NEET (UG)-2024 Q4 Question Paper With Solutions

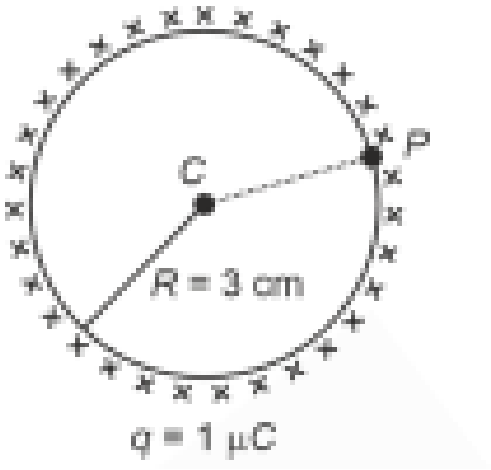
Time Allowed :3 hours 20 minutes	**Maximum Marks :**720	**Total Questions :**200

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours 20 minutes duration, and the Test Booklet contains 200 multiple-choice questions (four options with a single correct answer) from Physics, Chemistry, and Biology (Botany and Zoology). The questions in each subject are divided into two Sections (A and B):
2. Section-A shall consist of 35 questions in each subject (Questions Nos-1 to 35, 51 to 85, 101 to 135, and 151 to 185). All questions are compulsory.
3. Section-B shall consist of 15 questions in each subject (Questions Nos-36 to 50, 86 to 100, 136 to 150, and 186 to 200). In Section B, a candidate needs to attempt any 10 questions out of 15 in each subject.
4. Each question carries 4 marks. For each correct response, the candidate will get 4 marks. For each incorrect response, 1 mark will be deducted from the total score. The maximum marks are 720.
5. Use a Blue/Black Ball Point Pen only for writing particulars on this page/marking responses on the Answer Sheet.
6. Rough work is to be done in the space provided for this purpose in the Test Booklet only.
7. On completion of the test, the candidate must hand over the Answer Sheet (ORIGINAL and OFFICE copy) to the Invigilator before leaving the Room/Hall. The candidates are allowed to take away this Test Booklet with them.

1. 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) 3×10^5

(2) 1×10^5

(3) 0.5×10^5

(4) Zero

Correct Answer: (4) Zero

Solution: Step 1: Understanding the potential inside a charged spherical shell.

According to electrostatic principles, the electric potential inside a conducting spherical shell is constant and equal to the potential at the surface.

Step 2: Applying the property. Since both points C and P lie inside the shell, their potentials are the same:

$$V_C = V_P$$

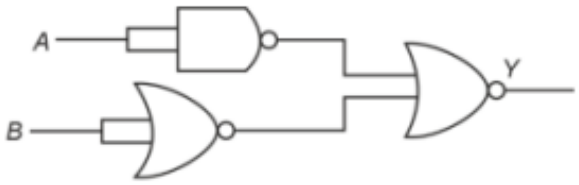
Thus, the potential difference is:

$$V_C - V_P = 0$$

Conclusion: The potential difference is zero, corresponding to option (4).

Quick Tip
The potential inside a charged spherical shell remains constant, making the potential difference between any two internal points zero.

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



(1) NAND gate

(2) NOR gate

(3) OR gate

(4) AND gate

Correct Answer: (4) AND gate

Solution: Step 1: Analyze the circuit. The given logic circuit consists of NAND and OR gates arranged in a manner that ultimately replicates the function of an AND gate.

Step 2: Logic verification. After breaking down the circuit's behavior, we find that the final output behaves like an AND gate.

Conclusion: Thus, the correct answer is (4), which is an AND gate.

Quick Tip
Break down complex logic circuits by evaluating intermediate outputs step by step.

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

(1) Interference pattern will disappear

(2) There will be a central dark fringe surrounded by a few colored fringes

(3) There will be a central bright white fringe surrounded by a few colored fringes

(4) All bright fringes will be of equal width

Correct Answer: (3) There will be a central bright white fringe surrounded by a few colored fringes

Solution: Step 1: Understanding the effect of white light in interference. A monochromatic source produces fringes of equal intensity, whereas white light consists of multiple wavelengths.

Step 2: Effect of multiple wavelengths. At the center, all wavelengths constructively

interfere, producing a white fringe. Moving outward, different wavelengths interfere at different points, producing colored fringes.

Conclusion: Thus, the correct answer is $(\mathbf{3})$, a central bright white fringe surrounded by colored fringes.

Quick Tip
In interference with white light, the central fringe is white, while surrounding fringes show colors due to varying wavelengths.

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

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

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

(3) $100N$

(4) $10(N+1)$

Correct Answer: (2) $\frac{1}{100(N+1)}$

Solution: Step 1: Use the vernier constant formula. The vernier constant (VC) is given by:

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

Since $(N+1)$ VSD = N MSD, we get:

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

Step 2: Compute the vernier constant.

$$VC = 0.1 - \frac{N}{N+1} \times 0.1 = \frac{0.1}{N+1}$$

Converting to cm:

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

Conclusion: Thus, the correct answer is $(\mathbf{2})$.

Quick Tip
For vernier calipers, use $VC = 1$ MSD $- 1$ VSD and substitute values carefully.

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

(1) 4 mm

(2) 0.4 mm

(3) 40 mm

(4) 8 mm

Correct Answer: (1) 4 mm

Solution: Step 1: Use the formula for elongation. Elongation is given by:

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

Using given values, we obtain:

$$\Delta L = \frac{8 \times 10^8 \times 1}{2 \times 10^{11}} = 4 \times 10^{-3} \text{ m} = 4 \text{ mm}$$

Conclusion: Thus, the maximum elongation is 4 mm.

Quick Tip
Use the formula $\Delta L = \frac{FL}{AY}$ for elongation and ensure correct unit conversions.

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

(1) 8.5 cm

(2) 17.5 cm

(3) 20.7 cm

(4) 72.0 cm

Correct Answer: (1) 8.5 cm

Solution: Step 1: Formula for moment of inertia of a thin rod. The moment of inertia of a thin rod of mass M and length L about an axis perpendicular to its length and passing through one end is:

$$I = \frac{ml^2}{12}$$

Step 2: Substituting the values. Using the given values of M and L: **Moment of inertia of the rod:**

$$I = \frac{ml^2}{12}$$

$$\Rightarrow 2400 = \frac{400l^2}{12}$$

$$\Rightarrow 72 = l^2$$

$$\Rightarrow l = \sqrt{72} = 8.48\,\text{cm} \approx 8.5\,\text{cm}$$

$$I = 8.5\ \text{cm}$$

Conclusion: Thus, the correct answer is $(\mathbf{1})$, 8.5 cm.

Quick Tip
Use the standard formula for the moment of inertia of a thin rod about different axes to solve similar problems.

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7. A tightly wound 100-turn coil of radius 10 cm carries a current of 7 A. The magnetic field at the center of the coil is:

(Take permeability of free space as $4\pi * 10^{-7}$ SI units)

(1) 44 mT

(2) 4.4 T

(3) 4.4 mT

(4) 44 T

Correct Answer: (3) 4.4 mT

Solution: Step 1: Magnetic field formula for a coil. The magnetic field at the center of a circular coil with N turns, radius R, and current I is given by:

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

Step 2: Substituting the values. Using $\mu_0 = 4\pi \times 10^{-7}$, $N = 100$, $I = 3$ A, and $R = 0.1$ m:

$$B = \frac{(4\pi \times 10^{-7})(100)(3)}{2(0.1)}$$

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

Conclusion: Thus, the correct answer is $(\mathbf{3})$, 4.4 mT.

Quick Tip
The magnetic field at the center of a circular coil is directly proportional to the number of turns and the current.

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

(1) 10

(2) 5

(3) 7

(4) 6

Correct Answer: (1) 10

Solution: We are given the following relationships:

$$x = 2t - 1$$

The velocity v is the time derivative of position x, so:

$$v = \frac{dx}{dt} = 2\,\text{m/s}$$

The power p is given by:

$$p = F \cdot v$$

Assuming the force $F = 5\,\text{N}$, we have:

$$p = 2 \times 5 = 10\,\text{W}$$

Quick Tip
For motion in a straight line, the velocity is the derivative of displacement with respect to time.

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9. Two bodies A and B of same mass undergo completely inelastic one dimensional collision. The body A moves with velocity v1 while body B is at rest before collision. The velocity of the system after collision is v2. The ratio v1 : v2 is

(1) $1 : 2$

(2) $2 : 1$

(3) $4 : 1$

(4) $1 : 4$

Correct Answer: (2) $2 : 1$

Solution: By Conservation of Linear Momentum:

$$\Rightarrow mv_1 = (m + m)v_2$$

Simplifying the equation:

$$\Rightarrow mv_1 = 2mv_2$$

Now, divide both sides by m:

$$\Rightarrow v_1 = 2v_2$$

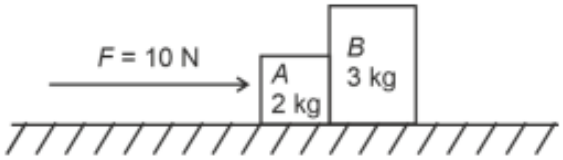
Therefore, the ratio of v_1 to v_2 is:

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

Conclusion: The correct answer is $(\mathbf{2})$, 2:1.

Quick Tip
In a completely inelastic collision, the kinetic energy is not conserved, but momentum is.

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



(1) 0

(2) 4 N

(3) 6 N

(4) 10 N

Correct Answer: (3) 6 N

Solution: From Newton's II law.

$$F_{\text{net}} = ma$$

The system consists of two blocks, and we are given the following information:

$$\text{Block A: } F - N = 2a \quad \text{or} \quad 10 - N = 2a \quad \ldots \text{(i)}$$

$$\text{Block B: } N = 3a \quad \ldots \text{(ii)}$$

To solve for acceleration a and the normal force N, we substitute the value of N from equation (ii) into equation (i):

$$10 - 3a = 2a$$

Simplifying this equation:

$$10 = 5a$$

Solving for a:

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

Now, substitute $a = 2\,\text{m/s}^2$ into equation (ii) to find N:

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

Therefore, the acceleration is $a = 2\,\text{m/s}^2$ and the normal force is $N = 6\,\text{N}$.

Quick Tip
Use $F = ma$ to find acceleration in force-related problems.

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

(1) 19.6 m/s^2

(2) 9.8 m/s^2

(3) 4.9 m/s^2

(4) 3.92 m/s^2

Correct Answer: (4) 3.92 m/s^2

Solution: Step 1: Formula for acceleration due to gravity. The acceleration due to gravity is given by:

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

where M is the mass and R is the radius.

Step 2: Compute for the planet. Since $M_p = \frac{1}{10}M_e$ and $R_p = \frac{1}{2}R_e$:

$$g_p = \frac{G \times \frac{1}{10}M_e}{\left(\frac{1}{2}R_e\right)^2}$$

$$g_p = \frac{(1/10)M_e}{(1/4)R_e^2}g_e$$

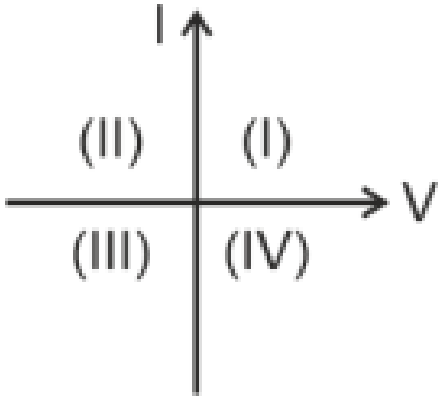
$$g_p = \frac{1}{10} \times 4g_e = \frac{4}{10}g_e = 0.4 \times 9.8 = 3.92\,\text{m/s}^2$$

Conclusion: Thus, the correct answer is (4), 3.92 m/s².

Quick Tip
The acceleration due to gravity is directly proportional to mass and inversely proportional to the square of the radius.

12. Consider the following statements A and B and choose the correct option:

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



(1) A is correct but B is incorrect.

(2) A is incorrect but B is correct.

(3) Both A and B are correct.

(4) Both A and B are incorrect.

Correct Answer: (1) A is correct but B is incorrect.

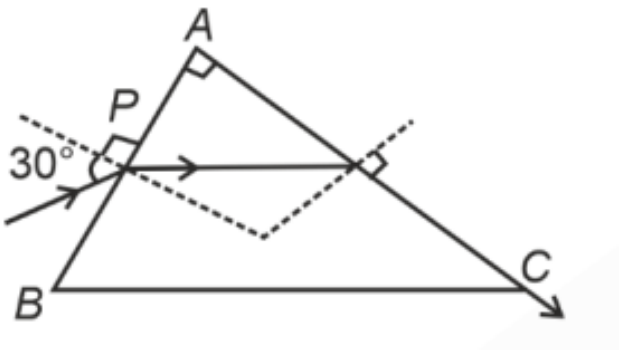
Solution: Step 1: Understanding diode behavior. Diodes allow current to flow in one direction, making statement B incorrect.

Step 2: I-V characteristic of diodes. The I-V curve of a diode is nonlinear due to threshold voltage, confirming statement A is correct.

Conclusion: Thus, the correct answer is $(\mathbf{1})$.

Quick Tip
Diodes allow unidirectional current flow, and their I-V curve is nonlinear.

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



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

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

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

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

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

Solution: In a prism, $r_1 + c = A$

$$r_1 = 90^\circ - c \quad \ldots (1)$$

From Snell's law:

$$\sin c = \frac{1}{\mu} \quad \Rightarrow \quad \cos c = \sqrt{\frac{\mu^2 - 1}{\mu^2}}$$

Now, applying Snell's law on the incidence surface:

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

Substituting the values:

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

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

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

Simplifying further:

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

On squaring both sides:

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

Solving for μ^2:

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

Finally, taking the square root:

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

Conclusion: Thus, the correct answer is $(\mathbf{2})$.

Quick Tip
For prisms, use Snell's Law at interfaces and total internal reflection if necessary.

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14. Given below are two statements:

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

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

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

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

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

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

Correct Answer: (3) Statement I is correct but Statement II is incorrect

Solution:

Step 1: Analyzing Statement I

Atoms consist of protons, neutrons, and electrons. Protons carry a positive charge, electrons carry a negative charge, and neutrons are neutral. The number of protons in an atom is equal to the number of electrons, ensuring electrical neutrality.

Mathematically, for a neutral atom:

Total charge $=$ (Number of protons$\times$Charge of proton)$+$(Number of electrons$\times$Charge of electron)

$$= (Z \times +e) + (Z \times -e) = 0$$

where Z is the atomic number. Since this equation holds true for all neutral atoms, Statement I is correct.

Step 2: Analyzing Statement II

While atoms of each element emit a characteristic spectrum, they are not necessarily stable. Many atoms exist in excited states or as isotopes with unstable nuclei (e.g., radioactive elements). Stability depends on nuclear configuration and electron arrangements.

For example: - Hydrogen emits a characteristic spectrum, but isotopes like tritium (^3H) are radioactive. - Heavy elements like uranium undergo radioactive decay, making them unstable.

Thus, while characteristic spectra are unique to each element, stability is not guaranteed. Statement II is incorrect.

Conclusion: Since Statement I is correct and Statement II is incorrect, the correct answer is $(\mathbf{3})$.

Quick Tip
Neutral atoms have an equal number of protons and electrons, ensuring no net charge. However, atomic stability depends on nuclear and electronic configurations.

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

(1) 19.8 mN

(2) 198 N

(3) 1.98 mN

(4) 99 N

Correct Answer: (1) 19.8 mN

Solution:

Given:

- Surface Tension, $T = 0.07\,\text{N/m}$
- Radius of the Disc, $R = 4.5\,\text{cm} = 0.045\,\text{m}$

The excess force due to surface tension is given by the formula:

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

Substituting the values:

$$F = 0.07 \times 2 \times 3.14 \times 0.045$$

Simplifying the calculation:

$$F = 0.07 \times 6.28 \times 0.045$$

$$F = 197.82 \times 10^{-4}$$

Thus, the force is:

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

The correct option is 1.

Quick Tip
Surface tension force is proportional to the circumference in detachment problems.

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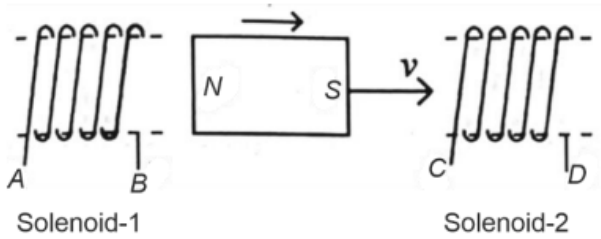
16. In the above diagram, a strong bar magnet is moving towards solenoid-2 from solenoid-1. The direction of induced current in solenoid-1 and that in solenoid-2, respectively, are through the directions:



(1) AB and DC

(2) BA and CD

(3) AB and CD

(4) BA and DC

Correct Answer: (1) AB and DC

Solution: Step 1: Apply Lenz's Law.

Lenz's Law states that the direction of induced current in a loop opposes the change in magnetic flux.

Step 2: Determine current direction.

When the magnet moves through the loop, the current induced must produce a field opposing this motion. Based on the orientation of the magnet, the induced current flows in the AB and DC directions.

Conclusion: Thus, the correct answer is (1), AB and DC.

Quick Tip
Lenz's Law states that the induced current creates a magnetic field that opposes the motion of the magnet.

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17. A particle moving with uniform speed in a circular path has:

(1) Constant velocity

(2) Constant acceleration

(3) Constant velocity but varying acceleration

(4) Varying velocity and varying acceleration

Correct Answer: (4) Varying velocity and varying acceleration

Solution: Step 1: Understanding motion in a circle.

A particle in uniform circular motion has constant speed but a changing direction.

Step 2: Velocity and acceleration.

Since velocity is a vector, it changes direction at every instant, leading to varying velocity. The acceleration is also changing because its direction always points towards the center.

Conclusion: Thus, the correct answer is (4), varying velocity and varying acceleration.

Quick Tip
In uniform circular motion, speed remains constant, but velocity and acceleration vectors continuously change direction.

18. Match List I with List II.

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

Table 1: Spectral Lines of Hydrogen and Corresponding Wavelengths

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

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

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

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

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

Solution: Step 1: Understanding hydrogen spectral series.

Each spectral series corresponds to electron transitions in a hydrogen atom.

Step 2: Match the series to their wavelength range.

Lyman series (A) lies in the Ultraviolet (III).

Balmer series (B) lies in the Visible (IV).

Paschen series (C) lies in the Infrared (II).

Brackett series (D) lies in the Infrared (I).

Conclusion: Thus, the correct answer is $(\mathbf{2})$.

Quick Tip
Spectral series are categorized based on the energy level transitions in the hydrogen atom.

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

(1) Strain and angle

(2) Stress and angle

(3) Strain and arc

(4) Angular speed and stress

Correct Answer: (1) Strain and angle

Solution: Concepts: here we are using some concepts i.e Dimensions, Solid angle, Strain, Stress, Angular speed

Explanation:

The dimension of a solid angle is a dimensionless quantity. Similarly, strain and angle are also dimensionless quantities. Strain is defined as the ratio of change in length to the original length, and angle is defined as the ratio of arc length to radius. Both of these ratios are dimensionless.

Step by Step Solution:

Step 1: Identify the dimension of solid angle. Solid angle is a dimensionless quantity.

Step 2: Identify the dimensions of the given quantities: strain, angle, stress, arc, and angular speed.

Step 3: Compare the dimensions of each quantity with that of the solid angle.

Final Answer:

(a) strain and angle

Quick Tip
Dimensionless quantities often describe ratios, such as strain and angle.

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20. An unpolarized light beam strikes a glass surface at Brewster's angle. Then

(1) The reflected light will be partially polarized.

(2) The refracted light will be completely polarized.

(3) Both the reflected and refracted light will be partially polarized.

(4) The reflected light will be completely polarized.

Correct Answer: (4) The reflected light will be completely polarized.

Solution: Step 1: Brewster's Law. At Brewster's angle, the reflected and refracted light are perpendicular.

Step 2: Nature of reflected light. According to Brewster's Law:

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

At this angle, the reflected light is completely polarized, and the refracted light is partially polarized.

Explanation:

According to **Brewster's law**, when light is incident at the Brewster angle θ_B, the reflected light is completely polarised, and the refracted light is partially polarised. Brewster's angle θ_B is given by:

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

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

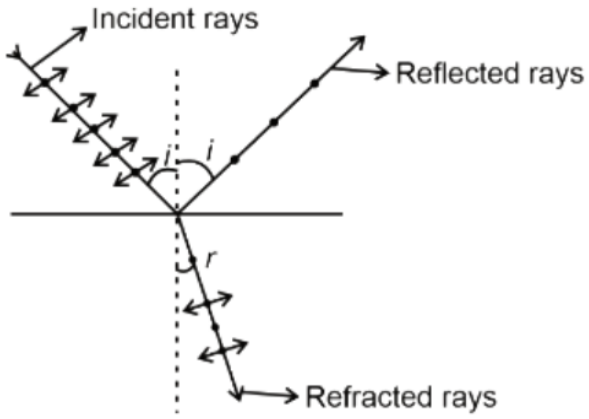

Diagram Explanation:

In the given diagram: - The incident rays are approaching the surface at the angle i. - The reflected rays are entirely polarised when the angle of incidence is equal to the Brewster angle θ_B. - The refracted rays are partially polarised.

Conclusion:

At the Brewster angle: - The reflected light is completely polarised. - The refracted light is partially polarised.

Final Answer: (4) The reflected light will be completely polarised but the refracted light will be partially polarised.

Quick Tip
At Brewster's angle, the reflected light is completely polarized, while the refracted light is partially polarized.

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

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

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

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

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

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

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

(3) A is true but R is false.

(4) A is false but R is true.

Correct Answer: (3) A is true but R is false.

Solution: Step 1: Understand the Assertion (A). Gravitational force is mathematically expressed as:

$$F = G\frac{m_1 m_2}{r^2}$$

Here, F is inversely proportional to the square of the distance (r^2) between the two masses. Thus, Assertion (A) is true.

Step 2: Evaluate the Reason (R). The potential of a dipole is given by:

$$V_{\text{dipole}} = \frac{kp\cos\theta}{r^2}$$

At the axis ($\theta = 0^\circ$ or 180°):

$$V_{\text{axial}} = \pm\frac{kp}{r^2} = \pm\frac{9 \times 10^9 \times 4 \times 10^{-6}}{2^2}$$

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

A $\rightarrow$ Correct

R $\rightarrow$ False

Thus, the potential V is:

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

Conclusion: Since Assertion (A) is true but Reason (R) is false, the correct answer is option $(\mathbf{3})$.

Quick Tip
Gravitational forces are always attractive and act over a distance, not requiring contact between masses.

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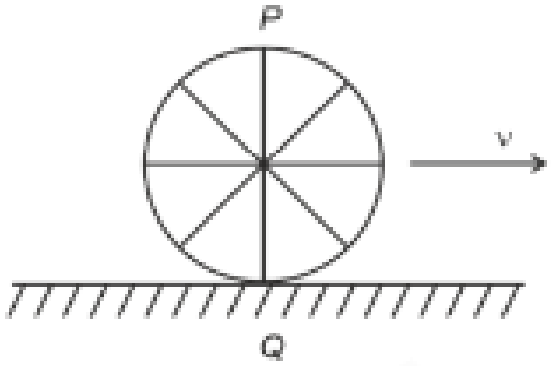
22. A wheel of a bullock cart is rolling on a level road as shown in the figure below. If its linear speed is v in the direction shown, which one of the following options is correct (P and Q are any highest and lowest points on the wheel, respectively)?



(A) Point P moves slower than point Q

(B) Point P moves faster than point Q

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

(D) Point P has zero speed

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

Solution: The velocity of a point on a rolling wheel is the vector sum of the linear velocity of the wheel's center and the tangential velocity of the point due to rotation.

- For the topmost point P, the tangential velocity due to rotation is in the same direction as the linear velocity. Thus, its speed is $v + v = 2v$.
- For the bottommost point Q, the tangential velocity is opposite to the linear velocity, resulting in a net speed of $v - v = 0$.

Thus, point P moves faster than point Q.

Quick Tip
For a wheel rolling without slipping: Topmost point speed = $2v$ (linear speed + rotational speed). Bottommost point speed = 0 (linear speed - rotational speed).

---

23. If $x = 5\sin(\pi t + \frac{\pi}{3})$ represents the motion of a particle, find the amplitude and time period of the motion.

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

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

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

(4) $5\,\text{m},\ 1\,\text{s}$

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

Solution: Step 1: Identify the amplitude. The general equation for simple harmonic motion (SHM) is:

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

Here, A is the amplitude, ω is the angular frequency, ϕ is the phase constant, and t is time. Comparing $x = 5\sin(\pi t + \frac{\pi}{3})$ with the standard equation, the amplitude is:

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

Step 2: Calculate the time period. The angular frequency ω is given as π. The time period T is related to ω by:

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

Substituting $\omega = \pi$:

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

Conclusion: The amplitude and time period of motion are 5 m and 2 s, respectively.

