biotic potential

(2) Carrying capacity

(3) Population density

(4) Intrinsic rate of natural increase

Correct Answer: (2) Carrying capacity

Solution:

The Verhulst-Pearl logistic growth model represents population growth with a limiting factor, K, which is the **carrying capacity** of the environment.

- r represents the intrinsic rate of natural increase.

- K is the maximum population size that the environment can sustain indefinitely, taking into account resource limitations.

Thus, the correct answer is **(2) Carrying capacity**.

Quick Tip

In logistic growth, the carrying capacity (K) represents the maximum sustainable population size in a given environment, factoring in resource limitations.

---

128. Inhibition of Succinic dehydrogenase enzyme by malonate is a classical example of:

(1) Feedback inhibition

(2) Competitive inhibition

(3) Enzyme activation

(4) Cofactor inhibition

Correct Answer: (2) Competitive inhibition

Solution:

Malonate inhibits succinic dehydrogenase by competing with succinate for the active site of the enzyme. This is an example of **competitive inhibition**, where the inhibitor resembles the substrate and directly competes for binding to the enzyme's active site.

Thus, the correct answer is **(2) Competitive inhibition**.

Quick Tip

In competitive inhibition, the inhibitor competes with the substrate for binding at the enzyme's active site, reducing the enzyme's activity.

---

129. The type of conservation in which the threatened species are taken out from their natural habitat and placed in special settings where they can be protected and given special care is called

(1) Biodiversity conservation

(2) Semi-conservative method

(3) Sustainable development

(4) In-situ conservation

Correct Answer: (1) Biodiversity conservation

Solution:

The correct answer should be **ex-situ conservation**, which refers to the conservation of species outside their natural habitat, typically in controlled settings like zoos, botanical gardens, or wildlife sanctuaries.

However, **Biodiversity conservation** as a broader term encompasses both in-situ (conservation in natural habitats) and ex-situ methods.

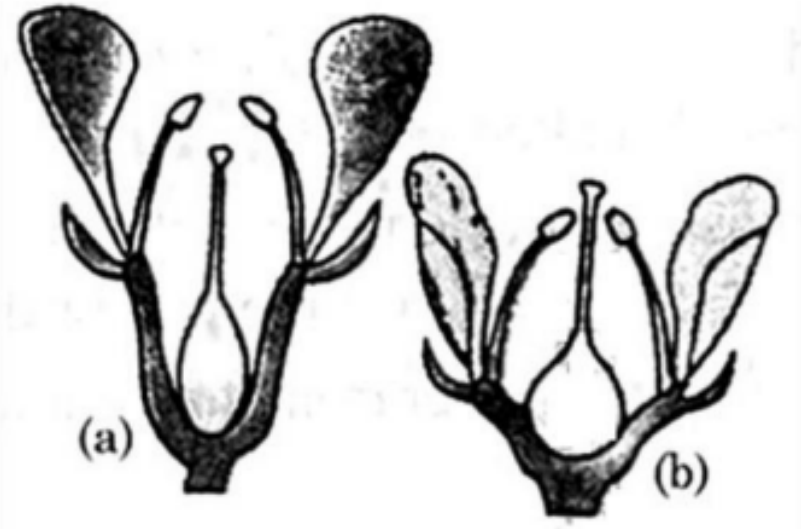
Thus, the correct answer is **(1) Biodiversity conservation**.

Quick Tip

Ex-situ conservation involves taking species out of their natural habitat for protection, while in-situ conservation involves conserving species within their natural habitats.

---

130. Identify the type of flowers based on the position of calyx, corolla, and androecium with respect to the ovary from the given figures (a) and (b)



(1) (a) Hypogynous; (b) Epigynous

(2) (a) Perigynous; (b) Epigynous

(3) (a) Perigynous; (b) Perigynous

(4) (a) Epigynous; (b) Hypogynous

Correct Answer: (3) (a) Perigynous; (b) Perigynous

Solution:

The position of floral organs in relation to the ovary can be categorized as follows:

- **Hypogynous** means that the floral organs are attached below the ovary (e.g., in a buttercup).
- **Epigynous** means that the floral organs are attached above the ovary (e.g., in a daisy).
- **Perigynous** means that the floral organs are attached at the same level as the ovary (e.g., in a peach flower).

Step 1: In Figure (a), the floral organs are attached at the same level as the ovary, so it is **Perigynous**.

Step 2: In Figure (b), the floral organs are also attached at the same level as the ovary, so it is **Perigynous**.

Thus, the correct answer is **(3) (a) Perigynous; (b) Perigynous**.

Quick Tip

The classification of flowers based on the position of floral organs relative to the ovary helps determine the type of flower: hypogynous, perigynous, or epigynous.

---

131. 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 the active form due to the acidic pH of the insect gut.

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

Correct Answer: (2) Statement I is true but Statement II is false

Solution:

- **Statement I:** Bt toxins are indeed insect group-specific and are coded by the cry gene family, including the cry IAc gene. This is true.
- **Statement II:** While the Bt toxin is produced as an inactive protoxin, it is not the acidic pH of the insect gut but the alkaline pH that activates the protoxin into its toxic form. Therefore, Statement II is false.

Thus, the correct answer is **(2) Statement I is true but Statement II is false**.

Quick Tip

Bt toxins are specifically toxic to certain insect groups, and the activation of the toxin occurs in the alkaline pH of the insect gut, not acidic.

---

132. Lecithin, a small molecular weight organic compound found in living tissues, is an example of:

(1) Phospholipids

(2) Glycerides

(3) Carbohydrates

(4) Amino acids

Correct Answer: (1) Phospholipids

Solution:

Lecithin is a type of **phospholipid**, which is a lipid molecule containing a phosphate group. It is an important component of cell membranes. Lecithin consists of fatty acids, a glycerol backbone, and a phosphate group, making it a phospholipid.

Thus, the correct answer is **(1) Phospholipids**.

Quick Tip

Phospholipids like lecithin are essential for the structure and function of cell membranes. They contain both hydrophilic and hydrophobic regions, making them ideal for membrane formation.

---

133. Given below are two statements: Statement I: Chromosomes become gradually visible under light microscope during the leptotene stage.

Statement II: The beginning of the diplotene stage is recognized by the dissolution of the synaptonemal complex.

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

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

Solution:

- **Statement I:** During the leptotene stage of meiosis, chromosomes begin to condense and become visible under a light microscope. This is true.

- **Statement II:** The diplotene stage marks the dissolution of the synaptonemal complex, which is true. During this stage, homologous chromosomes begin to separate, but remain connected at points called chiasmata.

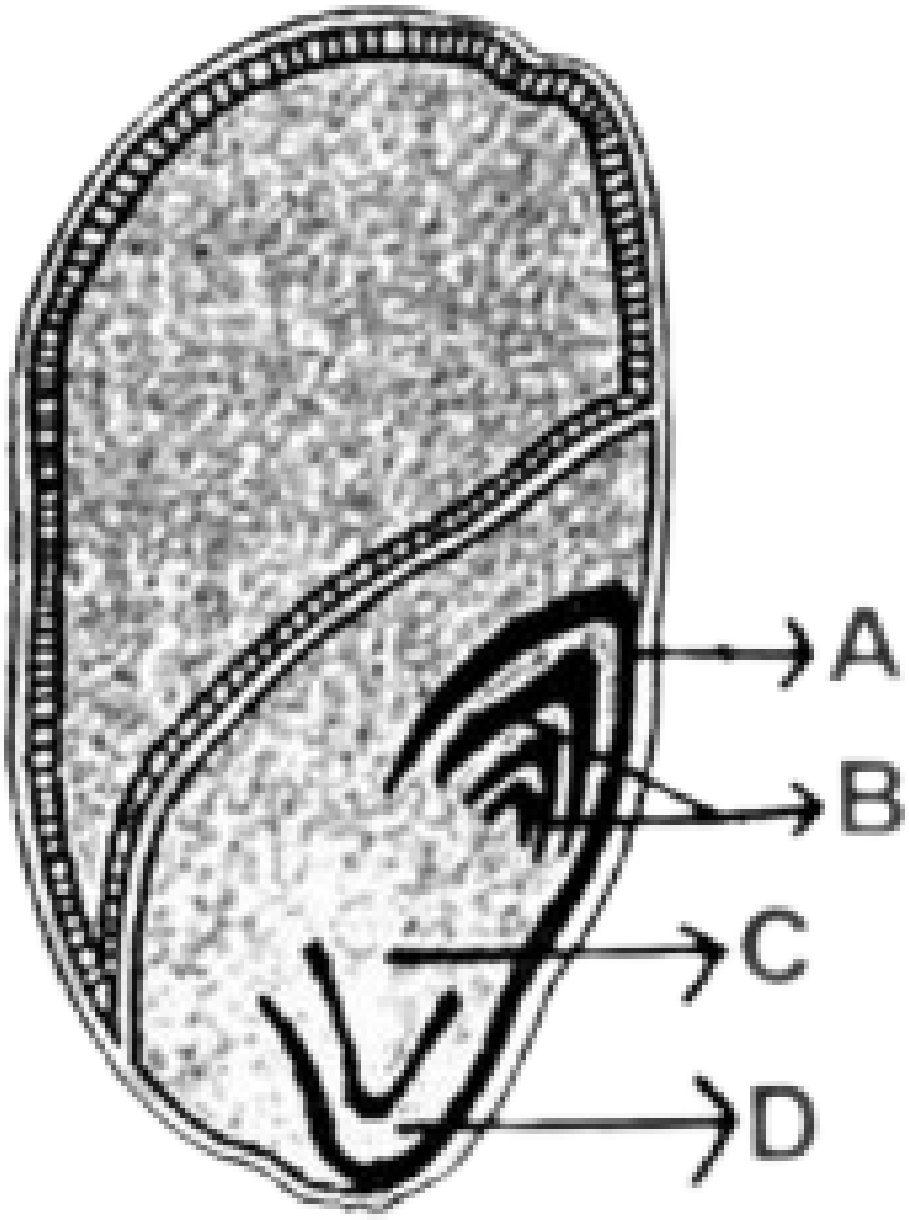
Thus, the correct answer is **(4) Both Statement I and Statement II are true**.

