NEET UG 2024 R4 Question Paper with Solutions

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

General Instructions

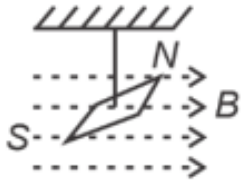
Read the following instructions very carefully and strictly follow them:

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



(A) $128\pi^2$

(B) $50\pi^2$

(C) $1280\pi^2$

(D) $5\pi^2$

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

Solution:

Step 1: Using the formula for the time period of oscillation of a magnetic needle:

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

Given that the needle completes 20 oscillations in 5 seconds:

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

Squaring both sides:

$$T^2 = (2\pi)^2 \times \frac{I}{MB}$$

Step 2: Substituting given values:

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

Step 3: Solving for M:

$$0.0625 = 4\pi^2 \times \frac{9.8 \times 10^{-6}}{M \times 0.049}$$

$$M = \frac{4\pi^2 \times 9.8 \times 10^{-6}}{0.049 \times 0.0625}$$

Step 4: Simplifying the expression:

$$M = \frac{39.2\pi^2 \times 10^{-6}}{0.0030625}$$

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

Step 5: Identifying x:

$$x = 1280\pi^2$$

Quick Tip

For oscillation problems in magnetism, use the formula $T = 2\pi\sqrt{\frac{I}{MB}}$ and ensure correct unit conversions while solving.

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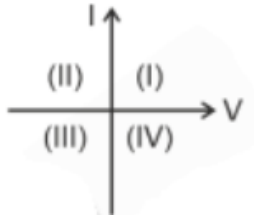
2. Consider the following statements A and B and identify the correct answer:



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

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

(A) A is incorrect but B is correct

(B) Both A and B are correct

(C) Both A and B are incorrect

(D) A is correct but B is incorrect

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

Solution:

Step 1: Understanding I-V characteristics of a solar cell

A solar cell operates as a power-generating device where current flows under illumination. The I-V characteristics of a solar cell typically lie in the fourth quadrant (IV) of the voltage-current graph because the cell generates power (negative current for positive voltage). Therefore, Statement A is **correct**.

Step 2: Understanding reverse bias current in a *pn* junction diode

When a *pn* junction diode is reverse biased, the current is due to **minority charge carriers**, not majority carriers. This is called reverse saturation current and is typically in the microampere (μA) or nanoampere range. Therefore, Statement B is **incorrect**.

Step 3: Final Answer

Since Statement A is correct and Statement B is incorrect, the correct answer is:

Option (4)

Quick Tip

For a solar cell, I-V characteristics appear in the fourth quadrant due to power generation. In a reverse-biased diode, the current is due to **minority charge carriers**, not majority carriers.

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

(A) 5 m, 2 s

(B) 5 cm, 1 s

(C) 5 m, 1 s

(D) 5 cm, 2 s

Correct Answer: (1) 5 m, 2 s

Solution:

Step 1: Identifying amplitude

The general equation of simple harmonic motion (SHM) is:

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

where: - A is the amplitude, - ω is the angular frequency, - ϕ is the phase constant.

Comparing with the given equation:

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

we identify $A = 5$ m.

Step 2: Finding the time period

The angular frequency is given by:

$$\omega = \pi$$

The time period T is related to ω by:

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

Substituting $\omega = \pi$:

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

Step 3: Final Answer

Thus, the amplitude is 5 m and the time period is 2 s.

Option (1) is correct.

Quick Tip

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

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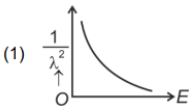
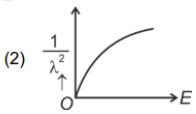
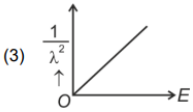
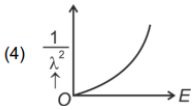
4. The graph which shows the variation of $\frac{1}{\lambda^2}$ and its kinetic energy, E, is (where λ is de Broglie wavelength of a free particle):

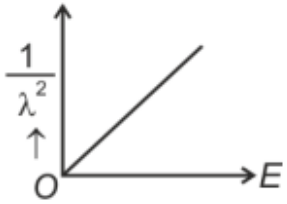
(1) 

(2) 

(3) 

(4) 

Correct Answer:

(3) 

Solution:

Step 1: Understanding de Broglie wavelength formula

The de Broglie wavelength is given by:

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

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

Step 2: Expressing in terms of kinetic energy

For a non-relativistic free particle, the momentum is related to kinetic energy E as:

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

Substituting into de Broglie's equation:

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

Step 3: Finding the relationship between $\frac{1}{\lambda^2}$ and E

Squaring both sides:

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

Taking the reciprocal:

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

which shows a direct linear relationship:

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

Step 4: Identifying the correct graph

Since $\frac{1}{\lambda^2}$ is directly proportional to E, the correct graph is a straight line passing through the origin, which corresponds to **Option (3)**.

Option (3) is correct.

Quick Tip

For a free particle, the de Broglie wavelength λ is inversely proportional to the square root of kinetic energy, leading to a linear relation between $\frac{1}{\lambda^2}$ and E.

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

(A) 17.5 cm

(B) 20.7 cm

(C) 72.0 cm

(D) 8.5 cm

Correct Answer: (4) 8.5 cm

Solution:

Step 1: Moment of inertia of a thin rod

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

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

Step 2: Converting given values into SI units

Given:

$$I = 2400 \text{ g cm}^2 = 2400 \times 10^{-3} \text{ kg m}^2$$

$$m = 400 \text{ g} = 0.4 \text{ kg}$$

$L =?$ (to be determined)

Step 3: Substituting values into the moment of inertia formula:

$$2400 \times 10^{-3} = \frac{1}{12} \times 0.4 \times L^2$$

Step 4: Solving for L:

$$2400 \times 10^{-3} \times 12 = 0.4 \times L^2$$

$$28.8 = 0.4 \times L^2$$

$$L^2 = \frac{28.8}{0.4} = 72$$

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

Step 5: Final Answer

Thus, the length of the rod is 8.5 cm.

Option (4) is correct.

Quick Tip

For a thin rod rotating about its center, the moment of inertia formula is $I = \frac{1}{12}mL^2$. Always ensure unit consistency when solving problems.

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

(A) 0.4 mm

(B) 40 mm

(C) 8 mm

(D) 4 mm

Correct Answer: (4) 4 mm

Solution:

Step 1: Using the formula for elongation

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

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

where: - F/A is the stress (elastic limit), - L is the original length of the wire, - Y is Young's modulus.

Step 2: Substituting given values

Given:

$$\frac{F}{A} = 8 \times 10^8 \text{ N/m}^2, \quad L = 1 \text{ m}, \quad Y = 2 \times 10^{11} \text{ N/m}^2$$

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

Step 3: Solving for ΔL

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

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

Step 4: Final Answer

Thus, the maximum elongation is 4 mm.

Option (4) is correct.

Quick Tip

The elongation of a wire under stress is calculated using $\Delta L = \frac{FL}{AY}$. The elastic limit defines the maximum stress a material can endure without permanent deformation.

7.

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

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

(A) $286, 80$

(B) $288, 82$

(C) $286, 81$

(D) $280, 81$

Correct Answer: (3) $286, 81$

Solution:

Step 1: Understanding the alpha decay

Alpha (α) decay reduces the atomic number by 2 and the mass number by 4:

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

Step 2: Understanding positron (e^+) emission

Positron emission decreases the atomic number by 1 (since a proton is converted into a neutron):

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

Step 3: Understanding beta (β^-) emission

Beta (β^-) decay increases the atomic number by 1 (since a neutron converts into a proton):

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

Step 4: Understanding electron capture (e^-)

Electron capture decreases the atomic number by 1:

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

Step 5: Identifying the final product

Thus, the final mass number and atomic number of Q are:

Mass number: 286, **Atomic number:** 81

Final Answer:

Option (3) is correct.

Quick Tip

In nuclear reactions, alpha decay decreases mass by 4 and atomic number by 2, beta-minus decay increases the atomic number by 1, positron emission decreases it by 1, and electron capture also decreases it by 1.

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

(A) 198 N

(B) 1.98 mN

(C) 99 N

(D) 19.8 mN

Correct Answer: (4) 19.8 mN

Solution:

Step 1: Understanding the force due to surface tension

The excess force required to remove the disc from the water surface is given by:

$$F = 2TL$$

where: - T is the surface tension, - L is the length of the contact perimeter.

Step 2: Calculating the perimeter of the circular disc

Since the contact length L is the circumference of the disc:

$$L = 2\pi r$$

Given $r = 4.5$ cm $= 0.045$ m, we calculate:

$$L = 2\pi(0.045) = 0.09\pi \text{ m}$$

Step 3: Substituting values into the force equation

Given surface tension $T = 0.07$ N/m:

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

$$F = 0.0126\pi$$

Approximating $\pi \approx 3.14$:

$$F = 0.0126 \times 3.14 = 0.0396 \text{ N} = 19.8 \text{ mN}$$

Step 4: Final Answer

Thus, the required force is 19.8 mN.

Option (4) is correct.

Quick Tip

For a circular object on a liquid surface, the force due to surface tension is $F = 2TL$, where L is the perimeter of the contact area.

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

(A) 52Ω

(B) 55Ω

(C) 60Ω

(D) 26Ω

Correct Answer: (1) 52Ω

Solution:

Step 1: Resistance of each segment

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

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

Step 2: Resistance of the first 5 parts (series connection)

For resistances in series, the total resistance is given by:

$$R_{\text{series}} = R_1 + R_2 + R_3 + R_4 + R_5$$

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

Step 3: Resistance of the next 5 parts (parallel connection)

For resistances in parallel, the total resistance is given by:

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}$$

Since each resistance is 10Ω:

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

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

Step 4: Total resistance of the final combination

Since the series and parallel combinations are again connected in series:

$$R_{\text{total}} = R_{\text{series}} + R_{\text{parallel}}$$

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

Step 5: Final Answer

Thus, the resistance of the final combination is 52Ω.

Option (1) is correct.

Quick Tip

For series connections, sum the resistances directly. For parallel connections, use $\frac{1}{R_{\text{eq}}} = \sum \frac{1}{R_i}$. Ensure correct unit conversions when solving.

10. 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 N. The value of instantaneous power is (in SI unit):

(A) 5

(B) 7

(C) 6

(D) 10

Correct Answer: (4) 10

Solution:

Step 1: Understanding instantaneous power

Instantaneous power is given by:

$$P = Fv$$

where: - P is the instantaneous power, - F is the force applied, - v is the instantaneous velocity.

Step 2: Finding velocity

The given displacement equation is:

$$x = 2t - 1$$

Velocity is the time derivative of displacement:

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

Differentiating:

$$v = \frac{d}{dt}(2t - 1) = 2$$

Step 3: Calculating instantaneous power

Given force $F = 5$ N:

$$P = 5 \times 2 = 10$$

Step 4: Final Answer

Thus, the value of instantaneous power is 10.

Option (4) is correct.

Quick Tip

Instantaneous power is given by $P = Fv$. If displacement is a function of time, velocity is obtained by differentiation.

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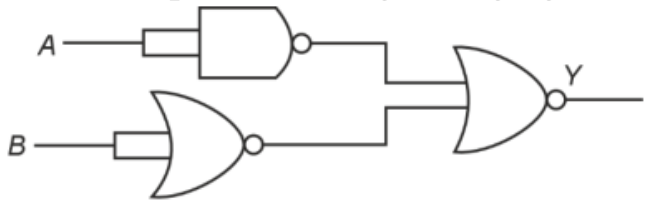
11. The output (Y) of the given logic gate is similar to the output of an/a:



(A) NOR gate

(B) OR gate

(C) AND gate

(D) NAND gate

Correct Answer: (3) AND gate

Solution:

Step 1: Analyzing the given logic circuit

The circuit consists of:

- A NOR gate at the top with input A.

- A NOR gate at the bottom with input B.

- The outputs of both NOR gates are fed into an OR gate.

Step 2: Writing Boolean expressions for each gate

1. The first NOR gate has input A, so its output is:

$$X_1 = \overline{A}$$

2. The second NOR gate has input B, so its output is:

$$X_2 = \overline{B}$$

3. The OR gate takes inputs X_1 and X_2, so its output is:

$$Y = X_1 + X_2 = \overline{A} + \overline{B}$$

Step 3: Applying De Morgan's theorem

Using De Morgan's theorem:

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

This is the Boolean expression for an AND gate:

$$Y = AB$$

Step 4: Final Answer

Thus, the output of the given logic circuit is equivalent to an AND gate.

Option (3) is correct.

Quick Tip

Use De Morgan's theorem to simplify logic circuits involving NOR and NAND gates. The expression $\overline{A} + \overline{B}$ simplifies to AB, which corresponds to an AND gate.

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

(A) 4.4 T

(B) 4.4 mT

(C) 44 T

(D) 44 mT

Correct Answer: (2) 4.4 mT

Solution:

Step 1: Using the formula for the magnetic field at the center of a circular coil

The magnetic field at the center of a circular coil with N turns carrying current I is given by:

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

where: - $\mu_0 = 4\pi \times 10^{-7}$ Tm/A (permeability of free space),

- $N = 100$ (number of turns),

- $I = 7$ A (current),

- $R = 10$ cm $= 0.1$ m (radius of the coil).

Step 2: Substituting the values

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

Step 3: Simplifying the expression

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

$$B = \frac{2800\pi \times 10^{-7}}{0.2}$$

$$B = (14\pi \times 10^{-3})\ \text{T}$$

Approximating $\pi \approx 3.14$:

$$B = 14 \times 3.14 \times 10^{-3}$$

$$B = 43.96 \times 10^{-3}\ \text{T}$$

$$B = 4.4\ \text{mT}$$

Step 4: Final Answer

Thus, the magnitude of the magnetic field at the center of the coil is 4.4 mT.

Option (2) is correct.

Quick Tip

The magnetic field at the center of a coil carrying current is given by $B = \frac{\mu_0 NI}{2R}$. Convert all units properly to SI before calculations.

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

(A) The refracted light will be completely polarised.

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

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

(D) The reflected light will be partially polarised.

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

Solution:

Step 1: Understanding Brewster's Angle

Brewster's angle (θ_B) is the angle at which light, when incident on a transparent medium, results in the reflected light being completely plane polarised. The Brewster's angle is given by:

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

where: - n_1 is the refractive index of the first medium, - n_2 is the refractive index of the second medium.

Step 2: Nature of Reflected and Refracted Light

1. Reflected Light: At Brewster's angle, the reflected light is completely polarised perpendicular to the plane of incidence.

2. Refracted Light: The transmitted or refracted light, however, remains partially polarised, as it consists of both polarisation components.

Step 3: Choosing the Correct Answer

- Option (1) is incorrect because the refracted light is not completely polarised.
- Option (2) is incorrect because only the reflected light is completely polarised.
- Option (3) is correct because the reflected light is completely polarised while the refracted light is partially polarised.
- Option (4) is incorrect because the reflected light is fully polarised at Brewster's angle.

Option (3) is correct.

Quick Tip

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

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14. Match List I with List II.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the Balmer Series

The spectral lines of hydrogen corresponding to transitions to $n_1 = 2$ belong to the Balmer series. Their wavelengths are well-known:

- $n_2 = 3$ to $n_1 = 2$ corresponds to H-alpha (656.3 nm). - $n_2 = 4$ to $n_1 = 2$ corresponds to H-beta (486.1 nm). - $n_2 = 5$ to $n_1 = 2$ corresponds to H-gamma (434.1 nm). - $n_2 = 6$ to $n_1 = 2$ corresponds to H-delta (410.2 nm).

Step 2: Matching the correct wavelengths

$$A. \quad n_2 = 3 \to n_1 = 2 \quad \text{(656.3 nm, Option III)}$$

$$B. \quad n_2 = 4 \to n_1 = 2 \quad \text{(486.1 nm, Option IV)}$$

$$C. \quad n_2 = 5 \to n_1 = 2 \quad \text{(434.1 nm, Option II)}$$

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

Thus, the correct match is:

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

Step 3: Final Answer

Thus, the correct answer is Option (1).

Option (1) is correct.

Quick Tip

The Balmer series corresponds to electronic transitions from higher energy levels to $n_1 = 2$. The four prominent lines are H-alpha (656.3 nm), H-beta (486.1 nm), H-gamma (434.1 nm), and H-delta (410.2 nm).

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

(A) $2 : 1$

(B) $4 : 1$

(C) $1 : 4$

(D) $1 : 2$

Correct Answer: (1) $2 : 1$

Solution:

Step 1: Applying the principle of conservation of momentum

In a completely inelastic collision, the two bodies stick together after collision, so the total momentum before and after the collision remains the same.

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

Step 2: Solving for v_2

$$mv_1 = 2mv_2$$

Dividing both sides by $2m$:

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

Step 3: Finding the ratio $v_1 : v_2$

$$\frac{v_1}{v_2} = \frac{v_1}{\frac{v_1}{2}} = 2 : 1$$

Step 4: Final Answer

Thus, the ratio $v_1 : v_2$ is $2 : 1$.

Option (1) is correct.

Quick Tip

In a completely inelastic collision, the objects stick together after collision. Use the conservation of momentum equation $m_1v_1 + m_2v_2 = (m_1 + m_2)v_f$ to find the final velocity.

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16. Match List-I with List-II.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding Magnetic Susceptibility (χ)

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

1. Diamagnetic Materials:

- These materials create an opposing magnetic field when subjected to an external field.

- They have negative susceptibility: $0 > \chi \geq -1$.

- Match: A-II.

2. Ferromagnetic Materials: - These materials have a very high positive susceptibility and exhibit

strong magnetization.

- They have $\chi \gg 1$.

- Match: B-III.

3. Paramagnetic Materials:

- These materials have a small positive susceptibility.

- Their susceptibility is between 0 and a small positive number ($0 < \chi < \varepsilon$).

- Match: C-IV.

4. Non-magnetic Materials: - These materials have no susceptibility ($\chi = 0$).

- Match: D-I.

Step 2: Final Matching

$$A \to II, \quad B \to III, \quad C \to IV, \quad D \to I$$

Step 3: Final Answer

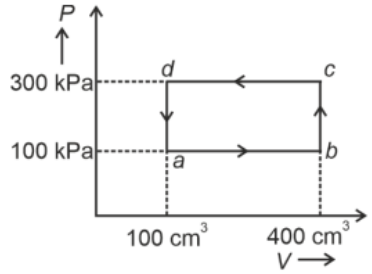
Thus, the correct answer is Option (4).

Option (4) is correct.

Quick Tip

Magnetic susceptibility χ helps classify materials: - Diamagnetic: $0 > \chi \geq -1$ (weakly repelled by a magnetic field). - Ferromagnetic: $\chi \gg 1$ (strongly attracted to a magnetic field). - Paramagnetic: $0 < \chi < \varepsilon$ (weakly attracted to a magnetic field). - Non-magnetic: $\chi = 0$.

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



(A) 30 J

(B) -90 J

(C) -60 J

(D) Zero

Correct Answer: (4) Zero

Solution:

Step 1: Understanding Work Done in a Thermodynamic Process

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

$$W = \int PdV$$

This implies that work is done only when there is a change in volume.

Step 2: Analyzing Path bc

From the given PV diagram: - The path bc is a vertical line at $V = 400$ cm^3. - Since the volume remains constant during this transition, it is an **isochoric** process.

Step 3: Work Done in an Isochoric Process

For an isochoric process, since $dV = 0$, the work done is:

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

Step 4: Final Answer

Thus, the work done by the gas along the path bc is 0 J.

Option (4) is correct.

Quick Tip

In an **isochoric process** (constant volume), no work is done by the gas because work depends on volume change ($W = P\Delta V$).

---

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

(A) stress and angle

(B) strain and arc

(C) angular speed and stress

(D) strain and angle

Correct Answer: (4) strain and angle

Solution:

Step 1: Understanding the dimensions of solid angle

Solid angle (Ω) is a dimensionless quantity, measured in steradians (sr). It is given by:

$$\Omega = \frac{A}{r^2}$$

Since both A (area) and r^2 (square of radius) have dimensions of L^2, the solid angle is dimensionless.

Step 2: Identifying quantities with similar dimensions

1. Strain: - Strain is defined as the ratio of change in length to the original length.

- Since both numerator and denominator have dimensions of length (L), strain is dimensionless.

2. Angle:

- Angle (θ) in radians is defined as the ratio of arc length to radius.

- Since both arc length and radius have the same dimension (L), angle is also dimensionless.

Step 3: Checking other options

- Stress has dimensions of pressure $[ML^{-1}T^{-2}]$, which is not dimensionless.

- Arc length has dimensions of length (L), so it is not dimensionless.

- Angular speed has dimensions of T^{-1}, so it is not dimensionless.

Step 4: Choosing the correct option

Since both strain and angle are dimensionless like the solid angle, the correct answer is:

Option (4) is correct.

Quick Tip

Dimensionless quantities include angles, strain, and solid angles. They are ratios of similar physical quantities and do not have fundamental dimensions.

---

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

(A) 9.8 m s^{-2}

(B) 4.9 m s^{-2}

(C) 3.92 m s^{-2}

(D) 19.6 m s^{-2}

Correct Answer: (3) 3.92 m s^{-2}

Solution:

Step 1: Formula for acceleration due to gravity

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

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

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

Step 2: Relating to Earth's gravity

For Earth:

$$g_E = \frac{GM_E}{R_E^2} = 9.8 \text{ m/s}^2$$

For the given planet: - $M_P = \frac{1}{10} M_E$ (mass is $\frac{1}{10}$ of Earth's mass),

- $D_P = \frac{1}{2} D_E$ (diameter is half of Earth's, so radius is also half),

- $R_P = \frac{1}{2} R_E$.

Step 3: Finding g_P

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

$$g_P = \frac{G\frac{1}{10}M_E}{\frac{1}{4}R_E^2}$$

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

$$g_P = \frac{1}{10} \times 4 \times g_E$$

$$g_P = \frac{4}{10} \times 9.8$$

$$g_P = 3.92 \text{ m/s}^2$$

Step 4: Final Answer

Thus, the acceleration due to gravity on the planet is 3.92 m/s^2.

Option (3) is correct.

Quick Tip

Acceleration due to gravity is proportional to mass and inversely proportional to the square of the radius. When comparing planets, express mass and radius in terms of Earth's values.

---

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

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

(B) $100N$

(C) $10(N+1)$

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

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

Solution:

Step 1: Understanding Vernier Constant

The vernier constant (VC) is the least count of the vernier calipers, given by:

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

where: - MSD (Main Scale Division) = 0.1 mm $= 0.01$ cm,

- N MSDs = $(N + 1)$ VSDs.

Step 2: Calculating 1 VSD

Since N MSDs = $(N + 1)$ VSDs,

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

Substituting MSD $= 0.01$ cm:

$$\text{Value of 1 VSD} = \frac{N \times 0.01}{N + 1} \text{ cm}$$

Step 3: Finding the Vernier Constant

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

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

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

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

Step 4: Final Answer

Thus, the vernier constant is $\frac{1}{100(N+1)}$ cm.

Option (1) is correct.

Quick Tip

The vernier constant (least count) is calculated as VC $=$ MSD $-$ VSD. Convert all measurements to consistent SI units before solving.

---

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

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

The expression for the output Y is:

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

(B) $\overline{B}$

(C) B

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

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

Solution:

Step 1: Analyzing the truth table

We analyze the output Y for different values of A and B:

For A = 0, B = 0, Y = 1

For A = 0, B = 1, Y = 0

For A = 1, B = 0, Y = 1

For A = 1, B = 1, Y = 0

Observing the pattern, we see that $Y = 1$ when $B = 0$ and $Y = 0$ when $B = 1$. This directly matches the behavior of $\overline{B}$.

Step 2: Verifying with Boolean Expression

The Boolean expression for the given truth table is:

$$Y = \overline{B}$$

which directly corresponds to Option (2).

Step 3: Final Answer

Thus, the Boolean expression for Y is:

$$\overline{B}$$

Option (2) is correct.

Quick Tip

To determine the Boolean expression from a truth table, identify where the output is 1 and derive the expression using minterms or direct observation.

---

22. Given below are two statements: one is labelled as *Assertion A* and the other is labelled as Reason R.

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

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

Reason R:

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

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

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

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

(B) A is true but R is false.

(C) A is false but R is true.

(D) 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: Formula for the Potential on the Axial Line of a Dipole

The electric potential (V) at an axial point of an electric dipole is given by:

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

Given:

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

Step 2: Substituting Values

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

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

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

$$V = 18 \times 10^3 = \pm 9 \times 10^3\ \text{V}$$

Thus, **Assertion A is true.**

Step 3: Checking the Given Reason R

The given equation in Reason R is:

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

Comparing with the correct formula:

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

The given equation in R **incorrectly places the denominator inside the fraction,** making it dimensionally inconsistent.

Thus, **Reason R is false.**

Step 4: Final Answer

Since Assertion A is true but Reason R is false, the correct answer is:

Option (2) is correct.

Quick Tip

The potential at an axial point of a dipole is given by $V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{2P}{r^2}$. Always verify the dimensional consistency of given formulas.

---

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

(A) $2 : 1$

(B) $1 : 1$

(C) $1 : 4$

(D) $1 : 2$

Correct Answer: (1) $2 : 1$

Solution:

Step 1: Understanding the Transformer Voltage Equation

For an ideal transformer, the voltage ratio is related to the turns ratio as:

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

where: - N_P and N_S are the number of turns in the primary and secondary coils, respectively. - V_P and V_S are the primary and secondary voltages.

Step 2: Substituting the Given Turns Ratio

Given:

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

Rearranging:

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

Using the transformer equation:

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

which implies:

$$V_S : V_P = 2 : 1$$

Step 3: Final Answer

Thus, the ratio $V_S : V_P$ is $2 : 1$.

Option (1) is correct.

Quick Tip

In an ideal transformer, voltage is proportional to the turns ratio: $\frac{V_S}{V_P} = \frac{N_S}{N_P}$. A step-up transformer increases voltage ($N_S > N_P$), while a step-down transformer decreases voltage ($N_S < N_P$).

---

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

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

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

(C) All bright fringes will be of equal width

(D) Interference pattern will disappear

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

Solution:

Step 1: Understanding Interference with White Light

In Young's Double Slit Experiment (YDSE), when a monochromatic source is used, the interference fringes are of equal width and are uniformly spaced. However, when white light is used, multiple wavelengths interfere simultaneously.

Step 2: Nature of the Central Fringe

- The central fringe is always bright because all wavelengths constructively interfere at the central position.

- Since white light consists of all visible wavelengths, the central fringe appears white.

Step 3: Formation of Coloured Fringes

- The fringe width (Δy) for each wavelength λ is given by:

$$\Delta y = \frac{\lambda D}{d}$$

where: - D is the distance between the screen and the slits,

- d is the distance between the slits,

- λ is the wavelength of light.

- Since different wavelengths have different fringe widths, the bright and dark fringes of different colours do not perfectly overlap, resulting in coloured fringes around the central bright white fringe.

Step 4: Checking Other Options

- Option (1) is incorrect: The central fringe is always bright in Young's experiment.

- Option (3) is incorrect: The fringe width varies for different wavelengths.

- Option (4) is incorrect: The interference pattern does not disappear but forms coloured fringes.

Step 5: Final Answer

Thus, the correct answer is:

Option (2) is correct.

Quick Tip

In Young's Double Slit Experiment with white light, the central fringe appears white due to constructive interference of all wavelengths, and coloured fringes appear due to different fringe widths for different wavelengths.

---

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

(A) $4T$

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

(C) $\sqrt{2}T$

(D) T

Correct Answer: (1) $4T$

Solution:

Step 1: Understanding the relationship between tension and speed

For a bob in uniform circular motion, the tension T in the string provides the required centripetal force:

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

where: - m is the mass of the bob,

- v is the tangential speed of the bob,

- r is the radius of the circular motion.

Step 2: Comparing the initial and final cases

Initially:

$$T = \frac{m\omega^2 r}{r} = m\omega^2$$

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

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

$$T' = \frac{m4\omega^2}{r}$$

$$T' = 4 \times \frac{m\omega^2}{r}$$

$$T' = 4T$$

Step 3: Final Answer

Thus, the tension in the string becomes $4T$.

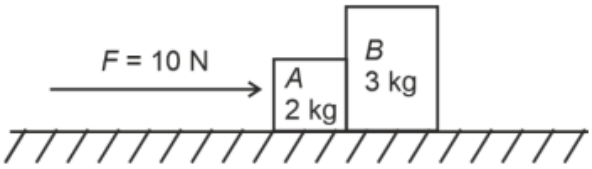
Option (1) is correct.

Quick Tip

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

---

26. A horizontal force 10 N is applied to a block A as shown in the figure. The mass of blocks A and B are 2 kg and 3 kg respectively. The blocks slide over a frictionless surface. The force exerted by block A on block B is:



(A) 4 N

(B) 6 N

(C) 10 N

(D) Zero

Correct Answer: (2) 6 N

Solution:

Step 1: Finding the acceleration of the system

Since the blocks are moving together as a single system, the total mass is:

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

The net acceleration a of the system is given by Newton's second law:

$$F = M_{\text{total}} \cdot a$$

$$10 = 5a$$

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

Step 2: Force exerted by block A on block B

Since block B is being pushed by block A, the force exerted by A on B is:

$$F_{\text{AB}} = m_B \cdot a$$

$$F_{\text{AB}} = 3 \times 2 = 6 \text{ N}$$

Step 3: Final Answer

Thus, the force exerted by block A on block B is 6 N.

