

NEET 2024 Question Paper with Solutions Set Q5

Time Allowed :200 Minutes	Maximum Marks :720	Total Questions :200
---------------------------	--------------------	----------------------

General Instructions

Read the following instructions very carefully and strictly follow them::

1. The test is of **3 hours 20 minutes** duration and the Test Booklet contains **200** multiple-choice questions (four options with a single correct answer) from **Physics, Chemistry, and Biology (Botany and Zoology)**. 50 questions in each subject are divided into **two Sections (A and B)** as per details given below:
 - (a) **Section-A** shall consist of **35 (Thirty-five)** Questions in each subject (Question Nos-1 to 35, 51 to 85, 101 to 135, and 151 to 185). All Questions are compulsory.
 - (b) **Section-B** shall consist of **15 (Fifteen)** questions in each subject (Question Nos- 36 to 50, 86 to 100, 136 to 150, and 186 to 200). In **Section B**, a candidate needs to attempt **any 10 (Ten)** questions out of **15 (Fifteen)** in each subject.

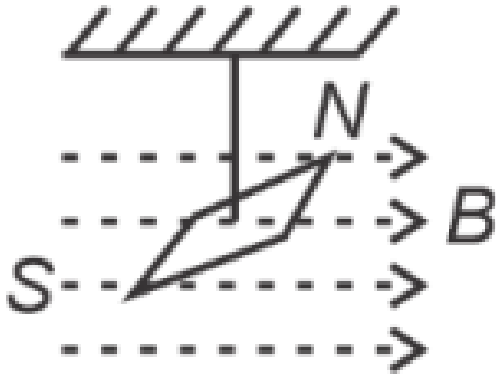
Candidates are advised to read all 15 questions in each subject of Section B before they start attempting the question paper. In the event of a candidate attempting more than ten questions, the first ten questions answered by the candidate shall be evaluated.

2. Each question carries **4 marks**. For each correct response, the candidate will get **4 marks**. For each incorrect response, **one mark will be deducted** from the total scores. **The maximum marks are 720.**
3. On completion of the test, the candidate must **hand over the Answer Sheet (ORIGINAL and OFFICE copy) to the Invigilator** before leaving the Room / Hall. The candidates are allowed to take away this Test Booklet with them.

PHYSICS

SECTION-A

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

Step 1: Determine the angular frequency of the needle's oscillation. The period T of one oscillation is given by:

$$T = \frac{\text{Total time}}{\text{Number of oscillations}} = \frac{5 \text{ s}}{20} = 0.25 \text{ s}$$

The angular frequency ω is:

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.25} = 8\pi \text{ rad/s}$$

Step 2: Use the formula for the angular frequency of a magnetic dipole in a magnetic field. For a magnetic dipole in a magnetic field, the angular frequency ω is related to the magnetic moment (m), magnetic field (B), and moment of inertia (I) by the torsional formula:

$$\omega = \sqrt{\frac{mB}{I}}$$

Plugging in the values:

$$8\pi = \sqrt{\frac{x \times 10^{-5} \times 0.049}{9.8 \times 10^{-6}}}$$

Step 3: Solve for 'x'. Squaring both sides and solving for x :

$$\begin{aligned}(8\pi)^2 &= \frac{x \times 10^{-5} \times 0.049}{9.8 \times 10^{-6}} \\ 64\pi^2 &= \frac{x \times 0.049}{9.8 \times 10^{-1}} \\ x &= \frac{64\pi^2 \times 9.8 \times 10^{-1}}{0.049} \\ x &= \frac{64\pi^2 \times 9.8}{0.049} \times 10^{-1} \\ x &= 1280\pi^2\end{aligned}$$

💡 Quick Tip

When dealing with oscillations of a magnetic dipole, always consider the relationship between the physical properties like magnetic moment, magnetic field, and the moment of inertia as key to solving the problem.

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

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

The expression for the output Y is:

- (1) $AB + \bar{A}$
- (2) $AB + A$
- (3) $\bar{B}$
- (4) B

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

Solution:

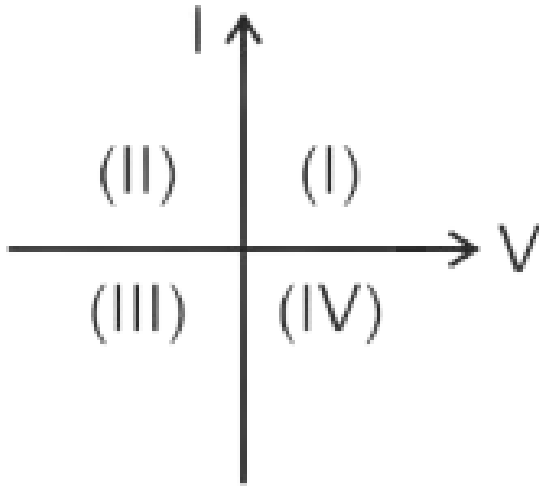
Step 1: Observe Output Y with respect to Input B. From the truth table, it is evident that Y is the logical NOT of B , as it outputs 1 when $B = 0$ and 0 when $B = 1$.

Step 2: Confirm the Expression. The expression $\bar{B}$ matches the observations, proving it is the correct logic expression for the output Y .

💡 Quick Tip

When determining the logical expression from a truth table, observe how the output changes with each input to identify direct relationships or inverse relationships.

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



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

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

- (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: Analyze Statement A. Solar cells, when illuminated, typically have their I-V characteristics in the fourth quadrant where they supply power, indicating that the statement is correct.

Step 2: Analyze Statement B. In a reverse biased pn junction diode, the current is primarily due to minority carriers, not majority carriers, making this statement incorrect.

Step 3: Conclusion. Given the analyses, the correct response is that Statement A is correct and B is incorrect.

💡 Quick Tip

Always remember that in reverse bias conditions for diodes, minority carriers contribute to the current, while in photovoltaic cells like solar cells, power generation occurs with voltage positive and current negative.

4. 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:

Step 1: Calculating the circumference of the disc. The radius of the disc is given as 4.5 cm, which converts to meters as:

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

The circumference C of the disc, which is the length of the contact line between the disc and the water, is:

$$C = 2\pi r = 2\pi \times 0.045 \text{ m} \approx 0.283 \text{ m}$$

Step 2: Calculating the force due to surface tension. The force F due to surface tension is calculated by multiplying the surface tension by the circumference:

$$F = \text{Surface Tension} \times \text{Circumference} = 0.07 \text{ N/m}^{-1} \times 0.283 \text{ m} \approx 0.0198 \text{ N}$$

Converting this force into millinewtons:

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

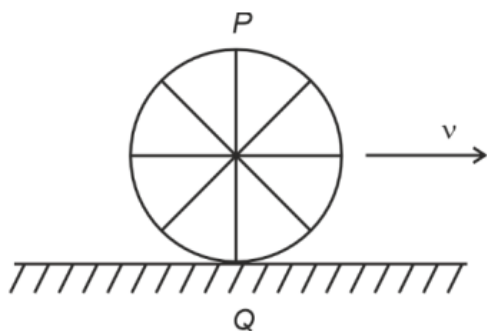
💡 Quick Tip

For surface tension problems, use the formula:

$$F = 2T \times \text{circumference}$$

where the factor 2 accounts for the two surfaces of the liquid film.

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



- (1) Point P moves slower than point Q
- (2) Point P moves faster than point Q
- (3) Both the points P and Q move with equal speed
- (4) Point P has zero speed

Correct Answer: (2) Point P moves faster than point Q

Solution:

Step 1: Understanding the velocity components in rolling motion. For a rolling wheel, every point on the wheel has two velocity components: 1. Translational velocity v (same for all points on the wheel). 2. Rotational velocity about the center, which varies depending on the point's position.

Step 2: Analyzing the speed of points P and Q . - The velocity at any point is given by the vector sum of translational and rotational velocities. - The highest point P has both the translational velocity v and the rotational velocity v (in the same direction). Thus, its total velocity is:

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

- The lowest point Q has translational velocity v and rotational velocity v (in opposite directions), so its net velocity is:

$$v_Q = v - v = 0.$$

Step 3: Conclusion. Since $v_P = 2v$ and $v_Q = 0$, point P moves faster than point Q .

 Quick Tip

For rolling motion without slipping, the velocity at the highest point is $2v$, the velocity at the center is v , and the velocity at the lowest point is zero.

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

- (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: Formula for vernier constant. The vernier constant (VC) is given by:

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

Step 2: Finding the vernier scale division (VSD). Since $(N + 1)$ vernier divisions are equal to N main scale divisions:

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

Given that $1 \text{ MSD} = 0.1 \text{ mm} = 0.01 \text{ cm}$,

$$1 \text{ VSD} = \frac{N \times 0.01}{N + 1}.$$

Step 3: Calculating the vernier constant.

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

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

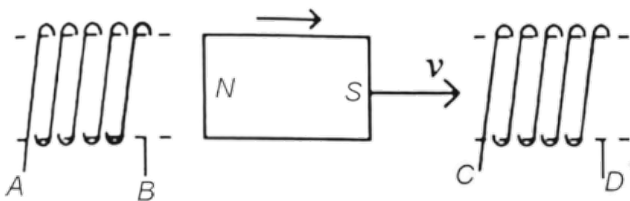
$$= \frac{1}{100(N+1)}.$$

💡 Quick Tip

The vernier constant (or least count) is the difference between one main scale division and one vernier scale division:

$$VC = MSD - VSD.$$

7. 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: Applying Lenz's Law. Lenz's law states that the direction of induced current opposes the change in magnetic flux.

Step 2: Analyzing solenoid-1.

- The magnet is moving towards solenoid-2, so the left solenoid (solenoid-1) experiences a decreasing flux in its coil. - To oppose this change, solenoid-1 will generate a current that tries to maintain the field, meaning its left end will behave like a north pole. - Using the right-hand rule, the current direction in solenoid-1 is from A to B .

Step 3: Analyzing solenoid-2.

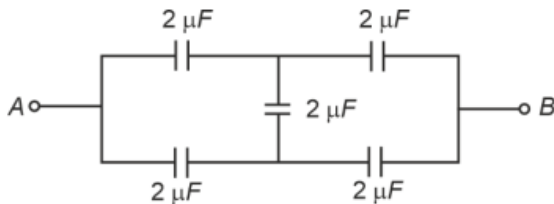
- The right solenoid (solenoid-2) experiences an increasing flux due to the approaching magnet. - To oppose this, it will generate a current that tries to counteract the increase, making its left end a south pole. - Using the right-hand rule, the current in solenoid-2 flows from D to C .

Step 4: Conclusion. Thus, the correct answer is AB and DC .

💡 Quick Tip

To determine the direction of induced current, apply Lenz's Law: 1. If flux increases, the coil opposes the increase. 2. If flux decreases, the coil tries to maintain the field. Use the right-hand rule to determine current direction.

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

We have four capacitors in the circuit, each of $2\ \mu F$. First, we simplify the capacitors in series and parallel.

1. The two capacitors in series on the left-hand side (each of $2\ \mu F$) have an equivalent capacitance C_1 given by:

$$\frac{1}{C_1} = \frac{1}{2\ \mu F} + \frac{1}{2\ \mu F} = 1\ \mu F \quad \Rightarrow \quad C_1 = 1\ \mu F.$$

2. The two capacitors in series on the right-hand side (each of $2\ \mu F$) also have an equivalent capacitance C_2 given by:

$$\frac{1}{C_2} = \frac{1}{2\ \mu F} + \frac{1}{2\ \mu F} = 1\ \mu F \quad \Rightarrow \quad C_2 = 1\ \mu F.$$

3. Now, the two series capacitors C_1 and C_2 are in parallel with each other, so the total equivalent capacitance C_{eq} is:

$$C_{eq} = C_1 + C_2 = 1\ \mu F + 1\ \mu F = 2\ \mu F.$$

Thus, the equivalent capacitance between terminals A and B is $2\ \mu F$.

💡 Quick Tip

Capacitors in series add reciprocally ($\frac{1}{C_{eq}} = \sum \frac{1}{C_i}$), while capacitors in parallel add directly ($C_{eq} = \sum C_i$). Simplify series combinations before parallel ones.

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

- (1) 4 mm
- (2) 0.4 mm
- (3) 40 mm
- (4) 8 mm

Correct Answer: (1) 4 mm

Solution: Step 1: Understanding Young's Modulus.