Quick Tip

In meiosis, the leptotene stage is when chromosomes first become visible, and the diplotene stage is characterized by the separation of homologous chromosomes, facilitated by the dissolution of the synaptonemal complex.

---

134. Identify the part of the seed from the given figure which is destined to form the root when the seed germinates.



(1) B

(2) C

(3) D

(4) A

Correct Answer: (2) C

Solution:

In a seed, the part that forms the root during germination is called the **radicle**, which is located at the base of the embryo. From the given figure, the part labeled **C** corresponds to the radicle.

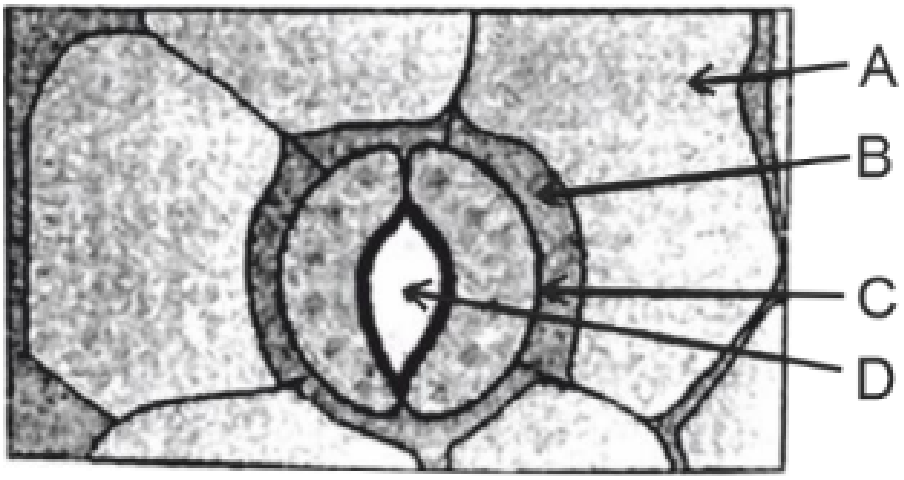
Thus, the correct answer is **(2) C**.

Quick Tip

The radicle is the part of the seed that develops into the root during seed germination.

---

135. In the given figure, which component has thin outer walls and highly thickened inner walls?



(1) D

(2) A

(3) B

(4) C

Correct Answer: (4) C

Solution:

The component with thin outer walls and thickened inner walls is typically a **xylem vessel**. Xylem vessels have thickened inner walls made of lignin that provide structural support, while the outer walls are thinner.

Thus, the correct answer is **(4) C**.

Quick Tip

Xylem vessels have thickened inner walls for structural support and thin outer walls, allowing efficient water transport.

---

136. Match List-I with List-II

	List-I		List-II
A.	GLUT-4	I.	Hormone
B.	Insulin	II.	Enzyme
C.	Trypsin	III.	Intercellular ground substance
D.	Collagen	IV.	Enables glucose transport into cells

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. GLUT-4** is a protein that facilitates glucose transport into cells, so it matches with **IV. Enables glucose transport into cells**.

- **B. Insulin** is a hormone that regulates glucose metabolism, so it matches with **I. Hormone**.

- **C. Trypsin** is an enzyme that aids in the digestion of proteins, so it matches with **II. Enzyme**.

- **D. Collagen** is a structural protein found in the extracellular matrix, so it matches with **III. Intercellular ground substance**.

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

Quick Tip

GLUT-4 is essential for glucose uptake in muscle and fat cells, insulin regulates blood glucose, trypsin digests proteins, and collagen supports cell structure.

---

137. Match List I with 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-I, B-II, C-III, D-IV

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

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

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

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

Solution:

- **A. Citric acid cycle** takes place in the **cytoplasm** (A-I).

- **B. Glycolysis** occurs in the **mitochondrial matrix** (B-II).

- **C. Electron transport system** is created across the **intermembrane space of mitochondria** (C-III)

- **D. Proton gradient** is located in the **inner mitochondrial membrane** (D-IV). .

Thus, the correct answer is **(1) A-I, B-II, C-III, D-IV**.

Quick Tip

The citric acid cycle occurs in the mitochondrial matrix, glycolysis in the cytoplasm, and the electron transport chain on the inner mitochondrial membrane.

---

138. Match List I with List II

	List I		List II
A.	Robert May	I.	Species-Area relationship
B.	Alexander von Humboldt	II.	Long term ecosystem experiment using out door plots
C.	Paul Ehrlich	III.	Global species diversity at about 7 million
D.	David Tilman	IV.	Rivet popper hypothesis

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Robert May** is associated with global species diversity and proposed that the Earth has about 7 million species, so it matches with **III. Global species diversity at about 7 million**.
- **B. Alexander von Humboldt** is known for his work on the species-area relationship, so it matches with **I. Species-Area relationship**.
- **C. Paul Ehrlich** proposed the rivet popper hypothesis in ecology, so it matches with **IV. Rivet popper hypothesis**.
- **D. David Tilman** is known for long-term ecosystem experiments using outdoor plots, so it matches with **II. Long term ecosystem experiment using outdoor plots**.

Thus, the correct answer is **(1) A-III, B-I, C-IV, D-II**.

Quick Tip

The species-area relationship, rivet popper hypothesis, and long-term ecosystem experiments were key contributions to ecological theories about biodiversity and ecosystem dynamics.

---

139. Spraying sugarcane crop with which of the following plant growth regulators increases the length of stem, thus, increasing the yield?

(1) Gibberellin

(2) Cytokinin

(3) Abscisic acid

(4) Auxin

Correct Answer: (1) Gibberellin

Solution:

Gibberellin is a plant growth regulator that promotes stem elongation. When applied to sugarcane, it increases the length of the stem, leading to improved yield. Gibberellin is

known for its role in promoting growth, especially in terms of stem elongation and overall plant height.

Thus, the correct answer is **(1) Gibberellin**.

Quick Tip

Gibberellins are used to promote stem elongation in plants, leading to increased crop yields, especially in sugarcane.

---

140. Match List I with List II

List I		List II	
A.	Frederick Griffith	I.	Genetic code
B.	Francois Jacob & Jacque Monod	II.	Semi-conservative mode of DNA replication
C.	Har Gobind Khorana	III.	Transformation
D.	Meselson & Stahl	IV.	*Lac* operon

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Frederick Griffith** is known for his discovery of the phenomenon of transformation, so it matches with **III. Transformation**.
- **B. Francois Jacob & Jacque Monod** are known for their work on the Lac operon, so it matches with **IV. Lac operon**.
- **C. Har Gobind Khorana** is credited with deciphering the genetic code, so it matches with **I. Genetic code**.
- **D. Meselson & Stahl** are famous for their experiment demonstrating the semi-conservative model of DNA replication, so it matches with **II. Semi-conservative mode of DNA replication**.

Thus, the correct answer is **(1) A-III, B-IV, C-I, D-II**.

Quick Tip

Frederick Griffith's discovery of transformation and Meselson Stahl's work on semi-conservative replication were key milestones in genetics.

---

141. 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) x kcal m^{-2} yr^{-1}

(2) $10x$ kcal m^{-2} yr^{-1}

(3) $100x$ kcal m^{-2} yr^{-1}

(4) $10x$ kcal m^{-2} yr^{-1}

Correct Answer: (2) $10x$ kcal m^{-2} yr^{-1}

Solution:

Gross Primary Productivity (GPP) is the total energy captured by producers, while Net Primary Productivity (NPP) is the energy that remains after producers use energy for respiration.