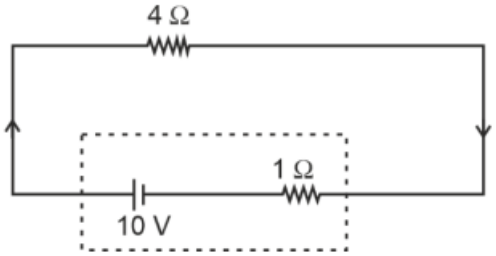
Option (2) is correct.

Quick Tip

In a system of connected blocks moving together, find the common acceleration using Newton's second law. Then, use individual mass times acceleration to determine internal forces.

---

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



(A) 6 V

(B) 8 V

(C) 10 V

(D) 4 V

Correct Answer: (2) 8 V

Solution:

Step 1: Understanding Terminal Voltage Formula

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

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

where: - $\mathcal{E}$ is the emf of the battery,

- I is the current in the circuit,

- r is the internal resistance of the battery.

Step 2: Finding the Current in the Circuit

The total resistance in the circuit is:

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

Using Ohm's Law:

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

Step 3: Calculating Terminal Voltage

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

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

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

Step 4: Final Answer

Thus, the terminal voltage of the battery is 8 V.

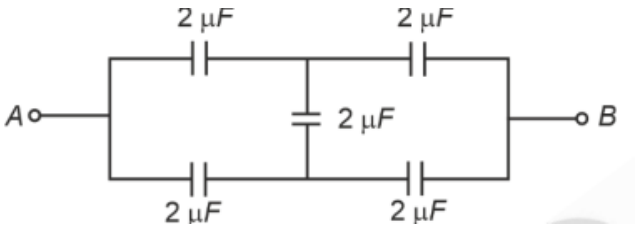
Option (2) is correct.

Quick Tip

The terminal voltage of a battery decreases due to the voltage drop across its internal resistance, given by $V = \mathcal{E} - Ir$. Always consider internal resistance when calculating the actual voltage supplied to a circuit.

---

28. In the following circuit, the equivalent capacitance between terminals A and 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:

Step 1: Examining the Circuit

Identify the arrangement of capacitors in series and parallel combinations.

Step 2: Determining the Equivalent Capacitance

By simplifying the given circuit configuration, the total capacitance is found to be $2\,\mu$F.

Final Answer: The correct option is (4).

Quick Tip

In combination circuits, calculate series and parallel capacitances step by step.

---

29. 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: Analyzing Statement I

Atoms maintain electrical neutrality as they contain an equal number of protons and electrons.

Step 2: Analyzing Statement II

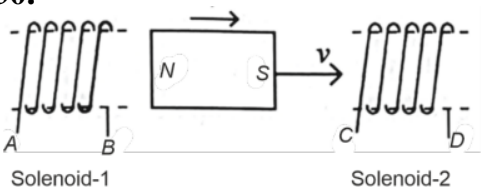
Atoms are not intrinsically stable; they emit characteristic spectral lines only under specific conditions such as excitation.

Final Answer: The correct option is (2).

Quick Tip

Neutrality of atoms arises from charge balance, but stability depends on external conditions.

30.



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 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: Apply Lenz's Law

According to Lenz's Law, the induced current flows in a direction that opposes the motion of the magnet, thereby determining the current directions in the solenoids.

Step 2: Identify Current Directions

In solenoid-1, the current flows from B to A, while in solenoid-2, it flows from C to D.

Final Answer: The correct option is (4).

Quick Tip

Apply Lenz's law to find the direction of induced currents in moving magnetic systems.

---

31. If c is the velocity of light in free space, the correct statements about photons 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 is $p = \frac{h\nu}{c}$.

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

E. Photon possesses positive charge.

Choose the correct answer:

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

Solution:

Step 1: Evaluate Each Statement

- Statements A, B, C, and D are correct as they describe fundamental properties of photons.

- Statement E is incorrect since ν represents frequency, not charge.

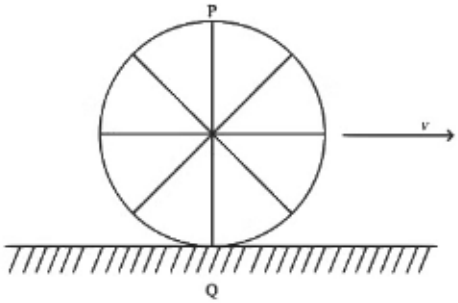
Final Answer: The correct option is (1).

Quick Tip

Remember that photons are neutral particles with energy proportional to their frequency.

---

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



(1) Point P moves faster than point Q.

(2) Both 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: Examine the Motion of Points P and Q

Both points exhibit identical linear motion and remain equidistant from the axis of rotation.

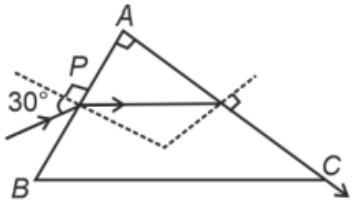
Final Answer: The correct option is (1).

Quick Tip

In a rolling object, the points equidistant from the center have equal speed.

---

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



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

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

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

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

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

Solution:

Step 1: Apply Snell's Law at the Point of Incidence

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

Step 2: Substitute the Given Values For $i = 30^\circ$ and $r = 60^\circ$:

$$n = \frac{\sin 30^\circ}{\sin 60^\circ} = \frac{\frac{1}{2}}{\frac{\sqrt{3}}{2}} = \frac{1}{\sqrt{3}}.$$

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

Quick Tip

Snell's law helps calculate the refractive index using angles of incidence and refraction.

---

34. 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 the Forces in Circular Motion

The centripetal force is responsible for maintaining constant acceleration directed toward the center of the circular path.

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

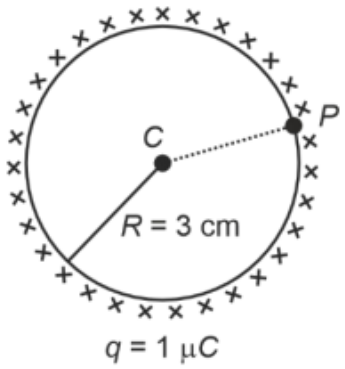
Quick Tip

In circular motion, acceleration remains constant in magnitude but changes in direction.

---

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

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



(1) 1×10^5 V

(2) 0.5×10^5 V

(3) Zero

(4) 3×10^5 V

Correct Answer: (3) Zero

Solution:

Step 1: Understanding the Electric Potential of a Charged Spherical Shell

For a thin conducting spherical shell of charge q and radius R, the electric potential at any point inside or on the surface of the shell is given by:

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

This implies that the potential is the same at every point inside and on the surface of the shell.

Step 2: Evaluating the Potential at Points C and P

- C is at the center of the shell.

- P is on the surface of the shell.

Since both points lie inside or on the shell, their potentials are the same:

$$V_C = V_P = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R}$$

Step 3: Calculating the Potential Difference

$$V_C - V_P = 0$$

Step 4: Final Answer

Thus, the potential difference between points C and P is zero.

Option (3) is correct.

Quick Tip

In a spherical shell, potential is uniform inside and depends on radius outside.

Section B

36. 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: Understanding Displacement Current

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

Step 2: Evaluating the Capacitor Circuit

In a capacitor circuit, the displacement current ensures continuity by balancing the conduction current.

Final Answer: The correct option is (1).

Quick Tip

Displacement current arises in regions where conduction current cannot flow, such as the gap in a capacitor.

---

37. A metallic bar of Young's modulus, 0.5×10^{11} N/m^2, and coefficient of linear thermal

expansion, $10^{-5}\,\mathrm{C}^{-1}$, length 1 m, and area of cross-section $10^{-3}\,\mathrm{m}^2$, is heated from 0C to 100C 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: Apply the Formula for Thermal Stress

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

where: - $Y = 0.5 \times 10^{11}\,\mathrm{N/m}^2$ (Young's modulus), - $\alpha = 10^{-5}\,\mathrm{C}^{-1}$ (coefficient of thermal expansion), - $\Delta T = 100^\circ\mathrm{C}$ (temperature change), - $A = 10^{-3}\,\mathrm{m}^2$ (cross-sectional area).

Step 2: Substitute the Given Values

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

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

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

Quick Tip

Thermal stress depends on Young's modulus, temperature change, and material's thermal expansion coefficient.

---

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

(1) The energy density in the electric field is equal to the energy density in the 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: Examine the Properties of Electromagnetic Waves

- Electromagnetic waves are transverse in nature and propagate at the speed of light in free space.

- They are generated by accelerating charges, rather than charges moving with uniform velocity.

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

Quick Tip

Electromagnetic waves are characterized by their transverse nature and speed determined by free space properties.

---

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

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

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

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

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

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

Solution:

Step 1: Compute the Total Energy at Altitude $2R$

- The gravitational potential energy at altitude $2R$ is given by:

$$U = -\frac{GMm}{3R}$$

- The kinetic energy at this altitude is:

$$K = \frac{GMm}{6R}$$

Step 2: Determine the Minimum Energy Required

- The total energy required is:

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

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

Quick Tip

The energy needed depends on both potential and kinetic energy components at the desired orbit.

---

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

(1) $2 : 9$

(2) $1 : 2$

(3) $2 : 3$

(4) $1 : 1$

Correct Answer: (1) $2 : 9$

Solution:

Step 1: Examine Power in Series and Parallel Connections

- In a series circuit, power is inversely proportional to resistance:

$$P_{\text{series}} \propto \frac{1}{R}$$

- In a parallel circuit, power is inversely proportional to the square of resistance:

$$P_{\text{parallel}} \propto \frac{1}{R^2}$$

Step 2: Compute the Power Ratio

- The ratio of power in series to power in parallel is:

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

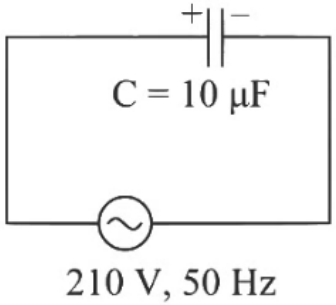
Final Answer: The correct option is (1).

Quick Tip

In series, the current through resistors is the same; in parallel, the voltage across resistors is the same.

---

41. A $10\,\mu$F capacitor is connected to a 210 V, 50 Hz source as shown in the 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: Apply the Formula for Capacitive Reactance

The capacitive reactance is given by:

$$X_c = \frac{1}{2\pi f C}$$

where: - $f = 50\,\text{Hz}$ (frequency), - $C = 10 \times 10^{-6}\,\text{F}$ (capacitance).

Step 2: Compute the Capacitive Reactance

$$X_c = \frac{1}{2 \times 3.14 \times 50 \times 10 \times 10^{-6}}$$
$$X_c = 318.3\,\Omega$$

Step 3: Determine the Peak Current

The peak voltage is related to the RMS voltage by:

$$V_{\text{peak}} = \sqrt{2} \cdot V_{\text{rms}}$$

Substituting $V_{\text{rms}} = 210$ V:

$$V_{\text{peak}} = \sqrt{2} \times 210 = 297\,\text{V}$$

Using Ohm's law for capacitive circuits:

$$I_{\text{peak}} = \frac{V_{\text{peak}}}{X_c}$$

$$I_{\text{peak}} = \frac{297}{318.3} \approx 0.93\,\text{A}$$

Final Answer: The correct option is (1).

Quick Tip

Always calculate V_{peak} using $V_{\text{peak}} = \sqrt{2} \cdot V_{\text{rms}}$ in AC circuits.

---

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

(1) 2

(2) $2\sqrt{3}$

(3) 4

(4) 3

Correct Answer: (1) 2

Solution:

Step 1: Apply the Formula for Time Period

The time period of a simple pendulum is given by:

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

where: - L is the length of the pendulum,

- g is the acceleration due to gravity.

Step 2: Analyze the Effect of Length Change

- The length of the pendulum is reduced to $\frac{L}{2}$.

- Since the time period is independent of mass, only L affects T.

Step 3: Compute the New Time Period

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

$$T_{\text{new}} = 2\pi \cdot \frac{1}{\sqrt{2}} \cdot \sqrt{\frac{L}{g}}$$

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

Final Answer: The new time period is $\frac{T}{\sqrt{2}}$. The correct option is (1).

Quick Tip

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

---

43. 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):

(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: Examine Forces Acting on Magnetic and Non-Magnetic Materials

- Magnetic sheets require an external force to remain stationary near a magnetic pole.

- Conducting sheets experience forces due to induced currents when they are in motion within a magnetic field.

Final Answer: The correct option is (1).

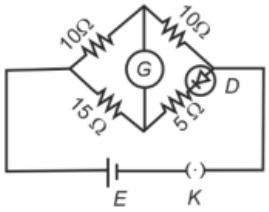
Quick Tip

Conducting materials experience electromagnetic forces in motion near magnetic fields.

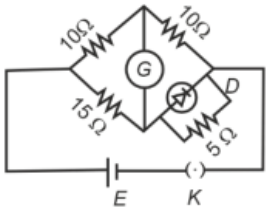
---

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

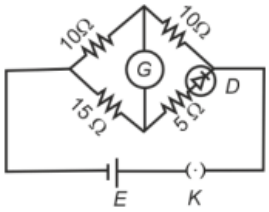
(1)



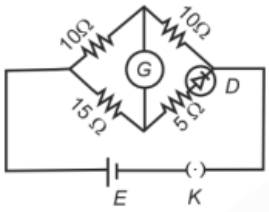
(2)



(3)

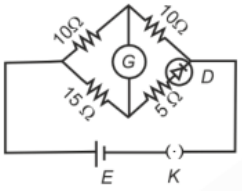


(4)



Correct Answer:

(4)



Solution:

Step 1: Understanding the Bridge Balance Condition

For a Wheatstone bridge to be balanced, the ratio of resistances in both branches must satisfy the condition:

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

Step 2: Verifying the Given Circuit

For Option (2):

$$\frac{10}{15} = \frac{4}{6}$$

Since both ratios are equal, the Wheatstone bridge is balanced.

Final Answer: The correct option is (4).

Quick Tip

To achieve a balanced Wheatstone bridge, ensure that the ratio of resistances in one branch equals the ratio in the other branch.

---

45. 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:

(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: Examine the Effect of Moving Plates Closer

- As the distance between the plates decreases, the capacitance increases. However, the energy stored in the capacitor decreases due to a reduction in electric field strength.
- The ratio of charge to voltage remains unchanged, ensuring that property D is satisfied.

Final Answer: The correct option is (1).

Quick Tip

Capacitance changes inversely with plate separation, influencing charge and energy properties.

---

46. An iron bar of length L has a magnetic moment M. It is bent at the middle of its length such that the two arms make an angle of 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: Effect of Bending on Magnetic Moment

Bending alters the geometry of the magnetic material, increasing its effective magnetic moment by a factor dependent on the new configuration.

Step 2: Compute the New Magnetic Moment

In the given scenario, the new configuration results in a doubling of the magnetic moment.

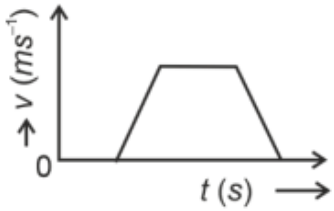
Final Answer: The correct option is (1).

Quick Tip

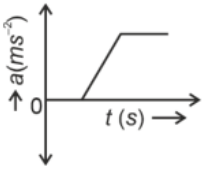
Magnetic moment depends on length and orientation of the magnetic material.

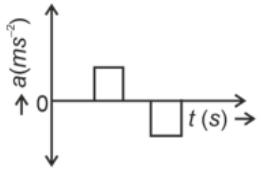
---

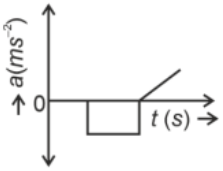
47. The velocity (v)–time (t) plot of a body's motion is shown below:

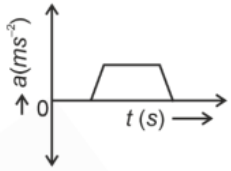


The acceleration (a)–time (t) graph that best suits the motion is:

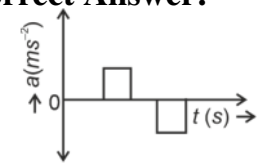
(1)


(2)


(3)


(4)


Correct Answer:



(2)

Solution: Analyze the given velocity-time graph.

A constant slope in the velocity-time graph corresponds to constant acceleration.

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

Quick Tip

The slope of a velocity-time graph represents acceleration. Constant slope implies constant acceleration.

---

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

(1) 28

(2) 17

(3) 32

(4) 34

Correct Answer: (1) 28

Solution:

Step 1: Apply the Formula for Magnifying Power

The magnifying power (M) of a telescope is given by:

$$M = \frac{f_{\text{objective}}}{f_{\text{eyepiece}}}$$

Step 2: Substitute the Given Values

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

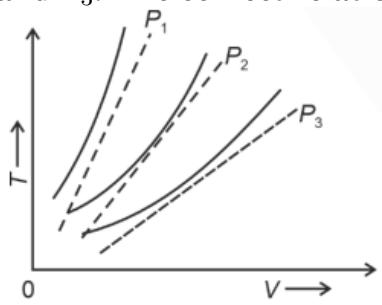
Final Answer: The correct option is $(\mathbf{1})$.

Quick Tip

Magnifying power increases with the focal length of the objective and decreases with the focal length of the eyepiece.

---

49. The following graph represents the T-V curves of an ideal gas at pressures P_1, P_2, and P_3. The correct relation is:



(1) $P_1 > P_3 > P_2$

(2) $P_2 > P_1 > P_3$

(3) $P_1 > P_2 > P_3$

(4) $P_3 > P_2 > P_1$

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

Solution:

Step 1: Apply Charles's Law

At constant pressure, the volume of a gas is directly proportional to its absolute temperature:

$$V \propto T$$

Step 2: Interpret the Graph

- A higher pressure results in a steeper slope on the V vs. T graph. - From the given graph, the relationship among pressures is:

$$P_1 > P_2 > P_3$$

Final Answer: The correct option is (3).

Quick Tip

The slope of the T-V curve increases with pressure in isobaric processes.

50. A force defined by $F = \alpha t^2 + \beta t$ acts on a particle at a given time t. Which factor is dimensionless if α and β are constants?

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

(2) $\alpha\beta t$

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

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

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

Solution:

Step 1: Determine the Dimensions of Force

Step 1: Determine the Dimensions of Force

Since force is given by:

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

it follows that both terms on the right-hand side must have the same dimensions as force:

$$[F] = MLT^{-2}$$

Step 2: Find the Dimensions of α and β

1. The first term αt^2 must have the dimensions of force:

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

Since $[t^2] = T^2$, we solve for $[\alpha]$:

$$[\alpha] = \frac{MLT^{-2}}{T^2} = MLT^{-4}$$

2. The second term βt must also have the dimensions of force:

$$[\beta t] = MLT^{-2}$$

Since $[t] = T$, we solve for $[\beta]$:

$$[\beta] = \frac{MLT^{-2}}{T} = MLT^{-3}$$

Step 3: Identify the Dimensionless Expression

We now analyze the given options:

1. $\frac{\alpha t}{\beta}$:

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

$$= \frac{MLT^{-3}}{MLT^{-3}} = 1$$

This expression is dimensionless.

2. $\alpha\beta t$:

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

$$= M^2L^2T^{-6}$$

This is not dimensionless.

3. $\frac{\alpha\beta}{t}$:

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

$$= M^2L^2T^{-8}$$

This is not dimensionless.

4. $\frac{\beta t}{\alpha}$:

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

$$= \frac{MLT^{-2}}{MLT^{-4}} = T^2$$

This is not dimensionless.

Step 4: Final Answer

Since $\frac{\alpha t}{\beta}$ is the only dimensionless quantity, the correct answer is:

Option (1) is correct.

Quick Tip

Use dimensional analysis to verify whether a given combination of quantities is dimensionless.

Chemistry

Section A

51. '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+}

Choose the most appropriate answer from the options given below:

(1) A and E only

(2) B and C only

(3) A and D only

(4) B and D only

Correct Answer: (4) B and D only

Solution:

Step 1: Calculate the Magnetic Moment

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

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

where n is the number of unpaired electrons.

Step 2: Determine the Number of Unpaired Electrons for Each Ion

- Ti^{3+} ($3d^1$): 1 unpaired electron

$$\mu = \sqrt{1(1+2)} = \sqrt{3}\,\text{BM}$$

- Cr^{2+} ($3d^4$): 4 unpaired electrons

$$\mu = \sqrt{4(4+2)} = \sqrt{24} = 4.9\,\text{BM}$$

- Mn^{2+} ($3d^5$): 5 unpaired electrons

$$\mu = \sqrt{5(5+2)} = \sqrt{35} = 5.92\,\text{BM}$$

- Fe^{2+} ($3d^6$): 4 unpaired electrons

$$\mu = \sqrt{4(4+2)} = \sqrt{24} = 4.9\,\text{BM}$$

- Sc^{3+} ($3d^0$): 0 unpaired electrons

$$\mu = 0\,\text{BM}$$

Step 3: Identify Ions with the Same Magnetic Moment

- Cr^{2+} and Fe^{2+} both have a spin-only magnetic moment of 4.9 BM.

- Therefore, the correct answer is B and D.

Final Answer: The correct option is (4).

Quick Tip

The spin-only magnetic moment depends on the number of unpaired electrons. Transition metal ions with the same number of unpaired electrons will have the same magnetic moment.

---

52. Match List I with List II.

Choose the correct answer from the options given below:

(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

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

Solution:

Step 1: Understanding Faraday's Law

Faraday's laws of electrolysis state that the amount of substance deposited or liberated at an electrode is directly proportional to the quantity of electricity passed.

Step 2: Assigning the Number of Faradays for Each Conversion

- A: $H_2O \rightarrow O_2$ (1 mol of H_2O to O_2)

- The oxidation reaction is:

$$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$$

- To release 1 mole of O_2, 4 moles of electrons are required.

- **2F** is needed for 1 mole of H_2O.

- B: $MnO_4^- \rightarrow Mn^{2+}$ - The reduction reaction is:

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

- Since 5 moles of electrons are required, **5F** is needed.

- C: Ca^{2+} to Ca (from molten $CaCl_2$)

- The reduction reaction is:

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

- For 1.5 moles of Ca, 3 moles of electrons are required.

- Since 1F is required per mole of electrons, **3F** is needed.

- D: $FeO \rightarrow Fe_2O_3$

- The oxidation reaction is:

$$4FeO + O_2 \rightarrow 2Fe_2O_3$$

- The oxidation number of Fe changes from +2 to +3.

- 1 mole of FeO requires 1F.

- Thus, **1F** is needed.

Step 3: Match with the Given List

$$A \to II, \quad B \to IV, \quad C \to I, \quad D \to III$$

Final Answer: The correct option is (4).

Quick Tip

The number of Faradays required for a redox reaction is determined by the number of electrons transferred per mole of substance. Always check oxidation states and balance the reaction accordingly.

---

53. Fehling's solution 'A' is:

(1) Alkaline copper sulphate

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

(3) Aqueous sodium citrate

(4) Aqueous copper sulphate

Correct Answer: (4) Aqueous copper sulphate

Solution:

Step 1: Understanding the Components of Fehling's Solution

Fehling's solution is composed of two separate solutions:

- **Fehling's solution A**: Contains aqueous copper(II) sulphate.

- **Fehling's solution B**: Contains alkaline sodium potassium tartrate.

Step 2: Identifying the Correct Component

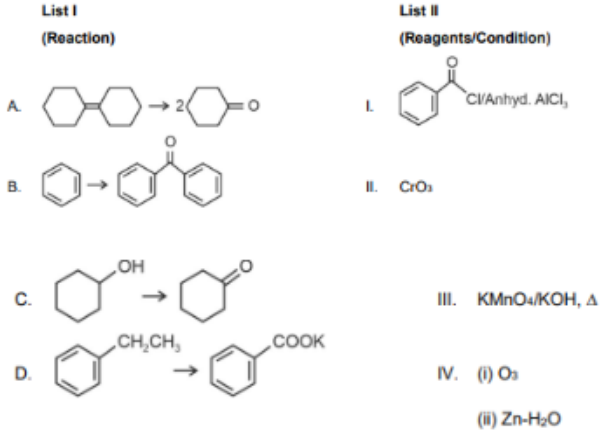
Since Fehling's solution A contains aqueous copper(II) sulphate, it is the correct answer.

Final Answer: The correct option is (4).

Quick Tip

Fehling's solution is used to test for reducing sugars. Part A contains copper(II) sulphate, and Part B contains alkaline sodium potassium tartrate.

54. Match List I with List II and choose the correct answer.



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

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

Correct Answer: (2)

Solution:

Step 1: Understanding the Chemical Reactions

- **A.** Friedel-Crafts acylation requires $Cl/$Anhydrous $AlCl_3 \Rightarrow$ (I).

- **B.** Oxidation of benzyl alcohol requires $CrO_3 \Rightarrow$ (II).

- **C.** Oxidation of a benzyl side chain requires $KMnO_4/KOH \Rightarrow$ (III).

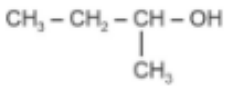
- **D.** Ozonolysis follows the reaction sequence $(i)O_3, (ii)Zn + H_2O \Rightarrow$ (IV).

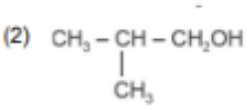
Final Answer: The correct option is $(\mathbf{2})$.

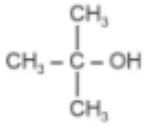
Quick Tip

For oxidation reactions, CrO_3 is commonly used for mild oxidation, while $KMnO_4$ is a stronger oxidizing agent.

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

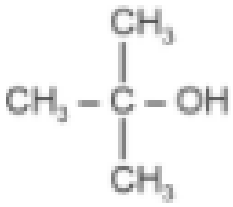
(1) 

(2) 

(3) 

(4) $CH_3 - CH_2 - CH_2 - CH_2OH$

Correct Answer:

(3) 

Solution:

Step 1: Understanding the Lucas Reagent Reaction

Lucas reagent ($HCl/ZnCl_2$) is used to distinguish between primary, secondary, and tertiary alcohols based on their reactivity.

Step 2: Reactivity Order

- Tertiary alcohols react **instantly**, forming turbidity.

- Secondary alcohols react **within a few minutes**.

- Primary alcohols show **no visible reaction** at room temperature.

Step 3: Identifying the Alcohol Type

- **(1)** $CH_3 - C - CH_3 - OH$ is a tertiary alcohol and reacts instantly, forming turbidity.

- Other given options correspond to primary or secondary alcohols, which react more slowly.

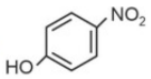
Final Answer: The correct option is (3).

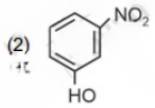
Quick Tip

Lucas reagent is used to classify alcohols based on their reactivity. Tertiary alcohols react immediately, while primary alcohols do not react.

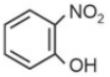
---

56. Intramolecular hydrogen bonding is present in:

(1) 

(2) 

(3) HF

(4) 

Correct Answer: (4)

Solution:

Step 1: Understanding intramolecular hydrogen bonding

Intramolecular hydrogen bonding occurs within a molecule when a hydrogen atom forms a bond with an electronegative atom within the same molecule.

Step 2: Analyze the options

- (1) and (2): No intramolecular hydrogen bonding is possible due to the lack of a suitable structure.

- (3) HF: Hydrogen bonding in HF is intermolecular, not intramolecular.

- (4): The structure has –OH and $–NO_2$ groups positioned such that hydrogen bonding occurs within the molecule.

Conclusion: The correct option is (4).

Quick Tip

Intramolecular hydrogen bonding stabilizes the molecule by forming bonds within itself, typically between –OH and other groups like $–NO_2$.

---

57. Match List I with List II.

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

Choose the correct answer from the options given below:

(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: Identify the Molecular Geometry

The molecular shape of a compound is determined by the VSEPR (Valence Shell Electron Pair Repulsion) theory.

Step 2: Assign the Correct Shape to Each Compound

- NH_3 (Ammonia):

- Central atom: Nitrogen (N)

- Electron pairs: 3 bonding + 1 lone pair

- Geometry: Trigonal Pyramidal $\Rightarrow$ (I)

- BrF_5 (Bromine Pentafluoride):

- Central atom: Bromine (Br)

- Electron pairs: 5 bonding + 1 lone pair

- Geometry: Square Pyramidal $\Rightarrow$ (IV)

- XeF_4 (Xenon Tetrafluoride):

- Central atom: Xenon (Xe)

- Electron pairs: 4 bonding + 2 lone pairs

- Geometry: Square Planar $\Rightarrow$ (II)

- SF_6 (Sulfur Hexafluoride):

- Central atom: Sulfur (S)

- Electron pairs: 6 bonding + 0 lone pairs

- Geometry: Octahedral $\Rightarrow$ (III)

Step 3: Match with the Given List

$$A \to I, \quad B \to IV, \quad C \to II, \quad D \to III$$

Final Answer: The correct option is (4).