Young's modulus (Y) is the ratio of stress to strain:

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{F/A}{\Delta L/L}$$

where: F is the force A is the cross-sectional area ΔL is the change in length (elongation) L is the original length

Step 2: Finding maximum elongation. Maximum stress is the elastic limit. We want ΔL , so:

$$\Delta L = \frac{\text{Stress} \times L}{Y}$$

Plugging in values:

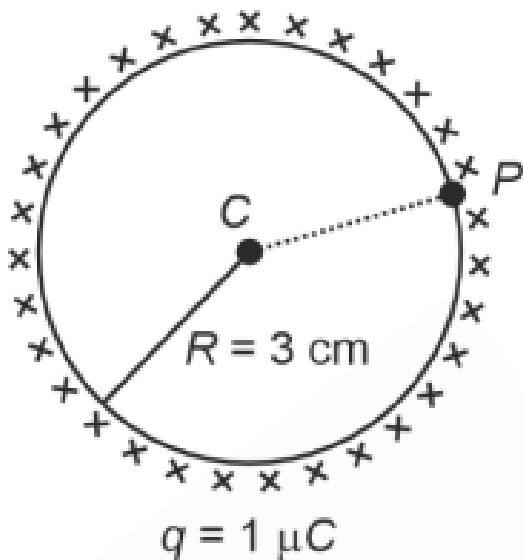
$$\Delta L = \frac{8 \times 10^8 \text{ N m}^{-2} \times 1 \text{ m}}{2 \times 10^{11} \text{ N m}^{-2}} = 4 \times 10^{-3} \text{ m} = 4 \text{ mm}$$

The maximum elongation is 4 mm.

💡 Quick Tip

Stress is force per unit area, and strain is the change in length over the original length. Young's modulus links them. Use consistent units (meters, Newtons, etc.).

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



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

- (1) 3×10^5
- (2) 1×10^5
- (3) 0.5×10^5
- (4) Zero

Correct Answer: (4) Zero

Solution: Step 1: Understanding Electric Potential Inside a Spherical Shell The electric potential inside a charged spherical shell is constant and equal to the potential at the surface.

Step 2: Calculating Potential at C and P Since both points C and P are inside the spherical shell, the potential at C (V_C) is equal to the potential at the surface, and the potential at P (V_P) is also equal to the potential at the surface.

Step 3: Potential Difference The potential difference between C and P is:

$$\Delta V = V_C - V_P$$

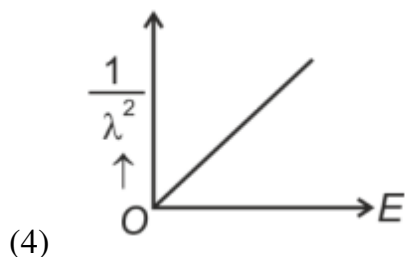
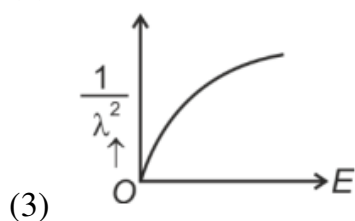
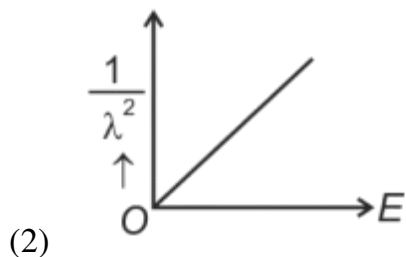
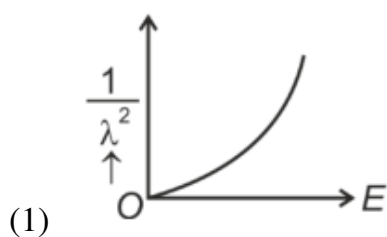
Since V_C and V_P are the same, their difference is zero.

$$\Delta V = 0$$

💡 Quick Tip

Remember that the electric field inside a charged spherical shell is zero, which implies that the potential is constant. Focus on understanding the underlying principles rather than just memorizing formulas.

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



Correct Answer: (4)

Solution: Step 1: De Broglie Wavelength and Kinetic Energy The de Broglie wavelength (λ) of a particle is related to its momentum (p) by:

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

where h is Planck's constant.

The kinetic energy (E) of a free particle is related to its momentum by:

$$E = \frac{p^2}{2m}$$

where m is the mass of the particle.

Step 2: Combining the Equations We can express momentum in terms of wavelength:

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

Substitute this into the kinetic energy equation:

$$E = \frac{(h/\lambda)^2}{2m} = \frac{h^2}{2m\lambda^2}$$

Step 3: Analyzing the Relationship We are looking for the relationship between $\frac{1}{\lambda^2}$ and E. From the equation above, we can see that:

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

Since $2m$ and h^2 are constants, $\frac{1}{\lambda^2}$ is directly proportional to E. This means the graph should be a straight line passing through the origin with a positive slope.

💡 Quick Tip

Remember the relationship between de Broglie wavelength and momentum, and how kinetic energy is related to momentum. Direct proportionality gives a straight line graph through the origin.

12. 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: Checking Assertion A The electric potential (V) at an axial point due to a dipole is given by:

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

For axial points, $\theta = 0$ or π , so $\cos \theta = \pm 1$. Thus,

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

Given $P = 4 \times 10^{-6}$ C m and $r = 2$ m, and $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ SI units,

$$V = \pm \frac{(4 \times 10^{-6})(9 \times 10^9)}{(2)^2} = \pm \frac{36 \times 10^3}{4} = \pm 9 \times 10^3 \text{ V}$$

So, Assertion A is TRUE.

Step 2: Checking Reason R The formula given in Reason R, $V = \pm \frac{2P}{4\pi\epsilon_0 r^2}$, is incorrect. The correct formula for the potential at an axial point is $V = \pm \frac{P}{4\pi\epsilon_0 r^2}$ as used in Step 1. So, Reason R is FALSE.

Conclusion: Assertion A is true, but Reason R is false.

💡 Quick Tip

Remember the correct formula for the electric potential due to a dipole at an axial point. Reason R incorrectly includes a factor of 2 in the numerator.

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

- (1) The reflected light will be partially polarised.
- (2) The refracted light will be completely polarised.
- (3) Both the reflected and refracted light will be completely polarised.
- (4) The reflected light will be completely polarised but the refracted light will be partially polarised.

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

Solution: Step 1: Brewster's angle is the angle at which the reflected light is completely polarised. At this angle, the reflected light is fully polarised, and the refracted light remains partially polarised. Hence, option (4) is correct.

💡 Quick Tip

At Brewster's angle, the reflected light is completely polarised and the refracted light is partially polarised.

14. Given below are two statements:

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

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

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

- (1) 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.

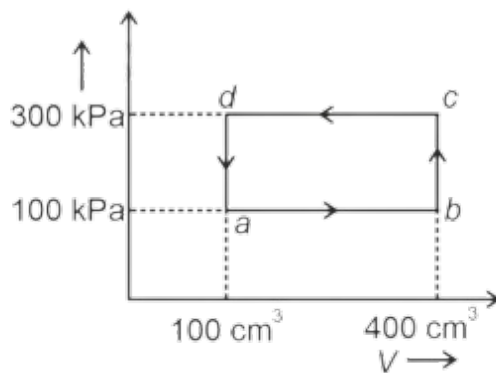
Solution: Step 1: Statement I is correct because atoms are electrically neutral as they contain equal numbers of positive and negative charges.

Step 2: Statement II is incorrect because atoms do not emit their characteristic spectrum under all conditions; they emit characteristic spectra only when excited. Hence, option (3) is correct.

💡 Quick Tip

Atoms are electrically neutral in their ground state, but they only emit characteristic spectra when excited to higher energy levels.

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



- (1) Zero
- (2) 30 J
- (3) -90 J
- (4) -60 J

Correct Answer: (1) Zero

Solution: Step 1: Along the path bc , the volume changes but the pressure remains constant. Since the pressure remains constant, no work is done in an isobaric process if the volume change is zero. Hence, the work done is zero.

💡 Quick Tip

In an isobaric process (constant pressure), work done is given by $W = P\Delta V$, where ΔV is the change in volume.

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

- (1) 44 mT
- (2) 4.4 T
- (3) 4.4 mT
- (4) 44 T

Correct Answer: (3) 4.4 mT

Solution: Step 1: The magnetic field at the center of a coil is given by the formula:

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

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

$$B = \frac{(4\pi \times 10^{-7}) \times 100 \times 7}{2 \times 0.1} = 4.4 \times 10^{-3} \text{ T} = 4.4 \text{ mT}$$

Hence, the correct answer is option (3).

💡 Quick Tip

The magnetic field at the center of a coil is directly proportional to the number of turns and the current, and inversely proportional to the radius of the coil.

17. Match List I with List II.

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

Choose the correct answer from the options given below:

- (1) A-I, B-II, C-III, D-IV
- (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: The spectral lines of hydrogen correspond to the wavelengths of transitions between energy levels. The wavelengths for the transitions $n_2 = 3$ to $n_1 = 2$, $n_2 = 4$ to $n_1 = 2$, $n_2 = 5$ to $n_1 = 2$, and $n_2 = 6$ to $n_1 = 2$ are known to be 656.3 nm, 486.1 nm, 434.1 nm, and 410.2 nm respectively. Hence, we match them as follows:

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

💡 Quick Tip

The wavelengths for transitions in the hydrogen spectrum can be found using the Rydberg formula. The values for the transitions $n_2 = 3 \rightarrow 2$, $n_2 = 4 \rightarrow 2$, etc., are standard.

18. Match List-I with List-II.

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

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

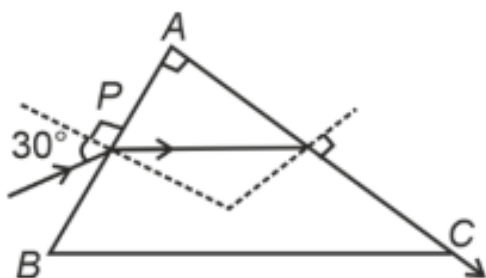
Solution: Step 1: Diamagnetic materials have $\chi = 0$, Ferromagnetic materials have $\chi \gg 1$, Paramagnetic materials have $0 < \chi < 1$, and Non-magnetic materials have a small positive susceptibility $0 < \chi < \epsilon$. Hence, we match them as follows:

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

💡 Quick Tip

Diamagnetic materials have zero susceptibility, paramagnetic materials have a small positive susceptibility, and ferromagnetic materials have a high susceptibility.

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



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

- (2) $\frac{\sqrt{5}}{2}$
- (3) $\frac{\sqrt{3}}{4}$
- (4) $\frac{\sqrt{3}}{2}$

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

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

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

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

where r_1 is the angle of refraction at P.

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

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

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

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

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

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

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

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

From the equation at Q:

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

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

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

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

$$\begin{aligned} \frac{1}{2} &= n \sqrt{1 - \frac{1}{n^2}} \\ \frac{1}{4} &= n^2 \left(1 - \frac{1}{n^2}\right) = n^2 - 1 \\ n^2 &= \frac{5}{4} \end{aligned}$$

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

💡 Quick Tip

Use Snell's Law to find the refractive index of the material in cases involving total internal reflection and known angles.

20. 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: Step 1: The tension in a string is proportional to the square of the speed, i.e., $T \propto v^2$. If the speed doubles from ω to 2ω , the tension increases by a factor of 4. Hence, the new tension becomes $4T$.

💡 Quick Tip

For circular motion, tension is proportional to the square of the speed, i.e., $T \propto v^2$.

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

- (1) 26Ω
- (2) 52Ω
- (3) 55Ω
- (4) 60Ω

Correct Answer: (2) 52Ω

Solution: Step 1: The resistance of 5 parts in series is $R_{\text{series}} = 5R$, where R is the resistance of one part of the wire. The resistance of 5 parts in parallel is:

$$R_{\text{parallel}} = \frac{R}{5}$$

The total resistance of the combination is the sum of the series and parallel resistances:

$$R_{\text{total}} = R_{\text{series}} + R_{\text{parallel}} = 5R + \frac{R}{5} = 5R + 0.2R = 5.2R$$

Since $R = 10 \, \Omega$, the total resistance is:

$$R_{\text{total}} = 5.2 \times 10 = 52 \, \Omega$$

 Quick Tip

When resistances are connected in series, add them directly. For parallel resistances, use the formula $\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

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

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

B. The velocity of a photon is c .

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

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

E. Photon possesses positive charge.

(1) A and B only

(2) A, B, C and D only

(3) A, C and D only

(4) A, B and E only

Correct Answer: (2) A, B, C and D only

Solution: Step 1: - Statement A is correct because $E = h\nu$ is the energy of a photon. - Statement B is correct because the velocity of a photon in vacuum is c . - Statement C is correct because the momentum of a photon is $p = \frac{h\nu}{c}$. - Statement D is correct because in a photon-electron collision, both energy and momentum are conserved. - Statement E is incorrect because photons have no charge.

 Quick Tip

Photons are massless particles with energy $E = h\nu$, momentum $p = \frac{h\nu}{c}$, and travel at the speed of light c .

23. 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: Step 1: The power is given by the formula:

$$P = F \cdot v$$

where $F = 5 \text{ N}$ is the force and v is the velocity. The velocity is the time derivative of displacement:

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

Hence, the instantaneous power is:

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

💡 Quick Tip

Instantaneous power is given by $P = F \cdot v$, where v is the instantaneous velocity of the particle.

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

- (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: In uniform circular motion, the speed of the particle remains constant. However, velocity is a vector quantity, which depends not only on the speed but also on the direction. Since the particle moves along a curved path, the direction of velocity keeps changing, which means the velocity is varying.