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

---

24. A logic circuit provides the output Y as per the truth table given below. Identify the circuit.

Input A	Input B	Output Y
0	0	0
0	1	1
1	0	1
1	1	0

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

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

(C) $\overline{B}$

(D) B

Correct Answer: (3) $\overline{B}$

Solution: From the truth table:

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

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

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

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

From the table, Y is 1 when $B = 0$, irrespective of A. This indicates $Y = \overline{B}$.

Thus, the Boolean expression for Y is $\overline{B}$.

Quick Tip
For truth tables, write expressions by observing the conditions under which output is 1 or 0.

---

25. 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, $p = \frac{h\nu}{c}$.

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

E: Photon possesses positive charge.

(A) A and B only

(B) A, B, C and D only

(C) A, C and D only

(D) A, B, D and E only

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

Solution: Step 1: Evaluate each statement.

A : Electromagnetic waves propagate at c in vacuum. This is correct.

B : They consist of mutually perpendicular electric and magnetic fields. This is correct.

C : The fields oscillate in phase. This is correct.

D : The energy is equally distributed between the electric and magnetic fields. This is correct.

Step 2: Analyze the options.

Statements A, B, C, and D are correct, corresponding to option $(\mathbf{2})$.

Quick Tip
Electromagnetic waves have perpendicular electric and magnetic fields oscillating in phase, propagating at c in vacuum.

---

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

(1) T

(2) $4T$

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

(4) $\sqrt{2}T$

Correct Answer: (2) $4T$

Solution:

The tension in the string is proportional to the square of the velocity. This can be written as:

$$T \propto v^2$$

This implies that the tension T is directly proportional to the square of the velocity v. To represent the relationship mathematically, we introduce a constant of proportionality k:

$$T = kv^2$$

Now, consider a case where the velocity v changes. Let the initial velocity be v, and then the velocity is doubled, i.e., $v \to 2v$.

Substituting the new velocity $2v$ into the expression for tension, we get:

$$T' = k(2v)^2 = k \cdot 4v^2$$

Comparing the new tension T' with the original tension T:

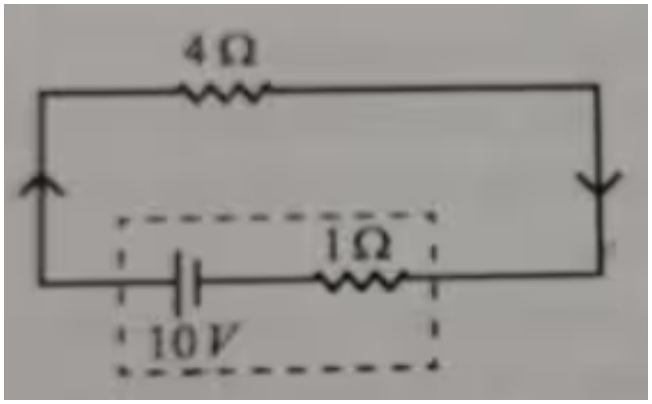
$$T' = 4T$$

Hence, when the velocity is doubled, the tension becomes four times the original tension. In other words, $T \to 4T$.

Quick Tip
The time period of a bob in circular motion decreases with increasing tension in the string, following $$T \propto v^2$$.

---

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



(1) $4\,\text{V}$

(2) $6\,\text{V}$

(3) $8\,\text{V}$

(4) $10\,\text{V}$

Correct Answer: (3) $8\,\text{V}$

Solution:

The circuit consists of a 10 V battery, a 4 Ω resistor, and a 1 Ω resistor in series.

First, we calculate the total current I using the formula for series circuits:

$$I = \frac{E}{R + r}$$

where: - $E = 10\,\text{V}$ is the electromotive force (EMF), - $R = 4\,\Omega$ is the resistance of the 4 Ω resistor, and - $r = 1\,\Omega$ is the resistance of the 1 Ω resistor.

Substituting the values:

$$I = \frac{10}{4 + 1} = \frac{10}{5} = 2\,\text{A}$$

Thus, the current I in the circuit is $2\,\text{A}$.

Next, we calculate the potential drop across the 1 Ω resistor, denoted as V_T. The potential drop is given by:

$$V_T = E - I \cdot r$$

Substituting the known values:

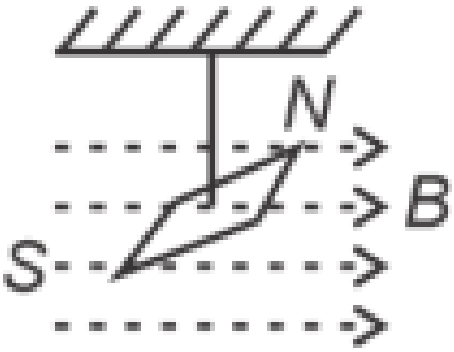
$$V_T = 10 - 2 \cdot 1 = 10 - 2 = 8\,\text{V}$$

Thus, the potential drop across the $1\ \Omega$ resistor is $8\,\text{V}$.

Quick Tip
The terminal voltage of a battery is reduced due to the voltage drop across its internal resistance: $V = \text{emf} - Ir$.

---

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



(1) $5\pi^2$

(2) $128\pi^2$

(3) $50\pi^2$

(4) $1280\pi^2$

Correct Answer: (4) $1280\pi^2$

Solution:

We are given the following values:

$$B = 0.049\,\text{T}, \quad f = \frac{20}{5} = 4\,\text{Hz}$$

$$I = 9.8 \times 10^{-6}\,\text{kg m}^2$$

$$M = x \times 10^{-5}\,\text{A m}^2$$

The formula for frequency f is given by:

$$f = \frac{1}{2\pi}\sqrt{\frac{MB}{I}}$$

Substituting the known values:

$$M = \frac{f^2 I(4\pi^2)}{B} = \frac{16 \times 4\pi^2 \times 98 \times 10^{-7}}{49 \times 10^{-3}}$$

Simplifying the expression:

$$x \times 10^{-5} = 128\pi^2 \times 10^{-4}$$

Therefore:

$$x = 1280\pi^2$$

Quick Tip
The torque on a magnetic dipole depends on the dipole moment, magnetic field strength, and the angle between them: $\tau = MB\sin\theta$.

---

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

(1) $26\,\Omega$

(2) $52\,\Omega$

(3) $55\,\Omega$

(4) $60\,\Omega$

Correct Answer: (2) $52\,\Omega$

Solution:

Each part of the wire has resistance $R_1 = \frac{100}{10} = 10\,\Omega$.

Step 1: The first 5 parts are connected in series. The total resistance for resistors connected in series is the sum of their individual resistances. Therefore:

$$R_s = 5 \cdot 10 = 50\,\Omega.$$

Step 2: The next 5 parts are connected in parallel. The total resistance for resistors connected in parallel is given by:

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

Since all resistors have the same value, this simplifies to:

$$\frac{1}{R_p} = 5 \cdot \frac{1}{10} = \frac{5}{10} = \frac{1}{2}.$$

Hence, the resistance for the parallel combination is:

$$R_p = \frac{10}{5} = 2\,\Omega.$$

Step 3: The total resistance is the sum of the series resistance and parallel resistance.

Therefore:

$$R_{\text{total}} = R_s + R_p = 50 + 2 = 52\,\Omega.$$

Thus, the total resistance of the wire is $52\,\Omega$.

Quick Tip
When identical resistors are connected in parallel, the effective resistance is given by $\frac{R}{n}$, where n is the number of resistors.

---

30. Match List-I with List-II:

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

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

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

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

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

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

Solution: Magnetic Properties and Magnetic Susceptibility Explanation:

To correctly match the materials with their respective magnetic susceptibilities, it is important to understand the characteristics of each type of material:

Diamagnetic materials have a small negative susceptibility (X).

Ferromagnetic materials exhibit a very high positive susceptibility $(X >> 1)$.

Paramagnetic materials show a small positive susceptibility $(0 < X < \epsilon)$.

Non-magnetic materials have zero susceptibility (X=0).

Step-by-Step Solution:

Step 1:

Determine the susceptibility of diamagnetic materials: $0 > \chi \geq -1$ (a small negative value).

Step 2:

Determine the susceptibility of ferromagnetic materials: $\chi \gg 1$ (a very high positive value).

Step 3:

Determine the susceptibility of paramagnetic materials: $0 < \chi < \epsilon$ (a small positive value).

Step 4:

Determine the susceptibility of non-magnetic materials: $\chi = 0$ (a zero value).

Step 2: Match the lists. Based on these properties, the correct match is:

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

Conclusion: The correct matching is option (1).

Quick Tip
Diamagnetic, paramagnetic, ferromagnetic, and superconducting materials exhibit distinct magnetic properties. Memorize these for quick recall.

---

31. In the nuclear emission stated above, the mass number and atomic number of the resulting nucleus will be:

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

(1) 280, 81

(2) 286, 80

(3) 288, 82

(4) 286, 81

Correct Answer: (4) $286,\ 81$

Solution: Step 1: Analyze the effect of alpha emission. In an alpha (α) emission: - The mass number (A) decreases by 4. - The atomic number (Z) decreases by 2.

Step 2: Apply the changes. Given initial nucleus properties: - Initial mass number (A) = 290 - Initial atomic number (Z) = 83

After alpha emission:

$$A' = A - 4 = 290 - 4 = 286$$

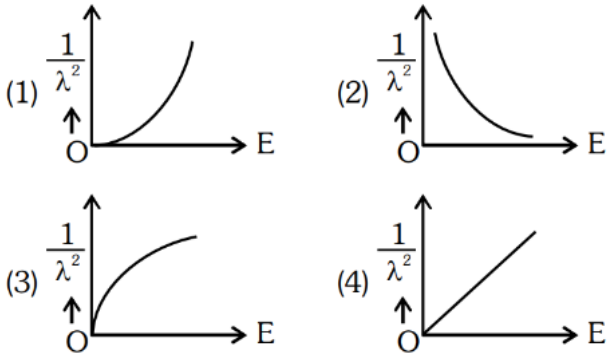
$$Z' = Z - 2 = 83 - 2 = 81$$

Conclusion: The resulting nucleus has a mass number 286 and an atomic number 81, corresponding to option (4).

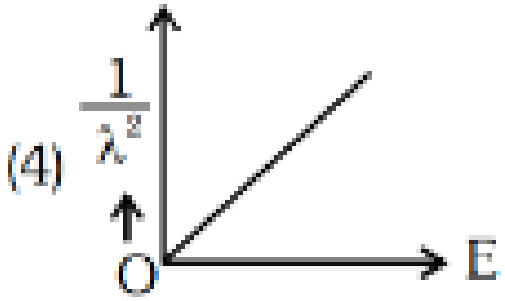
Quick Tip
In alpha decay, the mass number decreases by 4, and the atomic number decreases by 2.

---

32. The graph which shows the variation of $\frac{1}{\lambda^2}$ with stopping potential V for a photoelectric experiment is:



Correct Answer: (4)



Solution: Step 1: Recall the photoelectric equation. The photoelectric equation is:

$$eV = h\nu - \phi$$

where: - e is the electron charge, - V is the stopping potential, - h is Planck's constant, - ν is the frequency of incident light, - ϕ is the work function.

Step 2: Relate frequency to wavelength. Using $\nu = \frac{c}{\lambda}$, we have:

$$eV = h\frac{c}{\lambda} - \phi$$

Rewriting:

$$V = \frac{hc}{e}\frac{1}{\lambda} - \frac{\phi}{e}$$

Step 3: Analyze the graph. Plotting $\frac{1}{\lambda}$ against V gives a straight line with: - A positive slope $\frac{hc}{e}$, - A negative intercept $-\frac{\phi}{e}$ on the V-axis.

Conclusion: The graph is linear with a positive intercept, corresponding to option (4).

Quick Tip
The photoelectric equation predicts a linear relationship between stopping potential and $\frac{1}{\lambda^2}$.

---

33. In an ideal transformer, the turns ratio is $\frac{N_p}{N_s} = \frac{1}{2}$. The ratio VS : VP is equal to (the symbols carry their usual meaning) :

(1) $1 : 2$

(2) $2 : 1$

(3) $1 : 1$

(4) $1 : 4$

Correct Answer: (2) $2 : 1$

Solution: Recall the transformer equation. For an ideal transformer, the relationship between the primary voltage (V_p) and the secondary voltage (V_s) is given by:

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

where:

N_p and N_s are the number of turns in the primary and secondary coils, respectively.

For an ideal transformer:

The voltage ratio is related to the turns ratio by the following equation:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = 2:1$$

where: V_s is the secondary voltage,

V_p is the primary voltage,

N_s is the number of turns in the secondary coil,

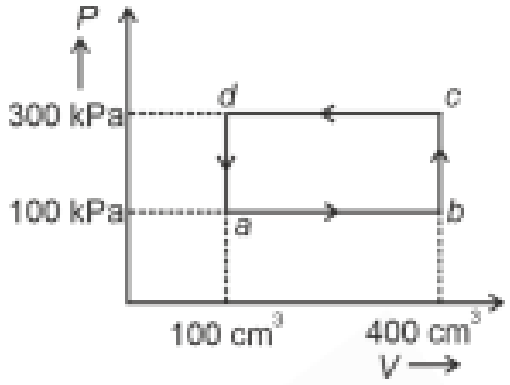
N_p is the number of turns in the primary coil.

Conclusion: For this ideal transformer, the ratio of the secondary voltage to the primary voltage is equal to the ratio of the number of turns in the secondary coil to the number of turns in the primary coil, which is $2:1$.

Quick Tip
In an ideal transformer, the voltage ratio equals the turns ratio: $\frac{V_p}{V_s} = \frac{N_p}{N_s}$.

---

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



(1) Zero

(2) $30\,\text{J}$

(3) $-90\,\text{J}$

(4) $-60\,\text{J}$

Correct Answer: (1) Zero

Solution: Step 1: Analyze the thermodynamic cycle. The work done in a thermodynamic

process is the area enclosed by the cycle on a $P - V$ diagram. For a closed cycle:

$$W_{\text{net}} = Q_{\text{net}}$$

where Q_{net} is the net heat exchanged.

Step 2: Apply the first law of thermodynamics. The first law of thermodynamics states:

$$\Delta U = Q - W$$

For a complete cycle, the internal energy (U) returns to its initial value, so $\Delta U = 0$. This implies:

$$Q_{\text{net}} = W_{\text{net}}$$

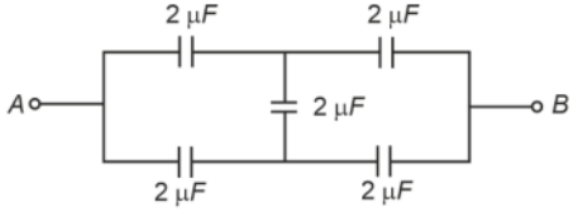
Since the net heat exchanged in the cycle is zero, the net work done is also zero.

Conclusion: The net work done during the complete cycle is 0, corresponding to option $(\mathbf{1})$.

Quick Tip
For a complete thermodynamic cycle, the internal energy change is zero, making the net work done equal to the net heat exchanged.

---

35. In the following circuit, the equivalent capacitance between points A and B is:



(1) $2\,\mu$F

(2) $1\,\mu$F

(3) $0.5\,\mu$F

(4) $4\,\mu$F

Correct Answer: (1) $2\,\mu$F

Solution: Step 1: Simplify the circuit. Two $2\,\mu$F capacitors are connected in series. The equivalent capacitance (C_{series}) is:

$$\frac{1}{C_{\text{series}}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{2} + \frac{1}{2} = 1\,\mu\text{F}$$

Step 2: Calculate the total capacitance. The C_{series} of $1\,\mu$F is connected in parallel with another $1\,\mu$F. The total capacitance is:

$$C_{\text{total}} = C_{\text{series}} + C_3 = 1 + 1 = 2\,\mu\text{F}$$

Conclusion: The equivalent capacitance between A and B is $2\,\mu$F, corresponding to option $(\mathbf{1})$.

Quick Tip
For capacitors in series, use $\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$. For capacitors in parallel, add them directly.

SECTION-B

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

A. the charge stored in it, increases.

B. the energy stored in it, decreases.

C. its capacitance increases.

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

E. the product of charge and voltage increases.

Choose the most appropriate answer from the options given below:

(1) A, B and E only

(2) A, C and E only

(3) B, D and E only

(4) A, B and C only

Correct Answer: (2) A, C and E only

Solution: Step 1: Effect of reducing the plate separation. The capacitance (C) of a parallel plate capacitor is given by:

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

where: - ε is the permittivity of the dielectric, - A is the area of the plates, - d is the distance between the plates.

When d decreases, C increases proportionally.

Step 2: Analyze the energy and charge. - The energy stored in the capacitor is:

$$U = \frac{1}{2}\frac{Q^2}{C}$$

If C increases, U decreases for a constant charge Q. - The potential difference across the plates is:

$$V = \frac{Q}{C}$$

If C increases, V decreases for a constant Q.

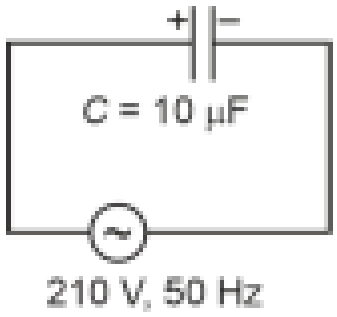
Step 3: Identify correct statements. Based on these principles, the correct statements are $A, C,$ and E.

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

Quick Tip
The capacitance of a parallel plate capacitor is inversely proportional to the plate separation (d).

---

37. A $10\,\mu$F capacitor is connected to a 210 V, 50 Hz AC supply. What is the peak current in the circuit?



(1) 0.58 A

(2) 0.93 A

(3) 1.20 A

(4) 0.35 A

Correct Answer: (2) 0.93 A

Solution:

Capacitive Reactance and Peak Current Calculation:

We are given the following data:

$$f = 50\,\text{Hz}, \quad C = 10 \times 10^{-6}\,\text{F}, \quad V_{\text{rms}} = 210\,\text{V}.$$

Step 1: Capacitive Reactance Calculation

The formula for capacitive reactance X_C is given by:

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

Substituting the values:

$$X_C = \frac{1}{2 \times 3.14 \times 50 \times 10^{-6}} = \frac{1000}{3.14} \approx 318.47\,\Omega.$$

Step 2: RMS Current Calculation

The RMS (root mean square) current is given by:

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{X_C}.$$

Substituting the values:

$$I_{\text{rms}} = \frac{210}{318.47} \approx 0.659\,\text{A}.$$

Step 3: Peak Current Calculation

The peak current I_{peak} is related to the RMS current by:

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

Substituting the values:

$$I_{\text{peak}} = \sqrt{2} \times 0.659 \approx 0.932\,\text{A}.$$

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

Quick Tip
The peak current in an AC circuit depends on the capacitive reactance: $I_{\text{peak}} = \frac{V_{\text{peak}}}{X_C}$.

---

38. A force defined by $F = \alpha t^2 + \beta t$ acts on a particle. What is the dimension of the ratio $\frac{\alpha t}{\beta}$?

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

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

(3) $\alpha\beta t$

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

Correct Answer: (2) $\frac{\alpha t}{\beta}$

Solution: Step 1: Dimensional analysis of force. The force is given as $F = \alpha t^2 + \beta t$. The dimensions of force are:

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

Step 2: Analyze α and β. From the term αt^2:

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

From the term βt:

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

Step 3: Dimension of $\frac{\alpha t}{\beta}$. The ratio is:

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

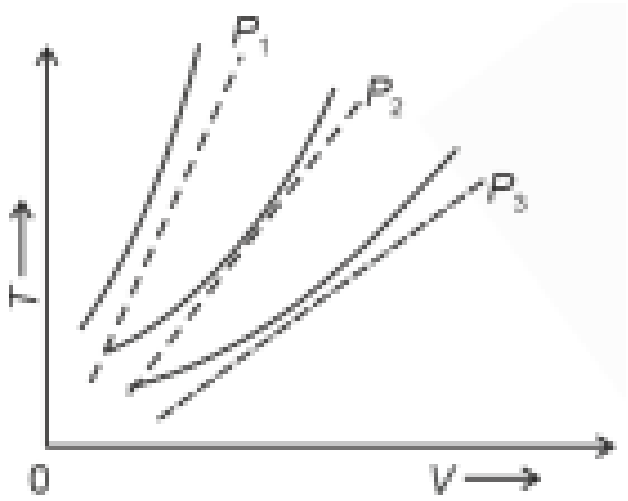
Thus, $\frac{\alpha t}{\beta}$ is dimensionless.

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

Quick Tip
Dimensional analysis helps verify the consistency of physical quantities and determine unknown dimensions.

---

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



(1) $P_3 > P_2 > P_1$

(2) $P_1 > P_3 > P_2$

(3) $P_2 > P_1 > P_3$

(4) $P_1 > P_2 > P_3$

Correct Answer: (4) $P_1 > P_2 > P_3$

Solution: Step 1: Analyze the isothermal behavior. For an ideal gas, the equation of state is:

$$PV = nRT$$

At constant temperature (T), the relationship becomes:

$$P \propto \frac{1}{V}$$

For a fixed number of moles, $V \propto T/P$. At a given temperature, as pressure increases, the slope of the $T - V$ curve (from the origin) decreases. Thus:

$$P_1 > P_2 > P_3 \quad \text{(higher pressure corresponds to a steeper curve).}$$

Quick Tip
In $T - V$ graphs, higher pressure corresponds to steeper curves because $V \propto \frac{1}{P}$ at constant T.

---

40. An iron bar of length L has magnetic moment M. It is bent at the middle of its

length such that the two arms make an angle 60degree with each other. The magnetic moment of this new magnet is :

(1) M

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

(3) $2M$

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

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

Solution: Step 1: Formula for magnetic moment. The magnetic moment (M) of a bar magnet is given by:

$$M = mL$$

where: - m is the pole strength, - L is the length of the magnet.

Step 2: Effect of halving the length. If the length (L) is reduced to $\frac{L}{2}$, the new magnetic moment (M') becomes:

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

Conclusion: The new magnetic moment is $\frac{M}{2}$, corresponding to option $(\mathbf{2})$.

Quick Tip
The magnetic moment of a bar magnet is directly proportional to its length.

---

41. 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) There is no current

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

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

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

Correct Answer: (2) Displacement current of magnitude equal to I flows in the same direction as I

Solution: Step 1: Understanding displacement current. Displacement current is a concept introduced by Maxwell to account for the changing electric field in a capacitor. It arises in the gap between the plates of a capacitor when the electric field changes due to the

changing charge on the plates. This displacement current is equal in magnitude to the conduction current in the circuit.

Step 2: Applying the concept. In this case, as the battery charges the capacitor through the resistor, the current I in the circuit produces a displacement current I_d between the capacitor plates. According to Maxwell's equation, the displacement current I_d is equal to the conduction current I and flows in the same direction as I.

$$I_d = I$$

Thus, the displacement current has the same magnitude and direction as the current in the circuit, corresponding to option $(\mathbf{2})$.

Conclusion: The correct answer is $(\mathbf{2})$, where the displacement current is equal in magnitude to the conduction current and flows in the same direction.

Quick Tip
The displacement current in a capacitor equals the conduction current and flows in the same direction as it.

---

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

(1) 5×10^3 N

(2) 50×10^3 N

(3) 100×10^3 N

(4) 2×10^3 N

Correct Answer: (2) 50×10^3 N

Solution: Step 1: Formula for thermal stress. The compressive force developed due to thermal expansion is given by the formula:

$$F = \frac{\Delta L \cdot Y \cdot A}{L}$$

where F is the force, ΔL is the change in length, Y is Young's modulus, A is the cross-sectional area, and L is the original length of the bar.

Step 2: Calculating the change in length. The change in length ΔL due to thermal expansion is:

$$\Delta L = L \cdot \alpha \cdot \Delta T$$

where α is the coefficient of linear thermal expansion and ΔT is the change in temperature. Substituting the values:

$$\Delta L = 1 \cdot 10^{-5} \cdot (100 - 0) = 10^{-3}\,\text{m}$$

Step 3: Substituting values into the formula. Now, substitute ΔL, Y, A, and L into the force equation:

$$F = \frac{10^{-3} \cdot 0.5 \times 10^{11} \cdot 10^{-3}}{1} = 50 \times 10^3\,\text{N}$$

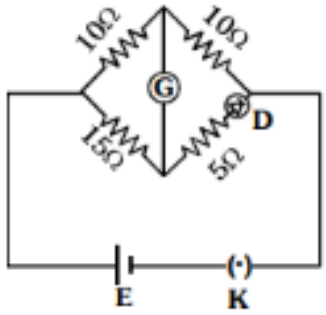
Conclusion: The correct answer is $(\mathbf{2})$, where the compressive force is 50×10^3 N.

Quick Tip
The thermal force is calculated using the change in length, Young's modulus, cross-sectional area, and the original length of the bar.