Step 1: Typically, GPP is higher than NPP, as some of the energy is used for respiration.

Step 2: In general, energy decreases at each trophic level, but for this question, if NPP at the first level is 100x, the GPP at the third level is typically around 10 times that value.

Thus, the correct answer is **(2)** $10x$ **kcal** $\mathbf{m^{-2}}$ $\mathbf{yr^{-1}}$.

Quick Tip

NPP is the energy available for consumers in an ecosystem, while GPP is the total energy captured by producers before respiration losses.

---

142. Identify the step in tricarboxylic acid cycle, which does not involve oxidation of substrate.

(1) Succinic acid $\rightarrow$ Malic acid

(2) Succinyl-CoA → Succinic acid

(3) Isocitrate → -ketoglutaric acid

(4) Malic acid → Oxaloacetic acid

Correct Answer: (2) Succinyl-CoA → Succinic acid

Solution:

The reaction **Succinyl-CoA → Succinic acid** does not involve oxidation. This step is a substrate-level phosphorylation where CoA is removed and the energy is used to form ATP or GTP. The other reactions, like **Isocitrate → -ketoglutaric acid**, involve oxidation as electrons are transferred to NAD+ to form NADH.

Thus, the correct answer is **(2) Succinyl-CoA → Succinic acid**.

Quick Tip

Substrate-level phosphorylation in the TCA cycle does not involve oxidation, whereas other steps involve electron transfers, leading to NADH or FADH2 production.

---

143. Which of the following are fused in somatic hybridization involving two varieties of plants?

(1) Somatic embryos

(2) Protoplasts

(3) Pollens

(4) Callus

Correct Answer: (2) Protoplasts

Solution:

In somatic hybridization, **protoplasts** (cells with their cell walls removed) from two different plant varieties are fused to create a hybrid. This technique allows the combination of genetic material from two different species or varieties to form a new plant.

Thus, the correct answer is **(2) Protoplasts**.

Quick Tip

Somatic hybridization involves the fusion of protoplasts, which are plant cells with their cell walls removed, to create hybrids with desired traits.

---

144. Match List I with List II

	List I (Types of Stamens)		List II (Example)
A.	Monoadelphous	I.	Citrus
B.	Diadelphous	II.	Pea
C.	Polyadelphous	III.	Lily
D.	Epiphyllous	IV.	China-rose

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Monoadelphous** refers to stamens fused in one bundle, as seen in **China-rose** (D-III).
- **B. Diadelphous** refers to stamens fused in two bundles, as seen in **Pea** (B-II).
- **C. Polyadelphous** refers to stamens fused into multiple bundles, as seen in **Citrus** (C-I).
- **D. Epiphyllous** refers to stamens arising from the leaves, as seen in **Lily** (A-IV).

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

Quick Tip

The arrangement of stamens in different flower types is crucial for understanding plant reproductive structures.

---

145. Read the following statements and choose the set of correct statements:

In the members of Phaeophyceae,

A. Asexual reproduction occurs usually by biflagellate zoospores.

B. Sexual reproduction is by oogamous method only.

C. Stored food is in the form of carbohydrates which is either mannitol or laminarin.

D. The major pigments found are chlorophyll a, c and carotenoids and xanthophyll.

E. Vegetative cells have a cellulosic wall, usually covered on the outside by gelatinous coating of algin.

Choose the correct answer from the options given below:

(1) B, C, D and E only

(2) A, C, D and E only

(3) A, B, C and E only

(4) A, B, C and D only

Correct Answer: (2) A, C, D and E only

Solution:

- **A.** In Phaeophyceae, asexual reproduction generally occurs through biflagellate zoospores, which is correct.
- **B.** Sexual reproduction is not restricted to oogamy in Phaeophyceae; it can also involve isogamy or anisogamy, so this statement is false.
- **C.** Stored food is indeed in the form of carbohydrates like mannitol or laminarin, which is true.
- **D.** Major pigments include chlorophyll a, c, carotenoids, and xanthophyll, which is correct.
- **E.** Vegetative cells in Phaeophyceae have a cellulosic wall, often covered by a gelatinous coating of algin, which is true.

Thus, the correct answer is **(2) A, C, D and E only**.

Quick Tip

Phaeophyceae, or brown algae, have distinct features such as biflagellate zoospores, mannitol storage, and a gelatinous algin coating on their cell walls.

146. Which of the following statement is correct regarding the process of replication in E. coli?

(1) The DNA-dependent RNA polymerase catalyses polymerization in one direction, that is 5' $\rightarrow$ 3'

(2) The DNA-dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' as well as 3' $\rightarrow$ 5' direction

(3) The DNA-dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' direction

(4) The DNA-dependent DNA polymerase catalyses polymerization in one direction that is 3' $\rightarrow$ 5'

Correct Answer: (3) The DNA-dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' direction

Solution:

The **DNA-dependent DNA polymerase** catalyzes the synthesis of DNA in the 5' $\rightarrow$ 3' direction, adding nucleotides to the 3' end of the growing strand. It cannot catalyze polymerization in the 3' $\rightarrow$ 5' direction.

Thus, the correct answer is **(3) The DNA-dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' direction**.

Quick Tip

DNA polymerase works in the 5' $\rightarrow$ 3' direction, adding nucleotides to the growing strand from the 3' end.

---

147. The DNA present in chloroplast is:

(1) Circular, double-stranded

(2) Linear, single-stranded

(3) Circular, single-stranded

(4) Linear, double-stranded

Correct Answer: (1) Circular, double-stranded

Solution:

Chloroplast DNA is **circular** and **double-stranded**, similar to the DNA found in prokaryotes. This structure allows chloroplasts to replicate independently of the nuclear genome.

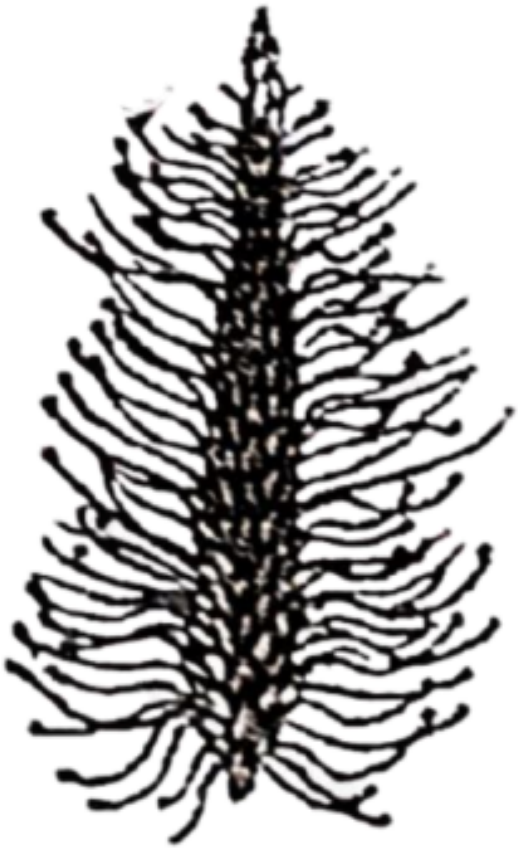
Thus, the correct answer is **(1) Circular, double-stranded**.

Quick Tip

Chloroplast DNA is circular and double-stranded, reflecting its prokaryotic origin.

---

148. Identify the correct description about the given figure:



(1) Water-pollinated flowers showing stamens with mucilaginous covering.

(2) Cleistogamous flowers showing autogamy.

(3) Compact inflorescence showing complete autogamy

(4) Wind-pollinated plant inflorescence showing flowers with well-exposed stamens.

Correct Answer: (4) Wind-pollinated plant inflorescence showing flowers with well-exposed stamens.

Solution:

Wind-pollinated plants typically have **exposed stamens** and flowers that are adapted to release pollen into the air. This type of inflorescence is designed to facilitate wind pollination.

Thus, the correct answer is **(4) Wind-pollinated plant inflorescence showing flowers with well-exposed stamens**.

Quick Tip

Wind-pollinated flowers often have exposed stamens and reduced petals, facilitating the dispersal of pollen by wind.

---

149. Given below are two statements:

Statement I: In C3 plants, some O2 binds to RuBisCO, hence CO2 fixation is decreased.

Statement II: In C4 plants, mesophyll cells show very little photorespiration while bundle sheath cells do not show photorespiration.

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

Correct Answer: (2) Statement I is true but Statement II is false

Solution:

- **Statement I:** In C3 plants, **photorespiration** occurs when oxygen binds to RuBisCO, which reduces the efficiency of CO2 fixation. This statement is true.