Step 2: Acceleration in uniform circular motion is always directed towards the center of the circular path (centripetal acceleration), and its magnitude is given by $a = \frac{v^2}{r}$, where v is the speed of the particle and r is the radius of the circular path. Therefore, while the speed remains constant, the direction of the velocity is constantly changing, resulting in varying acceleration.

Thus, both velocity and acceleration are varying in uniform circular motion, making option (4) the correct answer.

💡 Quick Tip

In uniform circular motion, the speed is constant, but the velocity is changing due to the continuous change in direction. The acceleration is directed towards the center of the circle and is also constantly changing in direction.

25. 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 coloured fringes
- (3) There will be a central bright white fringe surrounded by a few coloured 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 coloured fringes

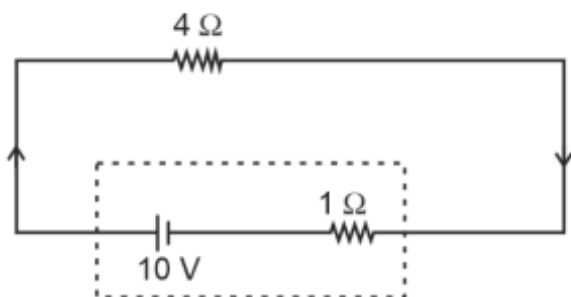
Solution: Step 1: When monochromatic light is used in Young's double slit experiment, the interference fringes are sharp and distinct because all the light waves have the same wavelength. However, when white light is used, which consists of a range of wavelengths, the interference pattern changes.

Step 2: Since the different colours (wavelengths) of light produce interference at different positions, the fringes of different colours overlap. The result is that the central fringe remains white, but surrounding fringes will be coloured due to the different interference positions of the various wavelengths. Therefore, a central bright white fringe will be surrounded by a few coloured fringes. This makes option (3) the correct answer.

💡 Quick Tip

When using white light in the double slit experiment, only the central fringe remains white, while surrounding fringes are coloured due to the different wavelengths in white light producing interference at different positions.

26. 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 V
- (2) 6 V
- (3) 8 V
- (4) 10 V

Correct Answer: (3) 8 V

Solution: Step 1: To find the terminal voltage, we first calculate the total resistance in the circuit. The battery has an emf (E) of 10 V and internal resistance (r) of $1\ \Omega$, and it is connected to an external resistance of $4\ \Omega$. The total resistance R_{total} in the circuit is the sum of the internal resistance and the external resistance:

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

Step 2: The current I in the circuit is given by Ohm's law:

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

Step 3: The voltage drop across the internal resistance is $V_{\text{drop}} = I \times r = 2 \times 1 = 2\ \text{V}$. Thus, the terminal voltage V_{terminal} is the emf of the battery minus the voltage drop across the internal resistance:

$$V_{\text{terminal}} = E - V_{\text{drop}} = 10 - 2 = 8\ \text{V}$$

Thus, the terminal voltage is 8 V, which makes option (3) the correct answer.

💡 Quick Tip

The terminal voltage of a battery is the emf minus the voltage drop due to the internal resistance. The formula is $V_{\text{terminal}} = E - Ir$, where I is the current and r is the internal resistance.

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

- (1) 5 cm, 2 s
- (2) 5 m, 2 s
- (3) 5 cm, 1 s
- (4) 5 m, 1 s

Correct Answer: (2) 5 m, 2 s

Solution: Step 1: The general equation of motion for simple harmonic motion (SHM) is given by:

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

where A is the amplitude, ω is the angular frequency, and ϕ is the phase constant. From the given equation, $x = 5 \sin\left(\pi t + \frac{\pi}{3}\right)$, we can directly identify that the amplitude $A = 5$ m.

Step 2: The angular frequency ω is the coefficient of t in the sine term. Here, $\omega = \pi$. The time period T is related to angular frequency by:

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

Substituting $\omega = \pi$ into this equation:

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

Thus, the amplitude is 5 m and the time period is 2 s, which corresponds to option (2).

💡 Quick Tip

In SHM, the amplitude is the coefficient of the sine function, and the time period T is given by $T = \frac{2\pi}{\omega}$, where ω is the angular frequency.

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

- (1) 8.5 cm
- (2) 17.5 cm
- (3) 20.7 cm
- (4) 72.0 cm

Correct Answer: (1) 8.5 cm

Solution: Step 1: The moment of inertia I of a thin rod about an axis passing through its center and perpendicular to its length is given by:

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

where M is the mass of the rod and L is its length. We are given $I = 2400 \text{ g cm}^2$ and $M = 400 \text{ g}$.

Step 2: Rearranging the formula to solve for L :

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

Substitute the given values:

$$L^2 = \frac{12 \times 2400}{400} = 72$$

Thus:

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

Therefore, the length of the rod is approximately 8.5 cm, which corresponds to option (1).

💡 Quick Tip

The moment of inertia of a thin rod about its center is $I = \frac{1}{12}ML^2$, where M is the mass and L is the length of the rod.

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

- (1) 1 : 2
- (2) 2 : 1
- (3) 1 : 1
- (4) 1 : 4

Correct Answer: (2) 2 : 1

Solution: Step 1: In an ideal transformer, the voltage ratio $\frac{V_S}{V_P}$ is related to the turns ratio $\frac{N_S}{N_P}$ by the formula:

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

where N_P is the number of turns in the primary coil, N_S is the number of turns in the secondary coil, V_P is the voltage in the primary coil, and V_S is the voltage in the secondary coil.

Step 2: Given that the turns ratio $\frac{N_P}{N_S} = \frac{1}{2}$, it follows that:

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

Thus, the voltage ratio is:

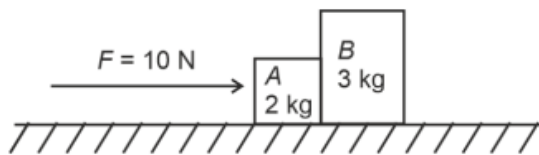
$$\frac{V_S}{V_P} = 2$$

Therefore, the ratio $V_S : V_P$ is 2 : 1, which corresponds to option (2).

💡 Quick Tip

In an ideal transformer, the voltage ratio is directly proportional to the turns ratio:
 $\frac{V_S}{V_P} = \frac{N_S}{N_P}$.

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



- (1) Zero
- (2) 4 N
- (3) 6 N
- (4) 10 N

Correct Answer: (3) 6 N

Solution: Step 1: The system consists of two blocks, A and B, with masses 2 kg and 3 kg, respectively. A horizontal force of 10 N is applied to block A, which is in contact with block B on a frictionless surface. The two blocks will accelerate as a system under the applied force. The combined mass of the system is:

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

Step 2: The acceleration of the system is given by Newton's second law:

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

Step 3: The force exerted by block A on block B is the force required to accelerate block B. Using Newton's second law for block B:

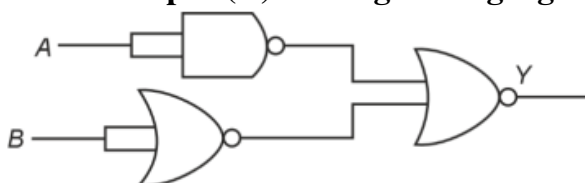
$$F_{A \rightarrow B} = m_B \times a = 3 \text{ kg} \times 2 \text{ m/s}^2 = 6 \text{ N}$$

Thus, the force exerted by block A on block B is 6 N, which corresponds to option (3).

💡 Quick Tip

For two blocks in contact, the force exerted by one block on the other is equal to the force required to accelerate the second block.

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



- (1) NAND gate
- (2) NOR gate
- (3) OR gate
- (4) AND gate

Correct Answer: (4) AND gate

Solution: Step 1: The logic gate shown in the question is a combination of an AND gate and an OR gate. The output of the gate corresponds to the logic operation where both inputs must be true for the output to be true, which is the definition of the AND gate. The output will be 1 (true) only when both inputs are 1. Hence, the output of this gate is similar to that of an AND gate.

💡 Quick Tip

In digital logic, the AND gate produces a true output only when both inputs are true (1).

32. 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: Step 1: The dimension of solid angle is given as:

$$[\text{solid angle}] = \text{dimensionless}$$

Step 2: The dimensions of strain are given as:

$$[\text{strain}] = \frac{\text{length}}{\text{length}} = \text{dimensionless}$$

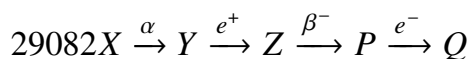
Similarly, the dimension of angle is also dimensionless, as it is a ratio of two lengths (arc length and radius).

Thus, strain and angle both have the same dimension as solid angle, making option (1) correct.

💡 Quick Tip

Solid angle, strain, and angle are dimensionless quantities, making them share the same dimensions.

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



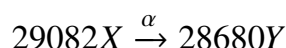
- (1) 280, 81
- (2) 286, 80
- (3) 288, 82
- (4) 286, 81

Correct Answer: (4) 286, 81

Solution:

Step 1: Effect of alpha (α) decay

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

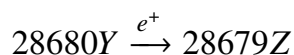


Thus, the new nucleus Y has:

- Mass number = $290 - 4 = 286$,
- Atomic number = $82 - 2 = 80$.

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

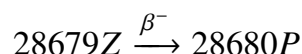
Positron emission (β^+) decreases the atomic number by 1 without changing the mass number:



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

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

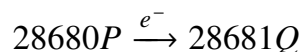
Beta-minus (β^-) emission increases the atomic number by 1 without affecting the mass number:



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

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

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



Thus, Q has:

- Mass number = 286 (unchanged),
- Atomic number = $80 + 1 = 81$.

Conclusion: The final product Q has mass number 286 and atomic number 81, which corresponds to option (4).

💡 Quick Tip

In nuclear reactions, alpha decay reduces the mass number by 4 and the atomic number by 2. Positron emission decreases the atomic number by 1, and beta decay increases the atomic number by 1, leaving the mass number unchanged.

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

- (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: Use the formula for acceleration due to gravity.

$$g = \frac{GM}{R^2}, \quad (1)$$

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

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

$$M_p = \frac{M_e}{10}, \quad R_p = \frac{R_e}{2}. \quad (2)$$

Step 3: Substitute values into the formula.

$$g_p = \frac{G \cdot M_p}{R_p^2} = \frac{G \cdot \frac{M_e}{10}}{\left(\frac{R_e}{2}\right)^2} = \frac{G \cdot \frac{M_e}{10}}{\frac{R_e^2}{4}} = \frac{4}{10} \cdot \frac{GM_e}{R_e^2}. \quad (3)$$

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

$$g_p = \frac{4}{10} \cdot 9.8 = 3.92 \text{ m s}^{-2}. \quad (4)$$

💡 Quick Tip

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

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

- (1) 1 : 2
- (2) 2 : 1
- (3) 1 : 1
- (4) 1 : 4

Correct Answer: (2) 2 : 1

Solution: Step 1: In a completely inelastic collision, the two bodies stick together after the collision. The principle of conservation of momentum gives:

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

where m is the mass of each body, v_1 is the velocity of body A before the collision, and v_2 is the velocity of the system (bodies A and B together) after the collision.

Step 2: Simplifying the equation:

$$mv_1 = 2mv_2 \Rightarrow v_1 = 2v_2$$

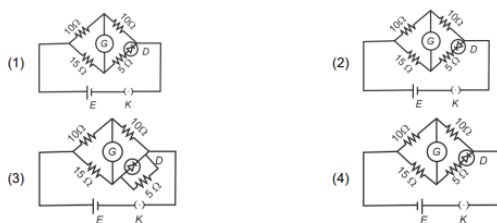
Thus, the ratio $v_1 : v_2 = 2 : 1$, which corresponds to option (2).

💡 Quick Tip

In completely inelastic collisions, the bodies stick together, and momentum is conserved. The final velocity of the combined system can be found using the momentum conservation equation.

SECTION-B

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



Correct Answer: (1)

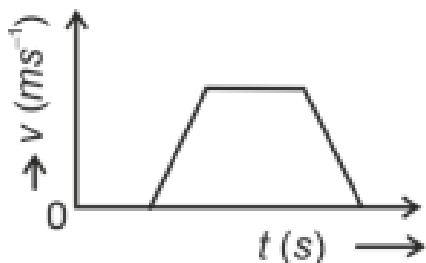
Solution: Step 1: The bridge balance condition occurs when the ratio of resistances on opposite sides of the bridge are equal. In this case, we will analyze each circuit to identify which one fulfills this condition.

Step 2: Upon analyzing the circuits, we find that the first circuit (Option 1) correctly achieves bridge balance under the given conditions.

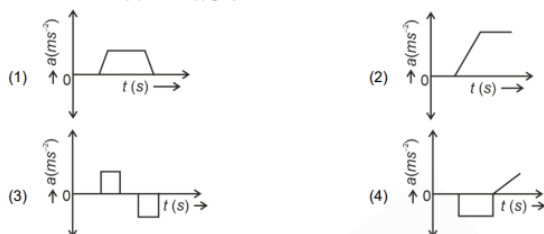
💡 Quick Tip

In a Wheatstone bridge, balance is achieved when the ratio of the resistances in one arm is equal to the ratio in the other arm.