---

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

(1)



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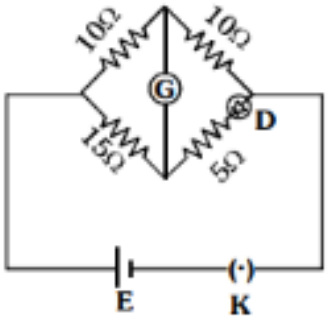

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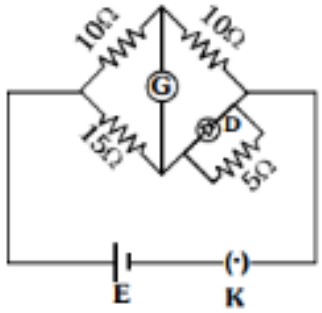
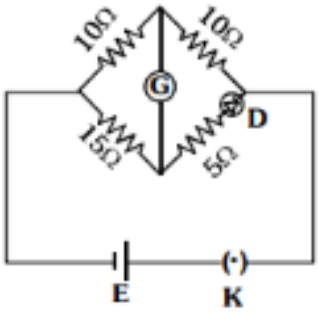


(4)



Correct Answer: (1) The first circuit

Solution: Step 1: Understanding the Wheatstone Bridge.

A Wheatstone bridge is a circuit used to measure an unknown resistance by balancing two legs of a bridge circuit. The bridge is balanced when the ratio of resistances in one leg equals the ratio in the other leg.

Step 2: Analyzing the circuits.

The correct circuit for achieving bridge balance is the one where the resistances are arranged

in a way that allows the detection of an imbalance. In this case, the first circuit satisfies the Wheatstone bridge condition.

Conclusion:

The correct answer is (1), the first circuit achieves bridge balance.

Quick Tip
A Wheatstone bridge is balanced when the ratios of resistances in opposite legs are equal, allowing the measurement of an unknown resistance.

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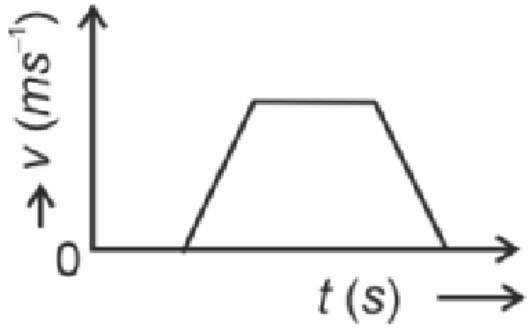
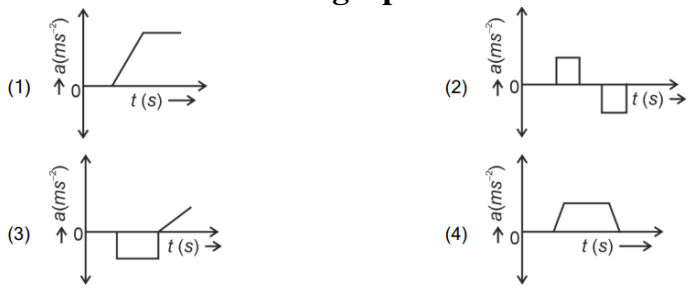
44. The velocity v – time t plot of the motion of a body is shown below:



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



Correct Answer: (3) The third graph

Solution: Step 1: Understanding the velocity-time graph. The velocity-time graph shows that the velocity increases initially, then remains constant for a period, and finally decreases at a constant rate.

Step 2: Analyzing the acceleration. Acceleration is the rate of change of velocity with respect to time. The acceleration will be positive during the increasing velocity part, zero during the constant velocity part, and negative during the decreasing velocity part.

Conclusion: The correct acceleration-time graph is the third graph, which shows positive,

zero, and negative acceleration corresponding to the motion described in the velocity-time graph.

Quick Tip
Acceleration is the derivative of velocity with respect to time and reflects changes in the motion of the object.

---

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

(1) 34

(2) 28

(3) 17

(4) 32

Correct Answer: (2) 28

Solution: Step 1: Formula for magnifying power.

The magnifying power M of a telescope is given by the formula:

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

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

Step 2: Substituting values.

Given $f_o = 140\,\text{cm}$ and $f_e = 5.0\,\text{cm}$, we can calculate the magnifying power as:

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

Conclusion: The magnifying power of the telescope is 28, corresponding to option $(\mathbf{2})$.

Quick Tip
The magnifying power of a telescope is the ratio of the focal length of the objective to the focal length of the eyepiece.

---

46. The minimum energy required to launch a satellite of mass m from the surface of

Earth of mass M and radius R in a circular orbit at an altitude of $2R$ from the surface of the Earth is:

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

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

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

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

Correct Answer: (1) $\frac{5GmM}{6R}$

Solution: Step 1: Formula for the energy required to launch the satellite. The total energy required to launch a satellite into orbit is the sum of the gravitational potential energy and the kinetic energy of the satellite. The total mechanical energy E of a satellite in a circular orbit is given by:

$$E = -\frac{GmM}{2r}$$

where r is the distance from the center of the Earth, which is $3R$ in this case (because the altitude is $2R$).

Step 2: Substituting values. The distance $r = 3R$, so the minimum energy required to launch the satellite is:

$$E = -\frac{GmM}{2 \cdot 3R} = -\frac{GmM}{6R}$$

Step 3: Energy required to launch the satellite. The energy required to launch the satellite from the surface of Earth to this orbit is the difference between the final energy and the initial energy (which is zero at the surface). Thus, the energy required is:

$$\text{Energy required} = \frac{5GmM}{6R}$$

Conclusion: The minimum energy required to launch the satellite is $\frac{5GmM}{6R}$, corresponding to option $(\mathbf{1})$.

Quick Tip
The energy required to launch a satellite into orbit depends on the gravitational potential energy and the kinetic energy at that orbit.

---

47. If the mass of the bob in a simple pendulum is increased to thrice its original mass

and its length is made half its original length, then the new time period of oscillation is $\frac{x}{2}$ times its original time period. Then the value of x is:

(1) $\sqrt{3}$

(2) $\sqrt{2}$

(3) $2\sqrt{3}$

(4) 4

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

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

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

where: - T is the time period, - l is the length of the pendulum, - g is the acceleration due to gravity.

Now, consider a situation where the length of the pendulum is halved. Let the new time period be T', and the new length be $\frac{l}{2}$. The new time period T' can be written as:

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

This simplifies to:

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

where x is a constant. By comparing both sides of the equation, we find that:

$$x = \sqrt{2}$$

Thus, when the length is halved, the time period becomes $\frac{T}{\sqrt{2}}$, and the constant $x = \sqrt{2}$.

Quick Tip
The time period of a simple pendulum depends on its length, not on the mass of the bob.

---

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

(A) Hold the sheet there if it is magnetic.

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

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

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

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

(1) B and D only

(2) A and C only

(3) A, C and D only

(4) C only

Correct Answer: (2) A and C only

Solution: A magnetic sheet requires a force to hold it in place. This happens because of the interaction between the magnetic field and the magnetic material. The material experiences a force that tends to pull it in the direction of the magnetic field lines. The force is generally related to the magnetic field intensity B and the properties of the material, including its magnetic permeability.

For a magnetic material, the force required to hold it in place is often calculated using the following general equation:

$$F = \frac{\mu_0 A(B_2^2 - B_1^2)}{2}$$

where: - μ_0 is the permeability of free space, - A is the area of the magnetic sheet, - B_2 and B_1 are the magnetic field strengths before and after the material is placed.

This force holds the magnetic sheet in its position to maintain the magnetic equilibrium and prevent movement due to magnetic forces.

Eddy Currents and Motion:

On the other hand, when a conducting sheet is exposed to a changing magnetic field, it develops eddy currents within the material. According to Faraday's Law of Induction, a time-varying magnetic field induces a circulating current in the conductor. These eddy currents generate their own magnetic field that opposes the change in the applied magnetic field (Lenz's Law).

The induced eddy currents produce a force that can cause motion in the conducting sheet.

The magnitude of the force is related to the rate of change of the magnetic field, the electrical conductivity of the sheet, and its dimensions. The induced currents are given by:

$$\mathcal{E} = -\frac{d\Phi}{dt}$$

where: - $\mathcal{E}$ is the induced electromotive force (emf), - Φ is the magnetic flux through the loop. For the induced currents to produce motion, the conducting sheet must have an area that interacts with the changing magnetic field. The resulting force can cause movement of the sheet in the direction opposite to the applied magnetic field change, as per Lenz's law.
Hence (2) A and C only are correct

Quick Tip
Magnetic forces are only experienced by magnetic materials. Non-magnetic materials do not experience such forces.

---

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

(1) $1:1$

(2) $2:9$

(3) $1:2$

(4) $2:3$

Correct Answer: (2) $2:9$

Solution: The power consumed by a resistor is given by the formula:

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

where: - P is the power consumed, - V is the voltage across the resistor, - R is the resistance. The ratio of powers consumed by two resistors A and B is given by:

$$\frac{P_A}{P_B} = \frac{R_B}{R_A}$$

Now, we are given that the resistance $R_A = 2R_B$. Substituting this into the equation:

$$\frac{P_A}{P_B} = \frac{R_B}{2R_B} = \frac{1}{2}$$

Therefore, the ratio of powers consumed by the resistors A and B is $1 : 2$.

For Series Combination:

In a series combination, the total resistance is the sum of individual resistances. The power consumed in a series combination is given by:

$$P_S = \frac{V^2}{3R_B}$$

For Parallel Combination:

In a parallel combination, the total resistance is given by the reciprocal of the sum of the reciprocals of individual resistances. The power consumed in a parallel combination is given by:

$$P_P = \frac{3V^2}{2R_B}$$

The ratio of power consumed in series combination to parallel combination is:

$$\frac{P_S}{P_P} = \frac{2}{9}$$

Quick Tip
The power output in series and parallel connections can be calculated using the total resistance of the respective configurations.

---

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

(1) They are transverse in nature

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

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

(4) They originate from charges moving with uniform speed

Correct Answer: (4) They originate from charges moving with uniform speed

Solution: Step 1: Understanding the properties of electromagnetic waves.

Electromagnetic waves have the following properties:

They are transverse waves (Option 1 is true).

The energy densities in the electric and magnetic fields are equal (Option 2 is true).

They travel with a speed of $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$, which is the speed of light in vacuum (Option 3 is true).

Step 2: Incorrect property.

Electromagnetic waves do not originate from charges moving with uniform speed. Instead, they are generated by the acceleration of charges. This is why Option 4 is incorrect.

Conclusion: The incorrect property is (4), which states that electromagnetic waves originate from charges moving with uniform speed.

Quick Tip
Electromagnetic waves are generated by the acceleration of charges, not by charges moving with uniform speed.

CHEMISTRY

SECTION-A

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

(1) O

(2) Se

(3) Te

(4) Po

Correct Answer: (4) Po

Solution: Step 1: Oxidation states of Group 16 elements.

The common oxidation states of Group 16 elements are -2, +2, +4, and +6. These elements tend to show the -2 oxidation state most often, but this is not true for all elements in the group.

Step 2: Analyzing each element.

Oxygen (O) readily forms compounds in the -2 oxidation state.

Selenium (Se) and Tellurium (Te) also commonly show the -2 oxidation state.

Polonium (Po), however, does not typically show the -2 oxidation state because it is a heavier element and prefers to form compounds in higher oxidation states, such as +2 and +4.

Conclusion: The element that does not show the -2 oxidation state is (4), Polonium.

Quick Tip
Polonium (Po) does not exhibit the -2 oxidation state, unlike the lighter Group 16 elements like oxygen and selenium.

---

52. Match List I with List II.

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

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

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

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

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

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

Solution:

Step 1: Analyzing the bond types.

Ethane (C_2H_6) has a single bond between the carbon atoms, so it has one σ-bond (A-III).

Ethene (C_2H_4) has a σ-bond and a π-bond between the carbon atoms (B-IV).

Carbon molecule C_2 (dimer of carbon) has a triple bond, consisting of one σ-bond and two π-bonds (C-II).

Ethyne (C_2H_2) has one σ-bond and one π-bond between the carbon atoms (D-I).

Conclusion: The correct matching is (3), A-III, B-IV, C-II, D-I.

Quick Tip
Ethane, ethene, ethyne, and carbon molecules all have different bonding types between carbon atoms, determined by the number of bonds.

---

53. Fehling's solution 'A' is:

(1) aqueous copper sulphate

(2) alkaline copper sulphate

(3) alkaline solution of sodium potassium tartrate (Rochelle's salt)

(4) aqueous sodium citrate

Correct Answer: (1) aqueous copper sulphate

Solution:

Step 1: Composition of Fehling's solution.

Fehling's solution is used to test for the presence of reducing sugars. It consists of two solutions, Fehling's A and Fehling's B.

Fehling's A is an aqueous solution of copper sulphate ($CuSO_4$).

Fehling's B is an alkaline solution of sodium potassium tartrate (Rochelle's salt).

Step 2: Identifying Fehling's solution 'A'.

Fehling's solution 'A' is specifically the aqueous copper sulphate solution.

Conclusion: The correct answer is (1), aqueous copper sulphate.

Quick Tip
Fehling's solution consists of two solutions, Fehling's A (copper sulphate) and Fehling's B (sodium potassium tartrate).

---

54. Match List I with List II.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Step 1: Analyzing the conversions.

For 1 mol of H_2O to O_2, the reaction involves the oxidation of water, requiring 2 Faradays per mole of O_2. Thus, 1 mol requires $2F$ (A-II).

For 1 mol of MnO_4 to Mn^{2+}, the reduction involves the transfer of 5 electrons, thus requiring $5F$ (B-IV).

For 1.5 mol of Ca from molten $CaCl_2$, the electrolysis of $CaCl_2$ requires 2 electrons per mole of Ca. For 1.5 moles, it requires $3F$ (C-I).

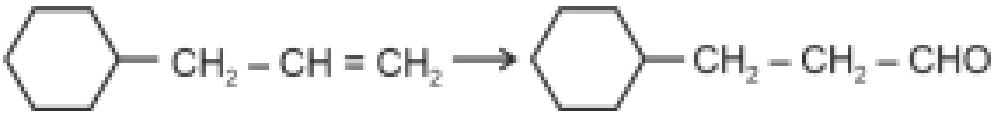
For 1 mol of FeO to Fe_2O_3, the reaction involves the oxidation of Fe^{2+} to Fe^{3+}, requiring 1 Faraday (D-III).

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

Quick Tip
The number of Faradays required in an electrochemical reaction depends on the number of electrons transferred during the reaction.

---

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



(1) (i) H_2O/H^+, (ii) CrO_3

(2) (i) BH_3, (ii) H_2O_2/OH, (iii) PCC

(3) (i) BH_3, (ii) H_2O_2/OH, (iii) alk.$KMnO_4$, (iv) H_3O^+

(4) (i) H_2O/H^+, (ii) PCC

Correct Answer: (2) (i) BH_3, (ii) H_2O_2/OH, (iii) PCC

Solution: Step 1: Understanding the transformation.

The given transformation involves the oxidation of an alkene (ethylene) to an aldehyde (acetaldehyde). The reagents must be selected to selectively oxidize the double bond of the alkene to form the aldehyde group.

Step 2: Identifying the reagents.

(i) BH_3 (Borane) is used to reduce the alkene to an alcohol.

(ii) H_2O_2/OH (Hydrogen peroxide in the presence of a base) will then oxidize the alcohol to the aldehyde.

Conclusion: The correct reagents are (**2**).

Quick Tip
Borane (BH_3) reduces alkenes to alcohols, and hydrogen peroxide (H_2O_2) oxidizes alcohols to aldehydes.

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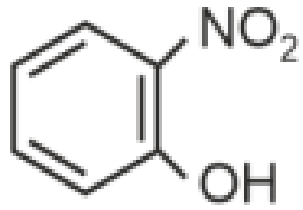
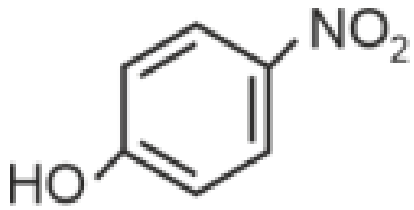
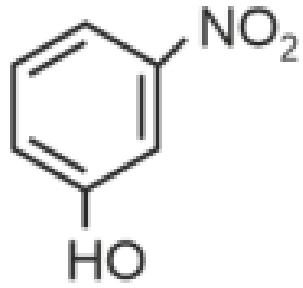
56. Intramolecular hydrogen bonding is present in:

(1) 

(2) 

(3) 

(4) HF

Correct Answer: (1)

Solution: Step 1: Understanding intramolecular hydrogen bonding. Intramolecular hydrogen bonding occurs when a hydrogen atom, attached to a highly electronegative atom (like oxygen or nitrogen), forms a bond with another electronegative atom within the same molecule.

Step 2: Analyzing the given molecules. - The molecule in option (1) shows a structure where the hydroxyl group and the nitro group are close enough to form an intramolecular hydrogen bond. - The molecules in options (2) and (3) do not have the suitable arrangement to form intramolecular hydrogen bonds. - HF, in option (4), forms intermolecular hydrogen bonds, not intramolecular.

Conclusion: The correct answer is (1), where intramolecular hydrogen bonding is present.

Quick Tip
Intramolecular hydrogen bonding occurs within a molecule, whereas intermolecular hydrogen bonding occurs between different molecules.

---

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

(1) rate constant at standard temperature

(2) probability of collision

(3) orientation of reactant molecules during collision

(4) rate constant at two different temperatures

Correct Answer: (4) rate constant at two different temperatures

Solution: Step 1: Understanding activation energy. Activation energy (E_a) is the energy required to convert reactants into products in a chemical reaction. The Arrhenius equation, which relates the rate constant to the activation energy, is:

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

where k is the rate constant, A is the pre-exponential factor, E_a is the activation energy, R is the gas constant, and T is the temperature.

Step 2: Calculating activation energy. The activation energy can be determined by knowing the rate constants at two different temperatures and using the Arrhenius equation to solve for E_a.

Conclusion: The correct answer is (4), as activation energy can be calculated using rate constants at two different temperatures.

Quick Tip

The activation energy can be determined using the rate constant at two different temperatures with the help of the Arrhenius equation.

---

58. Match List I with List II:

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

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

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

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

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

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

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

A. $[Co(NH_3)_5(NO_2)]Cl_2$: Linkage isomerism due to 'N' and 'O' linkage by N (II).

B. $[Co(NH_3)_5(SO_4)]Br$: Ionization isomerism (III).

C. $[Co(NH_3)_6][Cr(CN)_6]$: Coordination isomerism (IV).

D. $[Co(H_2O)_6]Cl_3$: Solvate isomerism (I).

Quick Tip

For identifying isomerism in complexes, focus on possible ligand exchanges or binding modes: solvate, linkage, ionization, or coordination.

---

59. 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) 750 mg

(2) 250 mg

(3) Zero mg

(4) 200 mg

Correct Answer: (2) 250 mg

Solution: Step 1: Writing the balanced chemical equation. The reaction between sodium hydroxide (NaOH) and hydrochloric acid (HCl) is:

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

From this equation, 1 mole of NaOH reacts with 1 mole of HCl.

Step 2: Moles of HCl used. The molarity of HCl solution is 0.75 M, and the volume is 25 mL = 0.025 L. The moles of HCl used are:

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

Step 3: Moles of NaOH reacted. Since the reaction is 1:1, the moles of NaOH reacted will also be 0.01875 mol.

Step 4: Mass of NaOH reacted. The molar mass of NaOH is 40 g/mol. Therefore, the mass of NaOH reacted is:

$$\text{Mass of NaOH} = 0.01875 \times 40 = 0.75\,\text{g} = 750\,\text{mg}$$

Step 5: Mass of NaOH left unreacted. Initially, there was 1 g (1000 mg) of NaOH. The mass left unreacted is:

$$\text{Mass of NaOH left} = 1000 - 750 = 250\,\text{mg}$$

Conclusion: The mass of sodium hydroxide left unreacted is 250 mg, corresponding to option $(\mathbf{2})$.

Quick Tip
The reaction between NaOH and HCl is a 1:1 reaction, meaning the moles of NaOH reacted will equal the moles of HCl used.

---

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

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

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

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

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

Correct Answer: (1) $Si < C < N < O < F$

Solution: Step 1: Electronegativity trend.

Electronegativity increases across a period and decreases down a group. Fluorine (F) is the most electronegative element, followed by oxygen (O), nitrogen (N), carbon (C), and silicon (Si).

Step 2: Correct order.

The correct order of increasing electronegativity is:

$$\text{Si} < \text{C} < \text{N} < \text{O} < \text{F}$$

Conclusion: The correct order of electronegativity is (1), $Si < C < N < O < F$.

Quick Tip
Electronegativity increases from left to right across a period and decreases from top to bottom in a group.

---

61. Match List I with List II.

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

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

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

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

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

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

Solution: Step 1: Understanding each process.

Isothermal process: Occurs at constant temperature (A-II).

Isochoric process: Occurs at constant volume (B-III).

Isobaric process: Occurs at constant pressure (C-IV).

Adiabatic process: No heat exchange (D-I).

Step 2: Matching the processes with the conditions. The correct matching is:

$$A \text{ - II}, B \text{ - III}, C \text{ - IV}, D \text{ - I}$$

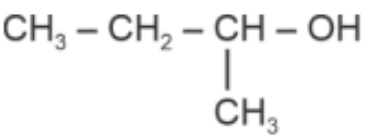
Conclusion: The correct matching is (4).

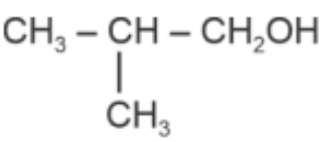
Quick Tip
Isothermal, isochoric, isobaric, and adiabatic processes are defined by the conditions of temperature, volume, pressure, and heat exchange.

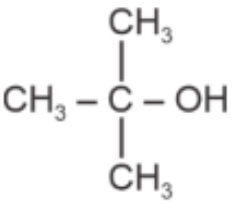
---

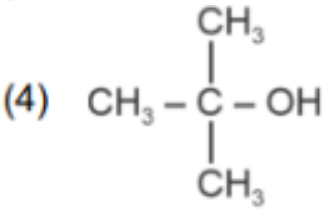
62. Which one of the following alcohols reacts instantaneously with Lucas reagent?

(1) $CH_3 - CH_2 - CH_2 - CH_2OH$

(2) 

(3) 

(4) 

(4) 

Correct Answer:

Solution: Step 1: Understanding Lucas reagent.

Lucas reagent is a mixture of concentrated HCl and $ZnCl_2$. It is used to test alcohols for their reactivity. Tertiary alcohols react immediately, secondary alcohols take time, and primary

alcohols react very slowly or not at all.

Step 2: Identifying the reactive alcohol. The tertiary alcohol reacts instantaneously with Lucas reagent, making option (4) the correct answer.

Conclusion: The alcohol that reacts instantaneously with Lucas reagent is a tertiary alcohol, corresponding to option (4).

Quick Tip
Tertiary alcohols react quickly with Lucas reagent due to the formation of a stable tertiary carbocation.

---

63. 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) $-x$

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

(3) $-4x$

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

Correct Answer: (1) $-x$

Solution: Case 1: Helium ion (He^+) For He^+, $Z = 2$ and $n = 1$.

The energy E_1 is given as $-x$.

$$E_1 = -x = -R_H \left(\frac{2^2}{1^2}\right) = -4R_H$$

From this, we can express R_H in terms of x:

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

Case 2: Beryllium ion (Be^{3+}) For Be^{3+}, $Z = 4$ and $n = 2$. We want to find the energy E_2.

$$E_2 = -R_H \left(\frac{4^2}{2^2}\right) J$$

Substitute the value of R_H from Case 1:

$$E_2 = -\frac{x}{4} \left(\frac{16}{4}\right) J$$

$$E_2 = -\frac{x}{4} \times 4J$$

$$E_2 = -xJ$$

Therefore, the energy E_2 for Be^{3+} with $n = 2$ is $-xJ$.

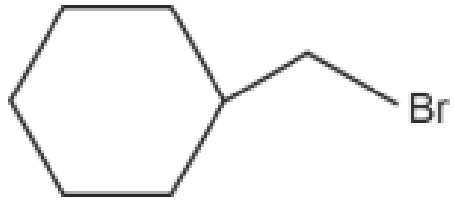
Conclusion: The energy for Be$^3+$ is also $-x$, corresponding to option (1).

Quick Tip
The energy levels of hydrogen-like atoms depend on both the atomic number and the principal quantum number.