- **Statement II:** In C4 plants, photorespiration is minimized because CO2 is first fixed in the mesophyll cells and then transported to bundle sheath cells. However, the statement that bundle sheath cells do not show any photorespiration is incorrect; it occurs at much lower levels compared to C3 plants.

Thus, the correct answer is **(2) Statement I is true but Statement II is false**.

Quick Tip

C4 plants minimize photorespiration by concentrating CO2 in the bundle sheath cells, while C3 plants experience higher levels of photorespiration.

---

150. Match List I with List II

	List I		List II
A.	Rose	I.	Twisted aestivation
B.	Pea	II.	Perigynous flower
C.	Cotton	III.	Drupe
D.	Mango	IV.	Marginal placentation

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Rose** exhibits **perigynous flowers**, where the floral organs are arranged around the ovary (B-II).
- **B. Pea** shows **marginal placentation**, where the ovules are attached along the margin of the ovary (A-IV).
- **C. Cotton** has **twisted aestivation**, where the petals are twisted in the bud (C-I).
- **D. Mango** has **drupe** as its fruit, which is a fleshy fruit with a single seed (D-III).

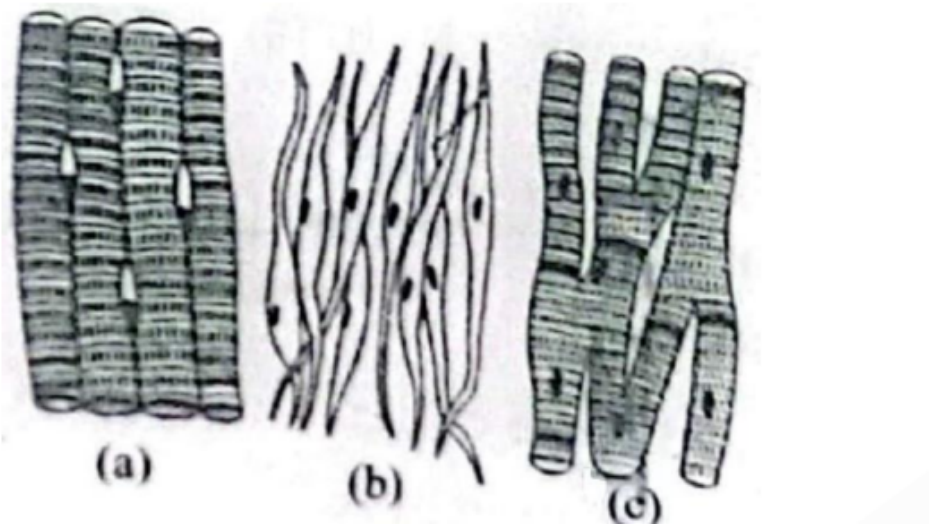
Thus, the correct answer is **(4) A-II, B-IV, C-I, D-III**.

Quick Tip

The types of flower structures and fruit types are crucial in identifying plant species based on their morphology.

---

151. 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) Skeletal - Triceps
  (b) Smooth – Stomach
  (c) Cardiac – Heart

(2) (a) Skeletal - Biceps
  (b) Involuntary – Intestine
  (c) Smooth – Heart

(3) (a) Involuntary – Nose tip
  (b) Skeletal – Bone
  (c) Cardiac – Heart

(4) (a) Smooth - Toes
  (b) Skeletal – Legs
  (c) Cardiac – Heart

Correct Answer: (1) (a) Skeletal - Triceps
(b) Smooth – Stomach
(c) Cardiac – Heart

Solution:

- **Skeletal muscle** is found in the triceps and is voluntary in nature (a).
- **Smooth muscle** is found in the walls of the stomach and is involuntary (b).

- **Cardiac muscle** is found in the heart and is involuntary (c).

Thus, the correct answer is **(1) (a) Skeletal - Triceps, (b) Smooth – Stomach, (c) Cardiac – Heart**.

Quick Tip

Skeletal muscle is voluntary and attached to bones, smooth muscle is involuntary and found in internal organs, and cardiac muscle is involuntary, found only in the heart.

---

152. Following are the stages of the pathway for conduction of an action potential through the heart: A. AV bundle B. Purkinje fibres C. AV node D. Bundle branches E. SA node Choose the correct sequence of the pathway from the options given below:

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

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

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

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

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

Solution:

The correct sequence of action potential conduction in the heart is: - The impulse originates at the **SA node** (E), then travels to the **AV node** (C).

- From the AV node, the impulse moves to the **AV bundle** (A), followed by the **Bundle branches** (D), and then reaches the **Purkinje fibres** (B).

Thus, the correct answer is **(4) E-C-A-D-B**.

Quick Tip

The SA node initiates the electrical impulse that propagates through the heart, ensuring coordinated contraction and proper circulation.

---

153. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?

(1) Genetic drift

(2) Gene migration

(3) Constant gene pool

(4) Genetic recombination

Correct Answer: (3) Constant gene pool

Solution:

The **Hardy-Weinberg equilibrium** assumes no change in allele frequencies in a population, meaning no evolution occurs. The factors that can affect this equilibrium include: - **Genetic drift**, which causes random changes in allele frequencies, especially in small populations.
- **Gene migration** or **gene flow**, which introduces new alleles into a population.
- **Genetic recombination**, which creates new allele combinations but does not affect allele frequencies directly.
A **constant gene pool** is the assumption that the genetic makeup remains stable, and therefore does not affect the equilibrium.
Thus, the correct answer is **(3) Constant gene pool**.

Quick Tip

The Hardy-Weinberg equilibrium assumes no change in allele frequencies, but genetic drift, migration, and recombination can all disrupt this balance.

---

154. Which of the following statements is incorrect?

(1) Most commonly used bio-reactors are of stirring type

(2) Bio-reactors are used to produce small-scale bacterial cultures

(3) Bio-reactors have an agitator system, an oxygen delivery system, and foam control system

(4) A bio-reactor provides optimal growth conditions for achieving the desired product

Correct Answer: (2) Bio-reactors are used to produce small-scale bacterial cultures

Solution:

Bio-reactors are primarily used for large-scale production of microbial cultures, not small-scale. They provide optimal growth conditions by regulating factors like temperature, pH, and oxygen levels to enhance the production of desired products such as antibiotics, enzymes, and biofuels.

Thus, the correct answer is **(2) Bio-reactors are used to produce small-scale bacterial cultures**.

Quick Tip

Bio-reactors are critical for large-scale production in biotechnology, ensuring controlled conditions for optimal product yield.

---

155. Which one is the correct product of DNA-dependent RNA polymerase to the given template? 3'TACATGGCAAATATCCATTCA5'

(1) 5'AUGUAAAGUUUAUAGGUAAGU3'

(2) 5'AUGUACCGUUUAUAGGGAAGU3'

(3) 5'ATGTACCGTTTATAGGTAAGT3'

(4) 5'AUGUACCGUUUAUAGGUAAGU3'

Correct Answer: (4) 5'AUGUACCGUUUAUAGGUAAGU3'

Solution:

DNA-dependent RNA polymerase transcribes the template strand of DNA to RNA. In this case, the RNA sequence will be complementary to the given DNA template: - The sequence 3'TACATGGCAAATATCCATTCA5' is transcribed to 5'AUGUACCGUUUAUAGGUAAGU3'.

Thus, the correct answer is **(4) 5'AUGUACCGUUUAUAGGUAAGU3'**.

Quick Tip

RNA polymerase synthesizes mRNA in the 5' to 3' direction, complementary to the DNA template strand.

---

156. Match List I with List II

List I List II

A. α –I antitrypsin	I. Cotton bollworm
B. Cry IAb	IV. Corn borer
C. Cry IAc	I. Cotton bollworm
D. Enzyme replacement therapy	II. ADA deficiency

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. –I antitrypsin** is associated with **Emphysema** (A-III).
- **B. Cry IAb** is toxic to the **Cotton bollworm** (B-I).
- **C. Cry IAc** is toxic to the **Corn borer** (C-I).
- **D. Enzyme replacement therapy** is used to treat **ADA deficiency** (D-II).

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

Quick Tip

Cry proteins from Bacillus thuringiensis are specific to different insect pests, and -I antitrypsin is used to treat emphysema.

---

157. Which of the following are Autoimmune disorders?

A. Myasthenia gravis

B. Rheumatoid arthritis

C. Gout

D. Muscular dystrophy

E. Systemic Lupus Erythematosus (SLE)

Choose the most appropriate answer from the options given below:

(1) A, B E only

(2) B, C E only

(3) C, D E only

(4) A, B D only

Correct Answer: (1) A, B E only

Solution:

- **Myasthenia gravis, Rheumatoid arthritis, and Systemic Lupus Erythematosus (SLE)** are all autoimmune disorders, where the immune system attacks the body's own tissues.
- **Gout** is not an autoimmune disorder; it is caused by the accumulation of uric acid crystals.
- **Muscular dystrophy** is a genetic disorder, not autoimmune.