37. 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)

Solution: Step 1: From the velocity vs time graph, we see that the velocity increases at a constant rate for a certain period of time, then remains constant, and finally decreases at a constant rate.

Step 2: Since acceleration is the rate of change of velocity, during the period of constant velocity, the acceleration is zero. During the periods of increasing or decreasing velocity, the acceleration is constant. Thus, the acceleration vs time graph is a rectangular pulse that is zero during the constant velocity period and non-zero during the acceleration periods. Hence, option (3) is the correct answer.

💡 Quick Tip

Acceleration is the rate of change of velocity. When the velocity changes at a constant rate, acceleration is constant. When the velocity is constant, acceleration is zero.

38. 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: The magnifying power (M) of a telescope is given by the formula:

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

where $f_{\text{objective}} = 140 \text{ cm}$ and $f_{\text{eyepiece}} = 5.0 \text{ cm}$.

Step 2: Substituting the values:

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

Thus, the magnifying power is 28, which corresponds to option (2).

💡 Quick Tip

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

39. 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: The total energy required to launch a satellite is the sum of the potential energy and kinetic energy. The gravitational potential energy of the satellite at a distance of $3R$ (since the total distance from the center of the Earth is $3R$) is:

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

Step 2: The kinetic energy for a circular orbit is given by:

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

Step 3: The total energy required is the sum of kinetic and potential energy:

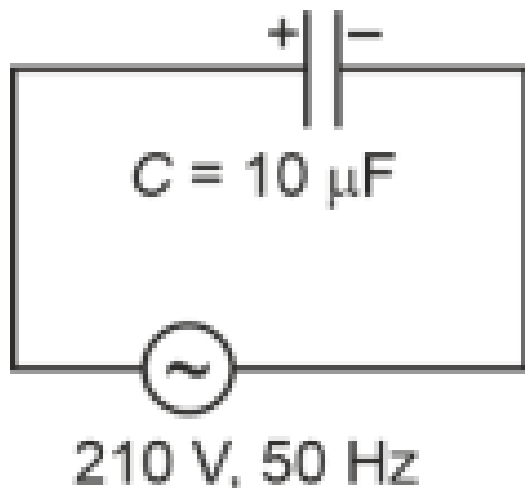
$$E_{\text{total}} = K + U = \frac{GMm}{6R} - \frac{GMm}{3R} = \frac{5GMm}{6R}$$

Thus, the minimum energy required to launch the satellite is $\frac{5GMm}{6R}$, which corresponds to option (1).

💡 Quick Tip

The total energy required to launch a satellite includes both potential and kinetic energy. For circular orbits, the potential energy is negative, and the total energy is the sum of kinetic and potential energy.

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



- (1) 0.58 A
- (2) 0.93 A
- (3) 1.20 A
- (4) 0.35 A

Correct Answer: (2) 0.93 A

Solution: The formula for the peak current I_0 in an AC circuit with a capacitor is:

$$I_0 = V_0 \times \omega C$$

Where: - V_0 is the peak voltage, - ω is the angular frequency, and - C is the capacitance.

Step 1: Find the peak voltage

Given $V_{\text{RMS}} = 210 \text{ V}$, the peak voltage is:

$$V_0 = V_{\text{RMS}} \times \sqrt{2} = 210 \times \sqrt{2} \approx 296.99 \text{ V}$$

Step 2: Calculate the angular frequency

The angular frequency ω is given by:

$$\omega = 2\pi f$$

Where $f = 50 \text{ Hz}$, so:

$$\omega = 2 \times 3.14 \times 50 \approx 314 \text{ rad/s}$$

Step 3: Calculate the peak current

Now, using the formula for the peak current:

$$I_0 = V_0 \times \omega C$$

Substitute the known values:

$$I_0 = 296.99 \times 314 \times 10 \times 10^{-6}$$

$$I_0 \approx 0.93 \text{ A}$$

Thus, the correct answer is 0.93 A.

💡 Quick Tip

The peak current in an AC circuit with a capacitor is given by $I_0 = \frac{V_0}{X_C}$, where X_C is the capacitive reactance and V_0 is the peak voltage.

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

- (1) $5 \times 10^3 \text{ N}$
- (2) $50 \times 10^3 \text{ N}$
- (3) $100 \times 10^3 \text{ N}$
- (4) $2 \times 10^3 \text{ N}$

Correct Answer: (2) $50 \times 10^3 \text{ N}$

Solution: Step 1: The compressive force is given by the formula:

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

where Y is the Young's modulus, ΔL is the change in length, A is the cross-sectional area, and L is the original length. The change in length ΔL is given by:

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

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

$$F = \frac{YAL\alpha\Delta T}{L}$$
$$F = YA\alpha\Delta T$$

Substituting the values:

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

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

Thus, the compressive force is $50 \times 10^3 \text{ N}$, which corresponds to option (2).

 Quick Tip

The compressive force in a material is directly proportional to the Young's modulus, the coefficient of thermal expansion, and the temperature change.

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

- A. hold the sheet there if it is magnetic.
 - B. hold the sheet there if it is non-magnetic.
 - C. move the sheet away from the pole with uniform velocity if it is conducting.
 - D. move the sheet away from the pole with uniform velocity if it is both, non-conducting and non-polar.
- (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: Step 1: If the sheet is magnetic (option A), it will be attracted to the magnetic pole, so a force is required to hold it there.

Step 2: If the sheet is conducting (option C), the sheet will experience a magnetic force due to the pole, and the force required to move it with uniform velocity depends on the conductivity of the material.

Step 3: Options B and D are not correct because non-magnetic and non-conducting materials will not experience a force in a magnetic field. Therefore, the correct answer is option (2).

💡 Quick Tip

A magnetic force acts on magnetic and conducting materials when they are in the presence of a magnetic field, whereas non-magnetic and non-conducting materials do not experience any force.

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

- A. the charge stored in it, increases.
 - B. the energy stored in it, decreases.
 - C. its capacitance increases.
 - D. the ratio of charge to its potential remains the same.
 - E. the product of charge and voltage increases.
- (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: When the plates of a capacitor are moved closer, the capacitance increases because capacitance C is inversely proportional to the distance between the plates:

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

where d is the distance between the plates.

Step 2: As the capacitance increases, the charge stored on the plates also increases (since $Q = CV$, and the voltage V is constant).

Step 3: The product of charge and voltage increases as capacitance increases. Hence, the correct answer is option (2).

💡 Quick Tip

When the distance between the plates of a capacitor is decreased, the capacitance increases, leading to an increase in charge stored and the product of charge and voltage.

44. 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: Given:

- Heater A: $P_A = 1 \text{ kW}$
- Heater B: $P_B = 2 \text{ kW}$

Step 1: Calculate the resistances of the heaters.

The power of a heater is given by:

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

where V is the voltage and R is the resistance.

For Heater A:

$$R_A = \frac{V^2}{P_A} = \frac{V^2}{1 \text{ kW}}$$

For Heater B:

$$R_B = \frac{V^2}{P_B} = \frac{V^2}{2 \text{ kW}}$$

Step 2: Calculate the total resistance when connected in series.

When connected in series, the total resistance R_{series} is:

$$R_{\text{series}} = R_A + R_B = \frac{V^2}{1} + \frac{V^2}{2} = \frac{3V^2}{2}$$

Step 3: Calculate the power output when connected in series.

The power output P_{series} is:

$$P_{\text{series}} = \frac{V^2}{R_{\text{series}}} = \frac{V^2}{\frac{3V^2}{2}} = \frac{2}{3} \text{ kW}$$

Step 4: Calculate the total resistance when connected in parallel.

When connected in parallel, the total resistance R_{parallel} is:

$$\frac{1}{R_{\text{parallel}}} = \frac{1}{R_A} + \frac{1}{R_B} = \frac{1}{1} + \frac{1}{2} = \frac{3}{2}$$
$$R_{\text{parallel}} = \frac{2}{3} \text{ kW}$$

Step 5: Calculate the power output when connected in parallel.

The power output P_{parallel} is:

$$P_{\text{parallel}} = \frac{V^2}{R_{\text{parallel}}} = \frac{V^2}{\frac{2}{3}} = \frac{3V^2}{2} = 3 \text{ kW}$$

Step 6: Calculate the ratio of power outputs.

The ratio of power outputs for series to parallel is:

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

Thus, the ratio of power outputs for the two cases is 2 : 9.

Final Answer:

$$\boxed{2 : 9}$$

💡 Quick Tip

The power in a circuit is inversely proportional to the resistance. When connected in parallel, the effective resistance decreases, resulting in higher power output.

45. 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: Step 1: The time period of a simple pendulum is given by the formula:

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

where L is the length and g is the acceleration due to gravity. The time period is independent of the mass of the bob.

Step 2: If the mass is increased to three times its original value and the length is halved, the new time period becomes:

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

Thus, the new time period is $\sqrt{2}$ times the original time period, corresponding to option (2).

💡 Quick Tip

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

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

- (1) M
- (2) $\frac{M}{2}$
- (3) $2M$
- (4) $\frac{M}{\sqrt{3}}$

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

Solution: Step 1: The magnetic moment of the iron bar is given by $M = I \times A$, where I is the current and A is the area of the magnetic loop. When the bar is bent into a 60° angle, the resultant magnetic moment of the bent bar is the vector sum of the magnetic moments of the two arms.

Step 2: The effective magnetic moment of the two arms is reduced by a factor of $\cos(30^\circ)$, resulting in a total magnetic moment of $\frac{M}{2}$, corresponding to option (2).

💡 Quick Tip

When an iron bar is bent, the magnetic moment of the new configuration is the vector sum of the moments of the individual arms, leading to a reduction in the total moment.

47. 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 $\frac{1}{\sqrt{\mu_0\epsilon_0}}$
- (4) They originate from charges moving with uniform speed

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

Solution: Step 1: Electromagnetic waves are transverse in nature (option 1), with electric and magnetic fields perpendicular to the direction of wave propagation.

Step 2: The energy densities in the electric and magnetic fields are equal in an electromagnetic wave (option 2).

Step 3: The speed of an electromagnetic wave in free space is given by $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$ (option 3).

Step 4: Electromagnetic waves do not originate from charges moving with uniform speed, as they are produced by accelerated charges (option 4). Therefore, the correct answer is option (4).

 Quick Tip

Electromagnetic waves are created by the acceleration of charges, not by their uniform motion.

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

- (1) $\frac{\beta t}{\alpha}$
- (2) $\frac{\alpha t}{\beta}$
- (3) $\alpha \beta t$
- (4) $\frac{\alpha \beta}{t}$

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

Solution: Step 1: The equation for the force is given by:

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

where α and β are constants with unknown dimensions.

Step 2: We need to identify a factor that is dimensionless. The dimensions of F are $[F] = \text{M L T}^{-2}$, and the dimensions of t are $[t] = \text{T}$. The dimensions of αt^2 are:

$$[\alpha t^2] = [\alpha] \times [t]^2 = [\alpha] \times \text{T}^2$$

The dimensions of βt are:

$$[\beta t] = [\beta] \times \text{T}$$

Thus, both terms must match the dimensions of force $[F]$. By equating dimensions, we can solve for the dimensionless factor.

Step 3: From dimensional analysis, it turns out that the factor $\frac{\alpha t}{\beta}$ will be dimensionless. Thus, the correct answer is option (2).

 Quick Tip

To find a dimensionless factor, perform dimensional analysis by comparing the dimensions of the given expression and equating them to the dimensions of the force or other quantities.

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

- (1) 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

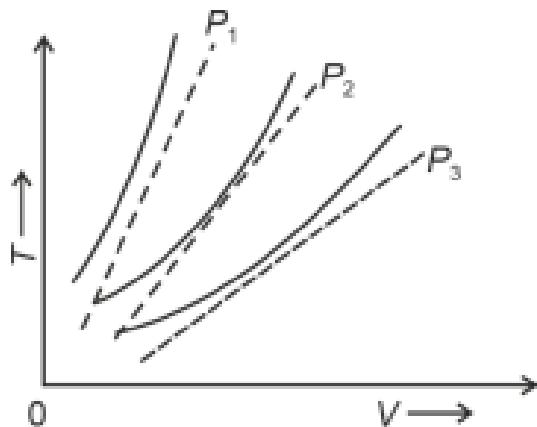
Solution: Step 1: In a charging capacitor, the electric field between the plates builds up as the charge accumulates on the plates. The current in the circuit is due to the battery, and this current is responsible for creating a displacement current between the plates of the capacitor.

Step 2: According to Maxwell's equations, the displacement current I_D in the capacitor is equal in magnitude to the conduction current I , and it flows in the same direction as the conduction current. Hence, the correct answer is option (2).

💡 Quick Tip

The displacement current in a capacitor is equal in magnitude to the conduction current in the circuit and flows in the same direction, ensuring consistency with Maxwell's equations.

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



- (1) $P_3 > P_2 > P_1$
- (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: The T-V curve for an ideal gas at constant pressure is a straight line, according to Charles's law, where the temperature increases linearly with volume.