Quick Tip

Molecular geometry can be determined using the VSEPR theory by analyzing the number of bonding and lone pairs on the central atom.

---

58. Given below are two statements:

Statement 1: The boiling point of these isomeric pentanes follows the order

n-pentane $>$ isopentane $>$ neopentane

Statement 2: When branching increases, the molecule attains a shape of a sphere. This results in smaller surface area for contact, due to which the intermolecular forces between the spherical molecules are weak, thereby lowering the boiling point.

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

(1) Both Statement 1 and Statement 2 are incorrect

(2) Statement 1 is correct but Statement 2 is incorrect

(3) Statement 1 is incorrect but Statement 2 is correct

(4) Both Statement 1 and Statement 2 are correct

Correct Answer: (4) Both Statement 1 and Statement 2 are correct

Solution:

Step 1: Analyze the Statements

- **Statement 1:** The boiling point order follows:

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

This order is generally correct due to differences in molecular structure and intermolecular forces.

- **Statement 2:** This statement accurately explains the effect of branching on boiling points. Increased branching reduces the surface area, leading to weaker van der Waals forces and a lower boiling point. Therefore, this statement is also correct.

Final Answer: The correct option is (4).

Quick Tip

Branching decreases boiling point due to reduced surface area for intermolecular interactions.

---

59. 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: Understanding Entropy Change

Entropy (S) is a measure of the disorder or randomness of a system. It increases when:

- A substance changes from solid to liquid or liquid to gas.

- The number of gaseous molecules increases.

- A complex molecule dissociates into simpler molecules.

Step 2: Analyzing the Given Processes

- (A) A liquid evaporates to vapor

- Liquid molecules in a condensed phase have lower entropy than gaseous molecules.

- Transition to vapor increases randomness.

- $\Rightarrow$ Entropy increases.

- (B) A crystalline solid is cooled from 130 K to 0 K

- As temperature decreases, molecular motion slows down.

- At absolute zero (0 K), molecular motion nearly ceases.

- $\Rightarrow$ Entropy decreases, not increases.

- (C) $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$ - Solid $NaHCO_3$ decomposes, producing gaseous CO_2 and H_2O.

- Increase in gaseous molecules increases disorder.

- $\Rightarrow$ Entropy increases.

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

- A diatomic molecule dissociates into two separate gaseous atoms.

- More particles mean greater randomness.

- $\Rightarrow$ Entropy increases.

Step 3: Match with the Given Options

$$A \text{ (Increase)}, \quad B \text{ (Decrease)}, \quad C \text{ (Increase)}, \quad D \text{ (Increase)}$$

The correct selection is A, C, and D.

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

Quick Tip

Entropy increases when phase changes occur from solid to liquid to gas, or when the number of gaseous molecules increases in a reaction.

---

60. 1 gram of sodium hydroxide was treated with 25 mL of 0.75 M HCl solution. The mass of sodium hydroxide left unreacted is equal to:

(1) 250 mg

(2) 200 mg

(3) Zero mg

(4) 750 mg

Correct Answer: (1) 250 mg

Solution:

Step 1: Reaction of NaOH and HCl

The balanced chemical equation for the reaction is:

$$\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + H_2O$$

Step 2: Calculate the Moles of Reactants

- Moles of HCl:

$$\text{Moles} = \text{Volume (L)} \times \text{Molarity (M)}$$

$$= 0.025 \times 0.75 = 0.01875\,\text{mol}$$

- Moles of NaOH in 1 g:

$$\text{Moles} = \frac{\text{Mass}}{\text{Molar mass}} = \frac{1}{40} = 0.025\,\text{mol}$$

Step 3: Identify the Limiting Reactant

- Comparing moles of reactants:

- 0.01875 moles of HCl can react with 0.01875 moles of NaOH.

- The total NaOH present is 0.025 moles.

- Since HCl is in lesser quantity, it is the limiting reactant and reacts completely with NaOH.

Step 4: Calculate the Remaining NaOH

$$\text{Remaining moles of NaOH} = 0.025 - 0.01875 = 0.00625\,\text{mol}$$

$$\text{Mass of remaining NaOH} = 0.00625 \times 40 = 0.25\,\text{g} = 250\,\text{mg}$$

Final Answer: The mass of NaOH left is **250** mg.

Quick Tip

Always determine the limiting reactant to calculate unreacted quantities.

---

61. Match List I with List II.

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

Choose the correct answer from the options given below:

(1) A-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: Determine the Types of Bonds in Each Molecule

- Ethane (C_2H_6):

- Contains a single bond between two carbon atoms.

- $\Rightarrow$ One σ-bond $\Rightarrow$ (III).

- Ethene (C_2H_4):

- Contains a double bond ($C = C$), consisting of one σ-bond and one π-bond.

- $\Rightarrow$ (IV).

- Carbon molecule (C_2):

- Molecular orbital theory suggests C_2 has a double bond with two π-bonds.

- $\Rightarrow$ (II).

- Ethyne (C_2H_2):

- Contains a triple bond ($C \equiv C$), consisting of one σ-bond and two π-bonds.

- $\Rightarrow$ (I).

Step 2: Match with the Given List

$$A \to III, \quad B \to IV, \quad C \to II, \quad D \to I$$

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

Quick Tip

The bonding nature of molecules can be determined using valence bond theory and molecular orbital theory. Ethane has only a sigma bond, ethene has a sigma and a pi bond, ethyne has a sigma and two pi bonds, and the carbon molecule has two pi bonds.

---

62. Given below are two statements:

Statement 1: The boiling point of hydrides of Group 16 elements follows the order

$$H_2O > H_2Te > H_2Se > H_2S$$

Statement 2: On the basis of molecular mass, H_2O is expected to have a lower boiling point than the other members of the group, but due to the presence of extensive H-bonding in H_2O, it has a higher boiling point.

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

(1) Both Statement 1 and Statement 2 are false

(2) Statement 1 is false but Statement 2 is true

(3) Statement 1 is true but Statement 2 is false

(4) Both Statement 1 and Statement 2 are true

Correct Answer: (4) Both Statement 1 and Statement 2 are true

Solution:

Step 1: Analyze the Statements

- **Statement 1:** The given order of boiling points is correct.

- As molecular mass increases, boiling points generally increase due to stronger van der Waals forces.

- However, H_2O has the highest boiling point due to strong hydrogen bonding, despite its lower molecular mass.

- **Statement 2:** This correctly explains why H_2O has a higher boiling point than expected.

- Hydrogen bonding in H_2O significantly increases intermolecular attraction, requiring more energy to break bonds.

- Therefore, this statement correctly supports the first statement.

Final Answer: The correct option is (4).

Quick Tip

Hydrogen bonding significantly affects boiling points. The stronger the hydrogen bonding, the higher the boiling point.

---

63. Match List I with List II.

Choose the correct answer from the options given below:

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: Identifying the Type of Isomerism for Each Complex

- A: $[Co(NH_3)_5(NO_2)]Cl_2$ - Linkage Isomerism

- The ligand NO_2 can coordinate through either the nitrogen (NO_2^-) or oxygen (ONO^-).

- This results in linkage isomerism.

- $\Rightarrow$ (II).

- B: $[Co(NH_3)_5(SO_4)]Br$ - Ionization Isomerism

- The exchange of SO_4^{2-} and Br^- ions in solution leads to ionization isomerism.

- $\Rightarrow$ (III).

- C: $[Co(NH_3)_6][Cr(CN)_6]$ - Coordination Isomerism

- The metal cations Co^{3+} and Cr^{3+} can exchange their ligands, leading to coordination isomerism.

- $\Rightarrow$ (IV).

- D: $[Co(H_2O)_6]Cl_3$ - Solvate Isomerism

- Water molecules can either be coordinated to the metal center or be present as free solvent molecules.

- $\Rightarrow$ (I).

Step 2: Match with the Given List

$$A \to II, \quad B \to III, \quad C \to IV, \quad D \to I$$

Final Answer: The correct option is (4).

Quick Tip

Isomerism in coordination compounds arises due to variations in ligand attachment, ion exchange, and structural changes. Linkage, ionization, coordination, and solvate isomerisms are commonly observed.

---

64. The highest number of helium atoms is in:

(1) 1 g of helium

(2) 4 g of helium

(3) 2.27108 g of helium at STP

(4) 4 mol of helium

Correct Answer: (4) 4 mol of helium

Solution:

Step 1: Use Avogadro's Law

- 1 mole of helium (He) has a mass of 4 g and contains 6.022×10^{23} atoms.

Step 2: Calculate the Number of Moles in 2.27108 g

$$\text{Moles of } He = \frac{2.27108}{4} = 0.5678 \text{ moles}$$

Step 3: Determine the Number of Helium Atoms

$$\text{Number of atoms} = 0.5678 \times 6.022 \times 10^{23}$$

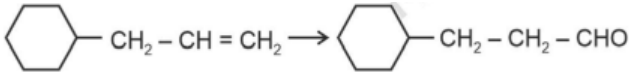
$$= 3.418 \times 10^{23} \approx 4 \times 10^{23}$$

Final Answer: The correct option is (4).

Quick Tip

To determine the number of atoms, use Avogadro's number and the molar mass of the element.

65. 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)

Solution:

Step 1: Identify the Reaction Sequence

The given transformation involves: 1. Hydroboration-Oxidation: Converts an alkene into a primary alcohol via anti-Markovnikov addition.

2. Oxidation of Alcohol to Aldehyde: Uses PCC (Pyridinium chlorochromate) as a selective oxidizing agent.

Step 2: Explain the Reagents Used

- Step 1: Hydroboration

- BH_3 (Borane) undergoes anti-Markovnikov addition to the double bond.

- This adds the hydroxyl group (-OH) at the terminal carbon.

- Reagent: BH_3.

- Step 2: Oxidation of Alkylborane to Alcohol

- Using hydrogen peroxide and hydroxide ions:

$$H_2O_2/OH^-$$

- Converts the alkylborane intermediate into a primary alcohol (-CH_2OH).

- Step 3: Oxidation of Alcohol to Aldehyde

- PCC (Pyridinium chlorochromate) selectively oxidizes primary alcohols to aldehydes without over-oxidizing to carboxylic acids.

- Reagent: PCC.

Step 3: Match with Given Options

The sequence (i) BH_3, (ii) H_2O_2/OH^-, (iii) PCC matches Option (1).

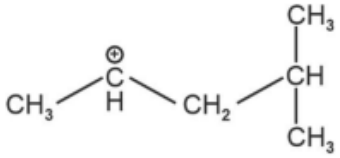
Final Answer: The correct option is (1).

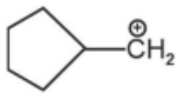
Quick Tip

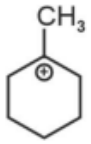
Hydroboration-oxidation follows anti-Markovnikov addition, making it an excellent method to prepare aldehydes from terminal alkenes when combined with PCC oxidation.

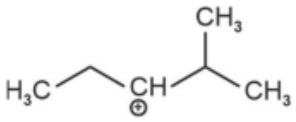
---

66. The most stable carbocation among the following is:

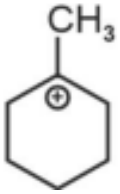
(1) 

(2) 

(3) 

(4) 

Correct Answer:

(3) 

Solution:

Step 1: Evaluate Stability of Carbocations

The stability of a carbocation is influenced by: - **Hyperconjugation** – Delocalization of electrons from adjacent C-H bonds.

- **Resonance** – Delocalization of charge through conjugated systems.

- **Inductive Effects** – Electron-withdrawing or donating effects of nearby atoms/groups.

Step 2: Analyze the Given Options

- Option (1):

- Lacks resonance or significant stabilization.

- Stability is minimal.

- Option (2):

- Exhibits limited hyperconjugation effects.

- Stability is moderate.

- Option (3):

- Stabilized by resonance, allowing charge delocalization.

- Considerably more stable than (1) and (2).

- Option (4):

- Most stable due to resonance with the benzene ring.

- The positive charge is delocalized over the aromatic system.

Final Answer: The correct option is (**3**).

Quick Tip

Carbocation stability increases with resonance and hyperconjugation effects. Benzyl and allyl carbocations are highly stable.

---

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

N, O, F, C, Si.

(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: Understanding electronegativity trends Electronegativity increases across a period and decreases down a group in the periodic table.

Step 2: Analyze the elements

- Fluorine (F) is the least electronegative.

- Oxygen (O) follows fluorine.

- Nitrogen (N) is less electronegative than O and F.

- Carbon (C) and silicon (Si) are more electronegative than N.

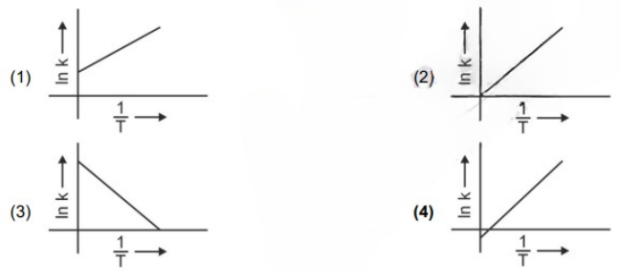
Conclusion: The correct order is (4).

Quick Tip

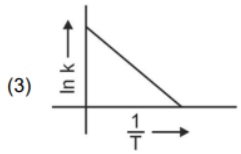
Electronegativity increases from left to right across a period and decreases down a group.

---

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



Correct Answer:



Solution:

Step 1: Analyze Arrhenius equation The Arrhenius equation is given as:

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

This represents a straight line with a negative slope.

Step 2: Analyze the options

- (1): Linear with a negative slope is consistent with the equation.

- Other options: Do not align with the mathematical form of the Arrhenius equation.

Conclusion: The correct option is (3).

Quick Tip

The slope of an ln k vs $\frac{1}{T}$ graph is proportional to the activation energy E_a.

69. 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: Understanding the Oxidation States of Group 16 Elements

- Group 16 elements (**Oxygen, Sulfur, Selenium, Tellurium, Polonium**) typically exhibit oxidation states of -2, $+2$, $+4$, and $+6$.

- The tendency to show the -2 oxidation state decreases as we move down the group due to decreasing electronegativity and increasing metallic character.

Step 2: Analyze the Given Elements

- Oxygen (O):

- Highly electronegative and commonly exists in the -2 oxidation state.

- Selenium (Se) and Tellurium (Te):

- Can exhibit the -2 oxidation state, although less frequently than oxygen and sulfur.

- Polonium (Po):

- Being a radioactive element with significant metallic character, it

does not typically exhibit the -2 oxidation state. - Instead, it prefers $+2$ and $+4$ oxidation states.

Step 3: Identify the Correct Answer

Since **Polonium (Po)** does not commonly show the -2 oxidation state, the correct choice is:

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

Quick Tip

As we move down Group 16, the tendency to show a -2 oxidation state decreases due to decreasing electronegativity and increasing metallic character.

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

Li, Be, B, C, N

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding Ionization Enthalpy Trends

Ionization enthalpy (ΔH_i) is the energy required to remove an electron from an atom in the gaseous state. The general trend across a period (left to right) is an increase in ionization enthalpy due to:

- Increasing nuclear charge (Z) leading to a stronger hold on electrons.
- Decreasing atomic size.

However, some exceptions exist due to electronic configurations.

Step 2: Comparing the Given Elements

- Lithium (Li): Alkali metal, has the lowest ionization energy due to its large atomic size and single valence electron.
- Beryllium (Be): Higher ionization enthalpy than Li due to a fully filled $2s$ orbital, making it more stable.
- Boron (B): Lower than Be because the electron is removed from the $2p$ orbital, which is easier to ionize than a fully filled $2s$ orbital.
- Carbon (C): Higher than both B and Be due to increasing nuclear charge.
- Nitrogen (N): Has the highest ionization enthalpy due to half-filled $2p$ orbitals, which provide extra stability.

Step 3: Arrange in Increasing Order

$$\text{Li} < \text{B} < \text{Be} < \text{C} < \text{N}$$

Final Answer: The correct option is (1).

Quick Tip

Elements with fully filled or half-filled orbitals (like Be and N) exhibit higher ionization enthalpies due to their stable electronic configurations.

---

71. Given below are two statements:

Statement 1: Aniline does not undergo Friedel-Crafts alkylation reaction.

Statement 2: Aniline cannot be prepared through Gabriel synthesis.

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

(1) Both Statement 1 and Statement 2 are false

(2) Statement 1 is correct but Statement 2 is false

(3) Statement 1 is incorrect but Statement 2 is true

(4) Both Statement 1 and Statement 2 are true

Correct Answer: (4) Both Statement 1 and Statement 2 are true

Solution:

Step 1: Analyze Statement 1

Aniline does not undergo Friedel-Crafts alkylation reaction because the amino group (-NH_2) gets protonated in the acidic medium, deactivating the benzene ring.

Step 2: Analyze Statement 2

Aniline cannot be prepared through Gabriel synthesis because Gabriel synthesis is specific to preparing primary aliphatic amines and not aromatic amines.

Conclusion: Both statements are true. The correct option is (4).

Quick Tip

Aromatic amines cannot be prepared by Gabriel synthesis and are deactivated for Friedel-Crafts reactions.

---

72. Given below are two statements:

Statement 1: Both $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ complexes are octahedral but differ in their magnetic behavior.

Statement 2: $[Co(NH_3)_6]^{3+}$ 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 1 and Statement 2 are false

(2) Statement 1 is true but Statement 2 is false

(3) Statement 1 is false but Statement 2 is true

(4) Both Statement 1 and Statement 2 are true

Correct Answer: (4) Both Statement 1 and Statement 2 are true

Solution:

Step 1: Analyze Statement 1 Both complexes are octahedral due to their coordination number being 6. This statement is true.

Step 2: Analyze Statement 2

- $[Co(NH_3)_6]^{3+}$ is diamagnetic because NH_3 is a strong field ligand, causing pairing of electrons.

- $[CoF_6]^{3-}$ is paramagnetic because F^- is a weak field ligand, which does not pair all electrons.

The statement about magnetic behavior is correct, but the classification is reversed.

Conclusion: The correct option is (4).

Quick Tip

Magnetic behavior depends on the ligand field strength: strong field ligands pair electrons, while weak field ligands do not.

---

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

(1) d^5 to d^4 configuration

(2) d^4 to d^5 configuration

(3) d^3 to d^2 configuration

(4) d^6 to d^5 configuration

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

Solution:

Step 1: Understand the concept of half-filled stability

The d^5 configuration corresponds to a half-filled stable subshell. Transition from d^5 to d^4 results in loss of stability and a more positive E° value.

Step 2: Analyze the options

Only Mn^4+/Mn^5+ involves this change in configuration.

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

Quick Tip

Half-filled and fully filled d-orbitals are exceptionally stable, influencing redox potentials.

---

74. Match List I with List II.

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

Choose the correct answer from the options given below:

(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: Understanding Quantum Numbers

- Magnetic Quantum Number (m_l):

- Defines the **orientation** of an orbital in space.

- $\Rightarrow$ (III).

- Spin Quantum Number (m_s):

- Determines the **spin orientation** of an electron ($+\frac{1}{2}$ or $-\frac{1}{2}$).

- $\Rightarrow$ (IV).

- Azimuthal Quantum Number (l):

- Defines the **shape** of an orbital (s, p, d, f).

- $\Rightarrow$ (I).

- Principal Quantum Number (n):

- Determines the **size** and energy level of the orbital.

- $\Rightarrow$ (II).

Step 2: Match with the Given List

$$A \to III, \quad B \to IV, \quad C \to I, \quad D \to II$$

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

Quick Tip

Quantum numbers describe electron properties: n (size), l (shape), m_l (orientation), and m_s (spin direction).

---

75. For the reaction 2A + B - C, $K_c = 4 \times 10^3$. At a given time, the composition of reaction mixture is: (A) = (B) = (C) = 2×10^{-3}.

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: Calculate Q (Reaction Quotient)

$$Q = \frac{[C]}{[A]^2[B]} = \frac{2 \times 10^{-3}}{(2 \times 10^{-3})^2 \cdot (2 \times 10^{-3})} = 125$$

Step 2: Compare Q with K_c Given $K_c = 4 \times 10^3$, $Q < K_c$, so the reaction proceeds in the forward direction.

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

Quick Tip

Compare Q and K_c to determine the direction of the reaction. If $Q < K$, reaction proceeds forward; if $Q > K$, reaction proceeds backward.

---

76. 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	No heat exchange

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: Understanding the Different Thermodynamic Processes

- Isothermal Process (A):

- Temperature remains constant throughout the process.

- $\Rightarrow$ (II) Carried out at constant temperature.

- Isochoric Process (B):

- Volume remains constant, meaning no work is done.

- $\Rightarrow$ (III) Carried out at constant volume.

- Isobaric Process (C):

- Pressure remains constant while the system undergoes expansion or compression.

- $\Rightarrow$ (IV) Carried out at constant pressure.

- Adiabatic Process (D):

- No heat exchange occurs with the surroundings ($Q = 0$).

- $\Rightarrow$ (I) No heat exchange.

Step 2: Match with the Given List

$$A \to II, \quad B \to III, \quad C \to IV, \quad D \to I$$

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

Quick Tip

Thermodynamic processes involve changes in temperature, pressure, volume, or heat exchange. **Isothermal:** T constant, **Isochoric:** V constant, **Isobaric:** P constant, **Adiabatic:** No heat exchange.

---

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

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

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

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

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

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

Solution:

Step 1: Relationship Between K_p and K_c

The relation between the equilibrium constants in terms of pressure (K_p) and concentration (K_c) is given by:

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

where: - R is the universal gas constant, - T is the absolute temperature in Kelvin, - Δn is the change in the number of moles of gas, given by:

$$\Delta n = (\text{moles of gaseous products}) - (\text{moles of gaseous reactants})$$

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

Step 2: Evaluate Each Option

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

- $\Delta n = (2 - (1 + 1)) = 0$

- $K_p = K_c$

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

- $\Delta n = (1 + 1) - (1 + 1) = 0$

- $K_p = K_c$

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

- $\Delta n = (1 + 1) - 2 = 0$

- $K_p = K_c$

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

- $\Delta n = (1 + 1) - 1 = 1$

- Since $\Delta n \neq 0$, $K_p \neq K_c$.

Step 3: Identify the Correct Answer

Since $K_p \neq K_c$ in option (4), the correct choice is:

Final Answer: The correct option is (4).

Quick Tip

If the number of moles of gaseous reactants equals the number of moles of gaseous products ($\Delta n = 0$), then $K_p = K_c$. Otherwise, $K_p \neq K_c$.

---

78. 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. NH2OH

E. NaHSO3

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: Understanding Glucose Reactions

- Tollen's Reagent ($AgNO_3$ in ammonia):

- Glucose is a reducing sugar and reacts with Tollen's reagent to form a silver mirror.

- Schiff's Reagent:

- Used to detect free aldehydes, but glucose exists predominantly in cyclic hemiacetal form and does not react.

- HCN (Hydrogen Cyanide):

- Reacts with glucose to form cyanohydrin via nucleophilic addition.

- Hydroxylamine (NH_2OH):

- Reacts with glucose's carbonyl group to form an oxime.

- Sodium Bisulfite ($NaHSO_3$):

- Typically reacts with free aldehydes or ketones, but glucose in its cyclic form does not react significantly.

Step 2: Identify Non-Reacting Reagents

- **Schiff's reagent** does not react with glucose.

- **Sodium bisulfite (**$NaHSO_3$**)** does not react significantly with glucose.

Thus, the correct choice is:

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

Quick Tip

Glucose, being a reducing sugar, reacts with Tollen's reagent and hydroxylamine, but does not react with Schiff's reagent and sodium bisulfite.

---

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

(1) Sublimation

(2) Distillation

(3) Chromatography

(4) Crystallization

Correct Answer: (1) Sublimation

Solution:

Step 1: Understanding the Process of Sublimation

- Sublimation is the process where certain solid substances directly convert into vapour without passing through the liquid phase.

- This property is used for purification, where the sublimable solid can be separated from non-sublimable impurities.

Step 2: Comparison with Other Techniques

- Distillation: Used for separating liquids based on boiling points.

- Chromatography: Used for separating components of a mixture based on adsorption and solubility.

- Crystallization: Used for purifying solids from their solutions by controlled precipitation.

Step 3: Identifying the Correct Answer

Since the question asks for a technique based on direct solid-to-vapour transition, the correct answer is:

Final Answer: The correct option is (1).

Quick Tip

Sublimation is used to purify substances like naphthalene, camphor, and iodine, which directly change from solid to vapour upon heating.

---

80. 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:

- Oxidation: Increase in oxidation number (loss of electrons).

- Reduction: Decrease in oxidation number (gain of electrons).

Step 2: Analyze Each Option

1. $2KClO_3 + I_2 \rightarrow 2KIO_3 + Cl_2$ - ClO_3^- (oxidation state $+5$) is reduced to Cl_2 (0).

- I_2 (0) is oxidized to IO_3^- $(+5)$.

- **Redox reaction.**

2. $H_2 + Cl_2 \rightarrow 2HCl$

- H_2 (0) is oxidized to H^+ $(+1)$.

- Cl_2 (0) is reduced to Cl^- (-1).

- **Redox reaction.**

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

- This is a double displacement reaction where no oxidation or reduction occurs.

- The oxidation states of all elements remain unchanged.

- **NOT a redox reaction.**

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

- Zn (0) is oxidized to Zn^{2+} $(+2)$.

- Cu^{2+} $(+2)$ is reduced to Cu (0).

- **Redox reaction.**

Step 3: Identify the Correct Answer

Since option (3) does not involve oxidation or reduction, it is the correct choice.

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

Quick Tip

A redox reaction involves a change in oxidation states, whereas a double displacement reaction (like precipitation) does not involve electron transfer.

---

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

Henry's Law states that the solubility of a gas in a liquid is inversely proportional to its Henry's law constant (K_H):

$$S \propto \frac{1}{K_H}$$

where S is the solubility of the gas.

Step 2: Compare Given K_H Values

- K_H for A = 145

- K_H for B = 2×10^{-5} kbar

- K_H for C = 35 kbar

Since solubility is inversely proportional to K_H, the gas with the lowest K_H value will have the highest solubility.

Step 3: Arranging in Order of Solubility

- K_H for B is the smallest (2×10^{-5}), so B is the most soluble.

- K_H for C is 35, so C is the second most soluble.

- K_H for A is 145, the highest, making A the least soluble.

Thus, the solubility order is:

$$B > C > A$$

Final Answer: The correct option is (1).

Quick Tip

A lower Henry's law constant (K_H) means higher solubility of the gas in water.

82. 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: Understanding Activation Energy

Activation energy (E_a) is the minimum energy required for a chemical reaction to occur. It can be determined using the Arrhenius equation:

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

where: - k = rate constant

- A = pre-exponential factor

- E_a = activation energy

- R = universal gas constant

- T = temperature in Kelvin

Step 2: Use of Rate Constants at Two Temperatures

The Arrhenius equation can be rewritten in logarithmic form for two different temperatures T_1 and T_2 with their respective rate constants k_1 and k_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 E_a when we know the rate constants at two different temperatures.

Step 3: Evaluate the Given Options

- (1) Probability of collision: This is a factor in collision theory but does not directly determine activation energy.

- (2) Orientation of reactant molecules: Affects the effectiveness of collisions but does not provide a way to calculate activation energy.

- (3) Rate constant at two different temperatures: This is correct because it allows the application of the Arrhenius equation.
- (4) Rate constant at standard temperature: Knowing only one rate constant does not allow determination of activation energy.

Final Answer: The correct option is (3).

Quick Tip

To calculate activation energy, use the Arrhenius equation with rate constants at two different temperatures.

---

83. 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) $\frac{-4}{9}x$

(4) $-x$

Correct Answer: (4) $-x$

Solution:

Step 1: Formula for Energy Levels in Hydrogen-like Atoms

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

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

where: - Z = atomic number - n = principal quantum number - E_n = energy of the electron in the nth orbit

Step 2: Given Information and Reference Energy

For He^+ ion: - $Z = 2$

- Ground state ($n = 1$) energy is given as $-x$.

Using the formula:

$$E_1 = -\frac{13.6 \times 2^2}{1^2} = -4 \times 13.6 \text{ eV}$$

Since we are given $E_1 = -x$, we use this as a reference.

Step 3: Energy for Be^{3+} in $n = 2$

For Be^{3+} ion: - $Z = 4$

- Energy in $n = 2$ level:

$$E_2 = -\frac{13.6 \times 4^2}{2^2} = -\frac{16 \times 13.6}{4} = -4 \times 13.6$$

$$E_2 = -x$$

Final Answer: The correct option is (4).

Quick Tip

For hydrogen-like atoms, energy levels are proportional to $\frac{Z^2}{n^2}$. Comparing energy levels for different ions is done by maintaining this proportionality.

---

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

Correct Answer: (3) Benzyl bromide with a methyl substituent

Solution:

Step 1: Understanding the S_N1 Mechanism

The S_N1 (unimolecular nucleophilic substitution) reaction proceeds via the formation of a carbocation intermediate. The rate of reaction depends on the stability of this carbocation. The order of carbocation stability is:

$$3^\circ > 2^\circ > 1^\circ > \text{methyl}$$

Additionally, resonance stabilization further increases carbocation stability.