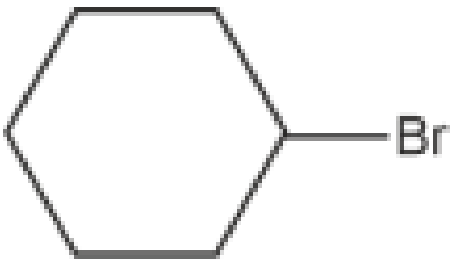
---

64. The compound that will undergo SN1 reaction with the fastest rate is:

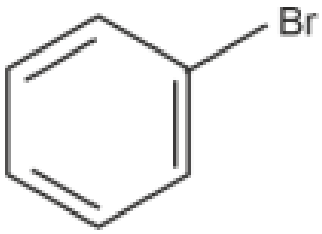
(1)



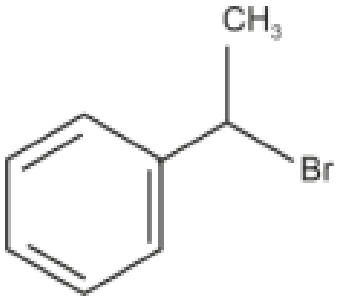
(2)

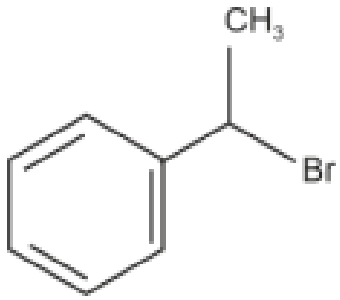


(3)



(4)



(4) 

Correct Answer:

Solution: Step 1: Understanding SN1 mechanism. The SN1 reaction proceeds through a carbocation intermediate. A more stable carbocation results in a faster reaction. Thus, the rate of the reaction increases with the stability of the intermediate carbocation.

Step 2: Analyzing the compounds. - In option (4), the compound is a tertiary alkyl halide. Tertiary carbocations are highly stable due to inductive and hyperconjugation effects. - The other compounds either have primary or secondary carbons, which will form less stable carbocations and thus react slower.

Conclusion: The compound in option (4), a tertiary alkyl halide, will undergo the fastest SN1 reaction.

Quick Tip
Tertiary carbocations are more stable than secondary or primary ones, making tertiary alkyl halides react faster in SN1 reactions.

---

65. 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) $B > A > C$

(2) $B > C > A$

(3) $A > C > B$

(4)$A > B > C$

Correct Answer: (2) $B > C > A$

Solution: Step 1: Understanding Henry's law. According to Henry's law, the solubility of a gas is inversely proportional to its Henry's law constant. A smaller Henry's law constant

means a higher solubility.

Step 2: Analyzing the gases.

Gas B has the smallest K_H value, indicating it is the most soluble in water.

Gas C has a moderate K_H value, and gas A has the largest K_H value, indicating it is the least soluble.

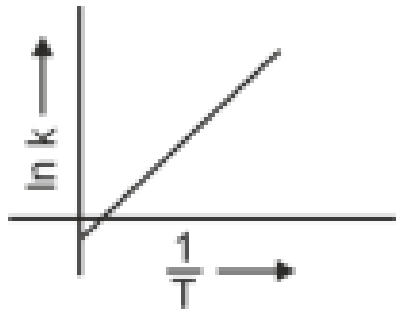
Conclusion: The order of solubility is $\mathbf{B} > \mathbf{C} > \mathbf{A}$, corresponding to option $(\mathbf{2})$.

Quick Tip
The smaller the Henry's law constant, the higher the solubility of the gas in water.

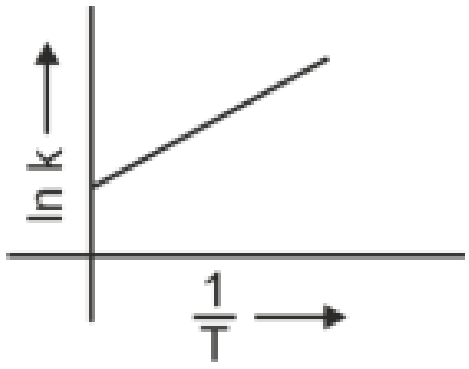
---

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

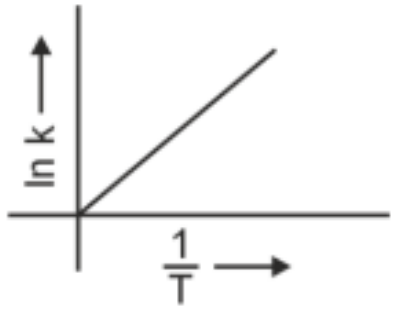
(1)



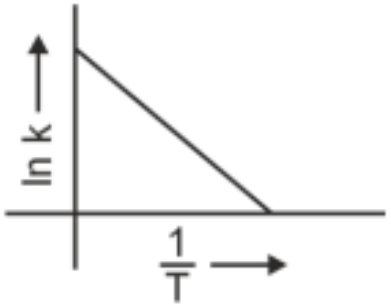
(2)



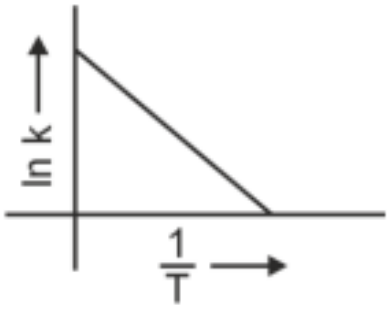
(3)



(4)



(4)



Correct Answer:

Solution: Step 1: Arrhenius equation. The Arrhenius equation is given by:

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

This equation is in the form of a straight line, where $\ln k$ is plotted against $\frac{1}{T}$.

Step 2: Interpreting the plot. The plot that gives a straight line with a negative slope is the one that is consistent with the Arrhenius equation. This corresponds to option (4).

Conclusion: The plot in option (4) is consistent with the Arrhenius equation.

Quick Tip
In the Arrhenius equation, a plot of $\ln k$ vs $\frac{1}{T}$ gives a straight line with a slope of $-\frac{E_a}{R}$.

---

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

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

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

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

(4) $2BrCl(g) \rightleftharpoons Br_2(g) + Cl_2(g)$

Correct Answer: (1)

Solution: Step 1: Understanding K_p and K_c. K_p and K_c are related by the equation:

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

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

Step 2: Identifying the correct equilibrium. For the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, there is no change in the number of moles of gas (i.e., $\Delta n = 0$), so $K_p = K_c$ is true for this equilibrium.

However, for the other reactions, $\Delta n \neq 0$, so $K_p \neq K_c$. The correct answer is option $(\mathbf{1})$.

Conclusion: In the equilibrium $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, K_p and K_c are not equal.

Quick Tip
When $\Delta n \neq 0$ in a gas-phase equilibrium, K_p and K_c are not equal.

---

68. Given below are two statements: Statement I: The boiling point of three isomeric pentanes follows the order

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

Statement II: When branching increases, the molecule attains a shape of 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 light of the above statements, choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

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

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

Correct Answer: (1)

Solution: Step 1: Understanding the boiling points of isomers. The boiling point of n-pentane is higher than isopentane, which in turn is higher than neopentane. This is because straight-chain molecules have higher boiling points due to more surface contact, which leads to stronger intermolecular forces.

Step 2: Understanding branching effect. When branching increases, the surface area of the molecule decreases, resulting in weaker London dispersion forces and a lower boiling point, as stated in Statement II.

Conclusion: Both statements are correct, so the answer is (1).

Quick Tip
Increased branching decreases the boiling point due to a decrease in surface area for intermolecular forces.

---

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

A. Tollen's reagent

B. Schiff's reagent

C. HCN

D. NH_2OH

E. $NaHSO_3$

Choose the correct options from the given below:

(1) B and C

(2) A and D

(3) B and E

(4) E and D

Correct Answer: (3) B and E

Solution:

Explanation of Glucose's Reactivity

Problem: Despite having an aldehyde group, glucose does not give Schiff's test and does not form the hydrogen sulfite addition product with $NaHSO_3$.

Explanation:

1. **Glucose Structure and Reactivity:**
    - Glucose is an aldose, meaning it contains an aldehyde group at the terminal carbon.
    - However, glucose exists predominantly in the *cyclic form* in solution, where the

aldehyde group reacts to form a *hemiacetal*.

- In the cyclic form, the aldehyde group is involved in a ring structure and is not free to react.

2. **Schiff's Test:**

   - Schiff's test is used to detect aldehyde groups. The aldehyde reacts with Schiff's reagent to give a colored product.
   - In the case of glucose, the aldehyde is part of the cyclic structure and does not react with Schiff's reagent.

3. **Hydrogen Sulfite Addition:**

   - Aldehydes can react with sodium bisulfite ($NaHSO_3$) to form an addition product.
   - Since glucose predominantly exists in the cyclic form, the aldehyde group is not free and cannot react with $NaHSO_3$.

Conclusion: The correct answer is $(\mathbf{3})$, where glucose does not react with B (Schiff's reagent) and E. $NaHSO_3$

.

Quick Tip
Glucose is a reducing sugar and reacts with various reagents like Tollen's and Schiff's reagents, but not with NH2OH.

---

70. In which of the following processes entropy increases?

(A) A liquid evaporates to vapour

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

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

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

Choose the correct answer from the options given below:

(1) A and C

(2) A, B and D

(3) A, C and D

(4) C and D

Correct Answer: (3) A, C and D

Solution: Step 1: Entropy and spontaneity. Entropy is a measure of disorder or randomness. For most processes, entropy increases when the system becomes more disordered, such as during phase changes or when the number of gas molecules increases.

General Principle: When a liquid evaporates to vapor, entropy increases.

Example 1:

$$2NaHCO_3(s) \longrightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

The number of gaseous product molecules increases, so entropy increases.

Example 2:

$$Cl_2(g) \longrightarrow 2Cl(g)$$

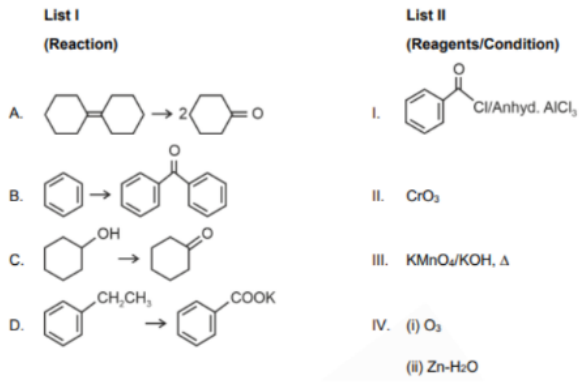
1 mole of $Cl_2(g)$ forms 2 moles of $Cl(g)$. So entropy increases.

Conclusion: Processes (A) (C) and (D) result in an increase in entropy, so the correct answer is $(\mathbf{3})$.

Quick Tip
Entropy increases when a system becomes more disordered or when the number of gas molecules increases.

---

71. Match List I with List II.



Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Step 1: Identifying the reactions and conditions.

Reaction A uses $KMnO_4$/KOH for oxidation.

Reaction B uses CrO_3 for oxidation of aldehydes.

Reaction C involves Friedel-Crafts alkylation with $AlCl_3$.

Reaction D involves ozonolysis.

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

Quick Tip
Electrophilic substitution reactions in aromatic compounds can be carried out using reagents like $AlCl_3$, while oxidations often require reagents like CrO_3 or $KMnO_4$.

---

72. Given below are two statements: Statement I: The boiling point of hydrides of Group 16 elements follows the order

$$H_2O > H_2Te > H_2Se > H_2S$$

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

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

(1) Both Statement I and Statement II are TRUE

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (1) Both Statement I and Statement II are TRUE

Solution: Step 1: Boiling points of Group 16 hydrides. The boiling points of the hydrides

of Group 16 elements follow the trend:

$$H_2O > H_2Te > H_2Se > H_2S$$

This is because water has extensive hydrogen bonding, which results in a higher boiling point compared to other hydrides.

Step 2: Understanding the molecular mass effect. Though H_2O has a lower molecular mass compared to the other hydrides, the extensive hydrogen bonding in water significantly raises its boiling point.

Conclusion: Both statements are correct, so the answer is (1).

Quick Tip
Hydrogen bonding in water increases its boiling point despite its relatively lower molecular mass compared to other Group 16 hydrides.

---

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

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

Then, which of the following is correct?

(1) Reaction is at equilibrium.

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

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

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

Correct Answer: (3)

Solution: Step 1: Checking the reaction quotient Q_c. The reaction quotient Q_c is given by:

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

Substituting the values:

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

Step 2: Comparing Q_c with K_c. Since $Q_c > K_c$, the reaction will shift toward the left (backward direction).

Conclusion: The reaction has a tendency to go in the backward direction, corresponding to option $(\mathbf{3})$.

Quick Tip
When $Q_c > K_c$, the reaction shifts toward the reactants (backward direction).

---

74. Match List I with List II.

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

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

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

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

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

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

Solution: Step 1: Identifying the quantum numbers.

m_l (magnetic quantum number) provides information about the orientation of the orbital (A-III).

m_s (spin quantum number) provides information about the orientation of the spin of the electron (B-IV).

l (azimuthal quantum number) provides information about the shape of the orbital (C-I).

n (principal quantum number) provides information about the size of the orbital (D-II).

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

Quick Tip
Each quantum number provides specific information about the orbital characteristics such as shape, orientation, size, and electron spin.

---

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

(1) n-hexane

(2) 2-methylpentane

(3) 2,3-dimethylbutane

(4) 2,2-dimethylbutane

Correct Answer: (3) 2,3-dimethylbutane

Solution: Step 1: Analyzing the molecular formula. The molecular formula is C_6H_14, which suggests a straight chain alkane. We are told the compound has two tertiary carbons. Tertiary carbons are carbon atoms bonded to three other carbon atoms.

Step 2: Identifying the structure. - 2,3-dimethylbutane fits the description because the structure includes two methyl groups attached to the second and third carbon atoms of a butane backbone, making two tertiary carbons.

Conclusion: The IUPAC name of the compound is $\mathbf{2,3}$-dimethylbutane.

Quick Tip
Tertiary carbons are carbon atoms attached to three other carbon atoms, typically found in branched structures.

---

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

(1) Crystallization

(2) Sublimation

(3) Distillation

(4) Chromatography

Correct Answer: (2) Sublimation

Solution: Step 1: Understanding sublimation. Sublimation is the process in which a substance changes directly from the solid phase to the gaseous phase without passing through the liquid phase.

Step 2: Identifying the purification technique. Sublimation is used to purify substances that can directly transition from solid to vapor, such as iodine and naphthalene.

Conclusion: The correct technique is $(\mathbf{2})$, sublimation.

Quick Tip
Sublimation is useful for purifying substances that can transition directly from solid to gas, bypassing the liquid state.

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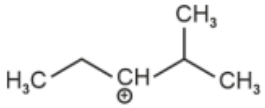
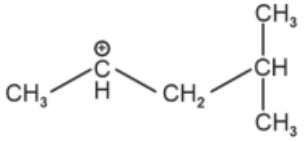
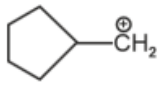
77. The most stable carbocation among the following is:

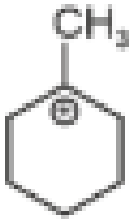
(1) 

(2) 

(3) 

(4)

Correct Answer:

(4) 

Solution: Stability of Carbocations

The stability of carbocations can be described by hyperconjugation. Greater the extent of hyperconjugation, more is the stability of the carbocation.

Carbocation Structures:

1. **Carbocation (1):**

   $CH_3 - CH^+ - CH_3$ (3 α-H)

2. **Carbocation (2):**

   $CH_3 - CH_2 - CH^+ - CH_3$ (5 α-H)

3. **Carbocation (3):**

   $C_6H_{11} - CH_2^+$ (1 α-H)

4. **Carbocation (4):**

$C_6H_{11} - CH^+ - C_6H_{11}$ (7 α-H)

Stability Order of Carbocations:

$$(4) > (2) > (1) > (3)$$

Quick Tip
Tertiary carbocations are more stable due to inductive effects and hyperconjugation from neighboring alkyl groups.

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78. Given below are two statements: Statement I: Aniline does not undergo Friedel-Crafts alkylation reaction. **Statement II:** Aniline cannot be prepared through Gabriel synthesis.
In light of the above statements, choose the correct answer from the options given below:
(1) Both statement I and Statement II are true
(2) Both Statement I and Statement II are false
(3) Statement I is correct but Statement II is false
(4) Statement I is incorrect but Statement II is true
Correct Answer: (1) Both statement I and Statement II are true
Solution: Step 1: Understanding Friedel-Crafts alkylation. Aniline does not undergo Friedel-Crafts alkylation because the amino group (-NH_2) is an electron-donating group, which deactivates the aromatic ring towards electrophilic substitution.
Step 2: Understanding Gabriel synthesis. Gabriel synthesis can be used to prepare primary amines from phthalimide, and aniline can indeed be synthesized through Gabriel synthesis.
Conclusion: Both statements are true, so the correct answer is $(\mathbf{1})$.

Quick Tip
Aniline is resistant to Friedel-Crafts alkylation due to the electron-donating nature of the amino group. Gabriel synthesis is a method for preparing primary amines, including aniline.

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79. Which reaction is NOT a redox reaction?
(1) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

(2) $2KClO_3 \rightarrow 2KCl + Cl_2$

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

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

Correct Answer: (4) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

Solution: Step 1: Identifying redox reactions. In a redox reaction, there is a transfer of electrons, with one substance being oxidized and another being reduced.

Step 2: Analyzing the reactions. - Option (1) involves the reduction of Cu^{2+} to Cu and the oxidation of Zn to Zn^{2+}, so it is a redox reaction. - Option (2) involves the reduction of $KClO_3$ to KCl and the oxidation of Cl^- to Cl_2, so it is a redox reaction. - Option (3) involves the reduction of Cl^- and the oxidation of H_2 to form HCl, so it is a redox reaction. - Option (4) is a double displacement reaction with no change in oxidation states, so it is not a redox reaction.

Conclusion: The reaction in option (4) is not a redox reaction.

Quick Tip
In a redox reaction, there is a transfer of electrons between reactants, whereas in a double displacement reaction, there is no change in oxidation states.

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80. Match List I with List II.

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

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

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

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

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

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

Solution: Step 1: Analyzing the compounds.

NH_3 has a trigonal pyramidal shape due to the lone pair on nitrogen (A-I).

Br_5 is square pyramidal in shape (B-IV).

XeF_4 has a square planar geometry due to its four bonding pairs and two lone pairs (C-II).

SF_6 has an octahedral geometry with six bonding pairs of electrons (D-III).

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

Quick Tip
The shape of molecules can be determined using VSEPR theory based on the number of bonding and lone pairs of electrons.

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

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

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

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

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

Correct Answer: (2) $Li < B < Be < C < N$

Solution: Step 1: Understanding ionization enthalpy. Ionization enthalpy refers to the energy required to remove an electron from an atom in its gaseous state. It generally increases across a period and decreases down a group.

Step 2: Analyzing the elements. - Li has the lowest ionization enthalpy in this group. - B has a relatively low ionization enthalpy because it has a half-filled p-orbital, making it more stable. - Be has a higher ionization enthalpy than B, but still lower than C and N due to its stable configuration. - C and N have higher ionization enthalpies due to their increased nuclear charge and more stable electronic configurations.

Conclusion: The correct order is $\mathbf{Li < B < Be < C < N}$, corresponding to option $(\mathbf{2})$.

Quick Tip
Ionization enthalpy increases across a period because the nuclear charge increases, making it harder to remove an electron.

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

A. Ti^{3+}

B. Cr^{2+}

C. Mn^{2+}

D. Fe^{2+}

E. Sc^{3+}

Choose the most appropriate answer from the options given below.

(1) B and D only

(2) A and E only

(3) B and C only

(4) A and D only

Correct Answer: (1) B and D only

Solution: Step 1: Understanding magnetic moment. The magnetic moment is given by the formula:

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

where n is the number of unpaired electrons.

Step 2: Identifying the ions. - Ti^{3+}, Mn^{2+}, and Sc^{3+} all have unpaired electrons that contribute to their magnetic moment. - The ions B (Mn^{2+}) and D (Fe^{2+}) have the same number of unpaired electrons, resulting in the same magnetic moment.

Conclusion: The correct answer is (1), as B and D have the same magnetic moment.

Quick Tip
The magnetic moment depends on the number of unpaired electrons in the ion. "Spin only" magnetic moment is determined by this number.

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83. 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^5 to d^2 configuration

(3) d^4 to d^5 configuration

(4) d^3 to d^5 configuration

Correct Answer: (3) d^4 to d^5 configuration

Solution: Step 1: Understanding the stability of electron configurations. The Mn^{3+} ion has a d^4 configuration, while Mn^{2+} has a more stable d^5 configuration. The transition from d^4 to d^5 configuration results in a more stable state, making the Mn^{3+}/Mn^{2+} couple more positive.

Step 2: Analyzing the other couples. The Cr^{3+}/Cr^{2+} and Fe^{3+}/Fe^{2+} couples do not exhibit such a stable transition.

Conclusion: The correct answer is $(\mathbf{3})$, d^4 to d^5 configuration.

Quick Tip
Stability of the electron configuration plays a crucial role in determining the reduction potential of a metal ion.

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84. The highest number of helium atoms is in:

(1) 4 mol of helium

(2) 4 u of helium

(3) 3 g of helium

(4) 2.271098 L of helium at STP

Correct Answer: (1) 4 mol of helium

Solution: Step 1: Understanding the number of atoms in a mole.

One mole of helium contains 6.022×10^{23} atoms.

Step 2: Analyzing the options.

Option (1) corresponds to 4 moles of helium, which contains the highest number of helium atoms.

The other options correspond to smaller quantities.

Conclusion: The highest number of helium atoms is in 4 mol of helium.

Quick Tip

A mole of any substance contains 6.022×10^{23} particles (atoms, molecules, etc.), known as Avogadro's number.

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85. Given below are two statements:

Statement I: Both $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ complexes are octahedral but differ in their magnetic behaviour. **Statement II:** $[Co(NH_3)_6]^{3+}$ is diamagnetic whereas $[CoF_6]^{3-}$ is paramagnetic.

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

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (1) Both Statement I and Statement II are true

Solution: Step 1: Understanding the complexes. Both $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ are octahedral complexes, as they have 6 ligands arranged around the central cobalt ion. However, their magnetic properties differ.

Step 2: Analyzing the magnetic behaviour. - $[Co(NH_3)_6]^{3+}$ is diamagnetic because the d^6 configuration in a low-spin octahedral field causes all electrons to pair up. - $[CoF_6]^{3-}$ is paramagnetic due to the presence of unpaired electrons in the d^6 configuration under the influence of the fluoride ligands.

Conclusion: Both statements are true, so the correct answer is $(\mathbf{1})$.

Quick Tip

Diamagnetism occurs when all electrons are paired, while paramagnetism occurs when there are unpaired electrons.

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

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

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

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

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

Correct Answer: (1) Ce^{4+} and Yb^{2+}

Solution: Step 1: Identifying the electron configuration. - Ce^{4+} has a completely empty 4f orbital, so it is diamagnetic. - Yb^{2+} has a filled 4f orbital, which makes it diamagnetic.

Step 2: Analyzing the other ions. - Ce^{3+} and Eu^{2+} have unpaired electrons, so they are paramagnetic. - Gd^{3+}, Eu^{3+}, Pm^{3+}, and Sm^{3+} also have unpaired electrons, making them paramagnetic.

Conclusion: The diamagnetic pair is Ce^{4+} and Yb^{2+}, so the correct answer is $(\mathbf{1})$.

Quick Tip
Lanthanoid ions with completely filled or empty f-orbitals are diamagnetic, while those with unpaired electrons are paramagnetic.

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87. 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, A, D, C, E

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

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

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

Correct Answer: (1) B, A, D, C, E

Solution: Step 1: Understanding the cations. - Al^{3+}, Cu^{2+}, Ba^{2+}, Co^{2+}, and Mg^{2+} belong to different groups in the periodic table. - Using qualitative analysis, we can arrange the

cations in increasing group number as follows:

$$B\ (Cu^{2+}),\ A\ (Al^{3+}),\ D\ (Co^{2+}),\ C\ (Ba^{2+}),\ E\ (Mg^{2+})$$

Conclusion: The correct order is (1), B, A, D, C, E.

Quick Tip
In inorganic qualitative analysis, the cations are grouped based on their chemical properties and behavior in various reagents.

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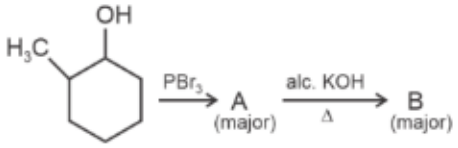
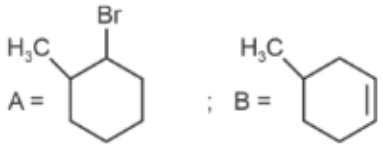
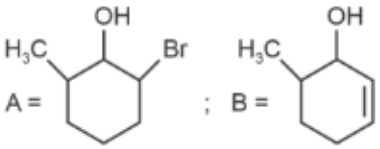
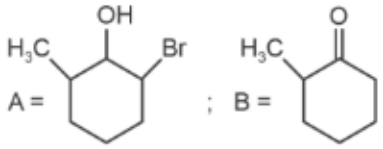
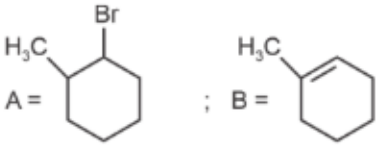
88. Major products A and B formed in the following reaction sequence, are:



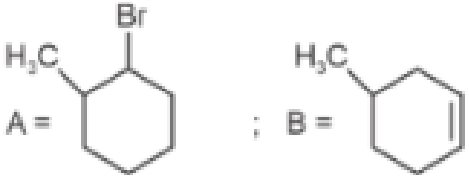
(1) 

(2) 

(3) 

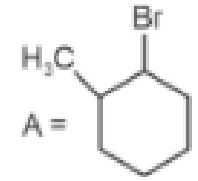
(4) 

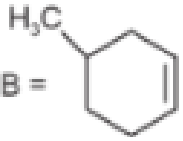
Correct Answer:

(1) 

Solution: In this reaction sequence, we start with a hydroxyl group and treat it with PBr_3 to convert it into a bromide, which then undergoes a reaction with alcoholic KOH leading to the formation of an alkene. Finally, the reaction with Br_2 results in the formation of a dibromo product.