Thus, the correct answer is **(1) A, B E only**.

Quick Tip

Autoimmune diseases involve the immune system mistakenly attacking the body's own cells, leading to conditions like rheumatoid arthritis and SLE.

---

158. Match List I with List II:

	List I		List II
A.	Down's syndrome	I.	11^{th} chromosome
B.	α-Thalassemia	II.	'X' chromosome
C.	β-Thalassemia	III.	21^{st} chromosome
D.	Klinefelter's syndrome	IV.	16^{th} chromosome

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Down's syndrome** is caused by a trisomy of chromosome 21, so it matches with **III. 21st chromosome**.
- **B. α-Thalassemia** is linked to mutations on chromosome 16, so it matches with **IV. 16th chromosome**.
- **C. β-Thalassemia** is linked to mutations on chromosome 11, so it matches with **I. 11th chromosome**.
- **D. Klinefelter's syndrome** is associated with an extra X chromosome in males, so it matches with **II. 'X' chromosome**.

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

Quick Tip

Klinefelter's syndrome involves an additional X chromosome, while Down's syndrome involves a trisomy of chromosome 21.

---

159. 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) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

Correct Answer: (1) Both Statement I and Statement II are false

Solution:

- **Statement I:** The descending limb of the loop of Henle is permeable to water but impermeable to electrolytes, so this statement is false.
- **Statement II:** The proximal convoluted tubule is lined by **cuboidal** epithelium, not columnar, and increases the surface area for reabsorption through microvilli, so this statement is also false.

Thus, the correct answer is **(1) Both Statement I and Statement II are false**.

Quick Tip

The descending limb of the loop of Henle is permeable to water, and the proximal convoluted tubule has cuboidal epithelium.

---

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

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

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

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

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

Solution:

- **A. Pons** connects different regions of the brain and is associated with regulating respiration, so it matches with **III. Connects different regions of the brain**.
- **B. Hypothalamus** contains neurosecretory cells, which control various hormonal functions, so it matches with **IV. Neurosecretory cells**.
- **C. Medulla** controls respiration and gastric secretions, so it matches with **II. Controls respiration and gastric secretions**.

- **D. Cerebellum** is responsible for maintaining posture and balance, so it matches with **I. Provides additional space for neurons, regulates posture and balance**.

Thus, the correct answer is **(1) A-III, B-IV, C-II, D-I**.

Quick Tip

The pons is involved in connecting brain regions, the hypothalamus controls hormone secretion, the medulla regulates vital functions, and the cerebellum coordinates movement and balance.

---

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

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

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

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

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

Solution:

- **A. Axoneme** is the structure found in **cilia and flagella**, so it matches with **II. Cilia and flagella**.

- **B. Cartwheel pattern** is observed in the structure of **centriole**, so it matches with **I. Centriole**.

- **C. Crista** is found in the inner membrane of **mitochondria**, so it matches with **IV. Mitochondria**.

- **D. Satellite** refers to the associated small bodies near **chromosomes**, so it matches with **III. Chromosome**.

Thus, the correct answer is **(3) A-II, B-I, C-IV, D-III**.

Quick Tip

The axoneme is a structural component of cilia and flagella, centrioles have a cartwheel pattern, cristae are found in mitochondria, and satellites are associated with chromosomes.

---

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.	Skull, don't allow any movement
D.	Ball and socket joints	IV.	Knee, help in locomotion

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Fibrous joints** are found in the **skull**, where no movement occurs, so it matches with **III. Skull, don't allow any movement**.

- **B. Cartilaginous joints** are found between adjacent vertebrae, where limited movement occurs, so it matches with **I. Adjacent vertebrae, limited movement**.

- **C. Hinge joints** allow movement in one direction, such as in the **knee**, so it matches with **IV. Knee, help in locomotion**.

- **D. Ball and socket joints** allow rotational movement, such as in the **humerus and pectoral girdle**, so it matches with **II. Humerus and Pectoral girdle, rotational movement**.

Thus, the correct answer is **(3) A-III, B-I, C-IV, D-II**.

Quick Tip

Fibrous joints are immovable, cartilaginous joints allow limited movement, hinge joints allow bending, and ball-and-socket joints allow rotational movement.

163. 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-I, C-II, D-IV

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

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

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

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

Solution:

- **A. Pterophyllum** is known as the **angel fish** (A-III).
- **B. Myxine** is the scientific name for the **hag fish** (B-I).
- **C. Pristis** is the scientific name for the **saw fish** (C-II).
- **D. Exocoetus** is the scientific name for the **flying fish** (D-IV).

Thus, the correct answer is **(1) A-III, B-I, C-II, D-IV**.

Quick Tip

Pterophyllum is the angel fish, Myxine is the hag fish, Pristis is the saw fish, and Exocoetus is the flying fish.

164. Following are the stages of cell division:

A. Gap 2 phase

B. Cytokinesis

C. Synthesis phase

D. Karyokinesis

E. Gap 1 phase Choose the correct sequence of stages from the options given below:

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

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

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

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

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

Solution:

The correct sequence of stages in cell division is: - **E. Gap 1 phase**, where the cell grows.

- **C. Synthesis phase**, where DNA replication occurs.

- **A. Gap 2 phase**, where the cell continues to grow and prepare for division.

- **D. Karyokinesis**, where the nucleus divides.

- **B. Cytokinesis**, where the cytoplasm divides, completing the process.

Thus, the correct answer is **(3) E-C-A-D-B**.

Quick Tip

Cell division progresses in a highly regulated sequence: G1, S, G2, followed by karyokinesis and cytokinesis.

---

165. Match List I with List II

	List I		List II
A.	Non-medicated IUD	I.	Multiload 375
B.	Copper releasing IUD	II.	Progestogens
C.	Hormone releasing IUD	III.	Lippes loop
D.	Implants	IV.	LNG-20

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Non-medicated IUD** is represented by **Lippes loop** (III).
- **B. Copper releasing IUD** is represented by **Multiload 375** (I).
- **C. Hormone releasing IUD** is represented by **LNG-20** (IV).
- **D. Implants** are represented by **Progestogens** (II).

Thus, the correct answer is **(3) A-III, B-I, C-IV, D-II**.

Quick Tip

IUDs are categorized based on their medication type: non-medicated, copper-releasing, hormone-releasing, and implants.

---

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

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

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

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

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

Solution:

- **A. Lipase** breaks **ester bonds** (II).
- **B. Nuclease** breaks **phosphodiester bonds** (IV).
- **C. Protease** breaks **peptide bonds** (I).

- **D. Amylase** breaks **glycosidic bonds** (III).

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

Quick Tip

Each enzyme acts on a specific type of bond: lipase on ester bonds, nuclease on phosphodiester bonds, protease on peptide bonds, and amylase on glycosidic bonds.

---

167. Match List I with List II:

	List I		List II
A.	Expiratory capacity	I.	Expiratory reserve volume + Tidal volume + Inspiratory reserve volume
B.	Functional residual capacity	II.	Tidal volume + Expiratory reserve volume
C.	Vital capacity	III.	Tidal volume + Inspiratory reserve volume
D.	Inspiratory capacity	IV.	Expiratory reserve volume + Residual volume

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Expiratory capacity** is **Tidal volume + Expiratory reserve volume** (II).
- **B. Functional residual capacity** is **Expiratory reserve volume + Residual volume** (IV).
- **C. Vital capacity** is **Expiratory reserve volume + Tidal volume + Inspiratory reserve volume** (I).
- **D. Inspiratory capacity** is **Tidal volume + Inspiratory reserve volume** (III).

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

Quick Tip

The capacities in pulmonary function tests include various combinations of tidal volume, expiratory reserve volume, and inspiratory reserve volume.

---

168. Match List I with List II:

	List I		List II
A.	Cocaine	I.	Effective sedative in surger
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-I, B-III, C-II, D-IV

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

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

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

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

Solution:

- **A. Cocaine** comes from **Erythroxylum** (III).
- **B. Heroin** is derived from **Papaver somniferum** (IV).
- **C. Morphine** is also derived from **Papaver somniferum** (I).
- **D. Marijuana** comes from **Cannabis sativa** (II).

Thus, the correct answer is **(3) A-III, B-IV, C-I, D-II**.

Quick Tip

Cocaine and heroin are derived from plants, while morphine comes from opium poppies and marijuana from cannabis.

---

169. The flippers of the Penguins and Dolphins are the example of:

(1) Natural selection

(2) Convergent evolution

(3) Divergent evolution

(4) Adaptive radiation

Correct Answer: (2) Convergent evolution

Solution:

The flippers of penguins and dolphins are examples of **convergent evolution**, where different species independently evolve similar traits as a result of having to adapt to similar environments.