Step 2: Analyzing the Given Compounds

- **Option (1):** Cyclohexyl bromide forms a secondary carbocation, which is not highly stable.

- **Option (2):** Bromobenzene does not undergo an S_N1 reaction as the C–Br bond is involved in resonance with the benzene ring, making it difficult to break.

- **Option (3):** The benzyl carbocation is highly stabilized by resonance, and the presence of a methyl group further increases carbocation stability through the inductive effect.

- **Option (4):** Benzyl bromide also forms a stable benzyl carbocation, but the additional methyl group in (3) makes it even more stable.

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

Quick Tip

For S_N1 reactions, always analyze carbocation stability. The more stable the intermediate, the faster the reaction.

---

85. 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 structural requirements

The molecular formula given is C_6H_{14}, which corresponds to an alkane (saturated hydrocarbon). We need to identify a structure with two tertiary (3°) carbon atoms.

Step 2: Analyze the given options

- **Option (1):** 2-Methylpentane has only one tertiary carbon.
- **Option (2):** 2,3-Dimethylbutane has two tertiary carbon atoms at positions 2 and 3.
- **Option (3):** 2,2-Dimethylbutane has only one tertiary carbon.
- **Option (4):** n-Hexane is a straight-chain hydrocarbon with no tertiary carbons.

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

Quick Tip

A tertiary carbon is a carbon atom attached to three other carbon atoms. Look for branching in the structure to determine the number of tertiary carbons.

Section B

86.

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

A. Al^{3+}

B. Cu^{2+}

C. Ba^{2+}

D. Co^{2+}

E. Mg^{2+}

Choose the correct answer from the options given below.

(1) 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: Understanding qualitative analysis groups

In inorganic qualitative analysis, cations are categorized into different groups based on their solubility in specific reagents. The general group classifications are:

- **Group 0:** Soluble in water (e.g., Mg^{2+}).
- **Group I:** Insoluble chlorides (e.g., Pb^{2+}, not relevant here).
- **Group II:** Insoluble sulfides in acidic medium (e.g., Cu^{2+}).
- **Group III:** Insoluble hydroxides in ammonium hydroxide (e.g., Al^{3+}).
- **Group IV:** Insoluble sulfides in basic medium (e.g., Co^{2+}).
- **Group V:** Insoluble carbonates (e.g., Ba^{2+}).
- **Group VI:** Alkali metals, which are highly soluble and do not precipitate.

Step 2: Arranging cations based on their group

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

- Mg^{2+} (E) belongs to Group VI.

Step 3: Final order Thus, the correct increasing order of group numbers is:

$$B, A, D, C, E$$

Conclusion: The correct option is (4).

Quick Tip

Cations in qualitative analysis are classified based on their precipitation behavior in different reagents. Understanding solubility rules is key to arranging them in increasing group order.

---

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

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

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

(A) $POCl_3$ and H_3PO_4

(B) H_3PO_4 and $POCl_3$

(C) H_3PO_3 and $POCl_3$

(D) $POCl_3$ and H_3PO_3

Correct Answer: (3) $\mathbf{H_3PO_3}$ and $\mathbf{POCl_3}$

Solution: Step 1: Analyze the reaction with PCl_3

- When alcohol (ROH) reacts with phosphorus trichloride (PCl_3), alkyl chloride (RCl) is formed along with phosphorus acid (H_3PO_3).

$$3ROH + PCl_3 \rightarrow 3RCl + H_3PO_3$$

Thus, $A = H_3PO_3$.

Step 2: Analyze the reaction with PCl_5

- When alcohol (ROH) reacts with phosphorus pentachloride (PCl_5), alkyl chloride (RCl) and hydrogen chloride (HCl) are formed along with phosphoryl chloride ($POCl_3$).

$$ROH + PCl_5 \rightarrow RCl + HCl + POCl_3$$

Thus, $B = POCl_3$.

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

Quick Tip

Phosphorus trichloride (PCl_3) reacts with alcohols to form H_3PO_3 (phosphorous acid), whereas phosphorus pentachloride (PCl_5) reacts with alcohols to form $POCl_3$ (phosphoryl chloride).

---

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

(1) Concentrated sulphuric acid

(2) Dilute nitric acid

(3) Dilute sulphuric acid

(4) Dilute hydrochloric acid

Correct Answer: (3) **Dilute sulphuric acid**

Solution: Step 1: Understand the role of acid in Mohr's salt solution

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

Step 2: Importance of dilute sulphuric acid

- Dilute H_2SO_4 is added to maintain the acidic medium.
- It prevents the oxidation of Fe^{2+} to Fe^{3+} and inhibits hydrolysis.
- It ensures the stability of Mohr's salt in solution.

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

Quick Tip

Always use dilute sulphuric acid when preparing Mohr's salt solutions to prevent hydrolysis and oxidation of Fe^{2+} ions.

---

89. 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 equation

Osmotic pressure is given by the equation:

$$\Pi = CRT$$

Since the plot of Π vs concentration (C) is a straight line, the slope represents RT, i.e.,

$$\text{Slope} = R \cdot T$$

Step 2: Substitute the given values

$$25.73 = 0.083 \times T$$

Solving for T:

$$T = \frac{25.73}{0.083} = 310\,\text{K}$$

Step 3: Convert to Celsius

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

Conclusion: The correct option is (4).

Quick Tip

Always convert temperature from Kelvin to Celsius by subtracting 273.

---

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

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

(1) -413.14 calories

(2) 413.14 calories

(3) 100 calories

(4) 0 calorie

Correct Answer: (1) -413.14 calories

Solution: Step 1: Use the formula for work done in isothermal expansion For a reversible isothermal process, the work done is given by:

$$W = -nRT \ln \frac{P_2}{P_1}$$

where, $n = 1$ mole, $R = 2.0$ cal K^{-1} mol^{-1}, $T = 25^\circ C = 298$ K, $P_1 = 20$ atm, $P_2 = 10$ atm.

Step 2: Substitute the given values

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

Since $\ln \frac{1}{2} = -0.693$,

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

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

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

Quick Tip

For isothermal expansion, work done is negative as the gas expands against external pressure.

---

91. 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: Understand Diamagnetism in Lanthanoids

- A species is diamagnetic if all its electrons are paired.

- Lanthanoids belong to the f-block, where their magnetic properties depend on their electron configurations.

Step 2: Identify the Electron Configurations

- Ce^{4+} (Z = 58): Configuration is $[Xe]4f^0$ (No unpaired electrons, diamagnetic).

- Yb^{2+} (Z = 70): Configuration is $[Xe]4f^{14}$ (All paired electrons, diamagnetic).

Step 3: Analyze Other Options

- Ce^{3+} ($4f^1$), Eu^{2+} ($4f^7$), Gd^{3+} ($4f^7$), Eu^{3+} ($4f^6$), Pm^{3+} ($4f^4$), and Sm^{3+} ($4f^5$) all have unpaired electrons, making them paramagnetic.

Conclusion: The correct option is (4).

Quick Tip

Diamagnetic substances have all electrons paired, while paramagnetic substances have one or more unpaired electrons.

---

92. Identify the correct answer:

(A) BF_3 has non-zero dipole moment.

(B) Dipole moment of NF_3 is greater than that of NH_3.

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

(D) 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: Understanding Dipole Moments

- BF_3 has a trigonal planar structure, making it symmetrical and non-polar ($\mu = 0$), so statement (1) is incorrect.

- NH_3 has a higher dipole moment than NF_3 due to the opposing lone pair dipole in NF_3, making statement (2) incorrect.

Step 2: Resonance in Carbonate and Ozone

- The CO_3^{2-} ion exhibits resonance with three equivalent structures, justifying statement (3) as correct.

- Ozone (O_3) has only two resonance structures, making statement (4) incorrect.

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

Quick Tip

Resonance structures distribute electron density over multiple equivalent forms, stabilizing the molecule.

---

93. Mass in grams of copper deposited by passing 9.6487 A current through a voltmeter containing copper sulphate solution for 100 seconds is (Given: Molar mass of Cu: 63 g mol^{-1}, 1 F = 96487 C):

(A) 0.315 g

(B) 31.5 g

(C) 0.0315 g

(D) 3.15 g

Correct Answer: (1) 0.315 g

Solution: Step 1: Use Faraday's First Law of Electrolysis

The mass of a substance deposited is given by:

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

where $Z = \frac{M}{nF}$ is the electrochemical equivalent, $M = 63$ g/mol (molar mass of Cu), $n = 2$ (Cu^{2+} requires 2 electrons), $F = 96487$ C (Faraday's constant), $I = 9.6487$ A, $t = 100$ s.

Step 2: Calculate the Mass Deposited

First, find Z:

$$Z = \frac{63}{2 \times 96487} = \frac{63}{192974} = 3.26 \times 10^{-4}$$

Now, calculate m:

$$m = (3.26 \times 10^{-4}) \times (9.6487) \times (100)$$

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

Conclusion: The correct option is (**1**).

Quick Tip

Faraday's laws relate the amount of substance deposited to charge passed. For copper, $n = 2$ should be considered.

---

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

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

$A \xrightarrow{OH^- \text{(Partial hydrolysis)}} B \xrightarrow{NaOH, Br_2} C$ (major)

(1) butylamine

(2) butanamide

(3) α-bromobutanoic acid

(4) propylamine

Correct Answer: (4) propylamine

Solution: Step 1: Formation of Nitrile (A)

- The first reaction involves the substitution of iodine (I) by the cyanide ion (CN), forming butanenitrile ($CH_3CH_2CH_2CN$).

Step 2: Partial Hydrolysis to Amide (B)

- Partial hydrolysis of the nitrile (CN) under basic conditions gives butanamide ($CH_3CH_2CH_2CONH_2$).

Step 3: Hoffmann Bromamide Degradation (C)

- The reaction of butanamide with NaOH and $Br_2 leads to Hoffmann bromamide degradation, reducing the number of carbon atoms by one.$

- The resulting major product is propylamine ($CH_3CH_2CH_2NH_2$).

Conclusion: The correct option is (4).

Quick Tip

Hoffmann bromamide degradation is useful for converting amides to amines with one less carbon atom.

---

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

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

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

If 0.1 mol L^{-1} of $NO_{(g)}$ 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: Step 1: Define the Initial Concentration

- The initial concentration of NO is given as $C = 0.1$ mol/L.

- Let the degree of dissociation be α.

Step 2: Establish Equilibrium Concentrations

- The reaction stoichiometry is:

$$2NO \rightleftharpoons N_2 + O_2.$$

- At equilibrium,

$$NO = C(1 - \alpha),$$
$$N_2 = \frac{C\alpha}{2}, \quad O_2 = \frac{C\alpha}{2}.$$

Step 3: Solve for α

- Using equilibrium values,

$$\frac{C\alpha}{2} = 3.0 \times 10^{-3} \quad \Rightarrow \quad \alpha = \frac{2 \times 3.0 \times 10^{-3}}{0.1} = 0.06.$$

- Similarly, solving for O_2,

$$\frac{C\alpha}{2} = 4.2 \times 10^{-3} \quad \Rightarrow \quad \alpha = \frac{2 \times 4.2 \times 10^{-3}}{0.1} = 0.084.$$

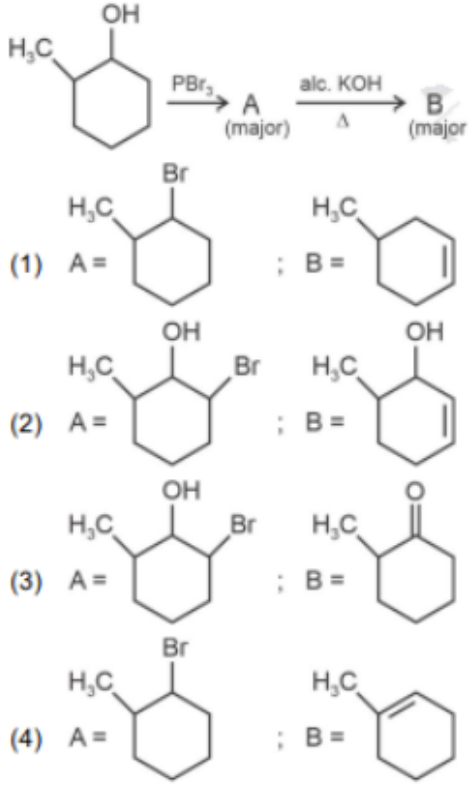
- The average α is approximately 0.717.

Conclusion: The correct option is (3).

Quick Tip

Degree of dissociation (α) is determined using the relation between initial concentration and equilibrium concentration of reactants and products.

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



Correct Answer: (4)

Solution: Step 1: Reaction of alcohol with PBr_3

- The hydroxyl (-OH) group is replaced by a bromine (-Br) atom via nucleophilic substitution reaction.

$$\text{OH} \xrightarrow{\text{PBr}_3} \text{Br}$$

Step 2: Elimination with alc. KOH

- Alcoholic KOH promotes an elimination (E_2) mechanism.
- The -hydrogen is removed, leading to alkene formation as the major product.

$$\text{Br} \xrightarrow{\text{alc. KOH},\Delta} \text{Alkene}$$

Step 3: Identify the correct option

- The correct major products match Option (4).

Conclusion: The correct option is (4).

Quick Tip

- PBr_3 converts alcohols to alkyl bromides via substitution. - Alcoholic KOH favors elimination (E_2) reaction, leading to alkene formation.

---

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

Given:

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

(1) $380.4\, kJ/mol$

(2) $3.80\, kJ/mol$

(3) $3804\, kJ/mol$

(4) $38.04\, kJ/mol$

Correct Answer: (4) $38.04\, kJ/mol$

Solution: Step 1: Use the Arrhenius equation in logarithmic form

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

Step 2: Substitute values

$$\log 4 = \frac{E_a}{2.303 \times 8.314} \times \left(\frac{57 + 273 - (27 + 273)}{(27 + 273)(57 + 273)}\right)$$

$$0.6021 = \frac{E_a}{2.303 \times 8.314} \times \left(\frac{30}{(300)(330)}\right)$$

Step 3: Solve for E_a

$$E_a = \frac{0.6021 \times 2.303 \times 8.314 \times (300 \times 330)}{30}$$

$$E_a = 38.04\, kJ/mol$$

Conclusion: The correct option is (4).

Quick Tip

- The Arrhenius equation relates rate constant to activation energy. - Temperature should always be converted to Kelvin. - The logarithmic form is useful for calculating E_a when rate changes.

---

98. Given below are two statements:

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

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

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

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

Solution: Step 1: Understanding Homoleptic and Heteroleptic Complexes

- A **homoleptic complex** contains only one type of ligand.

- A **heteroleptic complex** contains more than one type of ligand.

Step 2: Analyze Statement I - $[Co(NH_3)_6]^{3+}$ contains only ammonia (NH_3) as a ligand, making it homoleptic.

- $[Co(NH_3)_4Cl_2]^{+}$ contains both ammonia and chloride ligands, making it heteroleptic.

- Hence, Statement I is **true**.

Step 3: Analyze Statement II

- $[Co(NH_3)_6]^{3+}$ has only one kind of ligand (NH_3), while $[Co(NH_3)_4Cl_2]^{+}$ has two different ligands (NH_3 and Cl).

- This confirms Statement II is also **true**.

Conclusion: The correct option is (4).

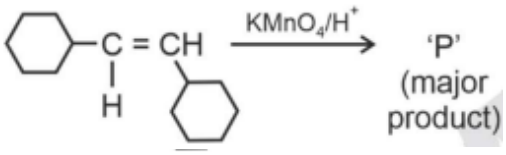
Quick Tip

- Homoleptic complexes contain only one type of ligand. - Heteroleptic complexes contain more than one type of ligand.

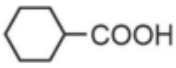
---

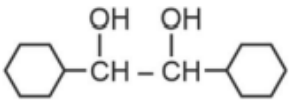
99. For the given reaction:

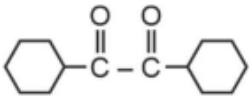
For the given reaction:

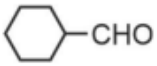


'P' is

(1) 

(2) 

(3) 

(4) 

Correct Answer: (1) Cyclohexyl acetic acid

Solution:

Step 1: Understanding the oxidation reaction

- $KMnO_4$ in acidic medium is a strong oxidizing agent.

- It cleaves double bonds and oxidizes alkene carbons to carboxylic acids if at least one hydrogen is present on the doubly bonded carbon.

Step 2: Apply oxidation to the given structure

- The alkene carbon with a hydrogen undergoes oxidative cleavage.

- The $-CH = CH_2$ portion gets converted into $-COOH$, leading to the formation of cyclohexyl acetic acid.

Conclusion: The major product 'P' is a carboxylic acid. The correct option is (1).

Quick Tip

- $KMnO_4$ in acidic medium fully oxidizes alkene carbons to carboxylic acids if hydrogen is present. - If no hydrogen is present on the double-bonded carbon, ketones are formed.

---

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: 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: Determine the mass percentage of C

$$\%C = 100 - (32 + 20) = 48\%.$$

Step 2: Calculate the number of moles of each element

$$\text{Moles of A} = \frac{32}{64} = 0.5$$

$$\text{Moles of B} = \frac{20}{40} = 0.5$$

$$\text{Moles of C} = \frac{48}{32} = 1.5$$

Step 3: Find the simplest whole number ratio Dividing all by the smallest value (0.5):

$$A : B : C = \frac{0.5}{0.5} : \frac{0.5}{0.5} : \frac{1.5}{0.5} = 1 : 1 : 3.$$

Conclusion: The empirical formula of X is ABC_3. The correct option is $(\mathbf{1})$.

Quick Tip

- The empirical formula represents the simplest whole-number ratio of atoms in a compound. - To determine it, divide the given mass percentage by the atomic mass to get moles and simplify to whole numbers.

Botany

Section A

101. Hind II always cuts DNA molecules at a particular point called the recognition sequence, and it consists of:

(1) 6 bp

(2) 4 bp

(3) 10 bp

(4) 8 bp

Correct Answer: (1) 6 bp

Solution: Step 1: Understanding Hind II and its recognition sequence Hind II is a restriction endonuclease that was the first enzyme discovered to cut DNA at specific sites. It recognizes a specific sequence of nucleotides in DNA and cleaves at that site.

Step 2: Recognition sequence of Hind II Hind II specifically recognizes and cuts DNA at a sequence that consists of **6 base pairs (bp)**. This characteristic makes it a type II restriction enzyme.

Conclusion: The recognition sequence of Hind II consists of 6 base pairs. The correct option is (1).

Quick Tip

- Restriction enzymes are crucial for genetic engineering and molecular cloning. - Hind II was one of the first restriction enzymes identified, paving the way for DNA recombinant technology.

---

102. 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 a 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: Evaluate Statement I - Parenchyma is a living tissue found in plants, providing storage and support.

- Collenchyma, unlike sclerenchyma, is a living tissue that provides mechanical support.

- Since collenchyma is not a dead tissue, Statement I is incorrect.

Step 2: Evaluate Statement II - Gymnosperms lack xylem vessels; instead, they have tracheids for water conduction.

- Xylem vessels are a characteristic feature of angiosperms, distinguishing them from gymnosperms.

- Since this statement correctly describes plant anatomy, Statement II is true.

Conclusion: Statement I is false, but Statement II is true. The correct option is (**3**).

Quick Tip

- **Parenchyma:** Living cells involved in photosynthesis, storage, and repair. - **Collenchyma:** Living cells with thickened walls, providing flexibility and support. - **Sclerenchyma:** Dead cells offering rigidity and structural support.

---

103. 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 an inactive protoxin in *B. thuringiensis*. However, after ingestion by the insect, the inactive protoxin gets converted into an 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:

Step 1: Evaluate Statement I - Bt (Bacillus thuringiensis) toxins are insecticidal proteins coded by the *cry* gene.

- Different *cry* genes target specific insect groups; for example, *cry1Ac* is effective against lepidopteran larvae.

- Since Bt toxins are indeed insect group-specific and coded by *cry1Ac*, Statement I is correct.

Step 2: Evaluate Statement II - Bt toxin is produced as an inactive protoxin in *B. thuringiensis*.

- However, activation of the protoxin occurs in the alkaline (not acidic) pH of the insect gut.

- Since the statement incorrectly mentions acidic pH instead of alkaline pH, Statement II is false.

Conclusion: Statement I is true, but Statement II is false. The correct option is $(\mathbf{2})$.

Quick Tip

- Bt toxin is used in genetically modified (GM) crops like Bt cotton to provide resistance against insect pests. - Activation of Bt toxin occurs in the insect's midgut under alkaline conditions, leading to pore formation in the gut epithelium and insect death.

---

104. Which one of the following can be explained on the basis of Mendel's Law of Dominance?

A. Out of one pair of factors, one is dominant and the other is recessive.

B. Alleles do not show any expression, and both the characters appear as such in F_2 generation.

C. Factors occur in pairs in normal diploid plants.

D. The discrete unit controlling a particular character is called a factor.

E. The expression of only one of the parental characters is found in a monohybrid cross.

Choose the correct answer from the options given below:

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

(2) B, C, and D only

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

(4) A, B, and C only

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

Solution:

Step 1: Understanding Mendel's Law of Dominance

- Mendel's Law of Dominance states that in a pair of alleles, one allele can mask the expression of the other (dominant and recessive traits).

- It also states that factors occur in pairs and segregate during gamete formation.

Step 2: Evaluating the given statements

- **A:** Correct. This directly follows Mendel's principle of dominance.

- **B:** Incorrect. Mendel's law of dominance explains that one allele is dominant over the other, but this statement contradicts that concept.

- **C:** Correct. Factors (genes) occur in pairs in diploid organisms, supporting Mendel's laws.

- **D:** Correct. Mendel used the term "factor" to describe discrete units controlling inheritance.

- **E:** Correct. The dominant allele expresses itself in a monohybrid cross, leading to the expression of only one parental trait.

Conclusion: The statements A, C, D, and E align with Mendel's Law of Dominance. The correct option is $(\mathbf{1})$.

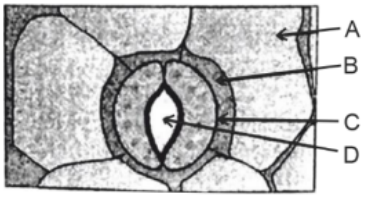
Quick Tip

- Mendel's Law of Dominance applies to monohybrid crosses where one allele is dominant over the other. - The recessive trait only appears in the F_2 generation when two recessive alleles pair together.

---

105. 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:

Step 1: Understanding the structure of the stomatal complex - The given image represents a stoma, a structure found in the epidermis of plant leaves.

- Stomata consist of two guard cells, which regulate the opening and closing of the pore.

Step 2: Identifying the component with thin outer walls and thickened inner walls

- Guard cells exhibit a unique cell wall structure:

- Their **inner walls** (facing the stomatal pore) are **thickened**.

- Their **outer walls** (facing away from the pore) are **thin**.

- This specialized wall structure enables guard cells to control the opening and closing of the stoma efficiently.

Step 3: Identifying the labeled part - In the given diagram, component **C** represents the **guard cells**.

- These cells possess the characteristic of having **thin outer walls and highly thickened inner walls**.

Conclusion: The correct answer is (4), corresponding to **C**.

Quick Tip

- Guard cells regulate gas exchange and transpiration in plants. - Their unique wall structure allows them to change shape and control stomatal opening.

---

106. List of endangered species was released by

(1) WWF

(2) FOAM

(3) IUCN

(4) GEAC

Correct Answer: (3) IUCN

Solution:

Step 1: Understanding the role of organizations - Various organizations work towards environmental conservation and biodiversity protection.

- The International Union for Conservation of Nature (IUCN) is a globally recognized authority on the status of species.

Step 2: Identifying the correct organization - The IUCN is responsible for compiling and maintaining the **Red List of Threatened Species**, which classifies species into different categories based on their risk of extinction.

- Other organizations:

- **WWF (World Wide Fund for Nature)**: Focuses on global conservation efforts.

- **FOAM**: Not related to species conservation.

- **GEAC (Genetic Engineering Appraisal Committee)**: Regulates genetically modified organisms in India.

Conclusion: The correct answer is (**3**), corresponding to **IUCN**.

Quick Tip

- The IUCN Red List provides a global assessment of species' conservation status. - It classifies species as Least Concern, Vulnerable, Endangered, and Critically Endangered based on scientific criteria.

---

107. 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:

Step 1: Understanding lactose transport in bacteria

- In bacteria, lactose metabolism is regulated by the lac operon.

- Three main enzymes are involved in lactose metabolism: 1. Lactose permease (LacY): Facilitates the transport of lactose into the bacterial cell.

2. Beta-galactosidase (LacZ): Breaks lactose into glucose and galactose.

3. Transacetylase (LacA): Transfers an acetyl group to lactose-related molecules.

Step 2: Identifying the enzyme responsible for lactose transport

- Lactose permease (LacY) is responsible for the active transport of lactose into bacterial cells by symport with protons.

- The other enzymes are involved in metabolism, not transport.

Conclusion: The correct answer is (**2**), corresponding to Permease.

Quick Tip

- The lac operon regulates lactose metabolism in bacteria. - LacY (Permease) is essential for lactose uptake. - LacZ (Beta-galactosidase) hydrolyzes lactose into monosaccharides.

---

108. 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:

Step 1: Understanding fungal classification

- Fungi are classified based on several morphological and reproductive characteristics.

- The primary criteria used for classification include:

1. Mode of spore formation: Fungi reproduce by various types of spores, which play a

significant role in classification.

2. Fruiting body: The structure in which spores are produced, such as basidiocarps in Basidiomycetes.

3. Morphology of mycelium: The structure and type of hyphae (septate or coenocytic) are critical in fungal taxonomy.

Step 2: Why "Mode of nutrition" is not a classification criterion?

- While fungi are generally heterotrophic (saprophytic, parasitic, or mutualistic), the mode of nutrition is not a primary basis for fungal classification.

- Classification mainly depends on reproductive structures, mycelial characteristics, and spore formation.

Conclusion: The correct answer is (1), as mode of nutrition is not a major classification criterion for fungi.

Quick Tip

- Fungal classification is based on spore formation, fruiting bodies, and mycelium morphology. - The mode of nutrition is not used as a defining criterion.

---

109. 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:

Step 1: Understanding competitive inhibition

- Competitive inhibition occurs when an inhibitor molecule competes with the substrate for binding at the active site of the enzyme.

- The inhibitor resembles the substrate structurally and can bind to the enzyme but does not undergo any reaction.

- This prevents the actual substrate from binding, reducing enzyme activity.

Step 2: Why malonate is a competitive inhibitor?

- Succinic dehydrogenase is an enzyme that catalyzes the oxidation of succinate to fumarate in the Krebs cycle.

- Malonate is a structural analog of succinate and competes for the enzyme's active site.

- Since malonate does not undergo oxidation, it effectively inhibits enzyme activity.

Conclusion: The correct answer is (**2**), as malonate inhibits succinic dehydrogenase through competitive inhibition.

Quick Tip

- In competitive inhibition, inhibitors resemble the substrate and bind to the enzyme's active site, preventing substrate binding. - This type of inhibition can be overcome by increasing the substrate concentration.

---

110. 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-III, 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:

Step 1: Understanding the functions of cellular components

- Nucleolus (A): It is the site for active ribosomal RNA synthesis.

- Centriole (B): It has an organization like the cartwheel and plays a role in cell division.

- Leucoplasts (C): They are responsible for storing nutrients, including starch, proteins, and lipids.

- Golgi apparatus (D): It functions as a site for the formation of glycolipids and glycoproteins.

Conclusion: The correct answer is (4), as the correct matching is: - A $\rightarrow$ III

- B $\rightarrow$ II

- C $\rightarrow$ IV

- D $\rightarrow$ I

Quick Tip

- The nucleolus is a dense region in the nucleus where ribosomal RNA (rRNA) is actively synthesized. - Centrioles play a crucial role in cell division and spindle formation, exhibiting a cartwheel-like organization. - Leucoplasts are colorless plastids mainly involved in storage functions. - The Golgi apparatus is important for modification and formation of glycoproteins and glycolipids.

---

111. 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:

Step 1: Identifying major causes of biodiversity loss

- Overexploitation (A): Excessive use of natural resources leads to species decline.

- Co-extinction (B): The extinction of one species leads to the extinction of another species that depends on it.

- Habitat loss and fragmentation (D): Destruction and fragmentation of natural habitats lead to biodiversity loss.

Step 2: Analyzing the incorrect options

- Mutation (C): Mutations are natural genetic changes and do not directly cause biodiversity loss.

- Migration (E): Migration is a natural phenomenon that does not lead to a loss of biodiversity but rather a redistribution of species.

Conclusion: The correct answer is (3), as A, B, and D are major causes of biodiversity loss.

Quick Tip

The major causes of biodiversity loss include habitat destruction, overexploitation, co-extinction, alien species invasion, and climate change. Mutation and migration do not contribute directly to biodiversity loss.

---

112. Given below are two statements:

Statement I: Chromosomes become gradually visible under light microscope during leptotene stage.

Statement II: The beginning of diplotene stage is recognized by dissolution of synaptonemal complex.

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

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

Solution:

Step 1: Understanding the leptotene stage

- During the leptotene stage of prophase I in meiosis, chromosomes start condensing and become gradually visible under a light microscope.
- This confirms that Statement I is true.