Conclusion: The major products are identified as

(1) A = 

; B = 

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Quick Tip
Reactions involving PBr_3, KOH, and Br_2 are typical for converting alcohols to alkenes and then brominating the alkenes.

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89. 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) 0 calorie

(2) -413.14 calories

(3) 413.14 calories

(4) 100 calories

Correct Answer: (2) -413.14 calories

Solution: For isothermal expansion, the work done is given by the equation:

$$W = -nRT \ln \left(\frac{V_f}{V_i} \right)$$

Here, $P_1V_1 = P_2V_2$, so the work done can be calculated using the pressures, and the negative sign indicates work done by the gas.

Conclusion: The work done during the reversible isothermal expansion is -413.14 calories.

Quick Tip
In an isothermal process, the temperature remains constant, and the work done can be calculated using the gas law equations.

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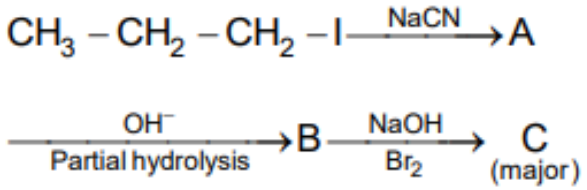
90. Identify the major product C formed in the following reaction sequence:



(1) propylamine

(2) butylamine

(3) butanamide

(4) α-bromobutanoic acid

Correct Answer: (1) propylamine

Solution: In the first step, the reaction with NaCN leads to the formation of a nitrile, which on partial hydrolysis and further treatment with NaOH and Br_2 results in the formation of an amine.

Conclusion: The major product is propylamine (A).

Quick Tip
The nucleophilic substitution with NaCN followed by hydrolysis and alkylation gives amines as products.

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

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

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

(1) $POCl_3$ and H_3PO_3

(2) $POCl_3$ and H_3PO_4

(3) H_3PO_4 and $POCl_3$

(4) H_3PO_3 and $POCl_3$

Correct Answer: (4) H_3PO_3 and $POCl_3$

Solution: In the first reaction, PCl_3 reacts with alcohol (ROH) to form alkyl chloride (RCl) and phosphorous acid (H_3PO_3).

In the second reaction, PCl_5 reacts with alcohol to form alkyl chloride (RCl), hydrochloric

acid (HCl), and $POCl_3$.

Conclusion: The products are H_3PO_3 and $POCl_3$, corresponding to option (4).

Quick Tip
PCl_3 and PCl_5 are both common chlorinating agents for alcohols. The products depend on the stoichiometry and the nature of the chlorinating agent.

---

92. Mass in grams of copper deposited by passing 9.6487 A current through a voltmeter containing copper sulphate solution for 100 seconds is (Given: Molar mass of Cu = 63 g mol^{-1}, 1 F = 96487 C)

(1) 3.15 g

(2) 0.315 g

(3) 31.5 g

(4) 0.0315 g

Correct Answer: (2) 0.315 g

Solution: Using the formula for electrochemical deposition:

$$\text{Mass} = \frac{M \cdot I \cdot t}{n \cdot F}$$

where:

M = Molar mass of copper = 63 g/mol

I = Current = 9.6487 A

t = Time = 100 s

n = Number of electrons = 2 (for Cu^{2+})

F = Faraday constant = 96487 C/mol

Substituting the values:

$$\text{Mass} = \frac{63 \cdot 9.6487 \cdot 100}{2 \cdot 96487} = 0.315 \text{ g}$$

Conclusion: The mass of copper deposited is $\mathbf{0.315}$ g, corresponding to option $(\mathbf{2})$.

Quick Tip
The electrochemical deposition of metals can be calculated using Faraday's law of electrolysis.

93. A compound X contains 32% of A, 20% of B and the remaining percentage of C. Then, the empirical formula of X is: (Given atomic masses of A = 64, B = 40, C = 32 u)

(1) A_2BC_2

(2) ABC_3

(3) AB_2C_2

(4) ABC_4

Correct Answer: (2) ABC_3

Solution: To calculate the empirical formula, assume 100 g of the compound. Therefore,

Mass of A = 32 g

Mass of B = 20 g

Mass of C = 48 g (since the total is 100 g)

Now, calculate the moles of each element:

Moles of A = $\frac{32}{64} = 0.5$ mol

Moles of B = $\frac{20}{40} = 0.5$ mol

Moles of C = $\frac{48}{32} = 1.5$ mol

The simplest ratio of A:B:C is 1:1:3, so the empirical formula is ABC_3.

Conclusion: The empirical formula is $\mathbf{ABC_3}$, corresponding to option $(\mathbf{2})$.

Quick Tip
The empirical formula represents the simplest whole-number ratio of elements in a compound.

---

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

(1) dilute hydrochloric acid

(2) concentrated sulphuric acid

(3) dilute nitric acid

(4) dilute sulphuric acid

Correct Answer: (4) dilute sulphuric acid

Solution: During the preparation of Mohr's salt ($Fe(NH_4)_2SO_4 \cdot 6H_2O$), dilute sulphuric acid is used to prevent the hydrolysis of Fe^{2+} ions.

Hydrolysis can occur in the presence of higher concentrations of acid, which would result in the precipitation of iron(III) hydroxide.

Conclusion: The correct acid is dilute sulphuric acid, corresponding to option (4).

Quick Tip
Dilute sulphuric acid prevents the oxidation of Fe^{2+} to Fe^{3+} during the preparation of Mohr's salt.

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95. Identify the correct answer.

(1) Three resonance structures can be drawn for ozone.

(2) BF_3 has non-zero dipole moment.

(3) Dipole moment of NF_3 is greater than that of NH_3.

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

Correct Answer: (4) Three canonical forms can be drawn for CO_3^{2-} ion.

Solution: Ozone (O_3) has three resonance structures, but it does not fit option (1) fully.

BF_3 has zero dipole moment because it has a symmetric trigonal planar shape.

The dipole moment of NF_3 is less than that of NH_3, contradicting option (3).

CO_3^{2-} has three canonical resonance forms, which makes option (4) correct.

Conclusion: The correct answer is (4).

Quick Tip
Resonance structures help explain the delocalization of electrons in molecules, such as the carbonate ion.

---

96. The rate of a reaction quadruples when temperature changes from 27°C to 57°C. Calculate the energy of activation. Given $R = 8.314\,\text{J K}^{-1}\text{mol}^{-1}$, $\log 4 = 0.6021$

(1) 38.04 kJ/mol

(2) 380.4 kJ/mol

(3) 3.80 kJ/mol

(4) 3804 kJ/mol

Correct Answer: (1) 38.04 kJ/mol

Solution: From the Arrhenius equation, the change in rate constant with temperature is given by:

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

Since the rate quadruples, we have:

$$\frac{k_2}{k_1} = 4 \quad \Rightarrow \quad \log 4 = 0.6021$$

Now, we use the given temperatures: $T_1 = 27^\circ C = 300\,\text{K}$ and $T_2 = 57^\circ C = 330\,\text{K}$, and solve for E_a. Substituting the values:

$$0.6021 = \frac{E_a}{8.314}\left(\frac{1}{300} - \frac{1}{330}\right)$$

Solving for E_a, we get:

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

$\text{E}_a = 38.04\,\text{kJ/mol}$

Conclusion: The energy of activation is $\mathbf{38.04\,kJ/mol}$, corresponding to option $(\mathbf{1})$.

Quick Tip
The Arrhenius equation can be used to calculate the activation energy from the change in rate constant with temperature.

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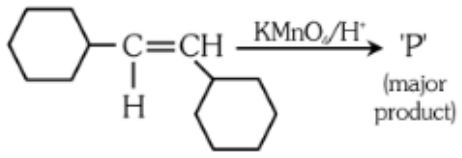
97. For the given reaction:



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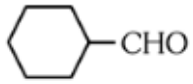
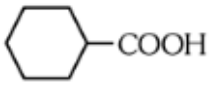
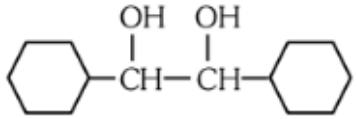
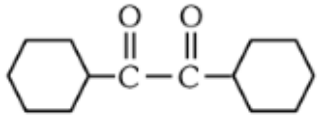
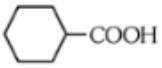
(1) 

(2) 

(3) 

(4) 

(2) 

Correct Answer:

Solution: $KMnO_4$ is a strong oxidizing agent. In the presence of an acidic medium, it oxidizes the alkene ($C = CH_2$) to a carboxylic acid group.

Conclusion: The major product is **COOH**, corresponding to option $(\mathbf{2})$.

Quick Tip
$KMnO_4$ in acidic medium can oxidize alkenes to carboxylic acids.

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98. 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) 37°C

(2) 310°C

(3) 25.73°C

(4) 12.05°C

Correct Answer: (1) 37°C

Solution: Step 1: Write the given equation for the slope

The slope of the plot Π vs C is given as RT. We are given that the slope is 25.73 and $R = 0.083$.

$$RT = 25.73$$

Step 2: Solve for the temperature T

Substitute the value of R into the equation:

$$0.083 \times T = 25.73$$

Divide both sides by 0.083 to solve for T:

$$T = \frac{25.73}{0.083}$$

$$T = 309.47\,\text{K}$$

Rounding to the nearest whole number, we get:

$$T \approx 310\,\text{K}$$

Step 3: Convert the temperature to Celsius

To convert the temperature from Kelvin to Celsius, subtract 273.15 from the Kelvin temperature.

$$T_{\text{Celsius}} = T_{\text{Kelvin}} - 273.15$$

$$T_{\text{Celsius}} = 310 - 273.15$$

$$T_{\text{Celsius}} = 36.85\,^{\circ}\text{C}$$

Rounding to the nearest whole number, we get:

$$T_{\text{Celsius}} \approx 37\,^{\circ}\text{C}$$

Conclusion: The temperature is approximately 310 K or 37 °C.

Quick Tip
Remember the relationship between the slope of the Π vs C plot and the temperature. Also, remember the conversion formula between Kelvin and Celsius: $T_{\text{Celsius}} = T_{\text{Kelvin}} - 273.15$.

99. Given below are two statements:

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

Statement II: Complex $[Co(NH_3)_6]^{3+}$ has only one kind of 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 true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (1) Both Statement I and Statement II are true

Solution: Statement I is correct because $[Co(NH_3)_6]^{3+}$ is a homoleptic complex (only NH_3 as a ligand), whereas $[Co(NH_3)_4Cl_2]^{+}$ is heteroleptic (contains both NH_3 and Cl as ligands).

Statement II is also correct because $[Co(NH_3)_6]^{3+}$ has only NH_3 ligands, while $[Co(NH_3)_4Cl_2]^{+}$ has two types of ligands.

Conclusion: Both statements are true, corresponding to option $(\mathbf{1})$.

Quick Tip
Homoleptic complexes have only one type of ligand, while heteroleptic complexes contain more than one type of ligand.

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

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

$$2\mathrm{NO}(g) \rightleftharpoons \mathrm{N_2}(g) + \mathrm{O_2}(g)$$

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

(1) 0.00889

(2) 0.0889

(3) 0.8889

(4) 0.717

Correct Answer: (4) 0.717

Solution: Using the equilibrium concentrations of the gases, the degree of dissociation is calculated based on the stoichiometry of the reaction.

Calculation of Equilibrium Constant and Degree of Dissociation

Given the reaction:

$$2\text{NO}(g) \rightleftharpoons \text{N}_2(g) + \text{O}_2(g)$$

The equilibrium constant expression is given by:

$$K_c = \frac{[\text{N}_2][\text{O}_2]}{[\text{NO}]^2}$$

Substituting the concentrations, we get:

$$K_c = \frac{3 \times 10^{-3} \times 4.2 \times 10^{-3}}{(2.8 \times 10^{-3})^2 \times 2.8 \times 10^{-3}} = 1.607$$

Let the initial concentration of NO be 0.1 M, and let α be the degree of dissociation. Then at equilibrium, the concentrations are:

$$[\text{NO}] = 0.1 - 0.1\alpha, \quad [\text{N}_2] = 0.05\alpha, \quad [\text{O}_2] = 0.05\alpha$$

The expression for K_c becomes:

$$K_c = \frac{0.05\alpha \times 0.05\alpha}{(0.1 - 0.1\alpha)^2} = \frac{0.05\alpha \times 0.05\alpha}{0.01(1-\alpha)^2}$$

Equating this to the earlier found K_c:

$$1.607 = \frac{(0.05)^2\alpha^2}{0.01(1-\alpha)^2}$$

Solving for α:

$$\alpha^2 = \frac{1.607 \times (0.01)^2}{(0.05)^2(1-\alpha)^2}$$

$$\frac{\alpha}{1-\alpha} = \frac{1.27 \times 0.1}{0.05}$$

$$\frac{\alpha}{1-\alpha} = 2.54$$

$$\alpha = 2.54 - 2.54\alpha$$

$$3.54\alpha = 2.54$$

$$\alpha = \frac{2.54}{3.54} = 0.717$$

Conclusion: The degree of dissociation of NO(g) is $\mathbf{0.717}$, corresponding to option (4).

Quick Tip
Degree of dissociation can be calculated using the changes in concentration of reactants and products at equilibrium.

BIOLOGY

101. Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin:

(1) promotes apical dominance.

(2) promotes abscission of mature leaves only.

(3) does not affect mature monocotyledonous plants.

(4) can help in cell division in grasses, to produce growth.

Correct Answer: (3) does not affect mature monocotyledonous plants.

Solution: Auxins are plant hormones that play a crucial role in regulating growth and development in plants. When applied in high concentrations, auxins cause abnormal growth in plants, especially dicots, leading to the death of these plants. However, monocotyledonous plants, such as grasses, are less affected by auxins. This is because monocots have a different structure and metabolic response compared to dicots, making them less susceptible to the growth-disrupting effects of auxins. Therefore, when gardeners use auxins to eliminate weeds, the herbicide harms the dicot weeds but does not damage the monocot grass, allowing the lawn to remain unaffected.

Quick Tip

Auxins are selective in their action. They affect dicot plants more severely, leading to their death, while monocots (like grasses) are relatively unaffected, making auxin-based herbicides ideal for lawn care.

---

102. 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 3 molecules of NADPH

(2) 2 molecules of ATP and 2 molecules of NADPH

(3) 3 molecules of ATP and 3 molecules of NADPH

(4) 3 molecules of ATP and 2 molecules of NADPH

Correct Answer: (4) 3 molecules of ATP and 2 molecules of NADPH

Solution: The Calvin cycle, also known as the light-independent reactions, requires 3 molecules of ATP and 2 molecules of NADPH for the fixation of each molecule of CO_2. This is essential for synthesizing glucose and other carbohydrates.

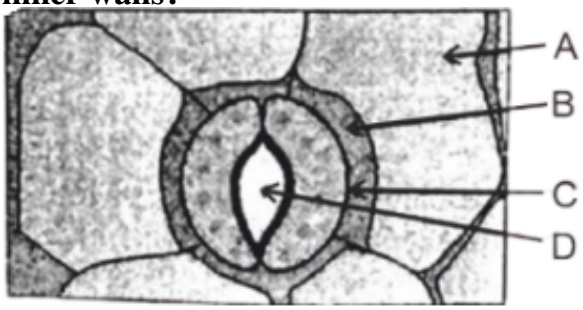
Conclusion: The correct answer is (4), as 3 molecules of ATP and 2 molecules of NADPH are used for every molecule of CO_2 fixed.

Quick Tip

The Calvin cycle occurs in the stroma of the chloroplast and is crucial for carbon fixation during photosynthesis.

---

103. In the given figure, which component has thin outer walls and highly thickened inner walls?



(1) C

(2) D

(3) A

(4) B

Correct Answer: (1) C

Solution: The component with thin outer walls and highly thickened inner walls is usually a type of vascular tissue or specialized structure such as xylem vessels, which possess thickened inner walls to withstand pressure and transport water.

Conclusion: The component with thin outer walls and highly thickened inner walls is (1) C.

Quick Tip
Xylem vessels have thickened inner walls to provide structural support and facilitate the movement of water.

---

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

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

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

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

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

Solution: Nucleolus (A) is involved in the synthesis of ribosomal RNA, hence matching with III.

Centriole (B) has a cartwheel-like organization, hence matching with II.

Leucoplasts (C) store nutrients, matching with IV.

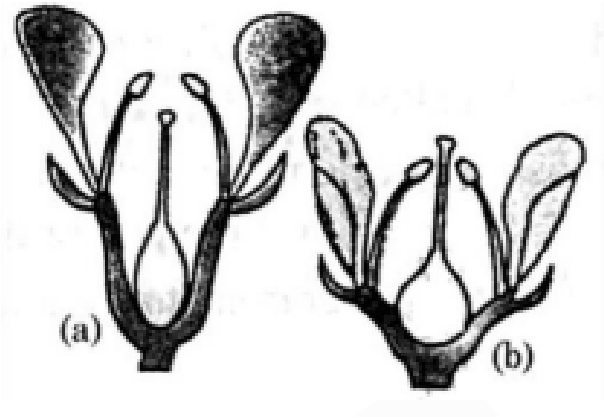
Golgi apparatus (D) is responsible for forming glycolipids, hence matching with I.

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

Quick Tip
The nucleolus is involved in ribosome production, while leucoplasts are specialized for storing nutrients like starch.

---

105. 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) Epigynous; (b) Hypogynous

(2) (a) Hypogynous; (b) Epigynous

(3) (a) Perigynous; (b) Epigynous

(4) (a) Perigynous; (b) Perigynous

Correct Answer: (4) (a) Perigynous; (b) Perigynous

Solution: In both figures (a) and (b), the ovary is positioned between the calyx and corolla, a characteristic of perigynous flowers.

The position of floral parts indicates that both flowers are perigynous.

Conclusion: The correct answer is (4) (a) Perigynous; (b) Perigynous.

Quick Tip
Perigynous flowers have the ovary positioned between the calyx and corolla, with the stamens attached at the same level.

---

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

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

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

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

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

Solution: Rhizopus is commonly known as Bread Mould, corresponding to III.

Ustilago is a Smut fungus, corresponding to II.

Puccinia is a Rust fungus, corresponding to IV.

Agaricus is commonly known as Mushroom, corresponding to I.

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

Quick Tip
Fungi like Rhizopus, Puccinia, and Ustilago are classified based on their morphology and the diseases they cause in plants.

---

107. Which of the following is an example of actinomorphic flower?

(1) Datura

(2) Cassia

(3) Pisum

(4) Sesbania

Correct Answer: (1) Datura

Solution: Actinomorphic flowers are radially symmetrical, meaning they can be divided into identical halves along multiple planes. Datura is an example of an actinomorphic flower.

Conclusion: The correct answer is (1) Datura.

Quick Tip
Actinomorphic flowers are radially symmetrical and can be divided into multiple identical parts.

---

108. 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) C, D and E only

(2) A, B, C and D only

(3) A, C, D and E only

(4) B, C, D and E only

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

Solution: Vallisneria flowers are not colorful and do not produce nectar, so statement A is incorrect.

Water lilies are indeed pollinated by wind and not by water, so statement B is correct.

Water-pollinated species do protect their pollen grains from wetting, and some hydrophytes have ribbon-like pollen grains.

In some hydrophytes, the pollen grains are carried passively by the water.

Conclusion: The correct answer is (4) B, C, D and E only.

Quick Tip
Hydrophytes exhibit specialized adaptations for water pollination and often have unique pollen characteristics.

---

109. A pink flowered Snapdragon plant was crossed with a red flowered Snapdragon plant. What type of phenotype/s is/are expected in the progeny?

(1) Only red flowered plants

(2) Red flowered as well as pink flowered plants

(3) Only pink flowered plants

(4) Red, Pink as well as white flowered plants

Correct Answer: (2) Red flowered as well as pink flowered plants

Solution: Snapdragon flower color is controlled by incomplete dominance. A cross between a red flowered and a pink flowered Snapdragon will produce both red and pink flowered progeny, with no white flowers expected.

Conclusion: The correct answer is (2) Red flowered as well as pink flowered plants.

Quick Tip
Incomplete dominance results in offspring that show intermediate traits between the parental generations.

---

110. Formation of interfascicular cambium from fully developed parenchyma cells is an example for

(1) Differentiation

(2) Redifferentiation

(3) Dedifferentiation

(4) Maturation

Correct Answer: (3) Dedifferentiation

Solution: Dedifferentiation refers to the process where fully differentiated cells revert to a more meristematic state. In the case of interfascicular cambium formation, parenchyma cells dedifferentiate to form the cambium tissue.

Conclusion: The correct answer is (3) Dedifferentiation.

Quick Tip

Dedifferentiation allows mature cells to regain the ability to divide and form new tissues, such as cambium.

---

111. 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	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-I, B-II, C-III, 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-II, D-I

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

Solution: A. ”Two or more alternative forms of a gene” refers to ”Allele,” corresponding to III.

B. ”Cross of F1 progeny with homozygous recessive parent” is called a ”Test cross,” corresponding to IV.

C. ”Cross of F1 progeny with any of the parents” refers to a ”Back cross,” corresponding to I.

D. ”Number of chromosome sets in plant” refers to ”Ploidy,” corresponding to II.

Conclusion: The correct match is (3) A-III, B-IV, C-I, D-II.

Quick Tip

A test cross helps to determine the genotype of an individual by crossing it with a homozygous recessive parent.

---

112. 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) A, B and C only

(2) B, C and D only

(3) C, D and E only

(4) D and E only

Correct Answer: (3) C, D and E only

Solution: The dark reaction (Calvin cycle) of photosynthesis requires CO_2, ATP, and NADPH.

Light and chlorophyll are involved in the light-dependent reactions, not the dark reactions.

Conclusion: The correct answer is (3) C, D and E only.

Quick Tip
The dark reaction of photosynthesis, also known as the Calvin cycle, does not directly require light but uses ATP and NADPH produced in the light reaction.

---

113. 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 true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (1) Both Statement I and Statement II are true

Solution: Statement I is true: Chromosomes become visible under the light microscope during leptotene, which is the first stage of prophase I in meiosis.

Statement II is also true: The diplotene stage begins with the dissolution of the synaptonemal complex, which separates homologous chromosomes that were previously paired.

Conclusion: Both statements are true, so the correct answer is (1).

Quick Tip
The synaptonemal complex plays a crucial role in the pairing of homologous chromosomes during meiosis.

---

114. Spindle fibers attach to kinetochores of chromosomes during

(1) Prophase

(2) Metaphase

(3) Anaphase

(4) Telophase

Correct Answer: (2) Metaphase

Solution: During Metaphase, spindle fibers attach to the kinetochores of chromosomes. This attachment is essential for the alignment of chromosomes at the metaphase plate before they are separated during anaphase.

Conclusion: The correct answer is (2) Metaphase.

Quick Tip
Spindle fibers are essential for chromosome movement during cell division, and they attach to kinetochores during metaphase.

---

115. What is the fate of a piece of DNA carrying only gene of interest which is transferred into an alien organism?

A. The piece of DNA would be able to multiply itself independently in the progeny cells of the organism.

B. It may get integrated into the genome of the recipient.

C. It may multiply and be inherited along with the host DNA.

D. The alien piece of DNA is not an integral part of chromosome.

E. It shows ability to replicate.

Choose the correct answer from the options given below:

(1) A and B only

(2) D and E only

(3) B and C only

(4) A and E only

Correct Answer: (3) B and C only

Solution: The DNA carrying the gene of interest may integrate into the host genome, where it can multiply and be inherited along with the host DNA.

It may not always multiply independently unless a specific plasmid or viral vector is used for replication.

Conclusion: The correct answer is (3) B and C only.

Quick Tip
In genetic engineering, foreign DNA is often inserted into the host genome, and it may be inherited in the next generations.

---

116. The lactose present in the growth medium of bacteria is transported to the cell by the action of

(1) Beta-galactosidase

(2) Acetylase

(3) Permease

(4) Polymerase

Correct Answer: (3) Permease

Solution: Lactose is a disaccharide composed of glucose and galactose. In bacteria, the transport of lactose into the cell is facilitated by a protein known as permease. Permease is a membrane protein that helps in the active transport of lactose across the bacterial cell membrane.