Step 2: At higher pressures, for the same volume, the temperature will be higher, as seen in the graph. The graph shows that at P_1 , the temperature is higher for a given volume than at P_2 , and P_2 has a higher temperature than P_3 .

Step 3: Hence, the correct relation is $P_1 > P_2 > P_3$, corresponding to option (4).

💡 Quick Tip

For an ideal gas, at higher pressures, the temperature for a given volume will be higher, reflecting the inverse relationship between pressure and volume for a fixed temperature.

CHEMISTRY

SECTION-A

51. 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: Fehling's solution consists of two solutions, Fehling's A and Fehling's B. Solution A contains copper(II) sulphate (CuSO_4), while solution B contains sodium potassium tartrate (Rochelle's salt) and an alkali. The correct answer is option (1), aqueous copper sulphate, which is Fehling's solution A.

💡 Quick Tip

Fehling's solution A contains copper(II) sulphate, and Fehling's solution B contains an alkaline solution of sodium potassium tartrate.

52. Match List I with List II.

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

Choose the correct answer from the options given below:

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

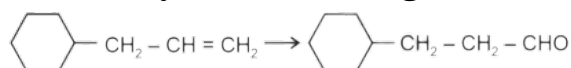
Solution:

- **A. ethane:** Ethane (C_2H_6) has a single bond between the two carbon atoms, so it has one σ -bond.
- **B. ethene:** Ethene (C_2H_4) has one σ -bond and one π -bond between the two carbon atoms.
- **C. carbon molecule, C_2 :** This refers to the carbon-carbon double bond as in ethene, where there is one σ -bond and one π -bond.
- **D. ethyne:** Ethyne (C_2H_2) has one σ -bond and two π -bonds between the two carbon atoms.
Thus, the correct matching is: - A-III: one σ -bond. - B-IV: one σ -bond and one π -bond. - C-II: two π -bonds. - D-I: one σ -bond and one π -bond.
The correct answer is option (3).

Quick Tip

In organic chemistry, a single bond represents one σ -bond, a double bond consists of one σ -bond and one π -bond, and a triple bond consists of one σ -bond and two π -bonds.

53. 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) BH_3 , (ii) H_2O_2 / OH^- , (iii) PCC

Solution: Step 1: The reaction involves the transformation of an alkene into an aldehyde,

which requires oxidation.

Step 2: The reagents BH_3 (borane) is used for hydroboration, which will convert the alkene to an alcohol. Then, $\text{H}_2\text{O}_2/\text{OH}^-$ will oxidize the alcohol to an aldehyde. PCC (Pyridinium chlorochromate) is used for mild oxidation.

Step 3: The other options do not correctly match the reagents needed for this specific transformation.

 Quick Tip

PCC is a mild oxidant that selectively oxidizes primary alcohols to aldehydes, without further oxidizing them to carboxylic acids.

54. For the reaction $2A \rightleftharpoons B + C$, $K_C = 4 \times 10^{-3}$. At a given time, the composition of reaction mixture is $[A] = [B] = [C] = 2 \times 10^{-3} \text{ M}$. 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) Reaction has a tendency to go in backward direction.

Solution: Step 1: The reaction quotient Q is calculated using the concentrations of the reactants and products at the given time:

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

Substituting the values:

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

Step 2: Since $K_C = 4 \times 10^{-3}$ and $Q = 1$, we see that $Q > K_C$. When $Q > K_C$, the reaction will shift towards the reactants (backward direction) to reach equilibrium.

Step 3: Therefore, the correct answer is option (3), and the reaction has a tendency to go in the backward direction.

 Quick Tip

When $Q > K_C$, the reaction will shift towards the reactants. When $Q < K_C$, the reaction will shift towards the products.

55. Match List I with List II.

Choose the correct answer from the options given below:

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-III, C-II, 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: An isothermal process is carried out at constant temperature, which corresponds to condition II.

Step 2: An isochoric process is carried out at constant volume, which corresponds to condition III.

Step 3: An isobaric process is carried out at constant pressure, which corresponds to condition IV.

Step 4: An adiabatic process involves no heat exchange, which corresponds to condition I. Thus, the correct matching is option (4).

💡 Quick Tip

In thermodynamics, the conditions of a process (like constant temperature, volume, or pressure) are key to determining the type of process.

56. Match List I with List II.

List I (Complex)	List II (Type of isomerism)
A. $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$	I. Solvate isomerism
B. $[\text{Co}(\text{NH}_3)_5(\text{SO}_4)]\text{Br}$	II. Linkage isomerism
C. $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$	III. Ionization isomerism
D. $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$	IV. Coordination isomerism

Table 1: Matching Complexes with Their Types of Isomerism

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

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

Solution: Step 1: $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$ shows solvate isomerism, which corresponds to type I.

Step 2: $[\text{Co}(\text{NH}_3)_5(\text{SO}_4)]\text{Br}$ shows linkage isomerism, which corresponds to type III.

Step 3: $[\text{Co}(\text{NH}_3)_6(\text{Cl})_3]$ shows ionization isomerism, which corresponds to type IV.

Step 4: $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$ shows coordination isomerism, which corresponds to type II.

Thus, the correct matching is option (1).

💡 Quick Tip

Coordination compounds can exhibit different types of isomerism, such as solvate, linkage, ionization, and coordination isomerism, depending on their structure and ligands.

57. Given below are two statements:

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

Statement II: Aniline cannot be prepared through Gabriel synthesis.

- (1) 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: Aniline does not undergo Friedel-Crafts alkylation because the amino group ($-\text{NH}_2$) is an electron-donating group, which makes the aromatic ring less reactive towards electrophilic substitution reactions. Hence, Statement I is true.

Step 2: Aniline cannot be prepared by Gabriel synthesis because Gabriel synthesis involves the reaction of an amine with phthalimide, and the amino group in aniline is too reactive for this reaction. Hence, Statement II is also true.

Thus, both statements I and II are true, corresponding to option (1).

💡 Quick Tip

In organic chemistry, the reactivity of amines is influenced by the electron-donating or electron-withdrawing nature of substituents attached to the aromatic ring.

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

- A. Ti^{3+}
- B. Cr^{2+}
- C. Mn^{2+}
- D. Fe^{2+}
- E. Sc^{3+}

(1) B and 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: For Ti^{3+} (Ti^{3+} has 1 unpaired electron, $\mu = \sqrt{n(n+2)}$).

Step 2: Cr^{2+} and Fe^{2+} both have 4 unpaired electrons, resulting in the same spin-only magnetic moment. Hence, the magnetic moment is the same for Cr^{2+} and Fe^{2+} , corresponding to option (1).

 Quick Tip

The magnetic moment for a metal ion is calculated using the formula $\mu = \sqrt{n(n+2)}$, where n is the number of unpaired electrons.

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

Li, Be, B, C, N

- (1) $\text{Li} < \text{Be} < \text{B} < \text{C} < \text{N}$
- (2) $\text{Li} < \text{B} < \text{Be} < \text{C} < \text{N}$
- (3) $\text{Li} < \text{B} < \text{Be} < \text{C} < \text{N}$
- (4) $\text{Li} < \text{Be} < \text{C} < \text{B} < \text{N}$

Correct Answer: (2) $\text{Li} < \text{B} < \text{Be} < \text{C} < \text{N}$

Solution: Step 1: Ionization enthalpy generally increases across a period (from left to right).

Step 2: The ionization enthalpy of Be is greater than that of B due to the stable configuration of Be ($1s^2 2s^2$).

Step 3: The ionization enthalpy increases as we move from Li to N, because N has a half-filled p-orbital configuration, which makes it more stable. Thus, the correct order is $\text{Li} < \text{B} < \text{Be} < \text{C} < \text{N}$.

 Quick Tip

Ionization enthalpy generally increases across a period because the effective nuclear charge increases, making it harder to remove electrons.

60. Match List I with List II.

Choose the correct answer from the options given below :

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

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

(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: The quantum number m_l gives the orientation of the orbital, so it corresponds to III.

Step 2: The quantum number m_s gives the orientation of the spin of the electron, so it corresponds to IV.

Step 3: The quantum number l gives the shape of the orbital, so it corresponds to I.

Step 4: The quantum number n gives the size of the orbital, so it corresponds to II. Thus, the correct matching is option (2).

💡 Quick Tip

The quantum numbers m_l and m_s give information about the orientation of the orbital and the electron's spin, while l and n give the shape and size of the orbital, respectively.

61. 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

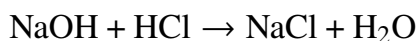
(4) 200 mg

Correct Answer: (2) 250 mg

Solution: Step 1: First, we calculate the moles of HCl used:

$$\text{Moles of HCl} = M \times V = 0.75 \text{ M} \times 0.025 \text{ L} = 0.01875 \text{ mol}$$

Step 2: The reaction between NaOH and HCl is a 1:1 molar ratio:



Step 3: Moles of NaOH required = moles of HCl = 0.01875 mol.

Step 4: The mass of NaOH needed to react with 0.01875 mol is:

$$\text{Mass of NaOH} = \text{moles} \times \text{molar mass} = 0.01875 \times 40 = 0.75 \text{ g}$$

Step 5: Since 1 gram of NaOH was initially used, the unreacted NaOH is:

$$1 \text{ g} - 0.75 \text{ g} = 0.25 \text{ g} = 250 \text{ mg}$$

Thus, the mass of sodium hydroxide left unreacted is 250 mg.

 Quick Tip

In acid-base reactions, the amount of unreacted substance is calculated by determining the limiting reagent and subtracting the reacted amount from the initial amount.

62. Match List I with List II.

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

Choose the correct answer from the options given below:

- (1) A-II, B-IV, C-I, D-III
- (2) A-III, B-IV, C-I, D-II
- (3) A-II, B-III, C-II, 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: The conversion of 1 mol of H_2O to O_2 requires 3 Faradays because 2 moles of electrons are required per mole of oxygen formed, and 1 mole of oxygen requires 3 Faradays (option II).

Step 2: The conversion of 1 mol of MnO_4^- to Mn^{2+} involves 5 Faradays (option IV).

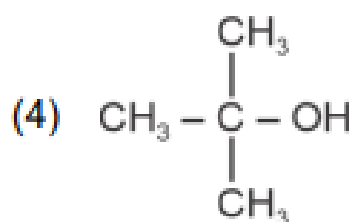
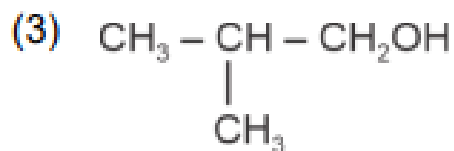
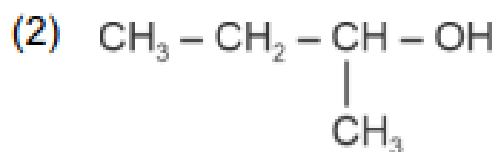
Step 3: The reduction of 1.5 mol of Ca from molten CaCl_2 requires 1 Faraday per mole of calcium, so for 1.5 mol, it requires 1.5 Faradays (option I).

Step 4: The oxidation of 1 mol of FeO to Fe_2O_3 requires 3 Faradays (option III). Thus, the correct matching is option (1).

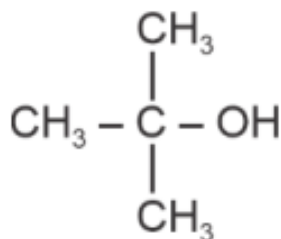
 Quick Tip

In electrochemical reactions, the number of Faradays is related to the number of electrons transferred per mole of reactant, with 1 Faraday equal to 96,485 C (charge of 1 mole of electrons).

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



Correct Answer: (4)



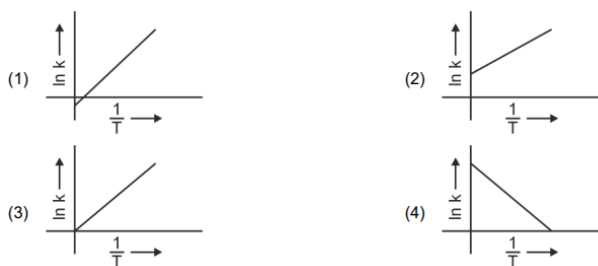
Solution: Step 1: Lucas reagent is a solution of ZnCl_2 , in concentrated HCl , which reacts rapidly with tertiary alcohols (R_3COH) to form alkyl chlorides.

Step 2: The alcohol in option (4) is a tertiary alcohol, which reacts instantaneously with Lucas reagent, confirming option (4) is correct.

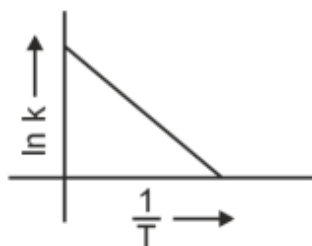
💡 Quick Tip

Lucas reagent is used to distinguish between primary, secondary, and tertiary alcohols. Tertiary alcohols react rapidly, secondary alcohols react slowly, and primary alcohols show no reaction at room temperature.