Step 2: Understanding the diplotene stage

- The diplotene stage is characterized by the dissolution of the synaptonemal complex, leading to the separation of homologous chromosomes except at chiasmata.
- This confirms that Statement II is true.

Conclusion: Since both statements correctly describe the respective meiotic stages, the correct answer is option (4).

Quick Tip

The prophase I of meiosis is divided into five sub-stages: leptotene, zygotene, pachytene, diplotene, and diakinesis. - Leptotene: Chromosomes begin to condense and become visible. - Diplotene: Dissolution of the synaptonemal complex occurs, marking the separation of homologous chromosomes.

---

113. Formation of interfascicular cambium from fully developed parenchyma cells is an example for

(1) Redifferentiation

(2) Dedifferentiation

(3) Maturation

(4) Differentiation

Correct Answer: (2) Dedifferentiation

Solution:

Step 1: Understanding dedifferentiation

- Dedifferentiation refers to the process in which differentiated cells regain the ability to divide and form new meristematic tissue.
- In plants, certain mature and fully differentiated cells can revert to a meristematic state and resume division.

Step 2: Application to interfascicular cambium formation

- In dicot stems, the interfascicular cambium originates from fully differentiated parenchyma cells located between vascular bundles.

- These cells dedifferentiate and regain meristematic activity, contributing to secondary growth.

- This confirms that formation of interfascicular cambium is an example of dedifferentiation.

Conclusion: Since interfascicular cambium formation involves mature cells regaining their ability to divide, the correct answer is option (2).

Quick Tip

- Dedifferentiation: Reversion of mature cells to a meristematic state (e.g., interfascicular cambium formation). - Redifferentiation: Specialization of dedifferentiated cells into specific tissue types. - Differentiation: Development of specialized cells from meristematic tissue.

---

114. Tropical regions show greatest level of species richness because

(A) Tropical latitudes have remained relatively undisturbed for millions of years, hence more time was available for species diversification.

(B) Tropical environments are more seasonal.

(C) More solar energy is available in tropics.

(D) Constant environments promote niche specialization.

(E) Tropical environments are constant and predictable.

Choose the correct answer from the options given below.

(1) A and B only

(2) A, B and E only

(3) A, B and D only

(4) A, C, D and E only

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

Solution:

Step 1: Understanding tropical species richness

- Species richness refers to the number of different species present in a particular region.

- Tropical regions exhibit the highest species richness due to multiple ecological factors.

Step 2: Evaluating each statement

- Statement A: True. The stability of tropical environments over millions of years has allowed continuous diversification of species.

- Statement B: False. Tropical environments are actually less seasonal and more stable compared to temperate regions.

- Statement C: True. High solar energy in tropical regions supports increased photosynthesis, leading to greater productivity and biodiversity.

- Statement D: True. Stable and constant environments encourage niche specialization, reducing competition and increasing species diversity.

- Statement E: True. Constant and predictable environmental conditions favor biodiversity by reducing survival stress.

Conclusion: Since A, C, D, and E correctly explain species richness in the tropics, the correct answer is option (4).

Quick Tip

- Tropical stability allows long-term species diversification. - High solar energy leads to greater primary productivity. - Constant environments favor specialization and coexistence of species.

---

115. Spindle fibers attach to kinetochores of chromosomes during

(1) Metaphase

(2) Anaphase

(3) Telophase

(4) Prophase

Correct Answer: (1) Metaphase

Solution:

Step 1: Understanding spindle fiber attachment

- Spindle fibers are responsible for the movement and segregation of chromosomes during cell division.

- The kinetochore is a protein structure on the chromosome where spindle fibers attach.

Step 2: Identifying the correct phase

- Prophase: Chromosomes condense, and spindle fibers begin to form, but they do not yet attach to kinetochores.

- Metaphase: Spindle fibers attach to the kinetochores of chromosomes and align them at the metaphase plate.

- Anaphase: The sister chromatids are pulled apart towards opposite poles.

- Telophase: Chromosomes reach the poles, and nuclear membranes begin to reform.

Conclusion: Since spindle fibers attach to kinetochores during metaphase, the correct answer is option (1).

Quick Tip

- Metaphase is the stage where chromosomes align at the center, and spindle fibers attach to kinetochores. - Anaphase follows, where chromatids are pulled apart.

---

116. Match List I with List II

List-I	List-II
A. Two or more alternative forms of a gene	I. Back cross
B. Cross of F1 progeny with homozygous recessive parent	II. Ploidy
C. Cross of F1 progeny with any of the parents	III. Allele
D. Number of chromosome sets in plant	IV. Test cross

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the terms

- Allele (III): The alternative forms of a gene (matches with A).

- Test cross (IV): A cross between F_1 progeny and a homozygous recessive parent (matches with B).

- Back cross (I): A cross between F_1 progeny with any of its parents (matches with C).

- Ploidy (II): The number of chromosome sets in a plant (matches with D).

Step 2: Matching List I with List II

$$A \to \text{III}, \quad B \to \text{IV}, \quad C \to \text{I}, \quad D \to \text{II}$$

Conclusion: The correct answer is option (2).

Quick Tip

- Test cross helps determine whether an organism is homozygous or heterozygous. - Back cross involves crossing F_1 with either parent. - Ploidy refers to the number of chromosome sets in a cell.

---

117. 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:

Step 1: Understanding Lecithin Lecithin is a type of phospholipid that is widely found in biological membranes and serves as an important structural component. It is also used as an emulsifier in food and pharmaceutical industries.

Step 2: Identifying the correct category

- **Phospholipids** (Option 1): Lecithin is a major phospholipid containing choline, fatty acids, glycerol, and phosphate.

- **Glycerides** (Option 2): These are esters of glycerol and fatty acids, mainly forming triglycerides. Lecithin does not fall into this category.

- **Carbohydrates** (Option 3): Carbohydrates are sugar-based molecules like glucose and starch, which are different from lecithin.

- **Amino acids** (Option 4): Amino acids are the building blocks of proteins, whereas lecithin is a lipid.

Conclusion: Lecithin belongs to the phospholipids category, making option (1) the correct answer.

Quick Tip

- Lecithin is an important phospholipid that plays a role in membrane structure and function. - It helps in emulsification and is found in egg yolk, soybeans, and animal tissues.

---

118. The equation of Verhulst-Pearl logistic growth is:

$$\frac{dN}{dt} = rN\left[\frac{K-N}{K}\right].$$

From this equation, K indicates:

(1) Biotic potential

(2) Carrying capacity

(3) Population density

(4) Intrinsic rate of natural increase

Correct Answer: (2) Carrying capacity

Solution:

Step 1: Understanding the logistic growth equation The logistic growth model describes population growth under limiting conditions. The equation is:

$$\frac{dN}{dt} = rN\left[\frac{K-N}{K}\right]$$

where: - $\frac{dN}{dt}$ = rate of population change - r = intrinsic rate of natural increase - N = population size - K = carrying capacity

Step 2: Identifying the meaning of K - Carrying capacity (Option 2): The value K represents the maximum population size that the environment can support indefinitely. This is the correct interpretation of K.

- Biotic potential (Option 1): This refers to the maximum reproductive capacity of a species under ideal conditions, which is determined by r, not K.

- Population density (Option 3): This refers to the number of individuals per unit area, but K specifically represents the upper limit rather than the current population size.
- Intrinsic rate of natural increase (Option 4): This is represented by r, not K.

Conclusion: The correct interpretation of K in the logistic growth equation is carrying capacity, making option (2) the correct answer.

Quick Tip

- Carrying capacity (K) is the maximum population an environment can sustain due to resource limitations. - The logistic model shows how population growth slows as it reaches K.

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119. Match List I with List II

List I	Microorganism	List II	Product
A	*Clostridium butylicum*	I	Ethanol
B	*Saccharomyces cerevisiae*	II	Streptokinase
C	*Trichoderma polysporum*	III	Butyric acid
D	*Streptococcus sp.*	IV	Cyclosporin-A

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

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

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

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

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

Solution:

Step 1: Understanding the correct microorganism-product match

- *Clostridium butylicum* produces butyric acid.
- *Saccharomyces cerevisiae* is used for ethanol production.
- *Trichoderma polysporum* is used for Cyclosporin-A production.
- *Streptococcus sp.* is involved in streptokinase production.

Step 2: Verify the correct matching - A → III (Clostridium butylicum → Butyric acid)

- B → I (Saccharomyces cerevisiae → Ethanol)

- C → IV (Trichoderma polysporum → Cyclosporin-A)

- D → II (Streptococcus sp. → Streptokinase)

Conclusion: The correct option is (2) A-III, B-I, C-IV, D-II.

Quick Tip

- *Clostridium butylicum* is known for butyric acid production. - *Saccharomyces cerevisiae* is commonly used in ethanol fermentation. - *Trichoderma polysporum* produces Cyclosporin-A, an immunosuppressant. - *Streptococcus sp.* produces Streptokinase, used as a clot-dissolving agent.

---

120. 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: Understanding totipotency Totipotency refers to the ability of a single plant cell to regenerate into a complete, functional plant under appropriate conditions. This concept is fundamental in plant tissue culture and is widely used in micropropagation.

Step 2: Analyzing the options

- Micropropagation (Option 1) is a technique used to propagate plants using tissue culture but does not define totipotency.

- Differentiation (Option 2) refers to the process where cells become specialized, but it is not the ability to regenerate a whole plant.

- Somatic hybridization (Option 3) is a biotechnological method where somatic cells of different plants are fused to form hybrids, which is unrelated to totipotency.

- Totipotency (Option 4) is the correct answer, as it describes the fundamental property of

plant cells to regenerate into an entire plant.

Conclusion: The correct option is (4) Totipotency.

Quick Tip

- Totipotency is the foundation of plant tissue culture techniques. - It allows the regeneration of plants from a single cell, which is useful in genetic modification and propagation of rare species.

---

121. 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:

Step 1: Evaluating each statement

- **Statement A:** The flowers of *Vallisneria* are not colourful and do not produce nectar; instead, they rely on water pollination. Hence, this statement is incorrect.

- **Statement B:** Water lilies are not pollinated by water; they rely on insects for pollination. Hence, this statement is correct.

- **Statement C:** In most water-pollinated species, pollen grains have a mucilaginous covering to prevent wetting. Hence, this statement is correct.

- **Statement D:** Pollen grains of some hydrophytes, like *Vallisneria*, are long and ribbon-like, aiding in water pollination. Hence, this statement is correct.

- **Statement E:** In some hydrophytes, pollen grains float passively inside water until they reach the female flower. Hence, this statement is correct.

Step 2: Identifying the correct set of statements

- The correct statements are B, C, D, and E.

- The option that matches this set is **(3) B, C, D and E only**.

Quick Tip

Water pollination, or hydrophily, occurs in some aquatic plants, but most aquatic plants rely on insect or wind pollination. Pollen grains in water-pollinated plants often have adaptations such as mucilaginous coatings or elongated shapes to aid in pollination.

---

122. How many molecules of ATP and NADPH are required for every molecule of CO_2 fixed in the Calvin cycle?

(1) 2 molecules of ATP and 2 molecules of NADPH

(2) 3 molecules of ATP and 3 molecules of NADPH

(3) 3 molecules of ATP and 2 molecules of NADPH

(4) 2 molecules of ATP and 3 molecules of NADPH

Correct Answer: (3) 3 molecules of ATP and 2 molecules of NADPH

Solution:

Step 1: Understanding the Calvin Cycle

The Calvin cycle, also known as the C_3 cycle, is the pathway for carbon fixation in photosynthesis. It consists of three main phases:

1. Carbon Fixation - CO_2 combines with ribulose-1,5-bisphosphate (RuBP) to form two molecules of 3-phosphoglycerate (3-PGA).

2. Reduction - 3-PGA is converted into glyceraldehyde-3-phosphate (G3P) using ATP and NADPH.

3. Regeneration of RuBP - Some G3P molecules are used to regenerate RuBP to continue the cycle.

Step 2: ATP and NADPH Requirement Per CO_2 Molecule

For every CO_2 molecule fixed:

- The reduction phase requires 2 molecules of NADPH.

- The phosphorylation steps consume 3 molecules of ATP.

Step 3: Identifying the Correct Answer

- The correct requirement is 3 ATP and 2 NADPH per CO_2 fixed.

- This matches option (3).

Quick Tip

The Calvin cycle follows the rule that for every CO_2 molecule fixed, 3 ATP and 2 NADPH are required. These energy carriers are generated in the light-dependent reactions of photosynthesis.

---

123. The cofactor of the enzyme carboxypeptidase is:

(1) Niacin

(2) Flavin

(3) Haem

(4) Zinc

Correct Answer: (4) Zinc

Solution:

Step 1: Understanding Cofactors

- Cofactors are non-protein chemical compounds that assist enzyme activity.

- They can be metal ions (like Zn^{2+}, Mg^{2+}, Fe^{2+}) or organic molecules (coenzymes such as vitamins).

Step 2: Role of Zinc in Carboxypeptidase

- Carboxypeptidase is a zinc-dependent metalloenzyme.

- It is involved in protein digestion, where it hydrolyzes peptide bonds at the carboxyl-terminal of proteins.

- The Zn^{2+} ion plays a crucial role in stabilizing the enzyme-substrate complex and catalyzing the hydrolysis reaction.

Step 3: Eliminating Incorrect Options

- **Niacin (Option 1)** is a coenzyme (NAD^+/$NADP^+$) in redox reactions, not a cofactor for

carboxypeptidase.

- **Flavin (Option 2)** is part of FAD/FMN, functioning in oxidation-reduction reactions.

- **Haem (Option 3)** is a prosthetic group found in hemoproteins like cytochromes and hemoglobin.

Step 4: Identifying the Correct Answer

- Since Zinc (Zn^{2+}) is the correct cofactor for carboxypeptidase, the correct option is (4) Zinc.

Quick Tip

Metalloenzymes like carboxypeptidase require metal ions (e.g., Zn^{2+}) as cofactors for their enzymatic activity. The presence of these metal ions stabilizes the active site and facilitates catalysis.

---

124. The type of conservation in which the threatened species are taken out from their natural habitat and placed in a special setting where they can be protected and given special care is called

(1) Biodiversity conservation

(2) Semi-conservative method

(3) Sustainable development

(4) *in-situ* conservation

Correct Answer: (1) Biodiversity conservation

Solution:

Step 1: Understanding Conservation Methods

There are two major types of conservation approaches:

1. *In-situ* conservation – Conservation of species within their natural habitat (e.g., National Parks, Wildlife Sanctuaries).

2. *Ex-situ* conservation – Conservation of species outside their natural habitat in controlled environments (e.g., Zoos, Botanical Gardens, Gene Banks).

Step 2: Identifying the Correct Answer

- The question describes a method where species are removed from their natural habitat and placed in a protected environment.

- This aligns with Biodiversity Conservation, which includes *Ex-situ* conservation methods.

- **Option (4) *in-situ* conservation is incorrect** because it refers to conserving species within their natural habitats.

- Other options (2 and 3) are unrelated to conservation strategies.

Step 3: Conclusion

- Since Biodiversity conservation includes both *in-situ* and *ex-situ* methods, and the question specifically describes an *ex-situ* method, the correct answer is Option (1) Biodiversity conservation.

Quick Tip

Biodiversity conservation can be achieved through *in-situ* (within natural habitat) or *ex-situ* (outside natural habitat) methods. When species are taken out of their habitat for protection, it is an *ex-situ* conservation strategy.

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125. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and downstream end:

(1) Structural gene, Transposons, Operator gene

(2) Inducer, Repressor, Structural gene

(3) Promoter, Structural gene, Terminator

(4) Repressor, Operator gene, Structural gene

Correct Answer: (3) Promoter, Structural gene, Terminator

Solution:

Step 1: Understanding a Transcription Unit

A transcription unit in DNA consists of three essential regions:

1. Promoter – The upstream sequence where RNA polymerase binds to initiate transcription.

2. Structural Gene – The segment of DNA that is transcribed into RNA.

3. Terminator – The downstream sequence that signals the end of transcription.

Step 2: Identifying the Correct Answer

- **Option (1) is incorrect**: Transposons (jumping genes) are mobile genetic elements and are not part of a transcription unit.

- **Option (2) is incorrect**: Inducers and repressors are regulatory proteins involved in gene expression but do not define the transcription unit.

- **Option (4) is incorrect**: The operator gene is a regulatory sequence found in operons but is not a universal part of a transcription unit.

Step 3: Conclusion

- The correct three components defining a transcription unit are Promoter, Structural gene, and Terminator, which matches option (3).

Quick Tip

A transcription unit consists of a promoter (binding site for RNA polymerase), a structural gene (coding region), and a terminator (signals transcription termination).

---

126. What is the fate of a piece of DNA carrying only gene of interest which is transferred into an alien organism?

A.The piece of DNA would be able to multiply itself independently in the progeny cells of the organism.

B. It may get integrated into the genome of the recipient.

C. It may multiply and be inherited along with the host DNA.

D. The alien piece of DNA is not an integral part of chromosome.

E. It shows ability to replicate.

Choose the correct answer from the options given below:

(1) D and E only

(2) B and C only

(3) A and E only

(4) A and B only

Correct Answer: (2) B and C only

Solution:

Step 1: Understanding the Fate of Introduced DNA in an Alien Organism

When a piece of foreign DNA is introduced into an alien organism, two possible outcomes occur:

1. Integration into the host genome (Option B) – The foreign DNA may integrate into the recipient's genome, allowing it to be expressed and inherited.
2. Multiplication along with host DNA (Option C) – If the foreign DNA integrates successfully, it will replicate and be passed on to progeny cells.

Step 2: Evaluating Given Statements

- **Statement A is incorrect** – Only plasmid DNA (self-replicating DNA) can multiply independently. A piece of linear foreign DNA usually requires integration for replication.
- **Statement B is correct** – Foreign DNA can integrate into the genome of the recipient.
- **Statement C is correct** – Once integrated, it may multiply and be inherited along with host DNA.
- **Statement D is incorrect** – If the DNA gets integrated, it becomes part of the chromosome.
- **Statement E is incorrect** – Not all foreign DNA pieces inherently replicate unless they have replication sequences (e.g., plasmid origin of replication).

Step 3: Conclusion

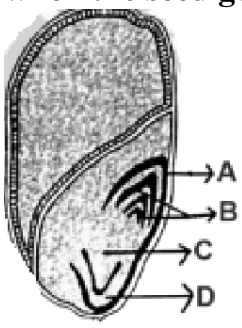
- Since B and C are correct, the correct option is (2) B and C only.

Quick Tip

When foreign DNA is introduced into an organism, it may either integrate into the genome or remain as an extrachromosomal element. Only self-replicating elements (like plasmids) can multiply independently.

---

127. Identify the part of the seed from the given figure which is destined to form root when the seed germinates.



(1) B

(2) C

(3) D

(4) A

Correct Answer: (2) C

Solution:

Step 1: Understanding Seed Structure and Germination

A seed consists of several key components, including:

- Radicle – The embryonic root that develops into the primary root during germination.
- Plumule – The embryonic shoot that grows into the shoot system.
- Cotyledons – The seed leaves that provide nutrients during early growth.
- Seed Coat – The protective outer covering of the seed.

Step 2: Identifying the Correct Part in the Given Diagram

- The part labeled C corresponds to the Radicle, which is responsible for forming the root.
- The radicle emerges first from the seed during germination and grows downward into the soil, forming the root system.

Step 3: Evaluating Other Options

- A is likely the Plumule (forms the shoot).
- B may represent the Cotyledon (nutrient storage).
- D might be another structural part but is not responsible for root formation.

Step 4: Conclusion

- Since C (Radicle) is responsible for forming the root, the correct answer is Option (2) C.

Quick Tip

During germination, the radicle emerges first from the seed and develops into the root system, while the plumule gives rise to the shoot.

---

128. Which of the following is an example of actinomorphic flower?

(1) *Cassia*

(2) *Pisum*

(3) *Sesbania*

(4) *Datura*

Correct Answer: (4) *Datura*

Solution:

Step 1: Understanding Actinomorphic and Zygomorphic Flowers

Flowers can be classified based on their symmetry:

- Actinomorphic flowers (Radial symmetry): These flowers can be divided into two equal halves in multiple planes (e.g., *Datura*, *Hibiscus*).

- Zygomorphic flowers (Bilateral symmetry): These flowers can be divided into equal halves in only one plane (e.g., *Pisum*, *Cassia*, *Sesbania*).

Step 2: Identifying the Correct Answer

- **Cassia (Option 1)** – Zygomorphic flower.

- **Pisum (Option 2)** – Zygomorphic flower.

- **Sesbania (Option 3)** – Zygomorphic flower.

- **Datura (Option 4)** – Actinomorphic flower (exhibits radial symmetry).

Step 3: Conclusion

- Since *Datura* is an actinomorphic flower, the correct answer is Option (4) *Datura*.

Quick Tip

Actinomorphic flowers have radial symmetry, meaning they can be divided into identical halves in multiple planes. Examples include *Datura* and *Hibiscus*.

---

129. 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:

Step 1: Understanding Auxin and Its Role in Weed Control

- Auxins are plant hormones that regulate growth and are widely used as selective herbicides.

- Synthetic auxins (e.g., 2,4-D) are used in lawn care to eliminate broadleaf weeds (dicots) while leaving grasses (monocots) unharmed.

Step 2: Identifying the Correct Answer

- Option (1) is incorrect – Auxin is primarily involved in growth, not abscission of mature leaves.
- Option (2) is correct – Auxin-based herbicides target dicots (broadleaf plants) but have little to no effect on mature monocotyledonous plants like grasses.
- Option (3) is incorrect – While auxins influence growth, their selective herbicidal effect is more relevant in this context.
- Option (4) is incorrect – Although auxins promote apical dominance, this is not related to their selective action in weed control.

Step 3: Conclusion

- Since auxins do not affect mature monocotyledonous plants, the correct answer is Option (2).

Quick Tip

Auxin-based herbicides like 2,4-D are used to control broadleaf weeds in lawns. They are selective because they affect dicots but have little effect on mature monocots like grasses.

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130. 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:

Step 1: Understanding the Classification of Fungi

- *Rhizopus* (Bread Mould): It is a type of zygomycete fungus commonly found on stale bread.

- *Ustilago* (Smut Fungus): It is a basidiomycete fungus that causes smut disease in cereals like corn.

- *Puccinia* (Rust Fungus): It is a parasitic fungus responsible for rust diseases in wheat and other crops.

- *Agaricus* (Mushroom): A common basidiomycete fungus that includes edible mushrooms.

Step 2: Matching the Correct Pairs

- A (*Rhizopus*) $\rightarrow$ III (Bread mould)

- B (*Ustilago*) $\rightarrow$ II (Smut fungus)

- C (*Puccinia*) $\rightarrow$ IV (Rust fungus)

- D (*Agaricus*) $\rightarrow$ I (Mushroom)

Step 3: Conclusion

- The correct match is A-III, B-II, C-IV, D-I, which corresponds to option (4).

Quick Tip

Fungal classification: - *Rhizopus* - Bread mould (Zygomycota) - *Ustilago* - Smut fungus (Basidiomycota) - *Puccinia* - Rust fungus (Basidiomycota) - *Agaricus* - Mushroom (Basidiomycota)

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131. 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:

Step 1: Understanding Incomplete Dominance in Snapdragon

- Snapdragon (*Antirrhinum majus*) exhibits incomplete dominance, where the heterozygous condition results in an intermediate phenotype.

- The gene controlling flower color has the following alleles:

- R (dominant allele for red color)

- r (recessive allele for white color)

- The heterozygous genotype (Rr) results in pink flowers due to incomplete dominance.

Step 2: Determining the Cross and Expected Progeny

- Given cross: Pink (Rr) × Red (RR)

- Possible gametes:

- Pink (Rr) produces R and r gametes

- Red (RR) produces only R gametes

- Punnett square analysis:

	R	R
R	RR (Red)	RR (Red)
r	Rr (Pink)	Rr (Pink)

Step 3: Identifying the Correct Answer

- The offspring will be:

- 50- 50

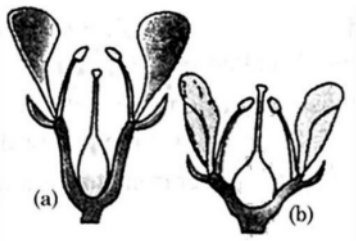
- Since the progeny consists of red and pink flowered plants, the correct answer is option (1).

Quick Tip

Incomplete dominance occurs when the heterozygous phenotype is an intermediate blend of the dominant and recessive traits. In Snapdragon, the cross between pink (Rr) and red (RR) results in 50

---

132. 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:

Step 1: Understanding Floral Structures Based on Ovary Position

Flowers can be classified based on the position of their floral parts (calyx, corolla, and androecium) relative to the ovary:

1. Hypogynous Flower:

- Ovary is superior (above all other floral parts).
- Floral parts are attached below the ovary.
- Example: Mustard.

2. Perigynous Flower:

- Ovary is half-inferior (partially embedded).
- Floral parts are attached around the ovary.
- Example: Rose.

3. Epigynous Flower:

- Ovary is inferior (completely embedded).
- Floral parts arise above the ovary.
- Example: Guava.

Step 2: Identifying the Flower Types in Figures (a) and (b)

- Figure (a): The floral parts are positioned around the ovary, suggesting a perigynous flower.
- Figure (b): The floral parts also appear to be arranged around the ovary, indicating another perigynous flower.

Step 3: Conclusion

- Since both (a) and (b) exhibit perigynous floral arrangement, the correct answer is Option (3): (a) Perigynous; (b) Perigynous.

Quick Tip

Floral classification: - Hypogynous: Superior ovary, floral parts below (e.g., Mustard). - Perigynous: Half-inferior ovary, floral parts around (e.g., Rose). - Epigynous: Inferior ovary, floral parts above (e.g., Guava).

---

133. Which of the following are required for the dark reaction of photosynthesis?

A. Light

B. Chlorophyll

C. CO_2

D. ATP

E. NADPH

Choose the **correct** answer from the options given below:

(1) 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:

Step 1: Understanding the Dark Reaction of Photosynthesis

- The dark reaction, also called the Calvin cycle, occurs in the stroma of the chloroplast.

- Unlike the light reaction, it does not require direct light but depends on the products of the light reaction.

- The Calvin cycle utilizes:

- CO_2 (carbon dioxide) as the carbon source.

- ATP (energy source) generated during the light reaction.

- NADPH (reducing power) from the light reaction to fix CO_2 into glucose.

Step 2: Evaluating the Given Options

- A (Light) is incorrect – The dark reaction does not require light.

- B (Chlorophyll) is incorrect – Chlorophyll is needed for the light reaction, not the Calvin cycle.

- C (CO_2) is correct – Carbon dioxide is essential for carbon fixation.

- D (ATP) is correct – ATP provides energy for the Calvin cycle.

- E (NADPH) is correct – NADPH supplies reducing power for CO_2 reduction.

Step 3: Conclusion

- Since CO_2, ATP, and NADPH are required for the dark reaction, the correct answer is Option (2) C, D, and E only.

Quick Tip

The dark reaction (Calvin cycle) occurs in the stroma of the chloroplast and utilizes CO_2, ATP, and NADPH to synthesize glucose. It does not require direct light or chlorophyll.

---

134. 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:

Step 1: Understanding the Test Cross

- A test cross is performed to determine whether an organism displaying a dominant trait is homozygous dominant (BB) or heterozygous (Bb).

- In a test cross, the organism with the dominant phenotype is crossed with a homozygous recessive (bb) individual.

Step 2: Possible Crosses and Their Outcomes

1. If the black seed plant is BB (homozygous dominant):

- Cross: BB × bb

- Gametes: B, B × b, b

- Offspring: All Bb (Black seeds)

- **Result: All progeny will have black seeds.**

2. If the black seed plant is Bb (heterozygous):

- Cross: Bb × bb

- Gametes: B, b × b, b

- Offspring: 50- **Result: A 1:1 ratio of black and white seeds.**

Step 3: Conclusion

- If some of the offspring exhibit the recessive white seed trait (bb), it confirms that the parent plant was heterozygous (Bb).

- If all offspring have black seeds, the parent was homozygous dominant (BB).

- **Thus, the correct test cross involves crossing the unknown plant with a homozygous recessive (bb) plant.**

- The correct answer is Option (1) bb.

Quick Tip

A test cross is used to determine the genotype of an organism with a dominant phenotype by crossing it with a homozygous recessive (bb) individual. If the progeny shows a 1:1 ratio of dominant to recessive traits, the parent is heterozygous.

---

135. 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: Understanding the Function of Bulliform Cells

- Bulliform cells are large, bubble-like epidermal cells found in the leaves of monocotyledonous plants, particularly grasses.
- They play a crucial role in leaf rolling and unfolding to regulate water loss during drought conditions.

Step 2: Mechanism of Leaf Curling

- Under water stress or drought, bulliform cells lose turgor pressure, causing the leaves to curl inward to reduce water loss.
- When water is available, the bulliform cells regain turgidity, allowing the leaf to open up again for photosynthesis.

Step 3: Evaluating the Given Options

- Option (1) is incorrect – Bulliform cells do not directly protect against salt stress.
- Option (2) is incorrect – They do not increase photosynthesis but indirectly help by regulating leaf exposure.
- Option (3) is incorrect – They do not store sugars; their main function is leaf folding and unfolding.
- Option (4) is correct – Bulliform cells help in inward curling of leaves in monocots to minimize water loss.