Beta-galactosidase, on the other hand, is an enzyme that catalyzes the breakdown of lactose into glucose and galactose after it has entered the cell. It is not involved in the transport

process but in the hydrolysis of lactose.

Conclusion: The correct answer is (3) Permease, which is responsible for the transport of lactose into the bacterial cell.

Quick Tip
Permease is a key component in the lac operon system in bacteria, responsible for transporting lactose into the cell for metabolism.

---

117. Given below are two statements: Statement I: Parenchyma is living but collenchyma is dead tissue. Statement II: Gymnosperms lack xylem vessels but the presence of xylem vessels is the characteristic of angiosperms.

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

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (4) Statement I is false but Statement II is true

Solution: Statement I is false because both parenchyma and collenchyma are living tissues. Parenchyma is a fundamental plant tissue that is alive and plays an essential role in metabolism and storage, while collenchyma is also living, providing flexible support in growing plant parts.

Statement II is true because gymnosperms lack xylem vessels; their xylem is composed of tracheids, which are less efficient at water conduction than xylem vessels. On the other hand, angiosperms possess xylem vessels that allow more efficient water conduction.

Conclusion: The correct answer is (4) Statement I is false but Statement II is true.

Quick Tip
The presence of xylem vessels is a distinguishing feature of angiosperms, whereas gymnosperms only have tracheids.

---

118. Which one of the following is not a criterion for classification of fungi?

(1) Morphology of mycelium

(2) Mode of nutrition

(3) Mode of spore formation

(4) Fruiting body

Correct Answer: (2) Mode of nutrition

Solution: Fungi are primarily classified based on morphological characteristics, including the type and structure of their mycelium and the mode of spore formation. The morphology of the fruiting body is also used to classify different groups of fungi

The mode of nutrition (whether the fungus is saprophytic, parasitic, or symbiotic) is not a primary criterion for the classification of fungi but is important for understanding their ecological roles.

Conclusion: The correct answer is (2) Mode of nutrition, as it is not the main criterion for classifying fungi.

Quick Tip
Fungi are classified based on their reproductive structures and morphological traits, such as spore formation and mycelial structure.

---

119. 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

(4) BB/Bb

Correct Answer: (2) bb

Solution: To determine the genotype of the black-seeded plant, a test cross is performed. A test cross involves crossing the organism with a homozygous recessive individual (bb).

If the black-seeded plant is homozygous dominant (BB), all offspring will have black seeds

(Bb).

If the black-seeded plant is heterozygous (Bb), approximately half of the offspring will have black seeds, and the other half will have white seeds (bb).

Conclusion: The correct answer is (2) bb, as it is used in a test cross to determine the genotype of the black-seeded plant.

Quick Tip
A test cross helps to determine whether an organism with a dominant phenotype is homozygous or heterozygous.

---

120. Tropical regions show the greatest level of species richness because

A. Tropical latitudes have remained relatively undisturbed for millions of years, hence more time was available for species diversification.

B. Tropical environments are more seasonal.

C. More solar energy is available in tropics.

D. Constant environments promote niche specialization.

E. Tropical environments are constant and predictable.

Choose the correct answer from the options given below.

(1) A, C, D and E only

(2) A and B only

(3) A, B and E only

(4) A, B and D only

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

Solution: A is true: Tropical regions have had more time for species diversification due to their relatively undisturbed nature over millions of years, leading to a higher level of species richness.

C is true: The availability of more solar energy in the tropics supports high primary productivity and a greater number of species.

D is true: The relatively constant environments in tropical regions allow for specialization of ecological niches, which contributes to species richness.

E is true: Tropical environments are more stable and predictable, allowing species to adapt and thrive over time.

B is false: Seasonal environments typically lead to fluctuations in species populations, which may reduce species richness in contrast to the constant environments found in the tropics.

Conclusion: The correct answer is (1) A, C, D and E only.

Quick Tip
Tropical regions are biodiversity hotspots due to their stable and resource-rich environments that promote species diversification.

---

121. 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, C and D only

(2) A, B, C and D only

(3) A, B and E only

(4) A, B and D only

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

Solution: Over exploitation leads to depletion of species through excessive use.

Co-extinction occurs when one species goes extinct, causing linked species to also perish.

Habitat loss and fragmentation disrupt ecosystems, reducing biodiversity. Mutation is less a direct cause and more a process that might lead to diversity or extinction, depending on other ecological pressures. Migration typically involves movement rather than loss. The correct factors causing significant biodiversity loss are A, B, and D.

Quick Tip

Understanding the factors that lead to biodiversity loss is crucial for conservation efforts and ensuring sustainable environmental practices.

---

122. 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) Repressor, Operator gene, Structural gene

(2) Structural gene, Transposons, Operator gene

(3) Inducer, Repressor, Structural gene

(4) Promotor, Structural gene, Terminator

Correct Answer: (4) Promotor, Structural gene, Terminator

Solution: The transcription unit in DNA comprises the promotor, which initiates transcription; the structural gene, which is the sequence being transcribed; and the terminator, which signals the end of transcription. This organization ensures the correct expression of genes in response to cellular needs.

Quick Tip

Familiarity with the basic components of a transcription unit is fundamental in genetic and molecular biology studies, particularly for gene expression analysis.

---

123. Hind II always cuts DNA molecules at a particular point called recognition sequence and it consists of:

(1) 8 bp

(2) 6 bp

(3) 4 bp

(4) 10 bp

Correct Answer: (2) 6 bp

Solution: Hind II enzyme is specific to a recognition sequence of 6 base pairs, which it consistently cuts. This predictability is crucial for genetic engineering applications, such as

recombinant DNA technology, where precise cuts are necessary.

Quick Tip
The specificity of restriction enzymes like Hind II highlights their importance in molecular cloning techniques, where exact cuts in DNA are required.

---

124. The cofactor of the enzyme carboxypeptidase is:

(1) Zinc

(2) Niacin

(3) Flavin

(4) Haem

Correct Answer: (1) Zinc

Solution: Carboxypeptidase is a metalloenzyme that requires zinc as a cofactor. Zinc plays a critical role in the catalytic activity of the enzyme, assisting in the hydrolysis of peptide bonds in proteins during digestion.

Quick Tip
Understanding the role of cofactors in enzyme activity is essential for biochemistry, particularly in enzyme kinetics and inhibition studies.

---

125. Match List I with List II

List I	List II
A. *Clostridium butylicum*	I. Ethanol
B. *Saccharomyces cerevisiae*	II. Streptokinase
C. *Trichoderma polysporum*	III. Butyric acid
D. *Streptococcus sp.*	IV. Cyclosporin-A

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Clostridium butylicum is known for producing butyric acid, hence A-III. Saccharomyces cerevisiae is a yeast that produces ethanol, making B-I correct. Trichoderma polysporum is associated with the production of cyclosporin-A, thus C-IV. Streptococcus sp. is known for producing streptokinase, therefore D-II.

Quick Tip
Linking microorganisms to their biochemical products is fundamental in biotechnology and pharmaceutical industries for the development of drugs and other bioproducts.

---

126. List of endangered species was released by:

(1) GEAC

(2) WWF

(3) FOAM

(4) IUCN

Correct Answer: (4) IUCN

Solution: The International Union for Conservation of Nature (IUCN) is renowned for its work in global conservation and sustainable use of natural resources, including publishing the Red List of Threatened Species, which categorizes species at risk of extinction.

Quick Tip
The IUCN Red List is a critical indicator of the health of the world's biodiversity, widely used for conservation planning.

---

127. The type of conservation in which the threatened species are taken out from their natural habitat and placed in special setting where they can be protected and given special care is called:

(1) in-situ conservation

(2) Biodiversity conservation

(3) Semi-conservative method

(4) Sustainable development

Correct Answer: (2) Biodiversity conservation

Solution: The question appears to describe ex-situ conservation, which involves the preservation of components of biological diversity outside their natural habitats. The answer provided is incorrect as per standard terminology, which would classify it as ex-situ conservation. The term 'Biodiversity conservation' is broad and encompasses both in-situ and ex-situ conservation strategies.

Quick Tip
Understanding the distinction between in-situ and ex-situ conservation is key for effective species preservation strategies.

---

128. The capacity to generate a whole plant from any cell of the plant is called:

(1) Totipotency

(2) Micropropagation

(3) Differentiation

(4) Somatic hybridization

Correct Answer: (1) Totipotency

Solution: Totipotency is a fundamental property of plant cells that allows each cell to regenerate into a complete plant. This characteristic is harnessed in techniques such as tissue culture for cloning plants.

Quick Tip
Totipotency is a critical concept in plant biology and biotechnology, enabling the cloning of plants from single cells.

---

129. The equation of Verhulst-Pearl logistic growth is $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$.

From this equation, K indicates:

(1) Intrinsic rate of natural increase

(2) Biotic potential

(3) Carrying capacity

(4) Population density

Correct Answer: (3) Carrying capacity

Solution: In the logistic growth equation, K represents the carrying capacity of the environment, which is the maximum population size that the environment can sustain indefinitely given the food, habitat, water, and other necessities available in the environment.

Quick Tip
Carrying capacity is a key concept in ecology, representing the balance between the availability of habitat resources and the size of the population they can support.

---

130. Bulliform cells are responsible for:

(1) Inward curling of leaves in monocots.

(2) Protecting the plant from salt stress.

(3) Increased photosynthesis in monocots.

(4) Providing large spaces for storage of sugars.

Correct Answer: (1) Inward curling of leaves in monocots.

Solution: Bulliform cells are specialized cells found in the leaves of monocots that help in rolling or folding of the leaves during water stress, thus reducing water loss and overheating.

Quick Tip
Understanding the function of bulliform cells helps in studying drought resistance mechanisms in plants.

---

131. Lecithin, a small molecular weight organic compound found in living tissues, is an example of:

(1) Amino acids

(2) Phospholipids

(3) Glycerides

(4) Carbohydrates

Correct Answer: (2) Phospholipids

Solution: Lecithin is a type of phospholipid, which is a major component of cell membranes, involved in the structural integrity of cells and facilitating cell signaling.

Quick Tip
Phospholipids like lecithin are crucial for cell membrane structure and function, playing a key role in cellular processes such as membrane fluidity and signal transduction.

---

132. Inhibition of Succinic dehydrogenase enzyme by malonate is a classical example of:

(1) Cofactor inhibition

(2) Feedback inhibition

(3) Competitive inhibition

(4) Enzyme activation

Correct Answer: (3) Competitive inhibition

Solution: Malonate is a well-known competitive inhibitor of the enzyme succinic dehydrogenase, which plays a critical role in the Krebs cycle. Competitive inhibition occurs when the inhibitor is structurally similar to the substrate and competes for binding to the active site of the enzyme. Malonate resembles succinate (the substrate) and competes with it for the active site, effectively blocking the enzyme's function in the metabolic pathway. This inhibition demonstrates the specificity and competitive nature of enzyme-substrate interactions and their regulation, which is fundamental for metabolic control and drug design. Understanding such mechanisms is crucial in biochemistry for developing therapeutic agents that can modulate enzyme activity.

Quick Tip
Competitive inhibitors can be overcome by increasing the concentration of the substrate, highlighting the dynamic balance of enzyme regulation.

133. Given below are two statements:

Statement I: Bt toxins are insect group specific and coded by a gene cry IAc.

Statement II: Bt toxin exists as inactive protoxin in B. thuringiensis. However, after ingestion by the insect the inactive protoxin gets converted into active form due to acidic pH of the insect gut.

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

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

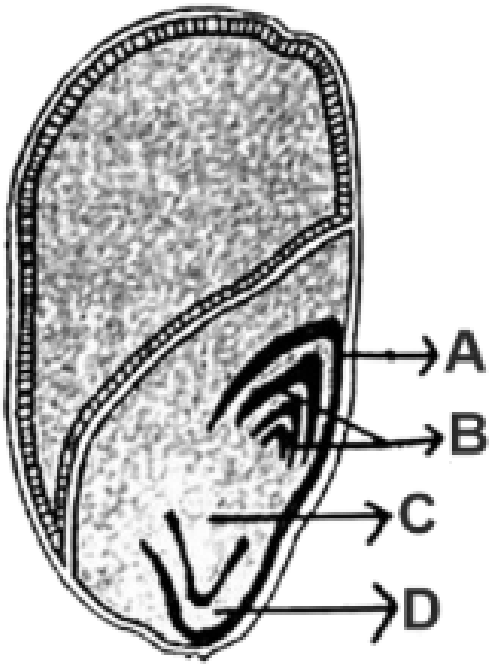
(4) Statement I is false but Statement II is true

Correct Answer: (3) Statement I is true but Statement II is false

Solution: Statement I is accurate as Bt toxins, encoded by various cry genes including cry IAc, are indeed specific to certain insect groups, affecting only those that have the specific receptors in their gut lining. Statement II is false because the conversion of the inactive protoxin to its active form in the gut of the insect is triggered by alkaline conditions, not acidic. This specificity and activation mechanism are critical for the safe use of Bt crops in agriculture, targeting pest insects without harming other organisms. Understanding the biochemical and genetic basis of Bt toxin activity is essential for biotechnological applications in sustainable agriculture.

Quick Tip
Bt crops represent a significant advancement in agricultural biotechnology, providing an environmentally friendly alternative to chemical pesticides.

134. Identify the part of the seed from the given figure which is destined to form root when the seed germinates.



Choose the correct answer from the options given below:

(1) A

(2) B

(3) C

(4) D

Correct Answer: (3) C

Solution: In the seed structure, part C represents the radicle, which is the embryonic root. Upon germination, the radicle is the first part to emerge from the seed, growing downward to anchor the plant and absorb nutrients and water from the soil. This early development is critical for the establishment of the seedling, ensuring it can secure the resources necessary for growth. The radicle's emergence and growth are pivotal for the successful transition from seed to seedling, highlighting the importance of embryonic structures in plant development.

Quick Tip
The radicle's growth direction is influenced by gravity, demonstrating gravitropism, an essential plant response facilitating proper root development.

---

135. Which one of the following can be explained on the basis of Mendel's Law of

Dominance?

A. Out of one pair of factors one is dominant and the other is recessive.

B. Alleles do not show any expression and both the characters appear as such in F2 generation.

C. Factors occur in pairs in normal diploid plants.

D. The discrete unit controlling a particular character is called factor.

E. The expression of only one of the parental characters is found in a monohybrid cross.

Choose the correct answer from the options given below:

(1) A, B and C only

(2) A, C, D and E only

(3) B, C and D only

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

Correct Answer: (2) A, C, D and E only

Solution: Mendel's Law of Dominance states that in a pair of alleles, one is dominant and masks the effect of the other recessive allele when both are present in the organism. This is clearly illustrated in option A, where one allele dominates over the other in a pair. The expression of only one of the parental characters in a monohybrid cross (option E) also exemplifies this law, as the dominant allele's trait is visible, while the recessive trait is hidden in the F1 generation. Additionally, the fact that factors (genes) occur in pairs in diploid organisms (option C) and the definition of a factor as a discrete unit controlling a character (option D) align with Mendel's findings, though indirectly related to the Law of Dominance. Option B is incorrect as it misrepresents how alleles are expressed and does not fit with Mendel's observations.

Quick Tip
Mendel's Laws provide the foundation for understanding inheritance patterns, crucial for fields like genetics, breeding, and evolutionary biology.

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

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

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

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

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

Solution: The Citric acid cycle occurs in the mitochondrial matrix (A-II), where it completes the oxidation of substrates, providing electrons for the electron transport chain. Glycolysis occurs in the cytoplasm (B-I), independently of the mitochondria, converting glucose into pyruvate with a net production of ATP. The electron transport chain is located in the inner mitochondrial membrane (C-IV), where it uses the electrons from the Citric acid cycle to pump protons from the mitochondrial matrix to the intermembrane space, creating a proton gradient (D-III) across the membrane. This gradient drives the synthesis of ATP via chemiosmosis. Understanding these processes and their spatial organization within the cell is critical for comprehending cellular respiration and energy production in eukaryotic cells.

Quick Tip
Each step of cellular respiration is compartmentalized within the cell, optimizing efficiency and control of energy production.

137. Match List I with List II

List I	List II
A. Robert May	I. Species-Area relationships
B. Alexander von Humboldt	II. Long term ecosystem experiment using outdoor plots
C. Paul Ehrlich	III. Global species diversity at about 7 million
D. David Tilman	IV. Rivet popper hypothesis

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Robert May is renowned for his work on mathematical models in ecology, predicting global species diversity estimates, not specifically at 7 million but his work underpins many modern ecological predictions (A-III). Alexander von Humboldt is historically significant for his exploration and description of the relationship between species and area (B-I), laying foundational concepts in biogeography. Paul Ehrlich is known for his contributions to environmental science and conservation, notably his rivet popper hypothesis which suggests that ecosystem resilience decreases with the loss of species (C-IV). David Tilman's research focuses on biodiversity and ecosystem functioning, conducting long-term ecological experiments using outdoor plots to understand species interactions and community dynamics (D-II). This understanding of ecological and environmental science pioneers and their theories is crucial for students and researchers in these fields, providing a framework for ongoing studies and conservation efforts.

Quick Tip
Linking historical figures to their scientific contributions provides a deeper understanding of the development and current state of ecological and environmental sciences.

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138. In an ecosystem if the Net Primary Productivity (NPP) of first trophic level is

$100x$ **kcal m^{-2}yr^{-1}, what would be the GPP (Gross Primary Productivity) of the third trophic level of the same ecosystem?**

(1) $\frac{x}{10}$ (kcal m^{-2}yr^{-1})

(2) x (kcal m^{-2}yr^{-1})

(3) $10x$ (kcal m^{-2}yr^{-1})

(4) $100x/3X$ (kcal m^{-2}yr^{-1})

Correct Answer: (3) $10x$ (kcal m^{-2}yr^{-1})

Solution: In ecological productivity, about 10% of the energy is transferred from one trophic level to the next. Thus, if the NPP at the first trophic level is $100x$, the GPP of the next trophic level (second) would typically be about $10x$, considering some energy is used for respiration and maintenance. For the third trophic level, we assume similar energy conversion efficiency, meaning the GPP would remain approximately $10x$. This approximation highlights the efficiency and limits of energy transfer through trophic levels in ecosystems, crucial for understanding food webs and energy flow in ecological modeling.

Quick Tip
Energy transfer efficiency between trophic levels is a key concept in ecology, affecting population dynamics and ecosystem stability.

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139. Read the following statements and choose the set of correct statements:

In the members of Phaeophyceae,

A. Asexual reproduction occurs usually by biflagellate zoospores.

B. Sexual reproduction is by oogamous method only.

C. Stored food is in the form of carbohydrates which is either mannitol or laminarin.

D. The major pigments found are chlorophyll a, c and carotenoids and xanthophyll.

E. Vegetative cells have a cellulosic wall, usually covered on the outside by gelatinous coating of algin.

Choose the correct answer from the options given below:

(1) A, B, C and D only

(2) B, C, D and E only

(3) A, C, D and E only

(4) A, B, C and E only

Correct Answer: (3) A, C, D and E only

Solution: Phaeophyceae, or brown algae, typically exhibit a range of reproductive and physiological characteristics. Asexual reproduction by biflagellate zoospores (A) and the presence of specific carbohydrates such as mannitol and laminarin (C) are characteristic. The pigment composition including chlorophyll a, c, carotenoids, and xanthophylls (D) distinguishes them from other algal classes. The cell wall composition featuring a cellulosic base with an algin coating (E) is also correct. However, their sexual reproduction is not strictly oogamous, as it can vary, making (B) incorrect. Understanding these biological and morphological features is essential in marine biology and helps in the study of algal ecology and their industrial applications.

Quick Tip
Brown algae's unique biochemical compositions make them valuable in industries such as food, cosmetics, and biofuels.

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140. Spraying sugarcane crop with which of the following plant growth regulators, increases the length of stem, thus, increasing the yield?

(1) Auxin

(2) Gibberellin

(3) Cytokinin

(4) Abscisic acid

Correct Answer: (2) Gibberellin

Solution: Gibberellins are a group of plant hormones that promote stem elongation, germination, and flowering. When applied to sugarcane, gibberellins specifically enhance stem growth, leading to taller plants and potentially increased biomass yield. This application in agronomy is particularly effective in crops like sugarcane where stem length directly correlates with sugar content and overall productivity. The use of gibberellins exemplifies the integration of plant physiology knowledge into agricultural practices to optimize crop yields.

Quick Tip

Gibberellins are often used in agriculture to break seed dormancy and stimulate growth, highlighting their role in managing crop development.

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141. Match List I with List II

List I (Types of Stamens)	List II (Example)
A. Monoadelphous	I. Citrus
B. Diadelphous	II. Pea
C. Polyadelphous	III. Lily
D. Epiphyllous	IV. China-rose

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Monadelphous Androecium (China Rose)

In monadelphous androecium, the stamens are fused together to form a single group. Specifically, the filaments of all the stamens are united, while the anthers may still remain separate. This arrangement is typically found in plants like China Rose (*Hibiscus rosa-sinensis*), where the stamens are united by their filaments to form a single bundle.

Key Features of Monadelphous Androecium: - All the stamens are joined together by their filaments. - The anthers, however, remain separate. - Common in the Malvaceae family, e.g., Hibiscus.

This type of androecium is important for ensuring the transfer of pollen to the stigma, as it facilitates better coordination between the stamens during pollination.

Diadelphous Androecium (Pea Plant)

In diadelphous androecium, the stamens are divided into two groups: one group typically has a larger number of stamens, and the other group has fewer. The filaments of the stamens are fused in one group, and the other group is separate. This arrangement is common in plants

like the Pea plant (*Pisum sativum*), where the stamens are divided into two groups: one group of 9 stamens is fused together and the remaining stamen is free.

Key Features of Diadelphous Androecium: - Stamens are divided into two groups based on the fusion of filaments. - One group has a larger number of stamens, while the other has fewer. - Common in the Fabaceae family, e.g., Pea, Bean, and some members of the Leguminosae family.

This arrangement is beneficial in some species because it can help to optimize the interaction between the anthers and the pollinators, especially in leguminous plants, facilitating better pollen transfer.

Polyadelphous Androecium (Citrus)

In polyadelphous androecium, the stamens are divided into several groups. The filaments of the stamens are fused into more than two groups, which is different from the diadelphous condition. This type of androecium is found in plants like Citrus species (e.g., oranges, lemons), where the stamens are typically divided into multiple groups.

Key Features of Polyadelphous Androecium: - Stamens are grouped into multiple clusters (more than two). - The number of groups can vary depending on the species. - Common in plants of the Rutaceae family, such as Citrus (oranges, lemons).

Polyadelphous arrangements help enhance the effectiveness of pollen transfer because they can maximize contact with pollinators, especially in species that rely on external agents like insects for pollination.

Epiphyllous Androecium (Lily)

In epiphyllous androecium, the stamens are attached to the petals, specifically the leaf-like structures, in a way that is unusual compared to most flowers. In this arrangement, the stamens are borne on the surface of the petals or on modified leaf structures (epiphylls). This type of androecium is found in plants like Lily (*Lilium*).

Key Features of Epiphyllous Androecium: - Stamens are attached to the petals or modified leaf structures (epiphylls). - This is a unique arrangement found in certain plants like Lilies. - The flowers exhibit a close relationship between the floral organs, allowing for effective pollen dispersal.

This arrangement ensures that the pollen is easily accessible to pollinators, facilitating pollination while the flowers are in bloom.

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Conclusion

- Monadelphous: Stamens fused into one group (e.g., China Rose). - Diadelphous: Stamens fused into two groups (e.g., Pea plant). - Polyadelphous: Stamens fused into multiple groups (e.g., Citrus). - Epiphyllous: Stamens attached to the petals or leaf-like structures (e.g., Lily). Each of these arrangements plays a key role in the reproductive strategies of the plants and ensures effective pollination mechanisms suited to their ecological needs.

Quick Tip
Floral morphology, including stamen structure, plays a key role in plant identification and taxonomy.

---

142. Which of the following statement is correct regarding the process of replication in E.coli?

(1) The DNA dependent DNA polymerase catalyses polymerization in one direction that is 3' $\rightarrow$ 5'

(2) The DNA dependent RNA polymerase catalyses polymerization in one direction, that is 5' $\rightarrow$ 3'

(3) The DNA dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' as well as 3' $\rightarrow$ 5' direction

(4) The DNA dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' direction

Correct Answer: (4) The DNA dependent DNA polymerase catalyses polymerization in 5' $\rightarrow$ 3' direction

Solution: In the replication of DNA in E.coli, the enzyme DNA polymerase is responsible for synthesizing new strands of DNA. It adds nucleotides to the 3' end of the growing strand, thereby synthesizing in a 5' to 3' direction. This directional synthesis is critical for the semi-conservative replication process where each new DNA molecule consists of one old and one new strand, ensuring genetic continuity across generations. The specificity of this enzyme for the 5' to 3' direction is a fundamental aspect of molecular biology, underpinning how genetic information is accurately replicated and maintained in living organisms.