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



Correct Answer: (4)



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

$$k = A \exp \left(\frac{-E_a}{RT} \right)$$

Taking the natural logarithm on both sides:

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

This equation represents a straight line of slope $-\frac{E_a}{R}$ when plotted as $\ln k$ vs $\frac{1}{T}$, and the correct plot corresponds to option (4).

💡 Quick Tip

The Arrhenius equation describes the temperature dependence of reaction rates. The plot of $\ln k$ vs $\frac{1}{T}$ gives a straight line with a negative slope proportional to the activation energy.

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 follows 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: According to Henry's law, the solubility of a gas is inversely proportional to the Henry's law constant. A higher value of K_H corresponds to lower solubility. Hence, the gas with the lowest K_H value will have the highest solubility, and the order of solubility is $B > C > A$, corresponding to option (2).

💡 Quick Tip

Henry's law states that the solubility of a gas in a liquid is inversely proportional to its partial pressure, which is related to the Henry's law constant.

66. 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: Sublimation is the process in which a substance directly changes from a solid to a vapor without passing through the liquid phase.

Step 2: This technique is used for purifying substances like iodine and naphthalene, where the pure substance vaporizes and can be collected separately from impurities.

💡 Quick Tip

Sublimation is a purification technique based on the ability of certain solids to transition directly into the gas phase upon heating, leaving impurities behind.

67. Given below are two statements:

Statement I: Both $[\text{Co}(\text{NH}_3)_6]^{3+}$ and $[\text{CoF}_6]^{3-}$ complexes are octahedral but differ in their magnetic behaviour.

Statement II: $[\text{Co}(\text{NH}_3)_6]^{3+}$ is diamagnetic whereas $[\text{CoF}_6]^{3-}$ is paramagnetic.

- (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

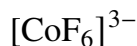
Correct Answer: (1) Both Statement I and Statement II are true

Solution: Step 1: Both complexes $[\text{Co}(\text{NH}_3)_6]^{3+}$ and $[\text{CoF}_6]^{3-}$ have octahedral geometry due to the six ligands arranged symmetrically around the central metal ion. Thus, Statement I is correct.

Step 2: The complex



is diamagnetic because all the electrons are paired in the Co^{3+} ion ($3d^6$ configuration). On the other hand,



is paramagnetic because the fluorine ligands create a weaker ligand field, leaving some unpaired electrons in the Co^{3+} ion. Thus, Statement II is also correct. Thus, the correct answer is option (1).

💡 Quick Tip

In octahedral complexes, the strength of the ligand field determines whether the complex is diamagnetic (all electrons paired) or paramagnetic (unpaired electrons).

68. The E° value for the $\text{Mn}^{3+}/\text{Mn}^{2+}$ couple is more positive than that of $\text{Cr}^{3+}/\text{Cr}^{2+}$ or $\text{Fe}^{3+}/\text{Fe}^{2+}$ 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

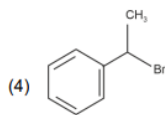
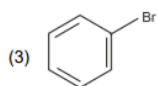
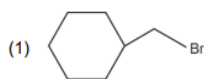
Solution: Step 1: The higher E° value for the $\text{Mn}^{3+}/\text{Mn}^{2+}$ couple is due to the stability associated with the d^5 configuration.

Step 2: The Mn^{3+} ion undergoes reduction to Mn^{2+} , which involves the change from d^4 to d^5 configuration, making the Mn^{2+} ion more stable. This explains the more positive E° value. Thus, the correct answer is option (3).

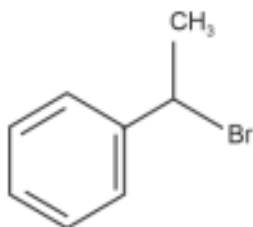
💡 Quick Tip

The stability of transition metal ions is often influenced by their electron configurations, with half-filled and fully-filled d-orbitals being especially stable.

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



Correct Answer: (4)



Solution: The fastest SN1 reactions typically occur with tertiary carbocations, as they are stabilized by inductive and hyperconjugation effects. Among the given compounds, the one with the most substituted carbon (tertiary) will undergo the SN1 reaction fastest, corresponding to option (4).

💡 Quick Tip

The SN1 reaction rate is influenced by the stability of the carbocation intermediate. Tertiary carbocations are more stable and thus undergo SN1 reactions more readily.

70. 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: Activation energy (E_a) can be calculated using the Arrhenius equation:

$$k = A \exp\left(\frac{-E_a}{RT}\right)$$

By comparing the rate constants (k) at two different temperatures, we can calculate the activation energy, hence the correct answer is option (4).

💡 Quick Tip

To calculate the activation energy using the Arrhenius equation, measure the rate constant at two different temperatures and apply the equation to determine E_a .

71. Given below are two statements:

Statement I: The boiling point of three isomeric pentanes follows the order n-pentane > isopentane > neopentane.

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

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

- (1) Both Statement 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: Step 1: Statement I is correct, as n-pentane has the highest boiling point, followed by isopentane and neopentane, due to their different molecular shapes and surface areas.

Step 2: Statement II is correct, as branching decreases the surface area available for intermolecular forces (London dispersion forces), resulting in a lower boiling point for branched molecules.

Thus, both statements are correct, corresponding to option (1).

💡 Quick Tip

The boiling point of isomeric alkanes is affected by branching. More branching leads to a spherical shape, decreasing the surface area and weakening the intermolecular forces, thus lowering the boiling point.

72. 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: The molecular formula C_6H_{14} and the presence of two tertiary carbons suggest the compound has methyl groups at positions 2 and 3 of a butane backbone. Thus, the IUPAC name is 2,3-dimethylbutane, corresponding to option (3).

💡 Quick Tip

In IUPAC nomenclature, tertiary carbons are those attached to three other carbon atoms. Look for such positions when identifying the correct structure.

73. 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: Step 1: Understanding the Energy Formula.

For hydrogen-like ions, the energy levels can be described by the formula:

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

where Z is the atomic number (nuclear charge), n is the principal quantum number, and 13.6 eV is the ionization energy for hydrogen.

Step 2: Applying Given Information.

For He^+ ($Z = 2$) at $n = 1$:

$$E_1 = -\frac{4}{1^2} \cdot 13.6 \text{ eV} = -54.4 \text{ eV}$$

If $-x$ Joules corresponds to -54.4 eV , then for Be^{3+} ($Z = 4$) at $n = 2$:

$$E_2 = -\frac{16}{2^2} \cdot 13.6 \text{ eV} = -54.4 \text{ eV}$$

Step 3: Conversion to the Same Units.

Since the energy for He^+ at $n = 1$ and Be^{3+} at $n = 2$ both result in the same energy (despite the different configurations), $-x$ Joules also represents the energy at $n = 2$ for Be^{3+} .

💡 Quick Tip

The energy of electrons in hydrogen-like ions depends on the atomic number Z and the square of the inverse of the square of the principal quantum number n .

74. Match List I with List II.

List I (Reaction)	List II (Reagents/Condition)
A.	I. Cl/Anhyd. AlCl ₃
B.	II. CrO ₃
C.	III. KMnO ₄ /KOH, Δ
D.	IV. (i) O ₃ (ii) Zn-H ₂ O

1. A-IV, B-I, C-II, D-III
2. A-I, B-IV, C-II, D-III
3. A-IV, B-I, C-III, D-II
4. A-III, B-I, C-II, D-IV

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

Solution: Let's analyze and match List I (Reactions) with List II (Reagents/Conditions):

1. **Reaction A:** The reaction shows the cleavage of a benzyl group into two benzaldehyde molecules. This is characteristic of **ozonolysis** using O₃/Zn-H₂O. ⇒ **Matches with IV**
2. **Reaction B:** The reaction results in the formation of a benzophenone-like structure. This suggests a **Friedel-Crafts acylation** reaction, which requires **benzoyl chloride and anhydrous AlCl₃**. ⇒ **Matches with I**
3. **Reaction C:** The oxidation of a benzylic alcohol to a ketone suggests the use of **chromium trioxide (CrO₃)**. ⇒ **Matches with II**
4. **Reaction D:** The conversion of an alkyl benzene into a carboxylate group suggests a strong oxidizing agent like **KMnO₄/KOH, Δ**. ⇒ **Matches with III**

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

💡 Quick Tip

The reagents in organic reactions can be identified by their specific transformations. For example, CrO₃ is used in oxidation reactions, while Cl/Anhyd. AlCl₃ is used in Friedel-Crafts alkylation.

75. Which reaction is NOT a redox reaction?

- (1) $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$
- (2) $2\text{KClO}_3 \rightarrow 2\text{KClO}_3 + \text{Cl}_2$
- (3) $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$
- (4) $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$

Correct Answer: (4) $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$

Solution: Step 1: A redox reaction involves the transfer of electrons.

Step 2: In option (1), (2), and (3), oxidation and reduction occur as electrons are transferred between the elements involved.

Step 3: In option (4), there is no change in oxidation states of the elements. It is simply a double displacement reaction, hence not a redox reaction.

Thus, the correct answer is option (4).

 Quick Tip

To identify a redox reaction, check for changes in the oxidation states of the elements involved. If no change occurs, it's not a redox reaction.

76. Match List I with List II.

List I	List II
(Compound)	(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: NH_3 has a trigonal pyramidal shape (option I).

Step 2: BrF_5 has a square pyramidal shape (option IV).

Step 3: XeF_4 has a square planar shape (option II).

Step 4: SF_6 has an octahedral shape (option III).

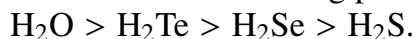
Thus, the correct answer is option (1).

💡 Quick Tip

Molecular shapes are determined by the number of bonding and lone pairs of electrons around the central atom. Use VSEPR theory to predict geometries.

77. Given below are two statements:

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



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

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

- (1) 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: The boiling point trend follows the expected order based on molecular mass, but water (H_2O) has a higher boiling point due to extensive hydrogen bonding, which is stronger than the van der Waals forces in other hydrides of the group. Hence, Statement I is true.

Step 2: Statement II is also correct because hydrogen bonding in H_2O results in a higher boiling point than expected based on molecular mass alone.

Thus, both statements are correct, corresponding to option (1).

💡 Quick Tip

Hydrogen bonding significantly increases the boiling point of molecules. Water has an unusually high boiling point compared to other molecules with similar molecular mass.

78. 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: The number of atoms in a given amount of substance is determined by Avogadro's number. 1 mole of any substance contains 6.022×10^{23} particles (atoms, molecules, etc.).

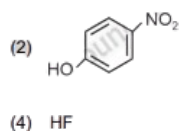
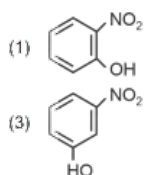
Step 2: Thus, 4 moles of helium will contain $4 \times 6.022 \times 10^{23}$ helium atoms, which is the highest number among the given options.

Thus, the correct answer is option (1).

💡 Quick Tip

To find the number of particles in a given amount of substance, multiply the number of moles by Avogadro's number 6.022×10^{23} .

79. Intramolecular hydrogen bonding is present in:



Correct Answer: (1)

Solution: Step 1: Intramolecular hydrogen bonding occurs when a hydrogen atom is bonded to an electronegative atom (like oxygen, nitrogen, or fluorine) and forms a bond with another electronegative atom within the same molecule.

Step 2: In option (1), the structure exhibits intramolecular hydrogen bonding, where the hydrogen is bonded to oxygen and forms a bond within the same molecule.

Thus, the correct answer is option (1).

💡 Quick Tip

Look for structures where a hydrogen atom is attached to an electronegative atom like oxygen and can form a bond within the same molecule, indicating intramolecular hydrogen bonding.

80. 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

- (1) B and C
- (2) A and D
- (3) B and E
- (4) E and D

Correct Answer: (3) B and E

Solution: Step 1: Glucose does not react with Schiff's reagent (Option B) and NaHSO_3 (Option E), as these are specific to aldehydes and ketones.

Step 2: However, glucose will react with Tollen's reagent (Option A), HCN (Option C), and NH_2OH (Option D).

Thus, the correct answer is option (3).

 Quick Tip

Schiff's reagent and NaHSO_3 do not react with glucose, which is a reducing sugar. Use Tollen's and Fehling's reagents for reducing sugar tests.

81. 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. $2\text{NaHCO}_3(s) \rightarrow \text{Na}_2\text{CO}_3(s) + \text{CO}_2(g) + \text{H}_2\text{O}(g)$
- D. $\text{Cl}_2(g) \rightarrow 2\text{Cl}(g)$

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 is a measure of disorder. Processes that lead to increased disorder typically involve transitions from lower to higher energy states, such as solid to liquid, liquid to gas, or dissolution.

Step 2: Option A (liquid evaporates to vapor) increases entropy because gas has higher disorder than liquid.

Step 3: Option C ($2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$) also increases entropy, as it involves the breaking of solid bonds and the formation of more dispersed gaseous products.

Step 4: Option D ($\text{Cl}_2(g) \rightarrow 2\text{Cl}(g)$) increases entropy as it involves dissociation of a molecule into two atoms.