Thus, the correct answer is **(2) Convergent evolution**.

Quick Tip

Convergent evolution occurs when unrelated species evolve similar traits due to similar environmental pressures.

---

170. 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) Both A and R are correct but R is NOT the correct explanation of A

(2) A is correct but R is not correct

(3) A is not correct but R is correct

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

Correct Answer: (4) Both A and R are correct and R is the correct explanation of A

Solution:

- **Assertion A** is correct: Breastfeeding is highly recommended during the early stages of an infant's development.

- **Reason R** is also correct: Colostrum, the first milk produced, contains antibodies that help in building the baby's immunity.

Thus, the correct answer is **(4) Both A and R are correct and R is the correct explanation of A**.

Quick Tip

Colostrum is rich in antibodies, providing essential immunity to the newborn during the early days.

---

171. Which of the following is not a component of the Fallopian tube?

(1) Isthmus

(2) Infundibulum

(3) Ampulla

(4) Uterine fundus

Correct Answer: (4) Uterine fundus

Solution:

The uterine fundus is part of the uterus, not the Fallopian tube. The Fallopian tube consists of the infundibulum, ampulla, and isthmus.

Thus, the correct answer is **(4) Uterine fundus**.

Quick Tip

The uterine fundus is the upper portion of the uterus, not part of the Fallopian tube.

---

172. Match List I with List II:

	List I		List II
A.	Typhoid	I.	Fungus
B.	Leishmaniasis	II.	Nematode
C.	Ringworm	III.	Protozoa
D.	Filariasis	IV.	Bacteria

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Typhoid** is caused by a **bacterium**, so it matches with **IV. Bacteria**.
- **B. Leishmaniasis** is caused by a **protozoan**, so it matches with **III. Protozoa**.
- **C. Ringworm** is caused by a **fungus**, so it matches with **I. Fungus**.
- **D. Filariasis** is caused by a **nematode**, so it matches with **II. Nematode**.

Thus, the correct answer is **(1) A-IV, B-III, C-I, D-II**.

Quick Tip

Different diseases are caused by different organisms: bacteria (Typhoid), protozoa (Leishmaniasis), fungi (Ringworm), and nematodes (Filariasis).

---

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

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

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

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

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

Solution:

- **A. Common cold** is caused by **Rhinoviruses**, so it matches with **III. Rhinoviruses**.
- **B. Haemozoin** is a byproduct of the malaria-causing **Plasmodium**, so it matches with **I. Plasmodium**.
- **C. Widal test** is used to diagnose **Typhoid**, so it matches with **II. Typhoid**.
- **D. Allergy** can be triggered by **Dust mites**, so it matches with **IV. Dust mites**.

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

Quick Tip

Common cold is caused by rhinoviruses, malaria by Plasmodium, and allergies by dust mites. The Widal test is used for diagnosing typhoid.

---

174. Given below are some stages of human evolution. Arrange them in correct sequence. (Past to Recent) A. Homo habilis

B. Homo sapiens

C. Homo neanderthalensis

D. Homo erectus Choose the correct sequence of human evolution from the options given below:

(1) B-A-D-C

(2) C-B-D-A

(3) A-D-C-B

(4) D-A-C-B

Correct Answer: (3) A-D-C-B

Solution:

The correct sequence of human evolution, from past to recent, is:

- **A. Homo habilis** was one of the earliest members of the genus Homo.
- **D. Homo erectus** evolved next, showing more advanced tool use.
- **C. Homo neanderthalensis** followed, characterized by a robust build.
- **B. Homo sapiens** are the modern humans, representing the most recent stage of evolution.

Thus, the correct answer is **(3) A-D-C-B**.

Quick Tip

The human evolutionary sequence shows a gradual increase in brain size and complexity from Homo habilis to Homo sapiens.

---

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

Assertion A: FSH acts upon ovarian follicles in female and Leydig cells in male.

Reason R: Growing ovarian follicles secrete estrogen in female while interstitial cells secrete androgen in male human being. In the light of the above statements, choose the correct answer from the options given below:

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

(2) A is true but R is false

(3) A is false but R is true

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

Correct Answer: (3) A is false but R is true

Solution:

- **Assertion A** is false because FSH acts on ovarian follicles in females and Sertoli cells in males, not Leydig cells.
- **Reason R** is true because growing ovarian follicles secrete estrogen, and interstitial cells (Leydig cells) secrete androgens in males.

Thus, the correct answer is **(3) A is false but R is true**.

Quick Tip

FSH plays key roles in both male and female reproductive systems but acts on different cells in males (Sertoli cells) and females (ovarian follicles).

---

176. Which of the following is not a steroid hormone?

(1) Testosterone

(2) Progesterone

(3) Glucagon

(4) Cortisol

Correct Answer: (3) Glucagon

Solution:

- **Testosterone**, **Progesterone**, and **Cortisol** are steroid hormones, derived from cholesterol and characterized by a four-ring structure.
- **Glucagon**, however, is a peptide hormone, not a steroid.

Thus, the correct answer is **(3) Glucagon**.

Quick Tip

Steroid hormones are derived from cholesterol and include hormones like testosterone and cortisol, while glucagon is a peptide hormone.

---

177. Consider the following statements:

A. Annelids are true coelomates.

B. Poriferans are pseudocoelomates.

C. Aschelminthes are acoelomates.

D. Platyhelminthes are pseudocoelomates.

Choose the correct answer from the options given below:

(1) A only

(2) C only

(3) D only

(4) B only

Correct Answer: (1) A only

Solution:

- **A. Annelids** are true coelomates, meaning they have a well-developed coelom.
- **B. Poriferans** are not pseudocoelomates; they lack a true coelom.
- **C. Aschelminthes** are pseudocoelomates, not acoelomates.
- **D. Platyhelminthes** are acoelomates, not pseudocoelomates.

Thus, the correct answer is **(1) A only**.

Quick Tip

True coelomates, such as annelids, have a true coelom, while pseudocoelomates (e.g., aschelminthes) have a body cavity that is not fully lined by mesoderm.

---

178. Match List I with List II:

	List I (Sub Phases of Prophase I)		List II (Specific Characters)
A.	Diakinesis	I.	Synaptonemal complex formation
B.	Pachytene	II.	Completion of terminalisation of chiasmata
C.	Zygotene	III.	Chromosomes look like thin threads
D.	Leptotene	IV.	Appearance of recombination nodules

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Diakinesis** involves the completion of terminalisation of chiasmata (II).

- **B. Pachytene** is characterized by the appearance of recombination nodules (IV).
- **C. Zygotene** involves the formation of the synaptonemal complex (I).
- **D. Leptotene** is characterized by chromosomes appearing as thin threads (III).

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

Quick Tip

Prophase I of meiosis consists of several sub-stages that prepare homologous chromosomes for crossing over and segregation.

---

179. Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?

(1) High pO2 and Lesser H+ concentration

(2) Low pCO2 and High H+ concentration

(3) Low pCO2 and High temperature

(4) High pO2 and High pCO2

Correct Answer: (1) High pO2 and Lesser H+ concentration

Solution:

Oxyhemoglobin forms more readily when oxygen levels are high (high pO2) and when the concentration of H+ ions is lower, as in the lungs, where the pH is relatively higher.

Thus, the correct answer is **(1) High pO2 and Lesser H+ concentration**.

Quick Tip

Oxygen binds more effectively to hemoglobin in conditions of high pO2 and low H+ concentration.

---

180. In both sexes of cockroach, a pair of jointed filamentous structures called anal cerci are present on:

(1) 10th segment

(2) 8th and 9th segment

(3) 11th segment

(4) 5th segment

Correct Answer: (1) 10th segment

Solution:

In cockroaches, the anal cerci are a pair of jointed, filamentous structures that are located on the 10th segment of the abdomen. These cerci are sensory organs that help the cockroach detect air currents and vibrations.

Thus, the correct answer is **(1) 10th segment**.

Quick Tip

The anal cerci in cockroaches are used for sensory perception, helping detect environmental changes.

---

181. Match List I with List II:

	List I		List II
A.	Pleurobrachia	I.	Mollusca
B.	Radula	II.	Ctenophora
C.	Stomochord	III.	Osteichthyes
D.	Air bladder	IV.	Hemichordata

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Pleurobrachia** is a member of the phylum **Ctenophora** (II).
- **B. Radula** is found in organisms from the phylum **Mollusca** (I).
- **C. Stomochord** is a characteristic feature of organisms from the phylum **Hemichordata** (IV).
- **D. Air bladder** is found in fish from the phylum **Osteichthyes** (III).

Thus, the correct answer is **(1) A-II, B-I, C-IV, D-III**.