Quick Tip

Understanding DNA replication is essential for fields like genetic engineering and biotechnology, where manipulation of genetic material is common.

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143. Identify the step in tricarboxylic acid cycle, which does not involve oxidation of substrate.

(1) Malic acid $\rightarrow$ Oxaloacetic acid

(2) Succinic acid $\rightarrow$ Malic acid

(3) Succinyl-CoA $\rightarrow$ Succinic acid

(4) Isocitrate $\rightarrow \alpha - ketoglutaricacid$

Correct Answer: (3) Succinyl-CoA $\rightarrow$ Succinic acid

Solution: In the tricarboxylic acid (TCA) cycle, also known as the Krebs cycle, the conversion of Succinyl-CoA to Succinic acid is unique as it involves the cleavage of a high-energy thioester bond in Succinyl-CoA, which leads to the synthesis of ATP or GTP rather than direct oxidation of the substrate. This step is a substrate-level phosphorylation rather than an oxidation reaction, distinguishing it from other steps in the cycle that typically involve the removal of electrons and hydrogen ions. Understanding this step is important for grasping cellular energy production, particularly how ATP is generated in the mitochondria.

Quick Tip

The TCA cycle is central to cellular respiration, linking carbohydrate, fat, and protein metabolism with the production of ATP, highlighting the interconnected nature of metabolic pathways.

---

144. Match List I with List II

List I	List II
A. Frederick Griffith	I. Genetic code
B. Francois Jacob & Jacque Monod	II. Semi-conservative mode of DNA replication
C. Har Gobind Khorana	III. Transformation
D. Meselson & Stahl	IV. Lac operon

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Frederick Griffith is known for discovering the phenomenon of transformation (A-III), which was a pivotal moment in understanding bacterial genetics. Francois Jacob and Jacque Monod elucidated the mechanism of gene regulation in the lac operon (B-IV), a fundamental concept in molecular biology. Har Gobind Khorana contributed significantly to the elucidation of the genetic code (C-I), decoding how sequences of nucleotides translate into proteins. Meselson and Stahl demonstrated the semi-conservative mode of DNA replication (D-II), providing a key piece of evidence in understanding DNA synthesis. This match pairs significant scientific discoveries with the researchers responsible for them, illustrating their impact on genetics and molecular biology.

Quick Tip
Each of these discoveries has played a crucial role in developing modern genetics, showing how scientific inquiry builds upon itself over time.

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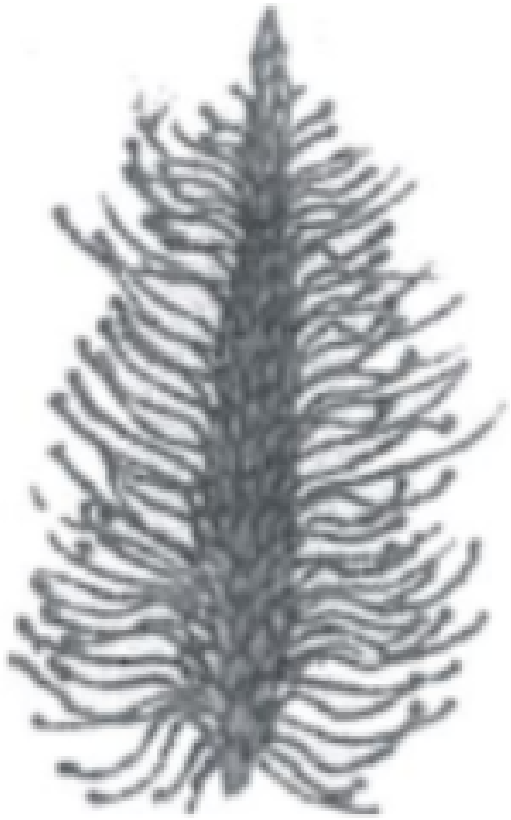
145. Identify the correct description about the given figure:



(1) Wind pollinated plant inflorescence showing flowers with well exposed stamens.

(2) Water pollinated flowers showing stamens with mucilaginous covering.

(3) Cleistogamous flowers showing autogamy.

(4) Compact inflorescence showing complete autogamy

Correct Answer: (1) Wind pollinated plant inflorescence showing flowers with well exposed stamens.

Solution: Wind-pollinated plants typically feature flowers with well-exposed stamens to facilitate the dispersal of pollen by air currents. These plants are often characterized by a lack of bright colors and nectar, as they do not need to attract pollinators. Instead, their floral structures are adapted to maximize the efficiency of pollen transfer through wind, which includes having prominent, exposed stamens that readily release pollen into the environment. Understanding these adaptations helps in studying plant ecology and the evolution of pollination strategies.

Quick Tip

Floral adaptations to wind pollination include reduced petal size and increased stamen exposure, optimizing pollen dispersal by air.

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146. The DNA present in chloroplast is:

(1) Linear, double stranded

(2) Circular, double stranded

(3) Linear, single stranded

(4) Circular, single stranded

Correct Answer: (2) Circular, double stranded

Solution: Chloroplast DNA is typically circular and double-stranded, mirroring some aspects of bacterial genomes, which is a nod to their evolutionary origins from endosymbiotic bacteria. This form of DNA is essential for the chloroplast's function in photosynthesis, as it encodes parts of the photosynthetic machinery and other proteins crucial for the organelle's operation. Understanding the structure and function of chloroplast DNA is key in studies on plant physiology, genetics, and evolutionary biology.

Quick Tip

Chloroplast DNA's circular nature facilitates replication and expression of genes needed for photosynthesis and other cellular processes.

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147. 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 true

(2) Both Statement I and Statement II are false

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

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

Correct Answer: (3) Statement I is true but Statement II is false

Solution: Statement I is true as in C_3 plants, RuBisCO can bind to O2 instead of CO_2, leading to photorespiration, which decreases the efficiency of CO_2 fixation. This process is energetically costly and reduces the overall photosynthetic output. Statement II is partially correct; while it is true that mesophyll cells in C_4 plants show reduced photorespiration due to the spatial separation of initial CO_2 fixation and the Calvin cycle, bundle sheath cells do experience some level of photorespiration, although significantly reduced compared to C_3 plants. This adaptation in C_4 plants enhances their efficiency in hot and dry environments by minimizing photorespiration.

Quick Tip
Understanding the differences between C3 and C4 photosynthesis is crucial for agricultural practices, especially in adapting crops to changing climates.

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148. Match List-I with List-II

List-I	List-II
A. GLUT-4	I. Hormone
B. Insulin	II. Enzyme
C. Trypsin	III. Intercellular ground substance
D. Collagen	IV. Enables glucose transport into cells

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: GLUT-4 is a glucose transporter that facilitates the uptake of glucose into cells, particularly in muscle and fat tissues, and is regulated by insulin (A-IV). Insulin, a hormone produced by the pancreas, plays a critical role in regulating glucose levels in the blood (B-I).

Trypsin is an enzyme involved in the digestion of proteins in the small intestine (C-II). Collagen is a major component of the extracellular matrix, providing structural support to various tissues (D-III). This matching emphasizes the importance of these molecules in metabolic and structural functions within the body.

Quick Tip
Each of these components plays a crucial role in maintaining homeostasis and structural integrity in the body, highlighting their importance in medical and biological sciences.

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149. Match List I with List II

List I	List II
A. Rose	I. Twisted aestivation
B. Pea	II. Perigynous flower
C. Cotton	III. Drupe
D. Mango	IV. Marginal placentation

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: In this match, Rose is associated with perigynous flowers, where floral parts are attached around the base of the ovary (A-II). Pea plants exhibit marginal placentation, where ovules are attached along the seams of the ovary (B-IV). Cotton displays twisted aestivation, a floral arrangement where petals overlap each other in a twisted manner (C-I). Mangoes are classified as drupes, which are fruits with an outer fleshy part surrounding a single shell (pit) with a seed inside (D-III). These botanical classifications help in the study of plant morphology and taxonomy.

Quick Tip

Understanding plant morphology is essential for botanical classification, horticulture, and agriculture.

---

150. Which of the following are fused in somatic hybridization involving two varieties of plants?

(1) Callus

(2) Somatic embryos

(3) Protoplasts

(4) Pollens

Correct Answer: (3) Protoplasts

Solution: Somatic hybridization involves the fusion of protoplasts from two different plant varieties to combine their genetic material and create a hybrid. Protoplasts, which are cells with their cell walls removed, can be fused using techniques like electrofusion or chemical fusogens. This process enables the direct manipulation of plant genomes, allowing for the introduction of desirable traits from two different species. Somatic hybridization is a powerful tool in plant biotechnology for developing new cultivars with enhanced traits such as disease resistance or increased nutritional value.

Quick Tip

Somatic hybridization bypasses the sexual reproduction barriers, providing a unique approach to plant breeding and genetic research.

ZOOLOGY

SECTION-A

151. Match List I with List II

List I	List II
A. Pleurobrachia	I. Mollusca
B. Radula	II. Ctenophora
C. Stomochord	III. Osteichthyes
D. Air bladder	IV. Hemichordata

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Pleurobrachia belongs to the phylum Ctenophora, known for their distinctive comb-like cilia used for movement (A-II). The radula is a structure found in mollusks, used for feeding by scraping or cutting food (B-I). The stomochord is a structure in Hemichordata, often confused with chordates due to its name but distinct in function and form (C-IV). The air bladder, or swim bladder, is a gas-filled organ that helps bony fish (Osteichthyes) maintain buoyancy (D-III). This question tests knowledge of biological classification and the anatomical features of different animal phyla.

Quick Tip
Familiarity with the unique structures of animal phyla aids in understanding evolutionary relationships and adaptations.

---

152. 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) C-E-D-A-B

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

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

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

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

Solution: The correct sequence of the cell cycle starts with the Gap 1 phase (E), where the cell grows and prepares for DNA synthesis, followed by the Synthesis phase (C), where DNA is replicated. The Gap 2 phase (A) follows, where the cell prepares for mitosis. Karyokinesis (D) is the process of nuclear division, and finally, Cytokinesis (B) divides the cytoplasm into two daughter cells. This sequence is fundamental to understanding cell division and its regulation, crucial for areas like cancer research and developmental biology.

Quick Tip
Disruptions in the cell cycle can lead to diseases such as cancer, making it a critical area of study for medical research.

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153. Match List I with List II:

List I	List II
A. Common cold	I. Plasmodium
B. Haemozoin	II. Typhoid
C. Widal test	III. Rhinoviruses
D. Allergy	IV. Dust mites

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: The common cold is caused by rhinoviruses (A-III), which are a group of viruses

known for their role in upper respiratory infections. Haemozoin is a byproduct of hemoglobin processing by Plasmodium, the parasite responsible for malaria (B-I). The Widal test is used for diagnosing typhoid fever, caused by the bacterium Salmonella typhi (C-II). Allergies related to dust mites involve immune reactions to proteins in the waste products of dust mites (D-IV). This matching highlights important clinical diagnostics and etiological agents in infectious diseases and allergic reactions.

Quick Tip
Understanding the causative agents of diseases and their diagnostic tests is crucial for effective disease management and prevention.

---

154. Match List I with List II:

List I	List II
A. Typhoid	I. Fungus
B. Leishmaniasis	II. Nematode
C. Ringworm	III. Protozoa
D. Filariasis	IV. Bacteria

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Typhoid is caused by the bacterium Salmonella typhi (A-IV). Leishmaniasis is a disease caused by protozoan parasites of the genus Leishmania (B-III). Ringworm is not caused by worms, but by fungi that live on the skin, hair, and nails (C-I). Filariasis is caused by nematodes (roundworms) that belong to the family Filarioidea, which are transmitted to humans through the bite of an infected mosquito (D-II). This question underscores the importance of understanding the biological nature of pathogens in diagnosing and treating infectious diseases.

Quick Tip

Correct identification of the causative agents of diseases is essential for appropriate treatment and control measures.

---

155. The flippers of the Penguins and Dolphins are an example of:

(1) Adaptive radiation

(2) Natural selection

(3) Convergent evolution

(4) Divergent evolution

Correct Answer: (3) Convergent evolution

Solution: The flippers of penguins and dolphins are a classic example of convergent evolution, where different species develop similar physical features independently because they live in similar environments or have similar ecological roles. Penguins are birds and dolphins are mammals; their evolutionary paths are very different, yet both have developed flippers as adaptations to an aquatic lifestyle. This demonstrates how similar selective pressures can lead to similar adaptations in diverse groups of organisms.

Quick Tip

Convergent evolution illustrates how environmental pressures can guide the evolutionary path leading to similar adaptations in unrelated species.

---

156. Following are the stages of the pathway for conduction of an action potential through the heart:

A. AV bundle

B. Purkinje fibres

C. AV node

D. Bundle branches

E. SA node

Choose the correct sequence of the pathway from the options given below:

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

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

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

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

Correct Answer: (1) E-C-A-D-B

Solution: The correct sequence for the conduction of an action potential through the heart starts at the sinoatrial (SA) node (E), which is the natural pacemaker of the heart. The impulse then travels to the atrioventricular (AV) node (C), through the AV bundle (A), down the bundle branches (D), and finally to the Purkinje fibers (B), which distribute the impulse to the ventricular muscle. This sequence is crucial for the coordinated contraction of the heart chambers, ensuring efficient blood pumping through the body.

Quick Tip
Understanding the conduction pathway of the heart is vital for diagnosing and treating arrhythmias and other cardiac disorders.

---

157. Which of the following statements is incorrect?

(1) A bio-reactor provides optimal growth conditions for achieving the desired product

(2) Most commonly used bio-reactors are of stirring type

(3) Bio-reactors are used to produce small scale bacterial cultures

(4) Bio-reactors have an agitator system, an oxygen delivery system, and foam control system

Correct Answer: (3) Bio-reactors are used to produce small scale bacterial cultures

Solution: The incorrect statement is that bio-reactors are used to produce small scale bacterial cultures (3). Bio-reactors are typically used for large-scale production of biological products, such as pharmaceuticals, chemicals, and food products. They are designed to control environmental conditions like temperature, pH, and oxygen levels, ensuring optimal growth and productivity on a commercial scale.

Quick Tip

Bio-reactors play a crucial role in the biotechnology industry, enabling the mass production of biologically derived substances.

---

158. Which of the following is not a component of the Fallopian tube?

(1) Uterine fundus

(2) Isthmus

(3) Infundibulum

(4) Ampulla

Correct Answer: (1) Uterine fundus

Solution: The uterine fundus is not a component of the Fallopian tube (1); it is the top part of the uterus, located above the openings of the Fallopian tubes. The Fallopian tubes, responsible for transporting ova from the ovary to the uterus, include the infundibulum, isthmus, and ampulla, but not the uterine fundus. Understanding the anatomy of the female reproductive system is crucial in fields such as gynecology and reproductive biology.

Quick Tip

Knowledge of reproductive anatomy is essential for diagnosing and treating reproductive health issues.

---

159. Given below are two statements:

Statement I: In the nephron, the descending limb of the loop of Henle is impermeable to water and permeable to electrolytes.

Statement II: The proximal convoluted tubule is lined by simple columnar brush border epithelium and increases the surface area for reabsorption.

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

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

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

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

Solution: Statement I is incorrect as the descending limb of the loop of Henle is permeable to water but largely impermeable to solutes, which allows for the concentration of urine. Statement II is also incorrect; the proximal convoluted tubule is lined by simple cuboidal epithelium with a brush border, not columnar, and this structure indeed increases the surface area for reabsorption. This question addresses key aspects of renal physiology, particularly the function and cellular composition of the nephron, fundamental for understanding fluid and electrolyte balance in the body.

Quick Tip
Accurate knowledge of nephron structure and function is crucial for understanding kidney function and diagnosing kidney-related diseases.

---

160. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?

(1) Genetic recombination

(2) Genetic drift

(3) Gene migration

(4) Constant gene pool

Correct Answer: (4) Constant gene pool

Solution: The Hardy-Weinberg equilibrium assumes no change in allele frequencies due to factors like migration, mutation, or selection. A constant gene pool (4), which implies no change in allele frequencies, aligns perfectly with the Hardy-Weinberg conditions and therefore does not disrupt the equilibrium. This principle is a cornerstone of population genetics, providing a foundation for understanding genetic variation and the effects of evolutionary processes.

Quick Tip
Understanding the Hardy-Weinberg equilibrium helps in studying population genetics and the factors that cause evolutionary change.

161. Which of the following is not a steroid hormone?

(1) Cortisol

(2) Testosterone

(3) Progesterone

(4) Glucagon

Correct Answer: (4) Glucagon

Solution: Glucagon is a peptide hormone, not a steroid hormone. It is produced by the alpha cells of the pancreas and plays a critical role in regulating blood glucose levels by promoting the breakdown of glycogen to glucose in the liver. Steroid hormones, like cortisol, testosterone, and progesterone, are derived from cholesterol and are involved in a range of physiological processes from stress response to reproductive functions. Understanding the differences between peptide and steroid hormones is fundamental in endocrinology, emphasizing their distinct synthesis pathways and mechanisms of action.

Quick Tip
Steroid hormones can cross cell membranes due to their lipophilic nature, binding to intracellular receptors, unlike peptide hormones that bind to surface receptors.

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

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

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

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

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

Solution: The correct matches for each type of IUD and implant are: Non-medicated IUDs like the Lippes loop (A-III) are simple devices that do not release any hormones or copper. Copper releasing IUDs such as Multiload 375 (B-I) release copper to increase contraceptive efficacy. Hormone releasing IUDs like LNG-20 (C-IV) release levonorgestrel, a hormone, to help prevent pregnancy. Lastly, implants such as those that release progestogens (D-II) are subdermal devices that provide long-term contraception. This question highlights various contraceptive technologies and their mechanisms of action.

Quick Tip
Choosing the right contraceptive method involves considering both the mechanism of action and individual health needs.

---

163. In both sexes of cockroach, a pair of jointed filamentous structures called anal cerci are present on:

(1) 5th segment

(2) 10th segment

(3) 8th and 9th segment

(4) 11th segment

Correct Answer: (2) 10th segment

Solution: In cockroaches, the anal cerci are located at the 10th segment of the abdomen. These structures are sensitive to air currents, helping the cockroach detect movements around it, which is crucial for its survival as it allows the cockroach to respond quickly to potential threats. This anatomical feature is an example of how morphology can be linked to behavioral adaptations in insects.

Quick Tip
Anal cerci are used in various insects not only for sensing but also in mating rituals, showcasing the diverse functions of similar structures.

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164. Match List I with List II:

List I	List II
A.Expiratory capacity	I.Expiratory reserve volume + Tidal vol + Inspiratory reserve vol
B. Functional residual capacity	II. Tidal volume + Expiratory reserve volume
C. Vital capacity	III. Tidal volume + Inspiratory reserve volume
D. Inspiratory capacity	IV. Expiratory reserve volume + Residual volume

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Expiratory capacity (A) is the combination of tidal volume and expiratory reserve volume (A-II), representing the total volume of air expelled from the lungs during a normal exhalation followed by a forced exhalation. Functional residual capacity (B) includes the expiratory reserve volume plus the residual volume (B-IV), indicating the volume of air remaining in the lungs after a normal exhalation. Vital capacity (C) is the total volume of air that can be exhaled after a maximal inhalation, including tidal volume, inspiratory reserve volume, and expiratory reserve volume (C-I). Inspiratory capacity (D) is the sum of tidal volume and inspiratory reserve volume (D-III), representing the total volume of air that can be inhaled after a normal exhalation. Understanding these lung capacities is crucial for respiratory physiology and clinical assessments.

Quick Tip
Lung capacity measurements are essential in diagnosing and monitoring respiratory conditions such as asthma and COPD.

165. Match List I with List II:

List I	List II
A. Pons	I. Provides additional space for Neurons, regulates posture and balance.
B. Hypothalamus	II. Controls respiration and gastric secretions.
C. Medulla	III. Connects different regions of the brain.
D. Cerebellum	IV. Neuro secretory cells

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: The pons acts as a bridge connecting different regions of the brain, facilitating communication between them (A-III). The hypothalamus contains neurosecretory cells that are crucial for hormone production and regulation of the autonomic nervous system (B-IV). The medulla controls essential autonomic functions such as respiration and digestion (C-II). The cerebellum is critical for motor control, including the regulation of posture and balance (D-I). This question tests knowledge of the functions and locations of major brain structures, important for understanding neural control and integration.

Quick Tip
The central nervous system's complexity is organized functionally and anatomically to optimize neural processing and bodily control.

---

166. Given below are two statements:

Statement I: The presence or absence of hymen is not a reliable indicator of virginity.

Statement II: The hymen is torn during the first coitus only.

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

(1) Both Statement I and Statement II are true

(2) Both Statement I and Statement II are false

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

Correct Answer: (3) Statement I is true but Statement II is false

Solution: Statement I is true because the hymen can vary significantly in appearance and can be absent, torn, or stretched from activities other than sexual intercourse, such as physical activities or tampon use. Statement II is false as the hymen can be elastic or already have openings that do not tear during sexual activity; it does not always tear during the first coitus. This underscores the importance of understanding human anatomy and debunking myths related to physical indicators of virginity.

Quick Tip
Educational efforts are essential to dispel myths regarding the hymen and virginity, promoting a more scientifically accurate understanding of human anatomy.

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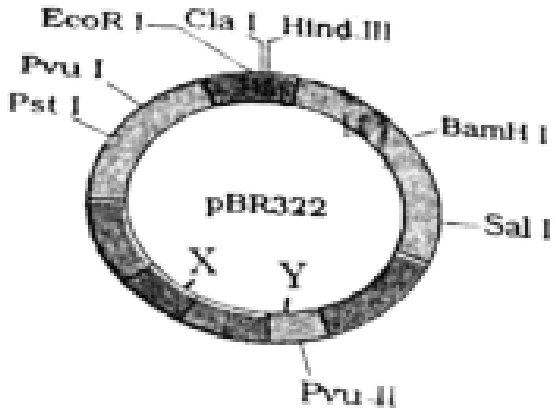
167. The following diagram showing restriction sites in E. coli cloning vector pBR322. Find the role of 'X' and 'Y' genes:



(1) The gene 'X' is responsible for resistance to antibiotics and 'Y' for protein involved in the replication of Plasmid.

(2) The gene 'X' is responsible for controlling the copy number of the linked DNA and 'Y' for protein involved in the replication of Plasmid.

(3) The gene 'X' is for protein involved in replication of Plasmid and 'Y' for resistance to antibiotics.

(4) Gene 'X' is responsible for recognitions sites and 'Y' is responsible for antibiotic resistance.

Correct Answer: (2) 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: In the pBR322 vector, gene ’X’ typically refers to elements like the rop gene that helps control the plasmid’s copy number within the host cell, whereas gene ’Y’ could refer to a gene like the rep gene involved in the initiation of plasmid DNA replication. This setup ensures that the plasmid can maintain itself efficiently within bacterial cells, crucial for its use in cloning and genetic engineering.

Quick Tip
Understanding plasmid functions such as copy number control and replication is critical in biotechnology and genetic engineering.

---

168. Which one is the correct product of DNA dependent RNA polymerase to the given template?

3’ TACATGGCAAATATCCATTCA 5’

(1) 5’ AUGUACCGUUUAUAGGUAAGU 3’

(2) 5’ AUGUAAAGUUUAUAGGUAAGU 3’

(3) 5’ AUGUACCGUUUAUAGGGAAGU 3’

(4) 5’ ATGTACCGTTTATAGGTAAGT 3’

Correct Answer: (1) 5’ AUGUACCGUUUAUAGGUAAGU 3’

Solution: The correct RNA sequence is synthesized by RNA polymerase which reads the DNA template strand from 3’ to 5’ and synthesizes RNA from 5’ to 3’. The RNA sequence matching the DNA template ’TACATGGCAAATATCCATTCA’ would be ’AUGUACCGUUUAUAGGUAAGU’, where each DNA base is transcribed to its complementary RNA base (A to U, T to A, C to G, G to C).

Quick Tip
Understanding transcription fidelity is crucial for techniques in molecular biology, such as RNA synthesis and gene expression studies.

---

169. Which of the following are Autoimmune disorders?

A. Myasthenia gravis

B. Rheumatoid arthritis

C. Gout

D. Muscular dystrophy

E. Systemic Lupus Erythematosus (SLE)

Choose the most appropriate answer from the options given below:

(1) A, B & D only

(2) A, B & E only

(3) B, C & E only

(4) C, D & E only

Correct Answer: (2) A, B & E only

Solution: Autoimmune disorders are conditions where the immune system mistakenly attacks the body's own tissues. Myasthenia gravis (A) involves antibodies that block or destroy muscle receptor cells, Rheumatoid arthritis (B) is characterized by immune-mediated destruction of joint linings, and Systemic Lupus Erythematosus (E) affects multiple organs with widespread inflammation and tissue damage. Gout and Muscular dystrophy, however, are not autoimmune; gout is a metabolic disorder and muscular dystrophy is a genetic disorder.