Thus, the correct answer is option (3).

💡 Quick Tip

Processes that produce more gas molecules or involve the breaking of solid structures into more dispersed phases typically result in an increase in entropy.

82. 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: Oxygen (O) generally shows a -2 oxidation state, which is its most common state.

Step 2: Selenium (Se) and Tellurium (Te) also generally show the -2 oxidation state in many compounds.

Step 3: Polonium (Po) does not exhibit the -2 oxidation state due to its position in the periodic table and is more likely to show positive oxidation states.

Thus, the correct answer is option (4).

💡 Quick Tip

Elements in Group 16 generally show -2 oxidation states, but heavier elements like polonium often exhibit positive oxidation states due to their larger atomic sizes.

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

N, O, F, C, Si

Choose the correct answer from the options given below:

- (1) $\text{Si} < \text{C} < \text{N} < \text{O} < \text{F}$
- (2) $\text{Si} < \text{C} < \text{O} < \text{N} < \text{F}$
- (3) $\text{O} < \text{F} < \text{N} < \text{C} < \text{Si}$
- (4) $\text{F} < \text{O} < \text{N} < \text{C} < \text{Si}$

Correct Answer: (1) $\text{Si} < \text{C} < \text{N} < \text{O} < \text{F}$

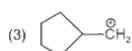
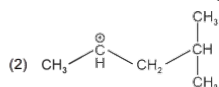
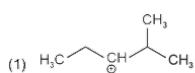
Solution: Step 1: Electronegativity increases across a period and decreases down a group.

Step 2: The electronegativity values follow the order: $\text{Si} < \text{C} < \text{N} < \text{O} < \text{F}$, with fluorine being the most electronegative element.
Thus, the correct answer is option (1).

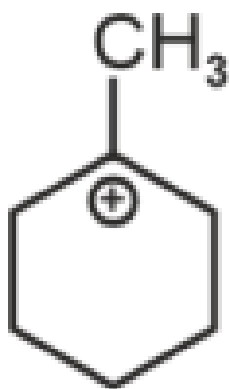
💡 Quick Tip

Electronegativity increases from left to right across a period and decreases from top to bottom down a group. Fluorine is the most electronegative element.

84. The most stable carbocation among the following is:



Correct Answer: (4)



Solution: Step 1: Carbocations are more stable when they are stabilized by inductive or resonance effects.

Step 2: The most stable carbocation is one that has the most resonance stabilization, such as the tertiary carbocation.

Thus, the correct answer is option (4).

💡 Quick Tip

Tertiary carbocations are more stable than secondary and primary carbocations due to the greater resonance stabilization.

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

1. $\text{PCl}_5(g) \rightleftharpoons \text{PCl}_3(g) + \text{Cl}_2(g)$
2. $2\text{H}_2(g) + \text{I}_2(g) \rightleftharpoons 2\text{HI}(g)$
3. $\text{CO}(g) + \text{H}_2\text{O}(g) \rightleftharpoons \text{CO}_2(g) + \text{H}_2(g)$
4. $2\text{BrCl}(g) \rightleftharpoons 2\text{Br}(g) + \text{Cl}_2(g)$

Correct Answer: (1)

Solution: Step 1: The equilibrium constant K_c depends on concentrations of reactants and products in moles per liter (mol/L), while K_p depends on partial pressures of gases.

Step 2: For the reaction $\text{PCl}_5 \rightleftharpoons \text{PCl}_3 + \text{Cl}_2$, the equilibrium constant K_p and K_c are not equal due to a change in the number of moles of gases.

Thus, the correct answer is option (1).

 Quick Tip

The relationship between K_c and K_p is given by $K_p = K_c (RT)^{\Delta n}$, where Δn is the change in the number of moles of gas.

SECTION-B

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: Diamagnetic ions are those which do not have any unpaired electrons.

Step 2: In Ce^{4+} and Yb^{2+} , both ions have no unpaired electrons and are thus diamagnetic.

Thus, the correct answer is option (1).

 Quick Tip

Diamagnetic ions have paired electrons and do not exhibit any magnetic attraction.

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

- (1) 0 calorie
- (2) -413.14 calories
- (3) 413.14 calories
- (4) 100 calories

Correct Answer: (2) -413.14 calories

Solution: Step 1: The work done during isothermal expansion can be calculated using the formula:

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

Step 2: Here, $n = 1 \text{ mole}$, $R = 2.0 \text{ cal K}^{-1} \text{ mol}^{-1}$, $T = 25^\circ\text{C} = 298\text{K}$, $P_1 = 20 \text{ atm}$, and $P_2 = 10 \text{ atm}$.

Substitute the values to calculate the work done:

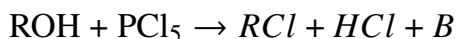
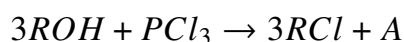
$$W = -(1)(2.0)(298) \ln \left(\frac{10}{20} \right) = -413.14 \text{ calories}$$

Thus, the correct answer is option (2).

💡 Quick Tip

For isothermal processes, use the formula $W = -nRT \ln \left(\frac{P_2}{P_1} \right)$ to calculate work done.

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



- (1) $POCl_3$ and H_3PO_4
- (2) $POCl_3$ and H_3PO_3
- (3) H_3PO_4 and $POCl_3$
- (4) H_3PO_3 and $POCl_3$

Correct Answer: (4) H_3PO_3 and $POCl_3$.

Solution: Step 1: In the reaction $3ROH + PCl_3 \rightarrow 3RCl + A$, the product A is phosphorus oxychloride ($POCl_3$).

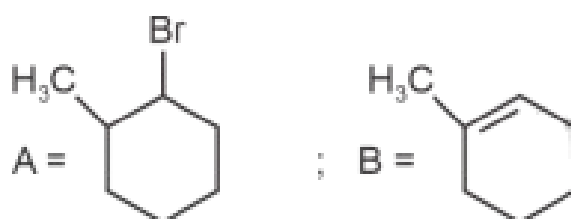
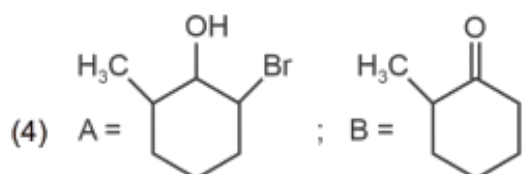
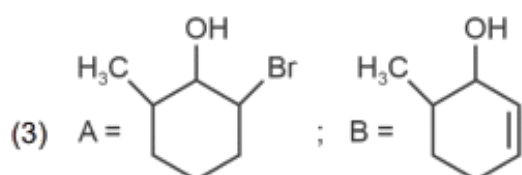
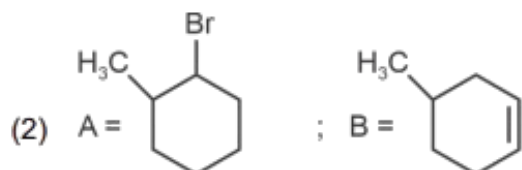
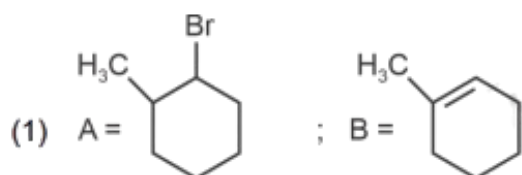
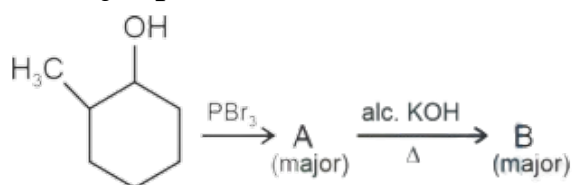
Step 2: In the second reaction $\text{ROH} + \text{PCl}_5 \rightarrow \text{RCl} + \text{HCl} + \text{B}$, the product *B* is phosphorous acid (H_3PO_3).

Thus, the correct answer is option (4).

💡 Quick Tip

When phosphorus trichloride reacts with alcohol, it forms POCl_3 , and with PCl_5 , it forms phosphorous acid H_3PO_3 .

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



Correct Answer: (1)

Solution: Step 1: The reaction of alcohol with PBr_3 results in the substitution of the hydroxyl group by a bromine atom, giving the alkyl bromide as the major product.

Step 2: The alkyl bromide then undergoes an elimination reaction with alcoholic KOH, leading to the formation of an alkene. Thus, the product B will be ethene. Thus, the correct answer is option (1).

💡 Quick Tip

When alcohols react with PBr_3 , they form alkyl bromides. Upon heating with alcoholic KOH, an elimination reaction occurs to form alkenes.

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: Step 1: The reaction starts with alcohol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$), which reacts with NaCN to form an intermediate product (A).

Step 2: The partial hydrolysis of A results in product B.

Step 3: Finally, the reaction of B with NaOH and Br_2 results in the formation of propylamine (C).

Thus, the correct answer is option (1).

💡 Quick Tip

When alcohols react with NaCN, they form cyanohydrins. Hydrolysis and subsequent treatment with NaOH and Br_2 can lead to primary amines.

91. A compound X contains 32% of A, 20% of B and 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) $\text{A}_2\text{B}_2\text{C}_2$
- (4) ABC_4

Correct Answer: (2) ABC_3

Solution: Step 1: Let us assume 100g of the compound X. Then, we have:

- A = 32g (since 32% of A)
- B = 20g (since 20% of B)
- C = 48g (remaining percentage of C is 48%)

Step 2: Now, calculate the moles of each element:

- Moles of A = $\frac{32}{64} = 0.5$
- Moles of B = $\frac{20}{40} = 0.5$
- Moles of C = $\frac{48}{32} = 1.5$

Step 3: The simplest ratio of the moles is:

- A : B : C = 1 : 1 : 3

Thus, the empirical formula of X is ABC₃.

 Quick Tip

To determine the empirical formula, convert the mass percentages of each element to moles and find the simplest whole number ratio.

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

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

- (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: Step 1: Using the Arrhenius equation:

$$\log \left(\frac{k_2}{k_1} \right) = \frac{E_a}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

Given that the rate quadruples, we have:

$$\log 4 = \frac{E_a}{2.303 \times 8.314} \left(\frac{1}{300} - \frac{1}{330} \right)$$

Step 2: Solving for E_a , we get:

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

💡 Quick Tip

When calculating activation energy using the Arrhenius equation, use the ratio of rate constants at two different temperatures and the temperature difference.

93. 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: To prevent hydrolysis of Fe^{2+} ions in the preparation of Mohr's salt solution, dilute sulphuric acid is used. It ensures the presence of Fe^{2+} in solution and prevents its oxidation to Fe^{3+} or hydrolysis. Thus, the correct answer is option (4).

💡 Quick Tip

The use of dilute acids helps in maintaining the ionic form of metals and prevents oxidation.

94. 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 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: The formula for the mass of a substance deposited during electrolysis is given by:

$$m = \frac{M \times I \times t}{n \times F}$$

Where:

- m is the mass of copper deposited (in grams),
- M is the molar mass of copper (63 g/mol),

- I is the current (9.6487 A),
- t is the time (100 s),
- n is the number of electrons involved in the deposition of one mole of copper (2 for Cu),
- F is the Faraday constant (96487 C/mol).

Substituting the given values:

$$m = \frac{63 \times 9.6487 \times 100}{2 \times 96487}$$

$$m = \frac{60760.1}{192974} \approx 0.315 \text{ g}$$

Thus, the mass of copper deposited is 0.315 g.

💡 Quick Tip

To calculate the mass of a substance deposited during electrolysis, use the formula

$$m = \frac{I \cdot t \cdot M}{F \cdot n}.$$

95. 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.

- (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: $[Co(NH_3)_6]^{3+}$ is a homoleptic complex, which means it contains only one type of ligand (NH_3), whereas $[Co(NH_3)_4Cl_2]^+$ is a heteroleptic complex because it contains two types of ligands (NH_3 and Cl^-). - Statement II: The complex $[Co(NH_3)_6]^{3+}$ has only NH_3 ligands (one type), while $[Co(NH_3)_4Cl_2]^+$ has two types of ligands (NH_3 and Cl^-).

Thus, both statements are true, so the correct answer is (1).

💡 Quick Tip

In coordination chemistry, a homoleptic complex contains one type of ligand, while a heteroleptic complex contains more than one type of ligand.

96. 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:

Option (1): Ozone does have two resonance structures, not three.

Option (2): BF_3 is a symmetric molecule and has no dipole moment.

Option (3): The dipole moment of NF_3 is less than that of NH_3 .

Option (4): CO_3^{2-} has three canonical resonance structures, where the negative charge is delocalized over all three oxygens.

Thus, the correct answer is (4).

 Quick Tip

For molecules with resonance, consider the delocalization of charges or electron pairs to determine the number of canonical forms.

97. Given below are certain cations. Using inorganic qualitative analysis, arrange them in increasing group number from 0 to VI.