Quick Tip

Pleurobrachia belongs to Ctenophora, the radula is a molluscan characteristic, the stomochord is present in Hemichordates, and air bladders are found in osteichthyes.

---

182. The "Ti plasmid" of Agrobacterium tumefaciens stands for:

(1) Tumor independent plasmid

(2) Tumor inducing plasmid

(3) Temperature independent plasmid

(4) Tumor inhibiting plasmid

Correct Answer: (2) Tumor inducing plasmid

Solution:

The **Ti plasmid** in Agrobacterium tumefaciens is responsible for inducing tumor formation in plants. It carries genes that integrate into the plant genome, causing uncontrolled growth and formation of tumors known as crown galls.

Thus, the correct answer is **(2) Tumor inducing plasmid**.

Quick Tip

The Ti plasmid is a crucial tool in plant genetic engineering, used for transferring genes into plant cells.

---

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

Assertion A: The presence or absence of hymen is not a reliable indicator of virginity.

Reason R: The hymen is torn during the first coitus only.

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

Correct Answer: (2) Statement I is true but Statement II is false

Solution:

- **Assertion A** is true because the hymen can stretch, tear, or remain intact for reasons unrelated to sexual activity.
- **Reason R** is false because the hymen can be torn or stretched due to various activities, not only during coitus.

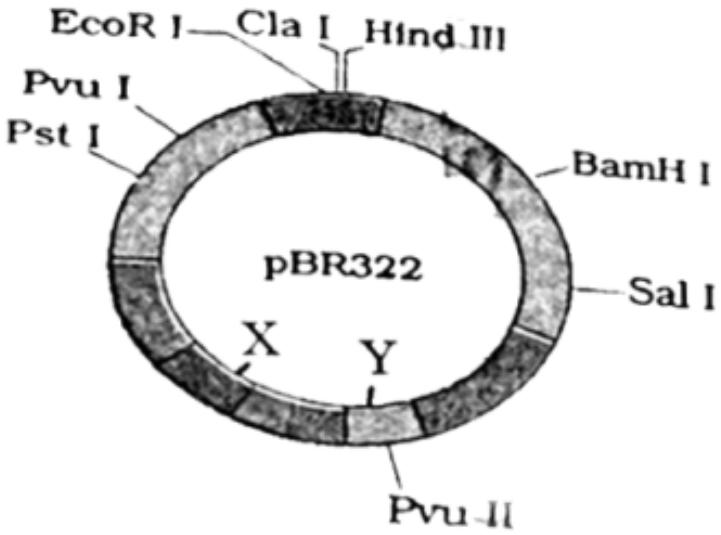
Thus, the correct answer is **(2) Statement I is true but Statement II is false**.

Quick Tip

The hymen is not a reliable indicator of virginity since it can be torn or stretched for various reasons other than sexual intercourse.

---

184. The following diagram shows restriction sites in E. coli cloning vector pBR322. Find the role of 'X' and 'Y' genes:



(1) The gene ‘X’ is responsible for controlling the copy number of the linked DNA and ‘Y’ for protein involved in the replication of Plasmid.

(2) The gene ‘X’ is for protein involved in replication of Plasmid and ‘Y’ for resistance to antibiotics.

(3) Gene ’X’ is responsible for recognition sites and ‘Y’ is responsible for antibiotic resistance.

(4) The gene ‘X’ is responsible for resistance to antibiotics and ‘Y’ for protein involved in the replication of Plasmid.

Correct Answer: (1) The gene ‘X’ is responsible for controlling the copy number of the linked DNA and ‘Y’ for protein involved in the replication of Plasmid.

Solution:

The vector pBR322 contains the **X** and **Y** genes.

- **Gene X** regulates the copy number of the plasmid DNA.
- **Gene Y** encodes a protein involved in the replication of the plasmid. This ensures that the plasmid can replicate inside the host cell.

Thus, the correct answer is **(1) The gene ‘X’ is responsible for controlling the copy number of the linked DNA and ‘Y’ for protein involved in the replication of Plasmid.**

Quick Tip

In plasmid vectors like pBR322, genes involved in replication control the number of copies of the plasmid within the host cell.

---

185. Which of the following is not a natural/traditional contraceptive method?

(1) Periodic abstinence

(2) Lactational amenorrhea

(3) Vaults

(4) Coitus interruptus

Correct Answer: (3) Vaults

Solution:

- **Periodic abstinence**, **Lactational amenorrhea**, and **Coitus interruptus** are all traditional methods of contraception.

- **Vaults** refer to a modern contraceptive method involving the insertion of a device and are not considered a natural or traditional method.

Thus, the correct answer is **(3) Vaults**.

Quick Tip

Natural contraceptive methods rely on natural cycles or behavioral strategies, while vaults are a modern, medical contraceptive option.

---

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

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

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

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

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

Solution:

- **A. Exophthalmic goiter** is caused by **hyper secretion of thyroid hormone** (III).
- **B. Acromegaly** is caused by **excessive secretion of growth hormone** (IV).
- **C. Cushing's syndrome** is caused by **excess secretion of cortisol, moon face, and hyperglycemia** (I).
- **D. Cretinism** is caused by **hypo-secretion of thyroid hormone and stunted growth** (II).

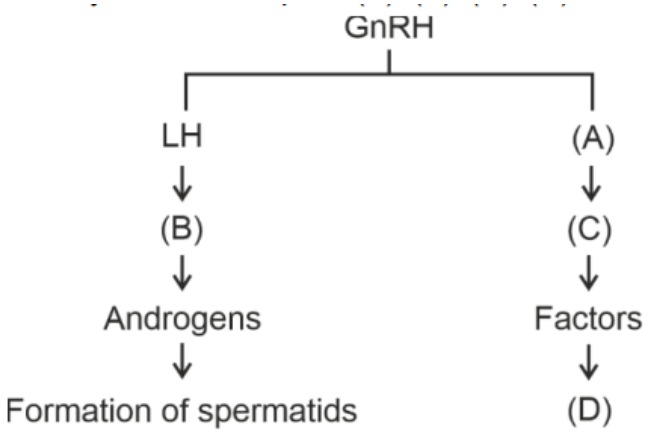
Thus, the correct answer is **(3) A-III, B-IV, C-I, D-II**.

Quick Tip

Endocrine disorders like Cushing's syndrome and acromegaly are caused by excessive hormone secretion, while cretinism is due to undersecretion of thyroid hormone.

---

187. Identify the correct option (A), (B), (C), (D) with respect to spermatogenesis.



(1) ICSH, Interstitial cells, Leydig cells, spermiogenesis.

(2) FSH, Sertoli cells, Leydig cells, spermatogenesis.

(3) ICSH, Leydig cells, Sertoli cells, spermatogenesis.

(4) FSH, Leydig cells, Sertoli cells, spermiogenesis.

Correct Answer: (4) FSH, Leydig cells, Sertoli cells, spermiogenesis.

Solution:

- **FSH (Follicle-stimulating hormone)** acts on the **Sertoli cells** to promote spermatogenesis (the production of sperm).
- **Leydig cells** are responsible for producing testosterone, which supports the process of spermatogenesis.
- **Spermiogenesis** is the final stage of spermatogenesis where spermatids mature into sperm.

Thus, the correct answer is **(4) FSH, Leydig cells, Sertoli cells, spermiogenesis**.

Quick Tip

FSH stimulates Sertoli cells in the seminiferous tubules to support spermatogenesis, while Leydig cells produce testosterone.

---

188. Given below are two statements:

Statement I: Mitochondria and chloroplasts both are double-membrane bound organelles.

Statement II: Inner membrane of mitochondria is relatively less permeable, as compared to chloroplast.

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

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

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

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

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

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

Solution:

- **Statement I** is correct: Both mitochondria and chloroplasts are double-membrane bound organelles, characteristic of eukaryotic cells.

- **Statement II** is incorrect: The inner membrane of the mitochondria is highly impermeable, whereas the inner membrane of the chloroplast is permeable to some molecules due to the presence of specific transporters.

Thus, the correct answer is **(2) Statement I is correct but Statement II is incorrect**.

Quick Tip

Mitochondria and chloroplasts are similar in structure, with double membranes, but their inner membranes have different permeability characteristics.

---

189. Given below are two statements:

Statement I: Gause's competitive exclusion principle states that two closely related species competing for different resources cannot exist indefinitely.

Statement II: According to Gause's principle, during competition, the inferior will be eliminated. This may be true if resources are limiting.

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

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

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

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

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

Correct Answer: (3) Statement I is false but Statement II is true.

Solution:

- **Statement I** is false because Gause's competitive exclusion principle states that two species competing for the same resources cannot coexist indefinitely. It is not about different resources.

- **Statement II** is true: In cases of competition for limiting resources, one species may outcompete the other, leading to the elimination of the inferior competitor.