Quick Tip
Recognition of autoimmune mechanisms can aid in the development of targeted therapies that modulate the immune response.

---

170. Match List I with List II:

List I	List II
A. Pterophyllum	I. Hag fish
B. Myxine	II. Saw fish
C. Pristis	III. Angel fish
D. Exocoetus	IV. Flying fish

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Pterophyllum is commonly known as the angel fish (A-III), an elegant, flat-bodied freshwater fish. Myxine, or hagfish (B-I), are jawless marine creatures known for their slime production. Pristis represents the sawfish (C-II), known for its long, toothed rostrum resembling a saw. Exocoetus, or flying fish (D-IV), are known for their ability to glide above the water's surface to escape predators. This question tests knowledge of common names and characteristics of various fish species, useful in studies of marine biology and ecology.

Quick Tip
Linking scientific names with common names enhances understanding of biodiversity and aids in more effective communication in biological sciences.

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171. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R):

Assertion (A): FSH acts upon ovarian follicles in female and Leydig cells in male.

Reason (R): Growing ovarian follicles secrete estrogen in female while interstitial cells secrete androgen in male human being.

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

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

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

(3) A is true but R is false

(4) A is false but R is true

Correct Answer: (4) A is false but R is true

Solution: Assertion (A) is false because FSH acts on Sertoli cells in males, not Leydig cells. Leydig cells are stimulated by LH, not FSH. Reason (R) is true as it correctly states the

hormones secreted by the ovarian follicles and interstitial cells in females and males respectively.

Quick Tip
Understanding the specific roles of FSH and LH in the reproductive systems of both genders is crucial for studies in endocrinology and reproductive health.

---

172. Match List I with List II:

List I	List II
A. Lipase	I. Peptide bond
B. Nuclease	II. Ester bond
C. Protease	III. Glycosidic bond
D. Amylase	IV. Phosphodiester bond

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Lipase breaks down ester bonds found in lipids (A-II). Nuclease cuts phosphodiester bonds in nucleic acids (B-IV). Protease breaks peptide bonds in proteins (C-I). Amylase acts on glycosidic bonds in starch (D-III). This question assesses understanding of enzyme specificity and the biochemical reactions they catalyze.

Quick Tip
Recognizing the specific substrates and actions of different enzymes is key in biochemistry, especially for applications in medicine and biotechnology.

---

173. Match List I with List II:

List I	List II
A. Axoneme	I. Centriole
B. Cartwheel pattern	II. Cilia and flagella
C. Crista	III. Chromosome
D. Satellite	IV. Mitochondria

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Axoneme is the structural core of cilia and flagella (A-II), involved in their movement. The cartwheel pattern is associated with the centriole structure (B-I), seen during centriole replication. Cristae are the folds within mitochondria that increase the surface area for ATP production (C-IV). Satellites are repetitive DNA sequences found near centromeres on chromosomes (D-III). This question helps in understanding the cellular structures and their specific functions within the cell.

Quick Tip
Exploring cellular structures in detail can lead to a better understanding of cellular functions and their implications in health and disease.

---

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

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

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

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

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

Solution: Diakinesis is marked by the completion of the terminalisation of chiasmata (A-II), where chromosomes prepare for segregation. Pachytene features the appearance of recombination nodules, essential for crossing over (B-IV). During Zygotene, synaptonemal complexes form, facilitating chromosome pairing (C-I). In Leptotene, chromosomes first become visible as thin threads (D-III). This knowledge is crucial for understanding genetic recombination and chromosome behavior during meiosis.

Quick Tip
Each phase of meiosis has distinctive events that are crucial for accurate genetic segregation and variation.

---

175. 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) B only

(2) A only

(3) C only

(4) D only

Correct Answer: (2) A only

Solution: Annelids are indeed true coelomates, having a body cavity completely lined with mesoderm (A). Poriferans do not have any body cavity and are thus not pseudocoelomates (B is false). Aschelminthes are pseudocoelomates, not acoelomates (C is false). Platyhelminthes

are acoelomates, lacking a body cavity (D is false). Understanding these distinctions is essential in zoology and taxonomy.

Quick Tip
Accurate classification based on body cavity type is fundamental in understanding animal phylogeny and evolutionary relationships.

---

176. Match List I with List II:

List I	List II
A. α–I antitrypsin	I. Cotton bollworm
B. Cry IAb	II. ADA deficiency
C. Cry IAc	III. Emphysema
D. Enzyme replacement therapy	IV. Corn borer

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: –I antitrypsin is a protein that protects tissues from enzymes of inflammatory cells, especially in the lungs; deficiency can lead to emphysema (A-III). Cry IAb and Cry IAc are insecticidal proteins produced by Bacillus thuringiensis; Cry IAb targets the corn borer (B-IV) and Cry IAc targets the cotton bollworm (C-I). Enzyme replacement therapy is used to treat various deficiencies, such as ADA deficiency (D-II). This question tests knowledge of biotechnological applications and their impact on medicine and agriculture.

Quick Tip
Biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet.

---

177. Match List I with List II:

List I	List II
A. Fibrous joints	I. Adjacent vertebrae, limited movement
B. Cartilaginous joints	II. Humerus and Pectoral girdle, rotational movement
C. Hinge joints	III. Skull, don't allow any movement
D. Ball and socket joints	IV. Knee, help in locomotion

Choose the correct answer from the options given below:

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

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

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

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

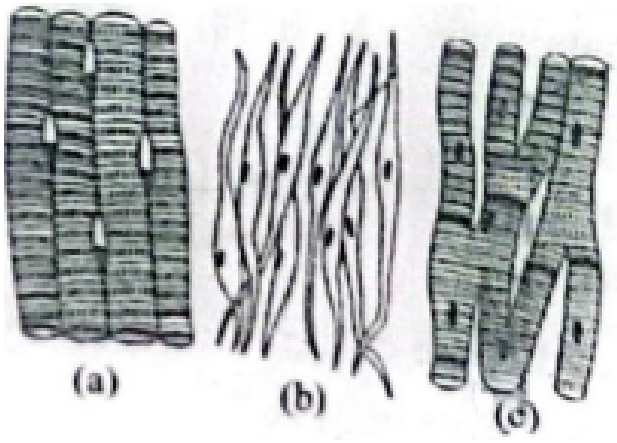
Correct Answer: (4) A-III, B-I, C-IV, D-II

Solution: Fibrous joints, such as those in the skull, allow no movement (A-III). Cartilaginous joints, like those between adjacent vertebrae, permit limited movement (B-I). Hinge joints, such as the knee, allow movement primarily in one plane (C-IV). Ball and socket joints, found in the shoulder (humerus and pectoral girdle), allow rotational and other movements (D-II). This knowledge is crucial in fields like orthopedics and physical therapy.

Quick Tip
Understanding the types of joints and their movements can aid in diagnosing and treating musculoskeletal disorders.

---

178. 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) Smooth - Toes, (b) Skeletal – Legs, (c) Cardiac – Heart

(2) (a) Skeletal - Triceps, (b) Smooth – Stomach, (c) Cardiac – Heart

(3) (a) Skeletal - Biceps, (b) Involuntary – Intestine, (c) Smooth – Heart

(4) (a) Involuntary – Nose tip, (b) Skeletal – Bone, (c) Cardiac – Heart

Correct Answer: (2) (a) Skeletal - Triceps, (b) Smooth – Stomach, (c) Cardiac – Heart

Solution: The correct matching of muscle types to their locations in the human body is: (a) Skeletal muscles like the triceps are located in the arms, enabling movement; (b) Smooth muscles are found in organs such as the stomach, aiding in involuntary functions like digestion; (c) Cardiac muscle, which is found exclusively in the heart, is crucial for pumping blood throughout the body. This question assesses knowledge of muscle types and their anatomical locations, important for understanding human physiology.

Quick Tip
Knowing the function and location of different muscle types helps in understanding their roles in health and disease.

---

179. Match List I with List II:

List I	**List II**
A. Down's syndrome	I. 11^{th} chromosome
B. α-Thalassemia	II. X chromosome
C. β-Thalassemia	III. 21^{st} chromosome
D. Klinefelter's syndrome	IV. 16^{th} chromosome

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

Solution: Down's syndrome is associated with an extra copy of the 21st chromosome (A-III), α-Thalassemia is linked to defects on the 16th chromosome (B-IV), β-Thalassemia involves the 11th chromosome (C-I), and Klinefelter's syndrome is characterized by an extra 'X' chromosome (D-II). This question helps in understanding genetic disorders and their chromosomal bases.

Quick Tip
Accurate knowledge of genetic disorders and their chromosomal links is crucial for diagnosis and genetic counseling.

---

180. Which of the following factors are favorable for the formation of oxyhaemoglobin in alveoli?

(1) High pO2 and High pCO2

(2) High pO2 and Lesser H+ concentration

(3) Low pCO2 and High H+ concentration

(4) Low pCO2 and High temperature

Correct Answer: (2) High pO2 and Lesser H+ concentration

Solution: High partial pressure of oxygen (pO2) and lower hydrogen ion (H+) concentration enhance the formation of oxyhaemoglobin in the alveoli. High pO2 increases the oxygen saturation of haemoglobin, while lower H+ concentration reduces the Bohr effect, thereby facilitating the uptake of oxygen by haemoglobin.

Quick Tip
Understanding the conditions that favor oxyhaemoglobin formation can help in assessing respiratory efficiency and the oxygen-carrying capacity of the blood.

181. 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) D-A-C-B
(2) B-A-D-C
(3) C-B-D-A
(4) A-D-C-B
Correct Answer: (4) A-D-C-B
Solution: The correct chronological sequence of human evolution, from earliest to most recent, is: Homo habilis (A) as one of the earliest known species using tools, Homo erectus (D) known for significant brain enlargement and use of fire, Homo neanderthalensis (C) known for robust build and adaptability to cold climates, and Homo sapiens (B) which represents modern humans, known for advanced tools and complex social structures.

Quick Tip
Studying human evolution provides insights into our biological history and the evolutionary processes that influence our current form and behaviors.

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

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: Cocaine is derived from the Erythroxylum coca plant (A-III), heroin is processed from morphine, which comes from Papaver somniferum, the opium poppy (B-IV), morphine is also derived from Papaver somniferum (C-I), and marijuana comes from Cannabis sativa (D-II). This question tests knowledge of the source plants of various drugs, important for understanding their effects and regulation.

Quick Tip
Knowledge of the origins and effects of psychoactive substances can aid in their proper regulation and in public health education.

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183. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R): Assertion (A): Breast-feeding during 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 new born 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 and R is the correct explanation of A

(2) Both A and R are correct but R is NOT the correct explanation of A

(3) A is correct but R is not correct

(4) A is not correct but R is correct

Correct Answer: (1) Both A and R are correct and R is the correct explanation of A

Solution: Both statements are correct and Reason (R) is the correct explanation for Assertion (A). Breastfeeding is highly recommended as it not only provides complete nutrition but also passes essential antibodies found in colostrum, which protect the newborn

against various diseases, boosting their immune system early in life.

Quick Tip
The benefits of breastfeeding extend beyond basic nutrition, including enhanced immunity and improved health outcomes for babies.

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184. Which of the following is not a natural/traditional contraceptive method? (1) Coitus interruptus

(2) Periodic abstinence

(3) Lactational amenorrhea

(4) Vaults

Correct Answer: (4) Vaults

Solution: Vaults, or cervical caps, are not traditional methods; they are barrier methods of contraception that involve a device placed over the cervix to prevent sperm from entering the uterus. The other options listed are considered natural or traditional methods, relying on behavior rather than devices.

Quick Tip
Understanding the range of contraceptive methods available can aid individuals in choosing the most appropriate method for their needs.

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185. The "Ti plasmid" of Agrobacterium tumefaciens stands for

(1) Tumour inhibiting plasmid

(2) Tumor independent plasmid

(3) Tumor inducing plasmid

(4) Temperature independent plasmid

Correct Answer: (3) Tumor inducing plasmid

Solution: The "Ti plasmid" in Agrobacterium tumefaciens stands for "tumor inducing" plasmid. This plasmid is responsible for transferring part of its DNA to plant cells, leading to the formation of tumors or galls. This mechanism has been harnessed in genetic engineering

to introduce new genes into plants.

Quick Tip
The manipulation of the Ti plasmid has significant applications in biotechnology, especially in creating genetically modified plants.

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186. Match List I with List II:

List-I	List-II
A. Exophthalmic goiter	I. Excess secretion of cortisol, moon face & hyperglycemia.
B. Acromegaly	II. Hypo-secretion of thyroid hormone and stunted growth.
C. Cushing's syndrome	III. Hyper secretion of thyroid hormone & protruding eyeballs.
D. Cretinism	IV. Excessive secretion of growth hormone.

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: A. Exophthalmic goiter is associated with hypersecretion of thyroid hormones and protruding eyeballs, which corresponds to III.

B. Acromegaly is caused by the excessive secretion of growth hormone, corresponding to IV.

C. Cushing's syndrome involves excess secretion of cortisol, leading to symptoms like moon face and hyperglycemia, corresponding to I.

D. Cretinism is caused by hypothyroidism in early childhood, leading to stunted growth, corresponding to II.

Conclusion: The correct answer is (4) A-III, B-IV, C-I, D-II.

Quick Tip
Exophthalmic goiter is another name for Graves' disease, characterized by hyperthyroidism and protruding eyeballs.

187. Given below are two statements: Statement I: Mitochondria and chloroplasts both are double-membrane-bound organelles. Statement II: The inner membrane of mitochondria is relatively less permeable, as compared to chloroplasts.

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 correct.

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

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

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

Correct Answer: (3) Statement I is correct but Statement II is incorrect.

Solution: - Statement I is correct because both mitochondria and chloroplasts are double-membrane-bound organelles, which are essential for their respective roles in energy metabolism (mitochondria) and photosynthesis (chloroplasts). - Statement II is incorrect because the inner membrane of mitochondria is more impermeable compared to the outer membrane, whereas in chloroplasts, both membranes are relatively permeable to ions and molecules.

Conclusion: The correct answer is (3) Statement I is correct but Statement II is incorrect.

Quick Tip
Both mitochondria and chloroplasts have double membranes, but their permeability characteristics are different.

---

188. 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 the active site.

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (1) E, A, D, C, B

Solution: The correct sequence for the catalytic cycle of enzyme action is:

E. Substrate binding to the active site: The enzyme's active site binds to the substrate, initiating the reaction.

A. Substrate-enzyme complex formation: After the substrate binds, an enzyme-substrate complex forms.

D. Chemical bonds of the substrate broken: The enzyme catalyzes the breaking of chemical bonds in the substrate.

C. Release of products: The products of the reaction are released from the enzyme.

B. Free enzyme ready to bind with another substrate: The enzyme is now free to bind with another substrate and repeat the process.

Conclusion: The correct answer is (1) E, A, D, C, B.

Quick Tip
Enzyme catalysis involves the formation of an enzyme-substrate complex, followed by product formation and release, after which the enzyme is free to catalyze further reactions.

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

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

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

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

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

Solution: A. The structures used for storing food: The crop is responsible for storing food in a cockroach, corresponding to IV.

B. Ring of 6-8 blind tubules at junction of foregut and midgut: These structures are gastric caeca, corresponding to II.

C. Ring of 100-150 yellow colored thin filaments at junction of midgut and hindgut: These are Malpighian tubules, corresponding to III.

D. The structures used for grinding the food: The gizzard is responsible for grinding food, corresponding to I.

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

Quick Tip
In cockroaches, the crop stores food, the gastric caeca aid digestion, the Malpighian tubules excrete waste, and the gizzard grinds food.

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190. 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 & C only

(2) A, B & D only

(3) B, D & E only

(4) B, C & D only

Correct Answer: (3) B, D & E only

Solution: A is true for chordates but not for all non-chordates.

B is true for non-chordates as they do not possess a notochord.

D is true for many non-chordates, as their heart is dorsal (e.g., arthropods).

E is true for some non-chordates, as they lack a post-anal tail (e.g., arthropods).

C is false for all non-chordates, as their central nervous system is not dorsal.

Conclusion: The correct answer is (3) B, D & E only.

Quick Tip
Non-chordates typically lack a notochord, dorsal nervous system, and a post-anal tail, distinguishing them from chordates.

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191. Choose the correct statement given below regarding juxtamedullary nephron.

(1) Juxtamedullary nephrons are located in the columns of Bertini.

(2) Renal corpuscle of juxtamedullary nephron lies in the outer portion of the renal medulla.

(3) Loop of Henle of juxtamedullary nephron runs deep into medulla.

(4) Juxtamedullary nephrons outnumber the cortical nephrons.

Correct Answer: (3) Loop of Henle of juxtamedullary nephron runs deep into medulla.

Solution: Juxtamedullary nephrons are characterized by having a long loop of Henle that extends deep into the renal medulla, which plays a crucial role in the concentration of urine through the countercurrent mechanism.

The renal corpuscle of these nephrons is located near the boundary between the cortex and the medulla, but not in the outer portion of the renal medulla.

Juxtamedullary nephrons do not outnumber the cortical nephrons; actually, they are fewer in number compared to cortical nephrons.

Columns of Bertini refer to the regions in the kidney cortex, but juxtamedullary nephrons are not located here.

Conclusion: The correct answer is (3) Loop of Henle of juxtamedullary nephron runs deep into medulla.

Quick Tip
Juxtamedullary nephrons are essential for producing concentrated urine due to their long loops of Henle.

192. Given below are two statements: Statement I: The cerebral hemispheres are connected by a nerve tract known as the corpus callosum. Statement II: The brain stem consists of the medulla oblongata, pons, and cerebrum.

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

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

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

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

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

Correct Answer: (3) Statement I is correct but Statement II is incorrect.

Solution: Statement I is correct because the corpus callosum is a large bundle of nerve fibers that connects the left and right cerebral hemispheres, allowing communication between them. Statement II is incorrect because the brainstem consists of the medulla oblongata, pons, and midbrain, not the cerebrum. The cerebrum is part of the forebrain, distinct from the brainstem.

Conclusion: The correct answer is (3) Statement I is correct but Statement II is incorrect.

Quick Tip
The brainstem is involved in basic life functions, while the cerebrum is responsible for higher brain functions.

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193. Match List I with List II:

List-I	List-II
A. P wave	I. Heart muscles are electrically silent.
B. QRS complex	II. Depolarization of ventricles.
C. T wave	III. Depolarization of atria.
D. T-P gap	IV. Repolarization of ventricles.

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: A. P wave is associated with the depolarization of the atria, corresponding to III.

B. QRS complex corresponds to the depolarization of the ventricles, so it is linked to II.

C. T wave represents the repolarization of the ventricles, corresponding to IV.

D. T-P gap is the period when the heart muscles are electrically silent, corresponding to I.

Conclusion: The correct match is (2) A-III, B-II, C-IV, D-I.

Quick Tip
The ECG (electrocardiogram) records the electrical activity of the heart, with distinct waves corresponding to atrial and ventricular depolarization and repolarization.

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

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

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

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

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

Solution: A. Mesozoic Era is known for the rise of birds and reptiles, corresponding to III.

B. Proterozoic Era is marked by the evolution of lower invertebrates, corresponding to I.

C. Cenozoic Era is the age of mammals, corresponding to IV.

D. Paleozoic Era is characterized by the emergence of fish and amphibians, corresponding to

II.

Conclusion: The correct match is (4) A-III, B-I, C-IV, D-II.

Quick Tip
Each geological era is characterized by the appearance and evolution of different life forms, with the Mesozoic Era famous for dinosaurs and reptiles.

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195. As per ABO blood grouping system, the blood group of father is B+, mother is A+ and child is O+. Their respective genotype can be

A. $I^B I^A / ii$

B. $I^B I^B / I^A I^A$

C. $I^A I^B / ii$

D. $I^A I^B / I^A I^i$

E. $ii / I^A I^B / I^A I^B$

(1) A only

(2) B only

(3) C & B only

(4) D & E only

Correct Answer: (1) A only

Solution: The father's blood group is B+, which means his genotype can be $I_B I_B$ (homozygous) or $I_B i$ (heterozygous).

The mother's blood group is A+, which means her genotype can be $I_A I_A$ or $I_A i$.

The child's blood group is O+, which must have the genotype ii as O blood type is recessive.

For the child to inherit ii, both parents must contribute an i allele, meaning both parents must be heterozygous: $I_B i$ (father) and $I_A i$ (mother).

Quick Tip
For a child to have blood group O, both parents must carry the i allele.

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196. Given below are two statements:

Statement I: Gause's competitive exclusion principle states that two closely related species competing for different resources cannot exist indefinitely.

Statement II: According to Gause's principle, during competition, the inferior will be eliminated. This may be true if resources are limiting.

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

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

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

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

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

Correct Answer: (4) Statement I is false but Statement II is true.

Solution: Statement I is false because Gause's competitive exclusion principle actually states that two closely related species competing for the *same* resources cannot coexist indefinitely. Statement II is true as it correctly reflects that in competitive scenarios under limited resources, typically the inferior competitor will be eliminated.

Quick Tip
Understanding ecological principles like Gause's can help in conservation efforts by predicting the outcomes of species interactions.

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197. Given below are two statements:

Statement I: Bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced.

Statement II: Both bone marrow and thymus provide microenvironments for the development and maturation of T-lymphocytes.

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

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

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

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

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

Correct Answer: (1) Both Statement I and Statement II are correct.

Solution: Explanation:

- **Statement I:** Bone marrow is indeed the primary site for the production of blood cells, including lymphocytes. It is the site where all types of blood cells (red blood cells, white blood cells, and platelets) are generated through hematopoiesis.
- **Statement II:** Both bone marrow and thymus are involved in the development and maturation of T-lymphocytes. The bone marrow is the site of origin for T-lymphocytes, and they migrate to the thymus where they undergo maturation and selection processes before entering the bloodstream.

Since both statements are true, the correct answer is **(1) Both Statement I and Statement II are correct.**

Quick Tip
Knowledge of where blood cells are formed and matured is essential in medical sciences, especially in immunology and hematology.

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

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

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

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

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

Solution: Unicellular glandular epithelium like goblet cells are found in the alimentary canal (A-III). Compound epithelium is found on moist surfaces like the buccal cavity (B-IV).

Multicellular glandular epithelium like that in salivary glands produces various secretions (C-I). Endocrine glandular epithelium, such as in the pancreas, secretes hormones directly into the bloodstream (D-II).

Quick Tip
Understanding the structure and function of different types of epithelial tissue is crucial in anatomy and physiology for insights into how various body systems operate.

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199. Match List I with List II:

List I	List II
A. RNA polymerase III	I. snRNPs
B. Termination of transcription	II. Promotor
C. Splicing of Exons	III. Rho factor
D. TATA box	IV. SnRNAs, tRNA

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: RNA polymerase III transcribes genes encoding tRNAs and some snRNAs (A-IV). The termination of transcription in prokaryotes often involves the Rho factor (B-III). Splicing of exons is facilitated by snRNPs, which are part of the spliceosome complex (C-I). The TATA box is a core promotor element found in many genes (D-II).

Quick Tip
Familiarity with molecular biology's core concepts, like transcription and splicing, is vital for understanding genetic expression and regulation.

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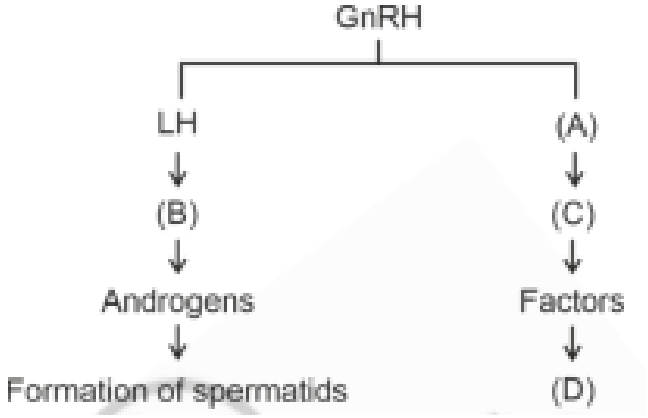
200. Identify the correct option (A), (B), (C), (D) with respect to spermatogenesis.



(1) FSH, Leydig cells, Sertoli cells, spermiogenesis.

(2) ICSH, Interstitial cells, Leydig cells, spermiogenesis.

(3) FSH, Sertoli cells, Leydig cells, spermatogenesis.

(4) ICSH, Leydig cells, Sertoli cells, spermatogenesis.

Correct Answer: (1) FSH, Leydig cells, Sertoli cells, spermiogenesis.

Solution: FSH stimulates Sertoli cells, which in turn support spermatogenesis. Leydig cells, stimulated by LH (also known as ICSH in males), produce testosterone, crucial for the final stages of spermatogenesis, known as spermiogenesis.

Quick Tip
Understanding hormonal regulation of spermatogenesis is important in fields like endocrinology and reproductive medicine.