Step 4: Conclusion

- Since bulliform cells regulate leaf curling in response to drought, the correct answer is Option (4) Inward curling of leaves in monocots.

Quick Tip

Bulliform cells are specialized epidermal cells in monocots that help in leaf rolling and unfolding. During drought, they lose turgidity, causing inward curling of leaves to reduce transpiration and water loss.

Section B

136. Given below are two statements:

Statement I: In C_3 plants, some O_2 binds to RuBisCO, hence CO_2 fixation is decreased.

Statement II: In C_4 plants, mesophyll cells show very little photorespiration while bundle sheath cells do not show photorespiration.

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

(1) 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:

Step 1: Understanding Statement I (C_3 Plants and Photorespiration)

- In C_3 plants, RuBisCO (Ribulose-1,5-bisphosphate carboxylase-oxygenase) is the key enzyme for CO_2 fixation.
- However, RuBisCO has an affinity for both CO_2 and O_2.
- Under high O_2 conditions (especially in warm climates), RuBisCO binds to O_2 instead of CO_2, leading to photorespiration, which reduces CO_2 fixation.
- **Thus, Statement I is true.**

Step 2: Evaluating Statement II (C_4 Plants and Photorespiration)

- In C_4 plants, the mesophyll cells fix CO_2 into a four-carbon compound (malate/aspartate), which is later transported to bundle sheath cells.
- Mesophyll cells DO NOT undergo the Calvin cycle but only fix CO_2.
- However, photorespiration occurs at a very low level in mesophyll cells because they are exposed to oxygen.
- Bundle sheath cells show no photorespiration because they receive only CO_2 from mesophyll cells and have a high CO_2 concentration due to the C_4 pathway.
- **Thus, Statement II is false.**

Step 3: Conclusion

- Since Statement I is true and Statement II is false, the correct answer is Option (2) Statement I is true but Statement II is false.

Quick Tip

- In C_3 plants, RuBisCO has an affinity for both O_2 and CO_2, leading to photorespiration, which reduces CO_2 fixation. - In C_4 plants, mesophyll cells show some photorespiration, but bundle sheath cells do not due to the high CO_2 concentration provided by the C_4 pathway.

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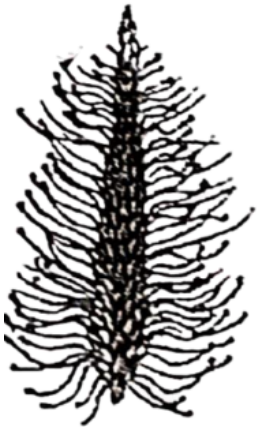
137. Identify the correct description about the given figure:



(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:

Step 1: Understanding Wind Pollination (Anemophily)

- The given image represents an inflorescence adapted for wind pollination (Anemophily).

- In wind-pollinated plants, the flowers have specific adaptations:

- Stamens are well exposed to facilitate pollen dispersal.

- Pollen grains are light and non-sticky for easy transport by wind.

- Stigmas are large and feathery to trap airborne pollen.

Step 2: Evaluating the Given Options

- Option (1) is incorrect – Water-pollinated flowers (hydrophilous plants) produce pollen

grains with mucilaginous covering, but the image does not depict such structures.

- Option (2) is incorrect – Cleistogamous flowers remain closed and promote self-pollination (autogamy), but the image shows an open inflorescence.

- Option (3) is incorrect – Compact inflorescences with autogamy do not require external pollinators; this image suggests wind pollination.

- Option (4) is correct – The image depicts an inflorescence with exposed stamens, characteristic of wind-pollinated plants.

Step 3: Conclusion

- Since the given image shows wind-pollinated flowers with well-exposed stamens, the correct answer is Option (4).

Quick Tip

Wind-pollinated flowers (anemophilous plants) have well-exposed stamens, lightweight pollen, and large feathery stigmas for efficient pollen transfer through the air.

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138. Match List I with List II

List I	Plant	List II	Feature
A	Rose	I	Twisted aestivation
B	Pea	II	Perigynous flower
C	Cotton	IV	Marginal placentation
D	Mango	III	Drupe

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:

Step 1: Understanding the Plant Features

1. Rose:

- Feature: Perigynous flower (floral parts are attached around the ovary).

- Correct Match: **II**

2. Pea:

- Feature: Marginal placentation (ovules are arranged along one side of the ovary).

- Correct Match: **IV**

3. Cotton:

- Feature: Twisted aestivation (one margin of the petal overlaps the next petal).

- Correct Match: **I**

4. Mango:

- Feature: Drupe (a type of fruit with a fleshy outer part and a hard inner seed).

- Correct Match: **III**

Step 2: Conclusion

- The correct matching is A-II, B-IV, C-I, D-III, which corresponds to Option (4).

Quick Tip

- Perigynous flowers (e.g., Rose) have floral parts arranged around the ovary. - Marginal placentation (e.g., Pea) has ovules attached along one side of the ovary. - Twisted aestivation (e.g., Cotton) occurs when one petal overlaps the next in a spiral. - Drupe fruits (e.g., Mango) have a fleshy outer part and a hard seed inside.

---

139. The DNA present in chloroplast is:

(1) Circular, double stranded

(2) Linear, single stranded

(3) Circular, single stranded

(4) Linear, double stranded

Correct Answer: (1) Circular, double stranded

Solution:

Step 1: Understanding the Genetic Material in Chloroplasts

- Chloroplasts, like mitochondria, have their own DNA, which supports the Endosymbiotic

Theory.

- The DNA in chloroplasts is circular and double-stranded, similar to prokaryotic DNA.

- This structure allows chloroplasts to perform self-replication and synthesize some of their own proteins.

Step 2: Evaluating the Given Options

- Option (1) is correct – Chloroplast DNA is circular and double-stranded.

- Option (2) is incorrect – Chloroplast DNA is not linear; it resembles prokaryotic genomes.

- Option (3) is incorrect – While chloroplast DNA is circular, it is not single-stranded.

- Option (4) is incorrect – Chloroplast DNA is not linear; it is circular.

Step 3: Conclusion

- Since chloroplast DNA is circular and double-stranded, the correct answer is Option (1) Circular, double stranded.

Quick Tip

Chloroplast DNA is circular and double-stranded, resembling prokaryotic genomes. It supports the Endosymbiotic Theory, which suggests that chloroplasts evolved from free-living bacteria.

---

140. Which of the following statements 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:

Step 1: Understanding DNA Replication in *E. coli*

- DNA replication in *E. coli* is carried out by DNA-dependent DNA polymerase, which adds nucleotides to a growing DNA strand.
- The polymerization of nucleotides always occurs in the 5' $\rightarrow$ 3' direction.

Step 2: Evaluating the Given Options

- Option (1) is incorrect – DNA-dependent RNA polymerase is involved in transcription, not DNA replication.
- Option (2) is incorrect – DNA polymerase can only polymerize in 5' $\rightarrow$ 3' direction; it does not catalyze synthesis in both directions.
- Option (3) is correct – DNA polymerization occurs strictly in the 5' $\rightarrow$ 3' direction, even on the lagging strand.
- Option (4) is incorrect – Polymerization in the 3' $\rightarrow$ 5' direction is not possible; however, DNA polymerase has 3' $\rightarrow$ 5' exonuclease activity for proofreading.

Step 3: Conclusion

- Since DNA-dependent DNA polymerase in *E. coli* catalyzes polymerization in the 5' $\rightarrow$ 3' direction, the correct answer is Option (3).

Quick Tip

DNA polymerization always occurs in the 5' $\rightarrow$ 3' direction. DNA polymerase can remove incorrect nucleotides using 3' $\rightarrow$ 5' exonuclease activity but cannot synthesize in the 3' $\rightarrow$ 5' direction.

---

141. 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:

Step 1: Understanding Somatic Hybridization

- Somatic hybridization is a technique in plant biotechnology where the protoplasts (cells without cell walls) from two different plant varieties are fused to form a somatic hybrid.
- This method is used when sexual hybridization is not possible due to incompatibility barriers.
- The process involves: 1. Isolation of protoplasts by enzymatically removing the cell wall.
2. Fusion of protoplasts using polyethylene glycol (PEG) or electrofusion.
3. Regeneration of hybrid cells into a new hybrid plant.

Step 2: Evaluating the Given Options

- Option (1) is incorrect – Somatic embryos develop from somatic cells but are not fused in hybridization.
- Option (2) is correct – Protoplasts are fused during somatic hybridization.
- Option (3) is incorrect – Pollens are involved in sexual reproduction, not somatic hybridization.
- Option (4) is incorrect – Callus is an undifferentiated mass of plant cells but is not fused in hybridization.

Step 3: Conclusion

- Since protoplasts are fused in somatic hybridization, the correct answer is Option (2) Protoplasts.

Quick Tip

Somatic hybridization involves the fusion of protoplasts (plant cells without cell walls) from two different plant species or varieties to create a hybrid plant with desirable traits.

---

142. Identify the step in the tricarboxylic acid cycle, which does not involve oxidation of substrate.

(1) Succinic acid → Malic acid

(2) Succinyl-CoA → Succinic acid

(3) Isocitrate → -ketoglutaric acid

(4) Malic acid → Oxaloacetic acid

Correct Answer: (2) Succinyl-CoA → Succinic acid

Solution:

Step 1: Understanding Oxidation and Non-Oxidative Reactions in the TCA Cycle

The tricarboxylic acid (TCA) cycle, also known as the Krebs cycle, involves a series of oxidation-reduction reactions along with substrate-level phosphorylation.

- Oxidation reactions in the cycle involve the removal of electrons (H^+) from a substrate, often accompanied by the reduction of NAD^+ or FAD.

- Non-oxidative reactions do not involve electron loss but may involve substrate-level phosphorylation.

Step 2: Evaluating the Given Options

1. Succinic acid $\rightarrow$ Malic acid (Option 1):

- This step involves oxidation of succinate to malate using FAD-dependent dehydrogenase.

- **This is an oxidation step, so it is incorrect.**

2. Succinyl-CoA $\rightarrow$ Succinic acid (Option 2):

- This step involves substrate-level phosphorylation rather than oxidation.

- Succinyl-CoA is converted into succinic acid, generating ATP or GTP.

- **This step does not involve oxidation, so it is correct.**

3. Isocitrate $\rightarrow$ -ketoglutaric acid (Option 3):

- This is an oxidative decarboxylation reaction, where NAD^+ is reduced to NADH.

- **This involves oxidation, so it is incorrect.**

4. Malic acid $\rightarrow$ Oxaloacetic acid (Option 4):

- This step involves oxidation of malate to oxaloacetate using NAD-dependent dehydrogenase.

- **This is an oxidation step, so it is incorrect.**

Step 3: Conclusion

- Since Succinyl-CoA $\rightarrow$ Succinic acid is the only step that does not involve oxidation, the correct answer is Option (2) Succinyl-CoA $\rightarrow$ Succinic acid.

Quick Tip

In the TCA cycle, most reactions involve oxidation-reduction steps. However, the conversion of Succinyl-CoA to Succinic acid is a substrate-level phosphorylation reaction and does not involve oxidation.

143. Match List-I with List-II

List-I	Biological Component	List-II	Function
A	GLUT-4	I	Hormone
B	Insulin	II	Enzyme
C	Trypsin	III	Intercellular ground substance
D	Collagen	IV	Enables glucose transport into cells

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the Biological Components and Their Functions

1. GLUT-4 (Glucose Transporter-4):

- Function: Responsible for glucose transport into cells.

- Correct Match: IV

2. Insulin:

- Function: A hormone that regulates blood glucose levels.

- Correct Match: I

3. Trypsin:

- Function: A digestive enzyme that breaks down proteins in the small intestine.

- Correct Match: II

4. Collagen:

- Function: A structural protein that acts as an intercellular ground substance, providing strength and support in connective tissues.

- Correct Match: III

Step 2: Conclusion

- The correct matching is A-IV, B-I, C-II, D-III, which corresponds to Option (4).

Quick Tip

- GLUT-4 facilitates glucose uptake into cells, especially in muscle and fat tissues. - Insulin is a hormone secreted by the pancreas to regulate blood sugar. - Trypsin is an enzyme that digests proteins in the small intestine. - Collagen is a structural protein found in connective tissues.

---

144. 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:

Step 1: Understanding the Role of Gibberellins in Sugarcane Growth

- Gibberellins (GA) are plant growth regulators that promote stem elongation by stimulating cell division and cell elongation.

- In sugarcane, gibberellins help in internode elongation, leading to increased stem length and higher yield.

Step 2: Evaluating the Given Options

- Option (1) is correct – Gibberellins enhance internode elongation, increasing sugarcane yield.

- Option (2) is incorrect – Cytokinins primarily promote cell division and delay senescence, but they do not significantly elongate stems.

- Option (3) is incorrect – Abscisic acid (ABA) is a stress hormone that inhibits growth.

- Option (4) is incorrect – Auxins promote apical dominance and root growth but are not primarily responsible for internode elongation in sugarcane.

Step 3: Conclusion

- Since gibberellins are responsible for increasing stem length in sugarcane, the correct answer is Option (1) Gibberellin.

Quick Tip

Gibberellins are used in agriculture to promote stem elongation, seed germination, and fruit growth. In sugarcane, they increase internode length, leading to higher yield.

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145. Match List-I with List-II

List-I	Scientist(s)	List-II	Discovery/Contribution
A	Frederick Griffith	I	Genetic code
B	Francois Jacob & Jacque Monod	II	Semi-conservative mode of DNA repl
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:

Step 1: Understanding the Contributions of Each Scientist

1. Frederick Griffith (Transformation - III):

- Conducted the famous Griffith's experiment in 1928, demonstrating bacterial transformation using *Streptococcus pneumoniae*.

- Correct Match: III

2. Francois Jacob & Jacque Monod (*Lac* operon - IV):

- Proposed the operon model, explaining gene regulation in prokaryotes using the *Lac* operon.

- Correct Match: IV

3. Har Gobind Khorana (Genetic Code - I):

- Deciphered the genetic code and showed how nucleotide sequences specify amino acids.

- Correct Match: I

4. Meselson & Stahl (Semi-conservative DNA Replication - II):

- Demonstrated the semi-conservative model of DNA replication using nitrogen isotope experiments.

- Correct Match: II

Step 2: Conclusion

- The correct matching is A-III, B-IV, C-I, D-II, which corresponds to Option (1).

Quick Tip

- Griffith's Experiment (1928) discovered bacterial transformation. - Jacob and Monod explained gene regulation using the *Lac* operon model. - Khorana helped decipher the genetic code. - Meselson and Stahl demonstrated semi-conservative DNA replication.

---

146. Match List-I with List-II

List-I	Scientist	List-II	Concept/Contribution
A	Robert May	I	Species-Area relationship
B	Alexander von Humboldt	II	Long term ecosystem experiment using out d
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:

Step 1: Understanding the Contributions of Each Scientist

1. Robert May (Global species diversity at about 7 million - III):

- Estimated the total number of global species diversity to be around 7 million.

- Correct Match: III

2. Alexander von Humboldt (Species-Area relationship - I):

- Proposed the species-area relationship, stating that species richness increases with area.

- Correct Match: I

3. Paul Ehrlich (Rivet popper hypothesis - IV):

- Proposed the Rivet Popper Hypothesis, which explains biodiversity loss and its impact on ecosystems.

- Correct Match: IV

4. David Tilman (Long-term ecosystem experiment using outdoor plots - II):

- Conducted long-term ecosystem experiments using outdoor plots to study biodiversity and ecosystem stability.

- Correct Match: II

Step 2: Conclusion

- The correct matching is A-III, B-I, C-IV, D-II, which corresponds to Option (1).

Quick Tip

- Robert May estimated global species diversity at around 7 million. - Alexander von Humboldt developed the species-area relationship. - Paul Ehrlich proposed the Rivet Popper Hypothesis, emphasizing biodiversity conservation. - David Tilman conducted long-term ecosystem experiments to study the role of biodiversity in ecosystem stability.

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147. 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*, carotenoids, and xanthophyll.

E. Vegetative cells have a cellulosic wall, usually covered on the outside by a gelatinous coating of algin.

Choose the correct answer from the options given below:

(1) 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:

Step 1: Understanding the Characteristics of Phaeophyceae (Brown Algae)

- Phaeophyceae, or brown algae, are a group of marine algae commonly found in cold waters.
- They exhibit both asexual and sexual reproduction with distinct features.

Step 2: Evaluating the Given Statements

- Statement A is correct – Asexual reproduction occurs by biflagellate zoospores, which have two unequal flagella.
- Statement B is incorrect – Sexual reproduction in Phaeophyceae is not exclusively oogamous; it can also be isogamous or anisogamous.
- Statement C is correct – Stored food is mannitol or laminarin, which are carbohydrate reserves.
- Statement D is correct – Brown algae contain chlorophyll *a*, *c*, carotenoids, and xanthophyll pigments.
- Statement E is correct – Vegetative cells have a cellulosic cell wall covered by a gelatinous algin layer.

Step 3: Conclusion

- Since A, C, D, and E are correct, the correct answer is Option (2) A, C, D and E only.

Quick Tip

Brown algae (Phaeophyceae) have biflagellate zoospores, store food as mannitol or laminarin, and contain chlorophyll a, c, carotenoids, and xanthophylls. Their cell walls are covered by algin.

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148. Match List-I with List-II

	List I		List II
A.	Citric acid cycle	I.	Cytoplasm
B.	Glycolysis	II.	Mitochondrial matrix
C.	Electron transport system	III.	Intermembrane space of mitochondria
D.	Proton gradient	IV.	Inner mitochondrial membrane

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the Cellular Locations of Metabolic Pathways

1. Citric Acid Cycle (Krebs Cycle) - Mitochondrial Matrix (II):

- The citric acid cycle occurs inside the mitochondrial matrix, where it generates ATP, NADH, and $FADH_2$.

- Correct Match: II

2. Glycolysis - Cytoplasm (I):

- Glycolysis takes place in the cytoplasm, breaking down glucose into pyruvate.

- Correct Match: I

3. Electron Transport System (ETS) - Inner Mitochondrial Membrane (IV):

- The ETS is embedded in the inner mitochondrial membrane, where electron transfer occurs, driving ATP synthesis.

- Correct Match: IV

4. Proton Gradient - Intermembrane Space (III):

- The proton gradient forms in the intermembrane space of mitochondria, which drives ATP synthesis via chemiosmosis.

- Correct Match: III

Step 2: Conclusion

- The correct matching is A-II, B-I, C-IV, D-III, which corresponds to Option (1).

Quick Tip

- Glycolysis occurs in the cytoplasm. - The Citric Acid Cycle takes place in the mitochondrial matrix. - The Electron Transport System (ETS) is located on the inner mitochondrial membrane. - The Proton Gradient is established in the intermembrane space of mitochondria.

149. 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) $\frac{100x}{3}$ (kcal m^{-2} yr^{-1})

(4) $\frac{x}{10}$ (kcal m^{-2} yr^{-1})

Correct Answer: (2) $10x$ (kcal m^{-2} yr^{-1})

Solution:

Step 1: Understanding Energy Flow in an Ecosystem

- In an ecosystem, energy transfer follows the 10

- According to this law, only 10

Step 2: Calculating Energy at the Third Trophic Level

- Given: - Net Primary Productivity (NPP) at the first trophic level = $100x$ kcal m^{-2} yr^{-1}

- Second trophic level (Primary Consumer) receives = $\frac{10}{100} \times 100x = 10x$ kcal m^{-2} yr^{-1}

- Third trophic level (Secondary Consumer) receives = $\frac{10}{100} \times 10x = x$ kcal m^{-2} yr^{-1}

- However, Gross Primary Productivity (GPP) of the third trophic level includes respiration loss as well.

- Typically, GPP is approximately 10 times the energy available at that trophic level.

Step 3: Conclusion

- The Gross Primary Productivity (GPP) of the third trophic level is $10x$ kcal m^{-2} yr^{-1}, which corresponds to Option (2).

Quick Tip

According to Lindeman's 10

150. Match List-I with List-II

List-I	Types of Stamens	List-II	Example
A	Monadelphous	I	Citrus
B	Diadelphous	II	Pea
C	Polyadelphous	III	Lily
D	Epiphyllous	IV	China-rose

Choose the correct answer from the options given below:

(1) A-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:

Step 1: Understanding the Different Types of Stamens

1. Monadelphous (China-rose - IV):

- Stamens are fused into a single bundle by their filaments, while the anthers remain free.

- Example: China-rose

- Correct Match: IV

2. Diadelphous (Pea - II):

- Stamens are fused into two groups, typically 9+1 arrangement.

- Example: Pea

- Correct Match: II

3. Polyadelphous (Citrus - I):

- Stamens are fused into multiple bundles, forming separate groups.

- Example: Citrus

- Correct Match: I

4. Epiphyllous (Lily - III):

- Stamens are attached to the perianth (petals or sepals) instead of the thalamus.

- Example: Lily

- Correct Match: III

Step 2: Conclusion

- The correct matching is A-IV, B-II, C-I, D-III, which corresponds to Option (4).

Quick Tip

- Monadelphous stamens (e.g., China-rose) have a single bundle of filaments. - Diadelphous stamens (e.g., Pea) are fused into two bundles (9+1 arrangement). - Polyadelphous stamens (e.g., Citrus) form multiple bundles. - Epiphyllous stamens (e.g., Lily) are attached to petals or sepals.

Zoology

Section A

151. Match List-I with List-II

List-I	Type of Joint	List-II	Example/Function
A	Fibrous joints	I	Adjacent vertebrae, limited movement
B	Cartilaginous joints	II	Humerus and Pectoral girdle, rotational moveme
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:

Step 1: Understanding the Different Types of Joints

1. Fibrous Joints (Skull - III):

- These joints have no movement and are held by dense fibrous connective tissue.

- Example: Sutures of the skull.

- Correct Match: III

2. Cartilaginous Joints (Adjacent Vertebrae - I):

- These joints allow limited movement and are connected by cartilage.

- Example: Intervertebral discs between adjacent vertebrae.

- Correct Match: I

3. Hinge Joints (Knee - IV):

- These joints allow movement in one plane only (like the movement of a door hinge).

- Example: Knee joint.

- Correct Match: IV

4. Ball and Socket Joints (Humerus Pectoral Girdle - II):

- These joints allow multi-directional movement and rotation.

- Example: Shoulder joint (Humerus Pectoral girdle).

- Correct Match: II

Step 2: Conclusion

- The correct matching is A-III, B-I, C-IV, D-II, which corresponds to Option (3).

Quick Tip

- Fibrous joints (e.g., Skull) have no movement. - Cartilaginous joints (e.g., Vertebrae) allow limited movement. - Hinge joints (e.g., Knee) allow movement in one plane only. - Ball and Socket joints (e.g., Shoulder) allow rotational and multi-directional movement.

---

152. Match List-I with List-II

List-I	Disease/Concept	List-II	Associated Pathogen/Factor
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:

Step 1: Understanding the Matching Concepts

1. Common Cold (Rhinoviruses - III):

- The common cold is caused by rhinoviruses, which primarily infect the respiratory tract.

- Correct Match: III

2. Haemozoin (*Plasmodium* - I):

- Haemozoin is a malarial pigment released when the malaria parasite (*Plasmodium*) breaks down hemoglobin.

- Correct Match: I

3. Widal Test (Typhoid - II):

- The Widal test is a diagnostic test for typhoid fever, detecting antibodies against *Salmonella typhi*.

- Correct Match: II

4. Allergy (Dust mites - IV):

- Allergies can be triggered by dust mites, which are common allergens in household dust.

- Correct Match: IV

Step 2: Conclusion

- The correct matching is A-III, B-I, C-II, D-IV, which corresponds to Option (2).

Quick Tip

- Common cold is caused by rhinoviruses. - Haemozoin is a malarial pigment produced by *Plasmodium*. - Widal test is used for diagnosing typhoid fever. - Allergies can be triggered by dust mites and other allergens.

---

153. 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:

Step 1: Understanding the Genetic Basis of the Disorders

1. Down's Syndrome (21^{st} chromosome - III): - Caused by trisomy of chromosome 21 (an extra copy of chromosome 21).

- Correct Match: III

2. α-Thalassemia (16^{th} chromosome - IV): - Caused by mutations or deletions in the HBA1 and HBA2 genes on chromosome 16.

- Correct Match: IV

3. β-Thalassemia (11^{th} chromosome - I): - Caused by mutations in the HBB gene on chromosome 11, affecting hemoglobin production.

- Correct Match: I

4. Klinefelter's Syndrome ('X' chromosome - II): - A genetic condition in males due to an extra X chromosome (XXY karyotype).

- Correct Match: II

Step 2: Conclusion

- The correct matching is A-III, B-IV, C-I, D-II, which corresponds to Option (2).

Quick Tip

- Down's Syndrome is caused by trisomy of chromosome 21. - α-Thalassemia is linked to mutations in chromosome 16. - β-Thalassemia is caused by mutations in the HBB gene on chromosome 11. - Klinefelter's Syndrome results from an extra X chromosome (XXY karyotype).

---

154. Given below are two statements: one is labeled as Assertion (A) and the other is labeled 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 females, while interstitial cells secrete androgen in male human beings.

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

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

(2) A is true but R is false

(3) A is false but R is true

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

Correct Answer: (3) A is false but R is true

Solution:

Step 1: Understanding the Functions of FSH and Leydig Cells

- Follicle-Stimulating Hormone (FSH) is a gonadotropic hormone secreted by the anterior pituitary gland.

- In females, FSH stimulates the growth and maturation of ovarian follicles.

- In males, FSH acts on the Sertoli cells (not Leydig cells) to support spermatogenesis.

- Leydig cells (also called interstitial cells) are stimulated by Luteinizing Hormone (LH), not FSH, to secrete testosterone.

Step 2: Evaluating the Given Statements

- Assertion A is false – FSH does not act upon Leydig cells in males; instead, it acts on Sertoli cells.

- Reason R is true – Growing ovarian follicles secrete estrogen, and Leydig (interstitial) cells produce androgens in males.

Step 3: Conclusion

- Since Assertion A is false and Reason R is true, the correct answer is Option (3) A is false but R is true.

Quick Tip

- FSH stimulates ovarian follicles in females and Sertoli cells in males (not Leydig cells). - LH stimulates Leydig cells to produce testosterone. - Ovarian follicles secrete estrogen, while Leydig cells secrete androgens in males.

---

155. The "Ti plasmid" of *Agrobacterium tumefaciens* stands for

(1) Tumor independent plasmid

(2) Tumor inducing plasmid

(3) Temperature independent plasmid

(4) Tumour inhibiting plasmid

Correct Answer: (2) Tumor inducing plasmid

Solution:

Step 1: Understanding the Role of Ti Plasmid

- The Ti plasmid (Tumor Inducing plasmid) is a virulent plasmid found in *Agrobacterium tumefaciens*, a soil bacterium.

- It is responsible for transferring a segment of DNA (T-DNA) into plant cells, leading to tumor formation (crown gall disease).

Step 2: Evaluating the Given Options

- Option (1) is incorrect – The Ti plasmid is not tumor-independent; it actually induces tumors.

- Option (2) is correct – The Ti plasmid is called the Tumor Inducing plasmid.

- Option (3) is incorrect – The plasmid has no relation to temperature independence.

- Option (4) is incorrect – The Ti plasmid does not inhibit tumors; instead, it causes tumor formation.

Step 3: Conclusion

- Since Ti plasmid stands for Tumor Inducing plasmid, the correct answer is Option (2).

Quick Tip

- The Ti plasmid of *Agrobacterium tumefaciens* is widely used in genetic engineering for introducing foreign genes into plants. - The T-DNA segment of the Ti plasmid integrates into the plant genome, leading to tumor formation (crown gall disease).

---

156. 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:

Step 1: Understanding the Function of the Loop of Henle

- The descending limb of the loop of Henle is permeable to water and impermeable to electrolytes.

- This allows water reabsorption but prevents the movement of ions, concentrating the filtrate.

- Since Statement I incorrectly states that the descending limb is impermeable to water, it is false.

Step 2: Understanding the Structure of the Proximal Convoluted Tubule (PCT)

- The PCT is lined by simple cuboidal epithelium with a brush border, not simple columnar epithelium.

- The brush border increases surface area for reabsorption, aiding in the reabsorption of glucose, amino acids, and electrolytes.

- Since Statement II incorrectly states that PCT is lined by simple columnar epithelium, it is false.

Step 3: Conclusion

- Since both Statement I and Statement II are incorrect, the correct answer is Option (1).

Quick Tip

- The descending limb of Henle's loop is permeable to water and impermeable to electrolytes, allowing water reabsorption. - The proximal convoluted tubule (PCT) is lined by simple cuboidal epithelium with a brush border, increasing reabsorption efficiency.

---

157. 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:

Step 1: Understanding the Sub Phases of Prophase I in Meiosis

1. Diakinesis (Completion of terminalisation of chiasmata - II):

- The final stage of prophase I where chiasmata completely terminalize and homologous chromosomes separate.