Thus, the correct answer is **(3) Statement I is false but Statement II is true**.

Quick Tip

Gause's competitive exclusion principle emphasizes that species competing for the same resources cannot coexist for long if resources are limiting.

---

190. Regarding catalytic cycle of an enzyme action, select the correct sequential steps:

A. Substrate-enzyme complex formation.

B. Free enzyme ready to bind with another substrate.

C. Release of products.

D. Chemical bonds of the substrate broken.

E. Substrate binding to active site.

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **E. Substrate binding to the active site** occurs first.

- **A. Substrate-enzyme complex formation** follows after the substrate binds to the active site.

- **D. Chemical bonds of the substrate are broken**, leading to the formation of products.
- **C. Release of products** occurs next.
- **B. Free enzyme is ready to bind with another substrate** to complete the cycle.

Thus, the correct answer is **(4) E, A, D, C, B**.

Quick Tip

The catalytic cycle involves the enzyme-substrate complex formation, substrate breakdown, product release, and enzyme resetting for the next cycle.

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

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

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

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

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

Solution:

- **A. P wave** corresponds to the depolarisation of the atria (III).
- **B. QRS complex** corresponds to the depolarisation of the ventricles (II).
- **C. T wave** corresponds to the repolarisation of the ventricles (IV).
- **D. T-P gap** represents a period when heart muscles are electrically silent (I).

Thus, the correct answer is **(1) A-III, B-II, C-IV, D-I**.

Quick Tip

Understanding the P wave, QRS complex, and T wave is crucial for interpreting the electrical activity of the heart.

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192. Match List I with List II:

	List I		List II
A.	RNA polymerase III	I.	snRNPs
B.	Termination of transcription	II.	Promotor
C.	Splicing of Exons	III.	Rho factor
D.	TATA box	IV.	SnRNAs, tRNA

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. RNA polymerase III** synthesizes **snRNAs and tRNA** (IV).
- **B. Termination of transcription** involves the **Rho factor** (III).
- **C. Splicing of exons** is facilitated by **snRNPs** (I).
- **D. TATA box** is involved in the initiation of transcription and serves as a **promoter region** (II).

Thus, the correct answer is **(3) A-IV, B-III, C-I, D-II**.

Quick Tip

The TATA box and RNA polymerase are essential in the initiation of transcription, while snRNPs play a role in splicing.

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193. 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) Both Statement I and Statement II are incorrect.

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

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

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

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

Solution:

- **Statement I** is correct: The corpus callosum connects the left and right cerebral hemispheres.

- **Statement II** is incorrect: The brain stem consists of the medulla oblongata, pons, and midbrain, not the cerebrum.

Thus, the correct answer is **(2) Statement I is correct but Statement II is incorrect**.

Quick Tip

The brain stem does not include the cerebrum; it is composed of the medulla oblongata, pons, and midbrain.

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194. Match List I with List II related to digestive system of cockroach:

	List I		List II
A.	The structures used for storing of food	I.	Gizzard
B.	Ring of 6-8 blind tubules at junction of foregut and midgut.	II.	Gastric Caeca
C.	Ring of 100-150 yellow coloured thin filaments at junction of midgut and hindgut.	III.	Malpighian tubules
D.	The structures used for grinding the food.	IV.	Crop

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Crop** is responsible for storing food (IV).
- **B. Gastric Caeca** are responsible for aiding digestion in the foregut-midgut junction (II).
- **C. Malpighian tubules** are responsible for excretion in the cockroach (III).
- **D. Gizzard** is used for grinding food (I).

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

Quick Tip

In cockroaches, the digestive system includes specialized structures like the crop for storage and the gizzard for grinding food.

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195. Match List I with List II:

	List I		List II
A.	Mesozoic Era	I.	Lower invertebrates
B.	Proterozoic Era	II.	Fish & Amphibia
C.	Cenozoic Era	III.	Birds & Reptiles
D.	Paleozoic Era	IV.	Mammals

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Mesozoic Era** was dominated by **birds and reptiles** (III).
- **B. Proterozoic Era** featured **lower invertebrates** (I).
- **C. Cenozoic Era** is known for the dominance of **mammals** (IV).

- **D. Paleozoic Era** was characterized by **fish and amphibians** (II).

Thus, the correct answer is **(3) A-III, B-I, C-IV, D-II**.

Quick Tip

The geologic eras are marked by distinct groups of organisms, with mammals dominating the Cenozoic era, and fish and amphibians in the Paleozoic.

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196. 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) Both Statement I and Statement II are incorrect.

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

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

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

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

Solution:

- **Statement I** is correct: The bone marrow is indeed the primary site where all blood cells, including lymphocytes, are produced.
- **Statement II** is correct: Both the bone marrow and thymus provide microenvironments for the development and maturation of T-lymphocytes, with the thymus being the primary site for T-cell maturation.

Thus, the correct answer is **(4) Both Statement I and Statement II are correct.**

Quick Tip

The bone marrow produces blood cells, including lymphocytes, while the thymus is key for T-lymphocyte maturation.

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197. Match List I with List II:

	List I		List II
A.	Unicellular glandular epithelium	I.	Salivary glands
B.	Compound epithelium	II.	Pancreas
C.	Multicellular glandular epithelium	III.	Goblet cells of alimentary canal
D.	Endocrine glandular epithelium	IV.	Moist surface of buccal cavity

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- **A. Unicellular glandular epithelium** refers to **Goblet cells of the alimentary canal** (III).
- **B. Compound epithelium** is found in the **moist surface of the buccal cavity** (IV).
- **C. Multicellular glandular epithelium** includes **salivary glands** (I).
- **D. Endocrine glandular epithelium** is found in the **pancreas** (II).

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

Quick Tip

Unicellular glands like goblet cells are found in the alimentary canal, while multicellular glands include salivary and endocrine glands like the pancreas.

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198. Choose the correct statement given below regarding juxta medullary nephron:

(1) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.

(2) Loop of Henle of juxta medullary nephron runs deep into medulla.

(3) Juxta medullary nephrons outnumber the cortical nephrons.

(4) Juxta medullary nephrons are located in the columns of Bertini.

Correct Answer: (2) Loop of Henle of juxta medullary nephron runs deep into medulla.

Solution:

- **Statement 1** is incorrect because the renal corpuscle of juxta medullary nephrons lies in the cortex, not the outer portion of the renal medulla.
- **Statement 2** is correct: The Loop of Henle of juxta medullary nephrons extends deep into the medulla, which helps in water conservation.
- **Statement 3** is incorrect because cortical nephrons outnumber juxta medullary nephrons.
- **Statement 4** is incorrect because juxta medullary nephrons are not located in the columns of Bertini.

Thus, the correct answer is **(2) Loop of Henle of juxta medullary nephron runs deep into medulla.**

Quick Tip

Juxta medullary nephrons have long loops of Henle that extend into the medulla, crucial for water reabsorption and urine concentration.

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199. As per ABO blood grouping system, the blood group of father is B+, mother is A+ and child is O+. Their respective genotype can be:

A. $I^Bi/I^Ai/ii$
B. $I^BI^B/I^AI^A/ii$
C. $I^AI^B/iI^A/I^Bi$
D. $I^Ai/I^Bi/I^Ai$
E. $iI^B/iI^A/I^AI^B$

(1) B only
(2) C & B only
(3) D & E only
(4) A only

Correct Answer: (4) A only

Solution:

- **Father (B+)** must have the genotype **IBi** because he passed the O allele to the child.
- **Mother (A+)** must have the genotype **IAi** because she passed the O allele to the child.

- The child's genotype must be **ii**, as they inherited the O allele from both parents.

Thus, the correct answer is **(4) A only**.

Quick Tip

For O+ blood group, both parents must carry an O allele (genotype IAi or IBi).

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200. The following are the statements about non-chordates:

A. Pharynx is perforated by gill slits.

B. Notochord is absent.

C. Central nervous system is dorsal.

D. Heart is dorsal if present.

E. Post anal tail is absent.

Choose the most appropriate answer from the options given below:

(1) A, B & D only

(2) B, D & E only

(3) B, C & D only

(4) A & C only

Correct Answer: (2) B, D & E only

Solution:

- **Statement A** is incorrect because pharyngeal gill slits are not found in all non-chordates, but only in chordates.
- **Statement B** is correct: Non-chordates lack a notochord.
- **Statement C** is correct: In non-chordates, the central nervous system is dorsal.
- **Statement D** is correct: In many non-chordates, the heart, if present, is dorsal.
- **Statement E** is correct: Many non-chordates lack a post-anal tail.

Thus, the correct answer is **(2) B, D & E only**.

Quick Tip

Non-chordates lack a notochord, have a dorsal nervous system, and may have a dorsal heart.