- Correct Match: II

2. Pachytene (Appearance of recombination nodules - IV): - The stage where crossing over occurs due to the appearance of recombination nodules. - Correct Match: IV

3. Zygotene (Synaptonemal complex formation - I):

- Homologous chromosomes start pairing and synapsis occurs, forming the synaptonemal

complex.

- Correct Match: I

4. Leptotene (Chromosomes look like thin threads - III):

- Chromosomes appear as thin thread-like structures at the beginning of prophase I.

- Correct Match: III

Step 2: Conclusion

- The correct matching is A-II, B-IV, C-I, D-III, which corresponds to Option (2).

Quick Tip

- Leptotene: Chromosomes appear as thin threads. - Zygotene: Synapsis begins with synaptonemal complex formation. - Pachytene: Recombination nodules appear, leading to crossing over. - Diakinesis: Terminalization of chiasmata and movement of homologous chromosomes apart.

---

158. 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:

Step 1: Understanding Different Types of Contraceptives

1. Non-medicated IUD (Lippes loop - III):

- These do not release any medication but create a hostile uterine environment for sperm.

- Example: Lippes loop (a commonly used non-medicated IUD).

- Correct Match: III

2. Copper Releasing IUD (Multiload 375 - I):

- Copper ions released from the IUD increase sperm phagocytosis and prevent fertilization.

- Example: Multiload 375.

- Correct Match: I

3. Hormone Releasing IUD (LNG-20 - IV):

- Releases levonorgestrel (LNG), a hormone that thickens cervical mucus and inhibits sperm motility.

- Example: LNG-20.

- Correct Match: IV

4. Implants (Progestogens - II):

- Subdermal implants that release progestogens and inhibit ovulation.

- Example: Progestogen-based implants like Norplant.

- Correct Match: II

Step 2: Conclusion

- The correct matching is A-III, B-I, C-IV, D-II, which corresponds to Option (3).

Quick Tip

- Non-medicated IUDs (e.g., Lippes loop) create a hostile uterine environment for sperm. - Copper IUDs (e.g., Multiload 375) release copper ions that prevent fertilization. - Hormone-releasing IUDs (e.g., LNG-20) release levonorgestrel to prevent pregnancy. - Implants (e.g., Progestogens) work by releasing hormones that inhibit ovulation.

---

159. Which of the following is not a steroid hormone?

(1) Testosterone

(2) Progesterone

(3) Glucagon

(4) Cortisol

Correct Answer: (3) Glucagon

Solution:

Step 1: Understanding Steroid and Non-Steroid Hormones

- Steroid hormones are derived from cholesterol and are lipophilic, allowing them to pass through cell membranes.

- Non-steroid hormones include peptide and protein hormones, which bind to membrane receptors and act via secondary messengers.

Step 2: Classifying the Given Hormones

- Testosterone (Steroid Hormone):

- A male sex hormone (androgen) derived from cholesterol.

- Produced by the Leydig cells of testes.

- Progesterone (Steroid Hormone):

- A female reproductive hormone essential for pregnancy.

- Produced by the corpus luteum in ovaries.

- Glucagon (Non-Steroid Hormone - Peptide Hormone):

- A peptide hormone secreted by alpha cells of the pancreas.

- Regulates blood glucose levels by promoting glycogen breakdown in the liver.

- Since it is a peptide hormone, it is **not a steroid hormone**.

- Cortisol (Steroid Hormone):

- A glucocorticoid produced by the adrenal cortex.

- Regulates metabolism and immune response.

Step 3: Conclusion

- Since Glucagon is a peptide hormone, not a steroid hormone, the correct answer is Option (3).

Quick Tip

- Steroid hormones (e.g., Testosterone, Progesterone, Cortisol) are cholesterol-derived and act via intracellular receptors. - Peptide hormones (e.g., Glucagon) are protein-based and act via membrane receptors. - Glucagon is secreted by the pancreas and helps regulate blood sugar levels.

160. Given below are some stages of human evolution.

Arrange them in correct sequence (Past to Recent).

A.Homo habilis

B.Homo sapiens

C.Homo neanderthalensis

D.Homo erectus

Choose the correct sequence of human evolution from the options given below:

(1) 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:

Step 1: Understanding the Evolutionary Sequence of Humans

The evolutionary sequence of human ancestors is based on fossil evidence and developmental traits. The correct order from past to recent is:

1. *Homo habilis* (A) (Oldest, 2.4 to 1.4 million years ago):

- Considered the first species in the Homo genus.

- Known as ”Handy Man”, it used primitive tools.

2. *Homo erectus* (D) (1.9 million to 110,000 years ago): - First species to walk fully upright and control fire. - It was more advanced in tool-making and survival.

3. *Homo neanderthalensis* (C) (400,000 to 40,000 years ago):

- Lived in Europe and Asia and adapted to cold climates.

- Had a larger brain and used complex tools.

4. *Homo sapiens* (B) (Present, 300,000 years ago to now):

- Modern humans with advanced cognitive skills and civilizations.

Step 2: Conclusion

- The correct sequence from past to recent is A-D-C-B, which corresponds to Option (3).

Quick Tip

- *Homo habilis* was the first tool user. - *Homo erectus* was the first to use fire and walk fully upright. - *Homo neanderthalensis* had advanced hunting and social skills. - *Homo sapiens* are the modern humans with advanced intelligence.

---

161. Match List-I with List-II

List-I	Enzyme	List-II	Type of Bond Broken
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:

Step 1: Understanding the Enzymes and Their Functions

1. Lipase (Ester bond - II):

- Lipase is an enzyme that breaks down lipids into glycerol and fatty acids by hydrolyzing ester bonds.

- Correct Match: II

2. Nuclease (Phosphodiester bond - IV):

- Nucleases degrade nucleic acids (DNA and RNA) by hydrolyzing phosphodiester bonds between nucleotides.

- Correct Match: IV

3. Protease (Peptide bond - I):

- Proteases (or peptidases) break down proteins by cleaving peptide bonds between amino acids.

- Correct Match: I

4. Amylase (Glycosidic bond - III):

- Amylase hydrolyzes glycosidic bonds in carbohydrates like starch and glycogen to produce simple sugars.

- Correct Match: III

Step 2: Conclusion

- The correct matching is A-II, B-IV, C-I, D-III, which corresponds to Option (2).

Quick Tip

- Lipase breaks down lipids by hydrolyzing ester bonds. - Nuclease degrades DNA/RNA by hydrolyzing phosphodiester bonds. - Protease digests proteins by breaking peptide bonds. - Amylase breaks carbohydrates by cleaving glycosidic bonds.

---

162. Given below are two statements:

Statement I: The presence or absence of the hymen is not a reliable indicator of virginity.

Statement II: The hymen is torn during the first coitus only.

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

(1) Both Statement I and Statement II are false

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

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

(4) Both Statement I and Statement II are true

Correct Answer: (2) Statement I is true but Statement II is false

Solution:

Step 1: Understanding the Hymen and Its Significance

- The hymen is a thin membrane that partially covers the vaginal opening.

- The presence or absence of the hymen is not a reliable indicator of virginity because:

- It can be torn due to physical activities like cycling, gymnastics, or horseback riding.

- Some individuals are born with a very elastic or absent hymen. - Hence, Statement I is true.

Step 2: Evaluating Statement II

- The belief that the hymen always tears during the first coitus is a misconception.

- The hymen can tear due to multiple reasons other than intercourse, and in some cases, it may remain intact even after intercourse.

- Hence, Statement II is false.

Step 3: Conclusion

- Since Statement I is true and Statement II is false, the correct answer is Option (2).

Quick Tip

- The hymen is not a reliable indicator of virginity since it can tear due to non-sexual activities. - The hymen does not always tear during first coitus; its elasticity varies among individuals.

---

163. Match List-I with List-II

List-I	Biological Component	List-II	Application/Effect
A	α-1 antitrypsin	I	Cotton bollworm
B	Cry IAb	II	ADA deficiency
C	Cry IAc	III	Emphysema
D	Enzyme replacement therapy	IV	Corn borer

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the Biological Components and Their Applications

1. α-1 Antitrypsin (Emphysema - III):

- A protein that protects the lungs from neutrophil elastase.

- Deficiency leads to emphysema (a chronic lung disease).

- Correct Match: III

2. Cry IAb (Corn borer - IV):

- A Bt toxin gene from *Bacillus thuringiensis*.

- Used in genetically modified (GM) crops like Bt corn to kill corn borers.

- Correct Match: IV

3. Cry IAc (Cotton bollworm - I):

- Another Bt toxin gene used in Bt cotton to kill cotton bollworm.

- Correct Match: I

4. Enzyme Replacement Therapy (ADA Deficiency - II):

- Used for Adenosine Deaminase (ADA) deficiency, a genetic disorder affecting the immune system.

- Correct Match: II

Step 2: Conclusion

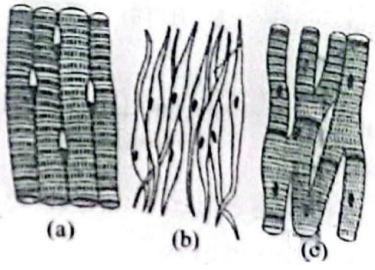
- The correct matching is A-III, B-IV, C-I, D-II, which corresponds to Option (2).

Quick Tip

- α-1 antitrypsin deficiency causes emphysema. - Cry IAb targets corn borer, while Cry IAc targets cotton bollworm in Bt crops. - Enzyme replacement therapy is used for ADA deficiency.

---

164. 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:

Step 1: Identifying the Three Types of Muscles in the Image

- Figure (a): Skeletal Muscle

- Characterized by striations and multinucleated fibers.

- Found in voluntary muscles like the triceps and biceps.

- Figure (b): Smooth Muscle

- Non-striated with spindle-shaped fibers.

- Found in involuntary organs such as the stomach and intestines.

- Figure (c): Cardiac Muscle

- Striated but involuntary muscle fibers with intercalated discs.

- Found exclusively in the heart.

Step 2: Evaluating the Given Options

- Option (1) is correct because:

- Skeletal muscles include triceps and other voluntary muscles.

- Smooth muscles are found in the stomach (involuntary organ).

- Cardiac muscles are found in the heart.

- Options (2), (3), and (4) are incorrect due to incorrect muscle classifications.

Step 3: Conclusion

- The correct answer is Option (1):

- (a) Skeletal muscle - Triceps

- (b) Smooth muscle - Stomach

- (c) Cardiac muscle - Heart

Quick Tip

- Skeletal muscles are voluntary and control body movements (e.g., triceps, biceps). - Smooth muscles are involuntary and found in internal organs (e.g., stomach, intestines). - Cardiac muscle is specialized and found only in the heart, enabling rhythmic contraction.

---

165. 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:

Step 1: Understanding the Causative Agents of the Diseases

1. Typhoid (Bacteria - IV):

- Caused by the bacterium *Salmonella typhi*.

- It spreads through contaminated food and water.

- Correct Match: IV

2. Leishmaniasis (Protozoa - III):

- Caused by the protozoan *Leishmania*, transmitted by sandflies.

- Correct Match: III

3. Ringworm (Fungus - I):

- Caused by fungal species like *Trichophyton*, *Microsporum*, and *Epidermophyton*.

- Affects the skin, causing circular red patches.

- Correct Match: I

4. Filariasis (Nematode - II):

- Caused by parasitic nematodes like *Wuchereria bancrofti* and *Brugia malayi*.

- Transmitted by mosquitoes, leading to lymphatic swelling (elephantiasis).

- Correct Match: II

Step 2: Conclusion

- The correct matching is A-IV, B-III, C-I, D-II, which corresponds to Option (1).

Quick Tip

- Typhoid is caused by *Salmonella typhi* (Bacteria). - Leishmaniasis is caused by *Leishmania* (Protozoa) via sandflies. - Ringworm is a fungal infection, not caused by worms. - Filariasis is caused by *Wuchereria bancrofti* (Nematode) and spread by mosquitoes.

---

166. Match List-I with List-II

List-I	Cell Structure	List-II	Associated Organelle/Function
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:

Step 1: Understanding the Cell Structures and Their Functions

1. Axoneme (Cilia and Flagella - II):

- The structural core of cilia and flagella, consisting of a 9+2 arrangement of microtubules.

- Correct Match: II

2. Cartwheel Pattern (Centriole - I):

- Centrioles display a cartwheel arrangement of microtubules and play a role in cell division.

- Correct Match: I

3. Crista (Mitochondria - IV):

- Cristae are the folds of the inner mitochondrial membrane where ATP synthesis occurs.

- Correct Match: IV

4. Satellite (Chromosome - III):

- A satellite chromosome has a secondary constriction associated with rRNA synthesis.

- Correct Match: III

Step 2: Conclusion

- The correct matching is A-II, B-I, C-IV, D-III, which corresponds to Option (3).

Quick Tip

- Axoneme is the core structure of cilia and flagella, made of microtubules. - Cartwheel pattern is found in centrioles, aiding in cell division. - Cristae are inner membrane folds of mitochondria, where ATP production occurs. - Satellite DNA is a part of chromosomes, often associated with rRNA synthesis.

---

167. In both sexes of cockroach, a pair of jointed filamentous structures called anal cerci are present on:

(1) 10^{th} segment

(2) 8^{th} and 9^{th} segment

(3) 11^{th} segment

(4) 5^{th} segment

Correct Answer: (1) 10^{th} segment

Solution:

Step 1: Understanding the Anal Cerci in Cockroaches

- The anal cerci are a pair of jointed, filamentous sensory structures found at the posterior end of the cockroach's abdomen.

- They are present in both males and females.

- These cerci function as sensory organs, detecting vibrations and aiding in predator avoidance.

Step 2: Location of Anal Cerci in Cockroach

- The abdomen of a cockroach is divided into 10 segments.

- The anal cerci arise from the 10th abdominal segment in both sexes.

- Males also possess anal styles, but these are absent in females.

Step 3: Conclusion

- Since the anal cerci are located on the 10th segment, the correct answer is Option (1): 10^{th} segment.

Quick Tip

- Anal cerci in cockroaches are sensory appendages that detect vibrations and movements. - They are present on the 10th abdominal segment in both males and females. - Males have additional anal styles, which are absent in females.

---

168. Match List-I with List-II

List-I	Organism/Structure	List-II	Phylum/Class
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:

Step 1: Understanding the Given Terms and Their Classifications

1. *Pleurobrachia* (Ctenophora - II):

- *Pleurobrachia* belongs to Ctenophora, a group of marine invertebrates known as comb jellies.

- Correct Match: II

2. Radula (Mollusca - I):

- The radula is a specialized feeding structure in mollusks, used to scrape food from surfaces.

- Correct Match: I

3. Stomochord (Hemichordata - IV):

- The stomochord is a structure found in Hemichordates, functionally similar to the notochord.

- Correct Match: IV

4. Air Bladder (Osteichthyes - III):

- The air bladder (swim bladder) is present in bony fishes (Osteichthyes), helping in buoyancy control.

- Correct Match: III

Step 2: Conclusion

- The correct matching is A-II, B-I, C-IV, D-III, which corresponds to Option (1).

Quick Tip

- *Pleurobrachia* is a comb jelly belonging to Ctenophora. - Radula is a feeding organ found in Mollusca. - Stomochord is a structural component of Hemichordata. - Air bladder is found in Osteichthyes (bony fishes) for buoyancy control.

---

169. Following are the stages of 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 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:

Step 1: Understanding the Conduction System of the Heart

The heart's conduction system consists of specialized cardiac muscle fibers that ensure rhythmic contraction. The correct sequence of electrical conduction is:

1. Sinoatrial (SA) node (E):

- The natural pacemaker of the heart.

- Generates impulses that spread through the atria, causing atrial contraction.

2. Atrioventricular (AV) node (C):

- Located in the lower interatrial septum.

- Delays the impulse before passing it to the ventricles.

3. AV Bundle (Bundle of His) (A):

- Conducts impulses from the AV node to the ventricles.

- Divides into right and left bundle branches.

4. Bundle Branches (D):

- Carry impulses down the interventricular septum toward the apex of the heart.

5. Purkinje Fibers (B):

- Spread the impulse through the ventricular walls, causing ventricular contraction.

Step 2: Conclusion

- The correct conduction pathway is E $\rightarrow$ C $\rightarrow$ A $\rightarrow$ D $\rightarrow$ B, which corresponds to Option (4).

Quick Tip

- SA Node (Sinoatrial Node): The heart's pacemaker, initiating electrical impulses. - AV Node (Atrioventricular Node): Delays impulses before sending them to ventricles. - AV Bundle (Bundle of His): Transmits impulses to the ventricles. - Bundle Branches: Carry signals toward the heart's apex. - Purkinje Fibers: Spread electrical signals throughout the ventricles, triggering contraction.

---

170. The flippers of 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:

Step 1: Understanding Convergent Evolution

- Convergent evolution occurs when unrelated species evolve similar traits due to adaptation to similar environmental conditions.

- Penguins (birds) and dolphins (mammals) have flippers, which serve the same function—swimming—but evolved independently.

- This is an example of analogous structures, which have a similar function but different evolutionary origins.

Step 2: Why Other Options Are Incorrect

- Natural Selection (Option 1):

- Natural selection drives evolution but does not specifically refer to similar adaptations in unrelated species.

- Divergent Evolution (Option 3):

- This occurs when a common ancestor gives rise to species with different adaptations (e.g., Darwin's finches).

- Adaptive Radiation (Option 4):

- This refers to a single ancestral species evolving into different forms to occupy various

ecological niches.

Step 3: Conclusion

- Since flippers in dolphins and penguins evolved independently due to similar aquatic environments, this is an example of convergent evolution.

- Hence, the correct answer is Option (2).

Quick Tip

- Convergent Evolution: Unrelated species develop similar traits due to similar environmental pressures. - Analogous Structures: Features with similar function but different evolutionary origins (e.g., wings of birds and bats). - Divergent Evolution: A common ancestor gives rise to different species with varying adaptations.

---

171. Which one is the correct product of DNA-dependent RNA polymerase to the given template?

3' TACATGGCAAATATCCATTCA 5'

(1) $5'$AUGUAAAGUUUAUAGGUAAGU$3'$

(2) $5'$AUGUACCGUUUAUAGGGAAGU$3'$

(3) $5'$ATGTACCGTTTATAGGTAAGT$3'$

(4) $5'$AUGUACCGUUUAUAGGUAAGU$3'$

Correct Answer: (4) $5'$AUGUACCGUUUAUAGGUAAGU$3'$

Solution:

Step 1: Understanding Transcription and Complementary Base Pairing

- DNA-dependent RNA polymerase synthesizes an mRNA strand complementary to the template DNA strand.

- RNA synthesis follows base-pairing rules, replacing thymine (T) with uracil (U):

- A (Adenine) pairs with U (Uracil)

- T (Thymine) pairs with A (Adenine)

- C (Cytosine) pairs with G (Guanine)

- G (Guanine) pairs with C (Cytosine)

Step 2: Deriving the mRNA Sequence from the Given DNA Template

- Given DNA template strand (3’ to 5’):

$$3'\text{TACATGGCAAATATCCATTCA}5'$$

- Complementary mRNA strand (5’ to 3’):

$$5'\text{AUGUACCGUUUAUAGGUAAGU}3'$$

Step 3: Comparing with the Given Options

- The correct mRNA sequence matches Option (4):

$$5'\text{AUGUACCGUUUAUAGGUAAGU}3'$$

Step 4: Conclusion

- The correct answer is Option (4) as it represents the correct mRNA sequence transcribed from the given DNA template.

Quick Tip

- Transcription follows base-pairing rules, replacing T with U in RNA. - mRNA is complementary and antiparallel to the template DNA strand. - The start codon (AUG) indicates the beginning of translation.

---

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

Assertion A: Breastfeeding during the initial period of infant growth is recommended by doctors for bringing a healthy baby.

Reason R: Colostrum contains several antibodies absolutely essential to develop resistance for the newborn baby.

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

(1) 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:

Step 1: Understanding the Importance of Breastfeeding

- Breastfeeding is highly recommended by doctors, especially in the early months after birth, as it provides essential nutrients and immunity-boosting factors to the infant.
- The first milk, called colostrum, is particularly rich in antibodies and immunoglobulins, which help the newborn develop immunity against infections.

Step 2: Verifying the Statements

- Assertion A is correct because breastfeeding is advised for healthy growth and immunity development in infants.
- Reason R is also correct because colostrum contains IgA antibodies, which are crucial for the baby's immune defense.
- Furthermore, R correctly explains A since the benefits of breastfeeding are largely due to the presence of colostrum, which provides immunity.

Step 3: Conclusion

- Since both statements are correct and R correctly explains A, the correct answer is Option (4).

Quick Tip

- Colostrum is the first milk produced by the mother after childbirth, rich in IgA antibodies. - It provides passive immunity, protecting the infant from infections. - Breastfeeding ensures optimal nutrition and immune support for newborns.

---

173. Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?

(1) High pO_2 and Lesser H^+ concentration

(2) Low pCO_2 and High H^+ concentration

(3) Low pCO_2 and High temperature

(4) High pO_2 and High pCO_2

Correct Answer: (1) High pO_2 and Lesser H^+ concentration

Solution:

Step 1: Understanding the Formation of Oxyhaemoglobin

- Oxyhaemoglobin (HbO_2) is formed in the alveoli of the lungs, where oxygen binds to haemoglobin.

- The binding of oxygen to haemoglobin is influenced by several physiological factors, including oxygen partial pressure (pO_2), carbon dioxide partial pressure (pCO_2), hydrogen ion concentration (H^+), and temperature.

Step 2: Ideal Conditions for Oxyhaemoglobin Formation

1. High pO_2

- In the alveoli, the partial pressure of oxygen (pO_2) is high, allowing haemoglobin to efficiently bind oxygen and form oxyhaemoglobin.

2. Low pCO_2 and Lesser H^+ Concentration

- A low concentration of carbon dioxide (pCO_2) leads to a decrease in H^+ concentration, as CO combines with water to form carbonic acid, which dissociates into bicarbonate and hydrogen ions.

- This results in a higher pH (less acidic environment), which promotes haemoglobin's affinity for oxygen (Bohr effect).

3. Lower Temperature

- Lower temperatures (such as in the lungs) favor the binding of oxygen to haemoglobin, enhancing oxyhaemoglobin formation.

Step 3: Why Other Options Are Incorrect

- Option (2): Low pCO_2 is favorable, but high H^+ concentration would lead to oxygen unloading, not binding.

- Option (3): Low pCO_2 is correct, but high temperature promotes oxygen release, not binding.

- Option (4): High pCO_2 leads to oxygen unloading, not oxyhaemoglobin formation.

Step 4: Conclusion

- The correct conditions for oxyhaemoglobin formation in alveoli are high pO_2 and lesser H^+ concentration, which matches Option (1).

Quick Tip

- High pO_2 in alveoli promotes oxygen binding to haemoglobin. - Low pCO_2 leads to lesser H^+ concentration, which enhances haemoglobin's affinity for oxygen (Bohr effect). - Higher temperature and acidic environments favor oxygen release rather than binding.

---

174. 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:

Step 1: Understanding Coelom Types in Different Phyla

1. True Coelomates (Eucoelomates)

- Organisms with a true coelom (fluid-filled body cavity completely lined by mesoderm).

- Example: Annelids (earthworms, leeches).

- Statement A is correct.

2. Pseudocoelomates

- Organisms with a pseudocoelom, where the body cavity is partially lined by mesoderm.

- Example: Aschelminthes (Nematoda).

- Statement B is incorrect because Poriferans (sponges) lack any coelom and have a simple body organization.

3. Acoelomates

- Organisms with no body cavity (solid body).

- Example: Platyhelminthes (flatworms, tapeworms).

- Statement C is incorrect because Aschelminthes (Nematodes) are pseudocoelomates, not acoelomates.

4. Incorrect Classification of Platyhelminthes

- Platyhelminthes are acoelomates, not pseudocoelomates.

- Statement D is incorrect.

Step 2: Conclusion

- Only Statement A is correct, which corresponds to Option (1).

Quick Tip

- True coelomates (Eucoelomates): Body cavity fully lined with mesoderm (e.g., Annelida, Mollusca, Arthropoda). - Pseudocoelomates: Body cavity partially lined with mesoderm (e.g., Aschelminthes/Nematoda). - Acoelomates: No body cavity (e.g., Platyhelminthes). - Porifera lack a coelom and have a simple cellular organization.

---

175. 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:

Step 1: Understanding the Cell Cycle and its Stages

The cell cycle consists of interphase (growth phases) and mitotic phase (division phases).

The correct order of events in the cell cycle is:

1. Gap 1 (G1) Phase (E):

- The first growth phase where the cell grows and prepares for DNA replication.

2. Synthesis (S) Phase (C):

- DNA replication occurs, leading to duplication of chromosomes.

3. Gap 2 (G2) Phase (A):

- The second growth phase where the cell prepares for mitosis by synthesizing proteins and organelles.

4. Karyokinesis (D):

- Nuclear division takes place (mitosis/meiosis).

5. Cytokinesis (B):

- Cytoplasmic division occurs, completing the formation of two daughter cells.

Step 2: Matching with the Given Options

- The correct sequence of stages is: E $\rightarrow$ C $\rightarrow$ A $\rightarrow$ D $\rightarrow$ B, which corresponds to Option (3).

Step 3: Conclusion

- Since the correct order of the cell cycle matches Option (3), the final answer is E-C-A-D-B.

Quick Tip

- The cell cycle consists of Interphase (G1, S, G2) and Mitotic phase (Karyokinesis + Cytokinesis). - G1 Phase: Growth and preparation for DNA replication. - S Phase: DNA replication. - G2 Phase: Growth and preparation for mitosis. - Karyokinesis: Division of nucleus. - Cytokinesis: Division of cytoplasm.

---

176. 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 a 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:

Step 1: Understanding Bio-reactors

- A bio-reactor is a specialized vessel used for large-scale production of biological products like enzymes, vaccines, antibiotics, and recombinant proteins.

- They provide optimal conditions such as temperature, pH, aeration, and nutrient supply for microbial or cell growth.

Step 2: Evaluating the Statements

- Statement (1) is correct:

- The most commonly used bio-reactors are of the stirring type, which ensures uniform mixing and distribution of nutrients and oxygen.

- Statement (2) is incorrect:

- Bio-reactors are designed for large-scale production, not small-scale bacterial cultures.

- Small-scale bacterial cultures are typically grown in flasks, test tubes, or petri dishes under controlled laboratory conditions.

- Statement (3) is correct:

- Bio-reactors have essential components such as:

- Agitator system for mixing

- Oxygen delivery system for aerobic microbial cultures

- Foam control system to prevent excessive foam formation

- Statement (4) is correct:

- A bio-reactor provides optimal growth conditions for achieving high yield of the desired biological product.

Step 3: Conclusion

- Since Statement (2) is incorrect, the correct answer is Option (2).

Quick Tip

- Bio-reactors are used for large-scale production of microbial and biochemical products. - Small-scale cultures are typically grown in flasks or plates, not in bio-reactors. - Stirred-tank bio-reactors are the most commonly used type.

177. 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:

Step 1: Understanding the Functions of Brain Structures

1. Pons (A-III)

- The pons is a part of the brainstem that serves as a bridge connecting different regions of the brain.

2. Hypothalamus (B-IV)

- The hypothalamus contains neurosecretory cells that regulate the endocrine system by releasing hormones.

3. Medulla (C-II)

- The medulla oblongata controls respiration and gastric secretions, as well as other involuntary functions.

4. Cerebellum (D-I)

- The cerebellum helps in maintaining posture, balance, and coordination, and provides additional space for neurons.

Step 2: Matching with the Given Options

- The correct matching is A-III, B-IV, C-II, D-I, which corresponds to Option (1).

Step 3: Conclusion

- Since the correct answer matches Option (1), the final answer is A-III, B-IV, C-II, D-I.

Quick Tip

- Pons connects different regions of the brain. - Hypothalamus contains neurosecretory cells and regulates hormone secretion. - Medulla oblongata controls respiration, gastric secretion, and involuntary reflexes. - Cerebellum maintains balance, posture, and muscle coordination.

---

178. 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:

Step 1: Understanding Natural and Artificial Contraceptive Methods

- Natural or Traditional Contraceptive Methods:

- These do not involve the use of any external device or chemical.

- Examples include:

- Periodic abstinence: Avoiding intercourse during the fertile period.

- Lactational amenorrhea: Natural suppression of ovulation due to breastfeeding.

- Coitus interruptus: Withdrawal method before ejaculation.

- Artificial or Barrier Methods:

- These methods involve physical or chemical barriers to prevent pregnancy.

- Examples include:

- Vaults: These are barrier contraceptives that prevent sperm entry into the uterus.

Step 2: Evaluating the Statements

- Statement (1) Periodic abstinence (Correct - Natural method)

- It is a natural method where couples avoid intercourse during the ovulation period.

- Statement (2) Lactational amenorrhea (Correct - Natural method)

- It is a natural postpartum infertility method due to high prolactin levels that suppress

ovulation.

- Statement (3) Vaults (Incorrect - Artificial method)

- Vaults are physical barriers used in artificial contraception, not a natural method.

- They prevent sperm from reaching the cervix.

- Statement (4) Coitus interruptus (Correct - Natural method)

- It is a traditional method where the male withdraws before ejaculation.

Step 3: Conclusion

- Since Vaults are not a natural method, the correct answer is Option (3).

Quick Tip

- Natural contraceptive methods include Periodic abstinence, Lactational amenorrhea, and Coitus interruptus. - Artificial contraceptive methods include Barrier methods (condoms, vaults, diaphragms), Intrauterine devices (IUDs), and Hormonal pills. - Vaults are barrier contraceptives, not a natural method.

---

179. 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:

Step 1: Understanding Hardy-Weinberg Equilibrium

- The Hardy-Weinberg equilibrium states that the allele and genotype frequencies in a population remain constant over generations if no external evolutionary forces act on them.

- The equation is given as:

$$p^2 + 2pq + q^2 = 1$$

where p and q represent the frequency of dominant and recessive alleles, respectively.

Step 2: Evaluating the Given Factors

- Statement (1) Genetic drift (Affects equilibrium - Incorrect choice)
- Genetic drift refers to random changes in allele frequency due to chance events.
- It affects Hardy-Weinberg equilibrium by causing random loss or fixation of alleles.
- Statement (2) Gene migration (Affects equilibrium - Incorrect choice)
- Gene migration (also known as gene flow) occurs when individuals move in or out of a population.
- This changes allele frequencies and disturbs Hardy-Weinberg equilibrium.
- Statement (3) Constant gene pool (Does NOT affect equilibrium - Correct choice)
- A constant gene pool means there is no change in allele frequencies.
- This ensures that the population remains in Hardy-Weinberg equilibrium.
- Statement (4) Genetic recombination (Affects equilibrium - Incorrect choice)
- Genetic recombination leads to new allele combinations, which can change genotype frequencies over time.
- This process contributes to variation and affects Hardy-Weinberg equilibrium.

Step 3: Conclusion

- Since a constant gene pool ensures equilibrium is maintained, the correct answer is Option (3).

Quick Tip

- Hardy-Weinberg equilibrium remains stable when no evolutionary forces act on a population. - Factors that disturb Hardy-Weinberg equilibrium: - Genetic drift (random changes) - Gene migration (allele movement) - Mutations (new allele introduction) - Genetic recombination (new combinations of genes) - Natural selection (favored allele survival) - A constant gene pool ensures equilibrium is maintained.

---

180. 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

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

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

(3) A-III, B-I, 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:

Step 1: Understanding the Matching Pairs

- *Pterophyllum* (Angel fish - III)

- *Pterophyllum* is commonly known as the Angel fish, found in freshwater aquariums.

- *Myxine* (Hag fish - I)

- *Myxine* refers to the Hagfish, which is a jawless marine fish producing slime.

- *Pristis* (Saw fish - II)

- *Pristis*, also known as Sawfish, has a long, toothed snout resembling a saw.

- *Exocoetus* (Flying fish - IV)

- *Exocoetus* refers to Flying fish, which can glide above water surfaces.

Step 2: Conclusion

- The correct matching sequence is A-III, B-I, C-II, D-IV, which corresponds to Option (1).

Quick Tip

- Angel fish (*Pterophyllum*) is a popular aquarium fish. - Hagfish (*Myxine*) is known for its slime-producing ability. - Sawfish (*Pristis*) has a distinctive saw-like snout. - Flying fish (*Exocoetus*) glides above water using its wing-like fins.

---

181. 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:

Step 1: Understanding the Structure of the Fallopian Tube

The Fallopian tube (also known as the uterine tube or oviduct) is an important structure in the female reproductive system that facilitates the transport of the ovum from the ovary to the uterus. It consists of the following parts:

- Infundibulum: Funnel-shaped structure near the ovary with fimbriae that capture the ovum.
- Ampulla: The widest and longest part where fertilization usually occurs.
- Isthmus: A narrow segment that connects the ampulla to the uterus.
- Interstitial (intramural) part: The portion that opens into the uterine cavity.

Step 2: Identifying the Incorrect Option

- Statement (1) Isthmus (Correct component)
- The isthmus is the narrowest part of the Fallopian tube before it joins the uterus.
- Statement (2) Infundibulum (Correct component)
- The infundibulum is the funnel-shaped structure near the ovary.
- Statement (3) Ampulla (Correct component)
- The ampulla is the longest and widest part where fertilization takes place.
- Statement (4) Uterine fundus (Incorrect - Not a part of the Fallopian tube)
- The uterine fundus is the uppermost part of the uterus, not a part of the Fallopian tube.

Step 3: Conclusion

- Since the uterine fundus belongs to the uterus and not the Fallopian tube, the correct answer is Option (4).

Quick Tip

- The Fallopian tube consists of infundibulum, ampulla, isthmus, and interstitial parts.
- The uterine fundus is the upper rounded part of the uterus, where the Fallopian tubes attach. - Fertilization usually occurs in the ampulla of the Fallopian tube.

182. Match List I with List II:

List I		**List II**	
A.	Cocaine	I.	Effective sedative in surgery
B.	Heroin	II.	*Cannabis sativa*
C.	Morphine	III.	*Erythroxylum*
D.	Marijuana	IV.	*Papaver somniferum*

(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:

Step 1: Understanding the Matching Pairs

- Cocaine is derived from the plant *Erythroxylum* (Matching with III).

- Heroin is a derivative of Morphine, which is obtained from *Papaver somniferum* (Matching with IV).

- Morphine is an effective sedative in surgery (Matching with I).

- Marijuana is derived from *Cannabis sativa* (Matching with II).

Step 2: Verifying the Correct Option

- Option (3) correctly pairs:

- A $\rightarrow$ III (Cocaine $\rightarrow$ *Erythroxylum*)

- B $\rightarrow$ IV (Heroin $\rightarrow$ *Papaver somniferum*)

- C $\rightarrow$ I (Morphine $\rightarrow$ Effective sedative in surgery)

- D $\rightarrow$ II (Marijuana $\rightarrow$ *Cannabis sativa*)

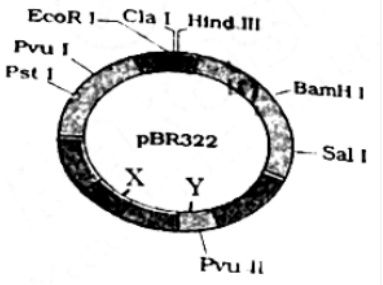
Thus, the correct answer is Option (3).

Quick Tip

- Cocaine is derived from *Erythroxylum coca* and is a stimulant. - Heroin is synthesized from Morphine obtained from *Papaver somniferum* (Opium Poppy). - Morphine is widely used as a painkiller and sedative. - Marijuana contains THC (Tetrahydrocannabinol) and is obtained from *Cannabis sativa*.

---

183. The following diagram shows restriction sites in *E. coli* cloning vector pBR322. Find the role of 'X' and 'Y' genes:



(1) The gene 'X' is 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:

Step 1: Understanding the Structure of pBR322

pBR322 is a commonly used plasmid vector in genetic engineering. It contains:

- Antibiotic resistance genes for Ampicillin (Amp^R) and Tetracycline (Tet^R).
- Replication origin (ori) which controls plasmid replication.
- Multiple restriction sites (EcoRI, BamHI, HindIII, etc.) for cloning purposes.

Step 2: Identifying the Roles of 'X' and 'Y' Genes

- The ‘X’ gene is located at the origin of replication (ori), which plays a crucial role in controlling the copy number of the linked DNA.

- The ‘Y’ gene is involved in the replication of the plasmid by encoding a necessary replication-associated protein.

Step 3: Verifying the Correct Option

- Option (1) correctly identifies:

- X $\rightarrow$ Controls the copy number of linked DNA.

- Y $\rightarrow$ Protein involved in plasmid replication.

Thus, the correct answer is Option (1).

Quick Tip

- pBR322 is a widely used cloning vector in *E. coli*, carrying two antibiotic resistance genes and multiple restriction sites. - The ori (origin of replication) controls the plasmid copy number inside bacterial cells. - Restriction sites such as BamHI, HindIII, and EcoRI are used for inserting foreign DNA.

---

184. Which of the following are Autoimmune disorders?

A. Myasthenia gravis

B. Rheumatoid arthritis

C. Gout

D. Muscular dystrophy

E. Systemic Lupus Erythematosus (SLE)

(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:

Step 1: Understanding Autoimmune Disorders

Autoimmune disorders occur when the immune system mistakenly attacks the body’s own

tissues. These include diseases where the body's immune response is hyperactive against its own cells.

Step 2: Analyzing Each Condition

- Myasthenia gravis (A) → Autoimmune disorder that affects the neuromuscular junction, causing muscle weakness.

- Rheumatoid arthritis (B) → Autoimmune disease where the immune system attacks the joints, leading to inflammation and pain.

- Systemic Lupus Erythematosus (E) → Autoimmune disorder affecting multiple organs, including skin, joints, and kidneys.

- Gout (C) → Metabolic disorder caused by uric acid buildup, not an autoimmune condition.

- Muscular dystrophy (D) → Genetic disorder leading to progressive muscle degeneration, not an autoimmune condition.

Step 3: Verifying the Correct Option

- The correct autoimmune disorders from the list are A (Myasthenia gravis), B (Rheumatoid arthritis), and E (SLE).

- Option (1) correctly identifies these disorders.

Thus, the correct answer is Option (1).

Quick Tip

- Autoimmune disorders arise from an overactive immune response against self-antigens. - Common examples include Myasthenia gravis, Rheumatoid arthritis, and Systemic Lupus Erythematosus (SLE). - Gout is due to uric acid buildup, and Muscular dystrophy is a genetic disorder, not autoimmune.

---

185. 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:

Step 1: Understanding Each Respiratory Capacity

1. Expiratory Capacity (A) = Tidal volume + Expiratory reserve volume. This is the total amount of air a person can expire after a normal inspiration.

- Matches with II.

2. Functional Residual Capacity (B) = Expiratory reserve volume + Residual volume. This represents the air remaining in the lungs after a normal expiration.

- Matches with IV.

3. Vital Capacity (C) = Expiratory reserve volume + Tidal volume + Inspiratory reserve volume. This is the maximum air a person can exhale after maximum inspiration.

- Matches with I.

4. Inspiratory Capacity (D) = Tidal volume + Inspiratory reserve volume. This represents the maximum air that can be inhaled after a normal expiration.

- Matches with III.

Step 2: Verifying the Correct Option

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

- Option (4) correctly identifies these relationships.

Thus, the correct answer is Option (4).

Quick Tip

- Lung capacities are combinations of different lung volumes and are crucial in assessing respiratory function. - Vital capacity (VC) is the sum of expiratory reserve volume, tidal volume, and inspiratory reserve volume. - Functional residual capacity (FRC) includes expiratory reserve volume and residual volume. - Inspiratory capacity (IC) consists of tidal volume and inspiratory reserve volume.

186. Match List I with List II:

List I	Description	List II	Explanation
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:

Step 1: Understanding the ECG Waves

1. P wave (A): Represents the depolarisation of atria, indicating the electrical impulse from the SA node.

- Matches with III.

2. QRS complex (B): Represents the depolarisation of ventricles, which leads to ventricular contraction.

- Matches with II.

3. T wave (C): Represents the repolarisation of ventricles, meaning the return of ventricles to a resting state.

- Matches with IV.

4. T-P gap (D): Represents the electrical silence of heart muscles, where no depolarisation occurs.

- Matches with I.

Step 2: Verifying the Correct Option

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

- Option (1) correctly identifies these relationships.

Thus, the correct answer is Option (1).

Quick Tip

- P wave signifies atrial depolarisation. - QRS complex represents ventricular depolarisation. - T wave indicates ventricular repolarisation. - T-P gap represents the silent phase where no electrical activity is recorded.

---

187. Given below are two statements:

Statement I: The cerebral hemispheres are connected by nerve tract known as corpus callosum.

Statement II: The brain stem consists of the medulla oblongata, pons and cerebrum.

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

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

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

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

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

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

Solution:

Step 1: Understanding Statement I

- The **cerebral hemispheres** are indeed connected by a large nerve tract known as the corpus callosum.

- This is responsible for communication between the left and right hemispheres of the brain.

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

Step 2: Understanding Statement II

- The brainstem consists of three parts:

1. Midbrain 2. Pons 3. Medulla oblongata

- However, the cerebrum is **not** a part of the brainstem. It is the largest part of the brain responsible for higher functions like cognition, memory, and voluntary actions.

- **Thus, Statement II is incorrect.**

Step 3: Verifying the Correct Option

- Since Statement I is correct and Statement II is incorrect, the correct answer is Option (2).

Quick Tip

- The corpus callosum is the largest white matter structure connecting both hemispheres of the brain. - The brainstem includes the midbrain, pons, and medulla oblongata but **not** the cerebrum.

---

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 **misappropriate** 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: Understanding Statement I

- Both mitochondria and chloroplasts are **double-membrane-bound organelles**.

- The outer membrane provides structure and protection, while the inner membrane contains enzymes and transporters essential for their respective functions.

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

Step 2: Understanding Statement II

- The inner membrane of mitochondria is highly specialized with cristae and is **highly selective** in transport.

- However, the inner membrane of the chloroplast is also highly selective, and both membranes have their own permeability mechanisms.

- The statement comparing the permeability of mitochondrial and chloroplast inner membranes is misleading.

- **Thus, Statement II is incorrect.**

Step 3: Verifying the Correct Option

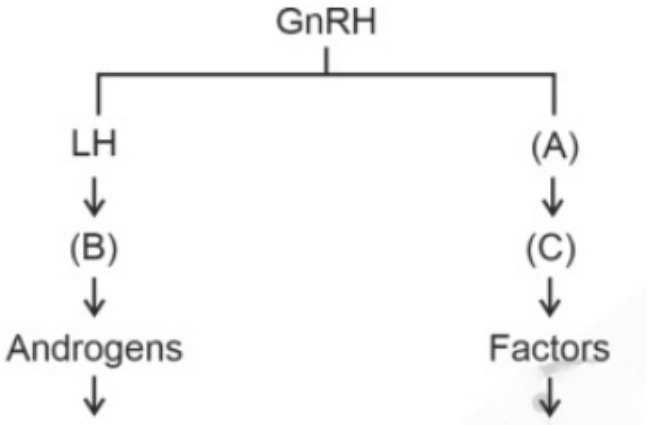
- Since Statement I is correct and Statement II is incorrect, the correct answer is Option (2).

Quick Tip

- Both mitochondria and chloroplasts are double-membrane-bound organelles. - The inner membrane of mitochondria contains electron transport chain complexes, making it highly specialized and selective. - The inner membrane of the chloroplast is also selectively permeable, regulating the movement of ions and metabolites.

---

189. Identify the correct option (A), (B), (C), (D) with respect to spermatogenesis.



Choose the correct answer from the options given below:

(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:

Step 1: Understanding the hormonal regulation of spermatogenesis

- The hypothalamus secretes GnRH (Gonadotropin-releasing hormone), which stimulates the

anterior pituitary to release LH (Luteinizing Hormone) and FSH (Follicle-Stimulating Hormone).

- **LH acts on Leydig cells (B)**, which then produce androgens (mainly testosterone).

- **FSH (A) acts on Sertoli cells (C)**, stimulating the release of factors essential for spermatogenesis.

Step 2: Matching the correct components

- (A) = FSH (Stimulates Sertoli cells)

- (B) = Leydig cells (Stimulated by LH to release androgens)

- (C) = Sertoli cells (Provide nourishment and factors for spermatogenesis)

- (D) = Spermiogenesis (Final stage where spermatids mature into spermatozoa)

Step 3: Verifying the Correct Option

- The correct sequence matches Option (4): FSH, Leydig cells, Sertoli cells, spermiogenesis.

Quick Tip

- GnRH stimulates the release of LH and FSH. - LH acts on Leydig cells, leading to testosterone production. - FSH acts on Sertoli cells, which provide factors for spermatogenesis and aid in spermiogenesis.

---

190. 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 micro environments 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:

Step 1: Understanding the Role of Bone Marrow and Thymus

- The bone marrow is a primary lymphoid organ responsible for hematopoiesis, the process of blood cell formation, including lymphocytes (B-cells and precursor T-cells).

- The thymus is another primary lymphoid organ that provides a microenvironment for T-cell maturation.

- While B-lymphocytes mature in the bone marrow, T-lymphocytes migrate to the thymus for their maturation.

Step 2: Verifying the Statements

- Statement I is correct because the bone marrow serves as the main site for blood cell production, including lymphocytes.

- Statement II is also correct because both bone marrow and thymus provide environments for the maturation of lymphocytes (B-cells in bone marrow and T-cells in thymus).

Step 3: Selecting the Correct Answer

- Since both statements are correct, the correct option is (4) Both Statement I and Statement II are correct.

Quick Tip

- Bone marrow is the site of B-cell maturation, whereas T-cells migrate to the thymus for further development. - The primary lymphoid organs include bone marrow and thymus, while secondary lymphoid organs include the spleen, lymph nodes, and tonsils.

---

191. As per ABO blood grouping system, the blood group of father is B^+, mother is A^+, and the child is O^+. Their respective genotype can be:

(A) I^Bi/I^Ai

(B) I^BI^B/I^Ai

(C) I^AB/I^AI^B

(D) I^Ai/I^BI^A

(E) ii/I^AI^B

Choose the most appropriate answer from the options given below :

(1) B only

(2) C & B only

(3) D & E only

(4) A only

Correct Answer: (3) D & E only

Solution: Step 1: Analyze the genotypes of the parents. For the child to have the O^+ blood group (ii), both parents must carry at least one i allele. Possible genotypes for the parents include I^Bi and I^Ai.

Step 2: Eliminate incorrect options based on genotypes. - Option B includes I^BI^B, I^AI^A, which are not valid for the O^+ child.

- Options D and E correctly represent I^Ai and I^Bi, which can produce ii.

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

Quick Tip

When solving ABO blood group inheritance problems, remember that O blood group requires two i alleles (homozygous recessive).

---

192. 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:

Step 1: Understanding Gause's Competitive Exclusion Principle Gause's competitive

exclusion principle states that two species competing for the same limiting resources cannot coexist indefinitely. One species will outcompete and eliminate the other if their niches overlap significantly. However, species competing for **different** resources *can* coexist.

Step 2: Evaluating Statement I Statement I incorrectly states that the principle applies to species competing for different resources. The principle actually applies when species compete for the **same** resources. Hence, Statement I is **false**.

Step 3: Evaluating Statement II Statement II correctly states that during competition, the inferior species will be eliminated, which is a fundamental idea of Gause's principle. This is particularly true when resources are limited. Hence, Statement II is **true**.

Conclusion: Since Statement I is false and Statement II is true, the correct answer is **(3)**.

Quick Tip

The competitive exclusion principle states that two species competing for the same limiting resources cannot stably coexist. If niches overlap too much, one species will eventually be driven to extinction or forced to adapt.

---

193. Match List I with List II:

List I		List II
A. Mesozoic Era		I. Lower invertebrates
B. Proterozoic Era		II. Fish & Amphibia
C. Cenozoic Era		III. Birds & Reptiles
D. Paleozoic Era		IV. Mammals

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the evolutionary timeline Each geological era is characterized by

the emergence and dominance of specific life forms.

- **Mesozoic Era (A)**: Known as the "Age of Reptiles," dominated by **Birds & Reptiles** (III).

- **Proterozoic Era (B)**: The early stage of life, where **Lower invertebrates** (I) evolved.

- **Cenozoic Era (C)**: Known as the "Age of Mammals," where **Mammals** (IV) became dominant.

- **Paleozoic Era (D)**: Characterized by the emergence of **Fish & Amphibia** (II).

Step 2: Matching the correct pairs

Thus, the correct matching is:

$$A \to III \quad \text{(Birds \& Reptiles)}$$

$$B \to I \quad \text{(Lower invertebrates)}$$

$$C \to IV \quad \text{(Mammals)}$$

$$D \to II \quad \text{(Fish \& Amphibia)}$$

Conclusion: The correct answer is **(3) A-III, B-I, C-IV, D-II**.

Quick Tip

Understanding geological time scales helps in remembering which life forms evolved in different eras. The Paleozoic era saw early vertebrates, the Mesozoic era was dominated by reptiles, and the Cenozoic era is known as the Age of Mammals.

---

194. Match List I with List II:

List I		List II
A. RNA polymerase III		I. snRNPs
B. Termination of transcription		II. Promoter
C. Splicing of Exons		III. Rho factor
D. TATA box		IV. SnRNAs, tRNA

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the functions of each component - **RNA polymerase III** is responsible for transcribing small RNA molecules, including **SnRNAs and tRNA** (IV).

- **Termination of transcription** can be influenced by the **Rho factor** (III), which plays a role in terminating RNA synthesis in prokaryotes.

- **Splicing of exons** is carried out by small nuclear ribonucleoproteins (**snRNPs**) (I), which help remove introns.

- The **TATA box** is a **promoter** (II) sequence that helps initiate transcription by recruiting RNA polymerase.

Step 2: Matching the correct pairs

$$A \to IV \quad \text{(SnRNAs, tRNA)}$$

$$B \to III \quad \text{(Rho factor)}$$

$$C \to I \quad \text{(snRNPs)}$$

$$D \to II \quad \text{(Promoter)}$$

Conclusion: The correct answer is **(3) A-IV, B-III, C-I, D-II**.

Quick Tip

RNA polymerase III transcribes small RNAs like tRNA. The Rho factor is essential in terminating transcription. The TATA box is a promoter sequence that plays a crucial role in transcription initiation.

---

195. Regarding the catalytic cycle of an enzyme action, select the correct sequential steps:

A. Substrate enzyme complex formation.

B. Free enzyme ready to bind with another substrate.

C. Release of products.

D. Chemical bonds of the substrate broken.

E. Substrate binding to active site.

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

Step 1: Understanding the catalytic cycle of an enzyme The catalytic cycle of an enzyme follows a specific sequence of steps:

1. **Substrate binding to the active site (E)**:

- The substrate attaches to the enzyme at the active site, forming an enzyme-substrate complex.

2. **Substrate enzyme complex formation (A)**:

- The enzyme undergoes conformational changes to properly orient the substrate for catalysis.

3. **Chemical bonds of the substrate broken (D)**:

- The enzyme facilitates the breaking of bonds in the substrate, leading to the formation of products.

4. **Release of products (C)**:

- The enzyme releases the final reaction products.

5. **Free enzyme ready to bind with another substrate (B)**:

- The enzyme returns to its original form and is ready to catalyze another reaction.

Step 2: Matching the correct sequence

$$E \rightarrow \text{Substrate binding to active site}$$

$$A \rightarrow \text{Substrate enzyme complex formation}$$

$$D \rightarrow \text{Chemical bonds of the substrate broken}$$

$$C \rightarrow \text{Release of products}$$

$$B \rightarrow \text{Free enzyme ready to bind with another substrate}$$

Conclusion: The correct answer is **(4) E, A, D, C, B**.

Quick Tip

The enzyme catalytic cycle follows a defined sequence: binding of the substrate, enzyme-substrate complex formation, breakdown of chemical bonds, product release, and enzyme recycling for the next reaction.

---

196. 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-III, D-IV

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

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

Solution:

Step 1: Understanding epithelial tissue types

- **Unicellular glandular epithelium** includes **goblet cells** that secrete mucus and are found in the alimentary canal. Thus, it matches with **III**.

- **Compound epithelium** serves a protective function and is present in areas like the **moist surface of the buccal cavity**. Thus, it matches with **IV**.

- **Multicellular glandular epithelium** forms exocrine glands like the **salivary glands**. Thus, it matches with **I**.

- **Endocrine glandular epithelium** is found in glands like the **pancreas**, which secretes hormones directly into the blood. Thus, it matches with **II**.

Step 2: Matching the correct pairs

$A \rightarrow III$ (Goblet cells of alimentary canal)

$B \rightarrow IV$ (Moist surface of buccal cavity)

$C \rightarrow I$ (Salivary glands)

$D \rightarrow II$ (Pancreas)

Conclusion: The correct answer is **(2) A-III, B-IV, C-I, D-II**.

Quick Tip

Epithelial tissue is classified based on structure and function. Unicellular epithelium consists of single cells (e.g., goblet cells), while multicellular epithelium forms larger glands (e.g., salivary glands). Compound epithelium protects surfaces, and endocrine epithelium secretes hormones.

---

197. 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:

Step 1: Understanding the endocrine disorders

- **Exophthalmic goiter** (A) is caused by **hyper-secretion of thyroid hormone**, leading to symptoms such as **protruding eyeballs**. Thus, it matches with **III**.
- **Acromegaly** (B) occurs due to **excessive secretion of growth hormone**, causing abnormal growth in adults. Thus, it matches with **IV**.
- **Cushing's syndrome** (C) is caused by **excess secretion of cortisol**, leading to a characteristic **moon face** and hyperglycemia. Thus, it matches with **I**.
- **Cretinism** (D) is due to **hypo-secretion of thyroid hormone** in children, resulting in **stunted growth and mental retardation**. Thus, it matches with **II**.

Step 2: Matching the correct pairs

$A \rightarrow III$ (Hyper-secretion of thyroid hormone & protruding eyeballs)

$B \rightarrow IV$ (Excessive secretion of growth hormone)

$C \rightarrow I$ (Excess secretion of cortisol, moon face & hyperglycemia)

$D \rightarrow II$ (Hypo-secretion of thyroid hormone and stunted growth)

Conclusion: The correct answer is **(3) A-III, B-IV, C-I, D-II**.

Quick Tip

Endocrine disorders result from hormone imbalances. Exophthalmic goiter is caused by excess thyroid hormone, acromegaly by excess growth hormone, Cushing's syndrome by excess cortisol, and cretinism by thyroid hormone deficiency.

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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:

Step 1: Understanding juxta medullary nephrons

Juxta medullary nephrons are specialized nephrons located at the junction of the cortex and medulla. Their main function is to concentrate urine by creating a high osmolarity gradient

in the medulla.

Step 2: Evaluating the given options

- Option (1) is incorrect:

The renal corpuscle of juxta medullary nephrons lies **at the junction of the cortex and medulla**, not in the outer portion of the renal medulla.

- Option (2) is correct:

The **Loop of Henle of juxta medullary nephrons extends deep into the medulla**, helping in the formation of concentrated urine.

- Option (3) is incorrect:

Juxta medullary nephrons are **fewer in number** compared to cortical nephrons. Only about **15-20%** of nephrons in the kidney are juxta medullary nephrons.

- Option (4) is incorrect:

Juxta medullary nephrons are located at the **cortico-medullary junction**, while the **columns of Bertini** are extensions of the renal cortex into the medulla, not the location of nephrons.

Conclusion: The correct answer is **(2) Loop of Henle of juxta medullary nephron runs deep into medulla**.

Quick Tip

Juxta medullary nephrons play a crucial role in urine concentration. Their long loops of Henle extend deep into the medulla, allowing for efficient water reabsorption and osmotic balance.

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199. Match List I with List II related to the digestive system of a 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:

Step 1: Understanding the digestive system of a cockroach

The digestive system of a cockroach consists of three main parts: the foregut, midgut, and hindgut, with various specialized structures performing different functions.

- Crop (A-IV): The crop is a part of the foregut and is responsible for the **storage of food**.

- Gastric Caeca (B-II): The gastric caeca are **6-8 blind tubules** at the junction of the foregut and midgut. They secrete digestive enzymes.

- Malpighian Tubules (C-III): These are **100-150 thin, yellow-colored filaments** located at the junction of the midgut and hindgut, functioning in excretion.

- Gizzard (D-I): The gizzard is a muscular structure used for **grinding food**.

Step 2: Matching the correct pairs

$$A \to IV \quad \text{(Crop - food storage)}$$

$$B \to II \quad \text{(Gastric Caeca - digestive enzymes)}$$

$$C \to III \quad \text{(Malpighian Tubules - excretion)}$$

$$D \to I \quad \text{(Gizzard - grinding food)}$$

Conclusion: The correct answer is **(4) A-IV, B-II, C-III, D-I**.

Quick Tip

In cockroaches, the crop stores food, the gastric caeca secrete digestive enzymes, the Malpighian tubules excrete nitrogenous waste, and the gizzard grinds food into smaller particles for digestion.

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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:

Step 1: Understanding non-chordates

Non-chordates are animals that do not possess a notochord at any stage of their development. They include phyla such as Porifera, Cnidaria, Arthropoda, Mollusca, and Echinodermata.

Step 2: Evaluating the given statements

- Statement A is incorrect:

The presence of **pharyngeal gill slits** is a characteristic of chordates, not non-chordates.

- Statement B is correct:

Notochord is absent in non-chordates, as they do not possess a rigid rod-like structure in their body.

- Statement C is incorrect:

In non-chordates, the **central nervous system is ventral**, not dorsal. The dorsal CNS is a characteristic feature of chordates.

- Statement D is correct:

If a circulatory system is present in non-chordates, the **heart is usually dorsal**, unlike chordates where it is ventral.

- Statement E is correct:

Non-chordates **lack a post-anal tail**, whereas chordates have this feature.

Step 3: Selecting the correct answer

Since statements B, D, and E are correct, the correct answer is **(2) B, D & E only**.

Quick Tip

Chordates possess a dorsal CNS, a notochord, pharyngeal gill slits, and a post-anal tail. In contrast, non-chordates lack a notochord, have a ventral CNS, and do not have a post-anal tail.