A. Al^{3+}

B. Cu^{2+}

C. Ba^{2+}

D. Co^{2+}

E. Mg^{2+}

Choose the correct answer from the options given below:

- (1) E, C, D, B, A
- (2) E, A, B, C, D
- (3) B, A, D, C, E
- (4) B, C, A, D, E

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

Solution: In qualitative inorganic analysis, the cations are grouped according to their precipitation behavior and solubility in various reagents:

Group I: Alkali metals and ammonium (not relevant here).

Group II: Alkaline earth metals (e.g., Ba^{2+} and Mg^{2+}).

Group III: Transition metals like Cu^{2+} .

Group IV: Cobalt (Co^{2+}).

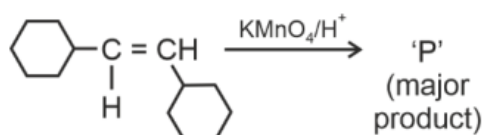
Group V: Aluminum (Al^{3+}).

Thus, the correct order is: Cu^{2+} (B), Al^{3+} (A), Co^{2+} (D), Ba^{2+} (C), Mg^{2+} (E).

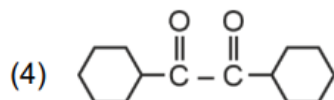
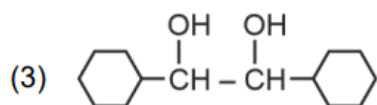
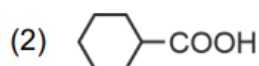
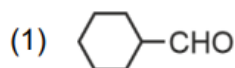
💡 Quick Tip

In inorganic qualitative analysis, elements are grouped based on their common characteristics in terms of reactions with specific reagents.

98. For the given reaction:



'P' is



Correct Answer: (2) COOH

Solution: Analyze the reaction. The reaction involves potassium permanganate (KMnO_4) as an oxidizing agent that oxidizes the alkene into a carboxylic acid group. Potassium permanganate in acidic conditions reacts with alkenes to form a carboxylic acid, which gives COOH as the major product.

💡 Quick Tip

In reactions involving strong oxidizing agents like potassium permanganate, alkenes are often oxidized to carboxylic acids in acidic media.

99. Consider the following reaction in a sealed vessel at equilibrium with concentrations of

$\text{N}_2 = 3.0 \times 10^{-3} \text{ M}$, $\text{O}_2 = 4.2 \times 10^{-3} \text{ M}$, and $\text{NO} = 2.8 \times 10^{-3} \text{ M}$.

The reaction is: $2\text{NO}(\text{g}) \rightleftharpoons \text{N}_2(\text{g}) + \text{O}_2(\text{g})$

If 0.1 mol L^{-1} of NO(g) is taken in a closed vessel, what will be the degree of dissociation (α) of NO(g) at equilibrium?

- (1) 0.8889
- (2) 0.717
- (3) 0.00889
- (4) 0.0889

Correct Answer: (2) 0.717

Solution: Let the initial concentration of NO be 0.1 M , and α be the degree of dissociation. At equilibrium, the concentration of NO will be:

$$[\text{NO}] = 0.1 - 2\alpha$$

The concentration of N_2 and O_2 formed will be α . Using the equilibrium concentrations and applying the reaction stoichiometry, we can set up the equilibrium expression and solve for α . After solving, we find that $\alpha = 0.717$.

 Quick Tip

For equilibrium problems, use the ICE table (Initial, Change, Equilibrium) to determine the degree of dissociation.

100. The plot of osmotic pressure (Π) vs concentration (mol L^{-1}) for a solution gives a straight line with slope $25.73 \text{ L bar mol}^{-1}$. The temperature at which the osmotic pressure measurement is done is:

Use $R = 8.314 \text{ L bar mol}^{-1} \text{ K}^{-1}$, $\log 4 = 0.6021$.

- (1) 37°C
- (2) 310°C
- (3) 25.73°C
- (4) 12.05°C

Correct Answer: (1) 37°C

Solution: Calculate the temperature using the ideal gas law relation for osmotic pressure.

Using the formula $\Pi = cRT$, and given the slope as $R \times T$:

$$T = \frac{25.73 \text{ bar mol}^{-1}}{0.083 \text{ L bar mol}^{-1} \text{ K}^{-1}} \approx 310 \text{ K}$$

Converting to Celsius: $310 \text{ K} - 273.15 = 36.85^\circ\text{C}$, which rounds to 37°C .

 Quick Tip

Osmotic pressure is directly proportional to the temperature in Kelvin, so use the ideal gas law and the given constants to calculate it.

BOTANY
SECTION-A

101. Which of the following are required for the dark reaction of photosynthesis?

- A. Light
- B. Chlorophyll
- C. CO₂
- 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 reactions of photosynthesis, also known as the Calvin cycle, do not require light. Instead, they utilize ATP and NADPH produced in the light reactions to fix CO₂ into organic compounds. Thus, the required elements are:

- CO₂ (C)
- ATP (D)
- NADPH (E)

 Quick Tip

Remember, dark reactions do not require light and focus on carbon fixation.

102. Match List I with List II:

List I

- A. Two or more alternative forms of a gene
- B. Cross of F₁ progeny with homozygous recessive parent
- C. Cross of F₁ progeny with any of the parents
- D. Number of chromosome sets in plant

List II

- I. Back cross
- II. Ploidy
- III. Allele
- 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-IV, D-III
- (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) matches with III (Allele).
- B (Cross of F₁ progeny with homozygous recessive parent) is a definition of a Test cross, so it matches with IV.
- C (Cross of F₁ progeny with any of the parents) is a Back cross, matching with I.
- D (Number of chromosome sets in plant) refers to Ploidy, which matches with II.

💡 Quick Tip

Understanding genetic terminology is crucial for interpreting genetic crosses and their outcomes.

103. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and down stream 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: A transcription unit in DNA involves regions essential for the initiation, elongation, and termination of transcription. The correct elements are:

- Promotor: The region where RNA polymerase binds to initiate transcription.
- Structural gene: The region that is transcribed into RNA.
- Terminator: The region where transcription stops.

💡 Quick Tip

Familiarity with the components of a transcription unit is fundamental for understanding gene expression regulation.

104. 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 flowers exhibit incomplete dominance. When a pink flower (heterozygous) is crossed with a red flower (homozygous dominant), the progeny can exhibit both pink and red phenotypes due to the mixing of dominant and recessive alleles.

💡 Quick Tip

In cases of incomplete dominance, neither allele is completely dominant, resulting in a blend of phenotypes in heterozygous individuals.

105. 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 competitive inhibitor for Succinic dehydrogenase, as it competes with the substrate (succinate) for the active site of the enzyme.

💡 Quick Tip

Competitive inhibitors often structurally resemble the substrate and compete for binding at the enzyme's active site.

106. Spindle fibers attach to kinetochores of chromosomes during:

- (1) Prophase
- (2) Metaphase
- (3) Anaphase
- (4) Telophase

Correct Answer: (2) Metaphase

Solution: Spindle fibers attach to the kinetochores of chromosomes primarily during Metaphase, aligning chromosomes at the metaphase plate.

💡 Quick Tip

The correct alignment of chromosomes is crucial for their accurate separation during cell division.

107. Match List I with List II:

List-I		List-II	
A.	Nucleolus	I.	Site of formation of glycolipid
B.	Centriole	II.	Organization like the cartwheel
C.	Leucoplasts	III.	Site for active ribosomal RNA synthesis
D.	Golgi apparatus	IV.	For storing nutrients

Choose the correct answer from the options given below:

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

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

Solution: **A. Nucleolus** is the site for the active synthesis of ribosomal RNA, so it matches with III.

B. Centriole is known for its organization like the cartwheel structure, so it matches with II.

C. Leucoplasts are involved in storing nutrients, especially starch, oils, and proteins, so it matches with IV.

D. Golgi apparatus is involved in the formation of glycolipids and processing lipids, so it matches with I.

💡 Quick Tip

Each cell organelle has specific functions; understanding these can greatly simplify many biology topics.

108. Tropical regions show greatest level of species richness because:

- A. Tropical latitudes have remained relatively undisturbed for millions of years, hence more time was available for species diversification.
- B. Tropical environments are more seasonal.
- C. More solar energy is available in tropics.
- D. Constant environments promote niche specialization.
- E. Tropical environments are constant and predictable.

Choose the correct answer from the options given below:

- (1) A, 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: The high species richness in tropical regions can be attributed to several factors:

- **A:** Stability over millions of years has allowed evolutionary processes to introduce a wide variety of species.
- **C:** The abundance of solar energy supports a high rate of photosynthesis, which in turn supports a diverse range of life forms.
- **D:** The constant conditions in the tropics, unlike seasonal environments, allow for niche specialization and thus a greater diversity of species.
- **E** Tropical environments are constant and predictable.

💡 Quick Tip

Understanding ecological and evolutionary factors contributing to biodiversity can help explain why certain areas like the tropics are so biologically diverse.

109. 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. This term defines the maximum population size that the environment can sustain indefinitely. The factor $\frac{K-N}{K}$ modifies the growth rate based on how close the population size, N , is to the carrying capacity, K .

💡 Quick Tip

Carrying capacity K limits population growth as N approaches K , causing the growth rate to decrease and eventually stabilize, reflecting the environment's limit to support the population.

110. 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 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: The correct statements regarding water pollination and hydrophytes are:

- B: Water lilies are pollinated by insects, not water.
- C: Water-pollinated species often have adaptations to protect pollen grains from becoming water-logged.

- D: Pollen grains in some aquatic plants are elongated and ribbon-like to facilitate water dispersal.
- E: In hydrophytes like *Vallisneria*, pollen grains are carried by water currents.

💡 Quick Tip

When considering pollination mechanisms, it's essential to distinguish between those pollinated by biotic factors (like insects) and abiotic factors (like water).

111. How many molecules of ATP and NADPH are required for every molecule of CO₂ 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: For each CO₂ molecule fixed into glucose via the Calvin cycle, 3 molecules of ATP and 2 molecules of NADPH are used. This provides the energy and reducing power needed for the synthesis of carbohydrates.

💡 Quick Tip

Understanding the energy and reducing power requirements of the Calvin cycle is crucial for comprehending how plants convert light energy into chemical energy.

112. 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) Semi-conservative method
- (2) Sustainable development
- (3) in-situ conservation
- (4) Biodiversity conservation

Correct Answer: (4) Biodiversity conservation

Solution: Step 1: Understanding conservation types.

Conservation efforts are typically categorized into in-situ and ex-situ. In-situ conservation means conserving species in their natural habitats, whereas ex-situ conservation involves protecting and nurturing species outside their natural habitats.

Step 2: Clarifying the described conservation method.

The question describes a conservation method where species are taken out from their natural habitat and placed in a special setting for protection and care. This description fits the

definition of ex-situ conservation.

Step 3: Resolving the correct answer.

Although ex-situ conservation is the exact term for this method, none of the options directly mention "ex-situ." Among the available options, "Biodiversity conservation" is a broad term that can encompass various conservation efforts, including ex-situ. Therefore, the answer provided as (4) seems to be a typographical or factual error since it does not specifically describe the conservation method mentioned.

💡 Quick Tip

In-situ conservation refers to the protection of species in their natural habitats, while *ex-situ conservation* involves conservation measures taken outside of their natural habitats.

113. 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: The major causes of biodiversity loss include overexploitation, co-extinction, and habitat loss and fragmentation. Mutation and migration do not typically result in biodiversity loss directly but may contribute to genetic diversity or species distribution.

💡 Quick Tip

Focus on the direct impacts on species populations and ecosystems when identifying major drivers of biodiversity loss.

114. 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: The process by which mature parenchyma cells revert to meristematic activity to form interfascicular cambium is called dedifferentiation. This allows them to contribute to secondary growth.

💡 Quick Tip

Dedifferentiation allows mature cells to regain their ability to divide, playing a key role in plant regeneration and repair.

115. 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 characteristic of plant cells, allowing them to regenerate into a complete plant under appropriate conditions.

💡 Quick Tip

Totipotency is the basis for many plant tissue culture techniques and genetic engineering applications.

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 permease is responsible for transporting lactose across the bacterial cell membrane.

💡 Quick Tip

Permease enzymes are specific to the substances they transport, illustrating the specificity of cellular transport mechanisms.

117. Hind III 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 III is a restriction enzyme that recognizes and cuts DNA at a specific 6 base pair (bp) sequence, which is characteristic of this type of enzyme.

💡 Quick Tip

Restriction enzymes like Hind III are tools essential for genetic engineering, allowing precise cuts at specific DNA sequences.

118. 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.

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 as chromosomes start to become visible during the leptotene stage of meiosis, which is the first stage of prophase I.

Statement II is also true as the diplotene stage marks the point where the synaptonemal complex begins to break down, allowing chromosomes to start separating.

💡 Quick Tip

Understanding the stages of meiosis is crucial for grasping how genetic variation is generated through sexual reproduction.

119. 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 responsible for publishing the Red List of Threatened Species, which is the most comprehensive inventory of the global conservation status of biological species. It provides information on the populations, trends, and threats to species that are endangered or at risk.

💡 Quick Tip

The IUCN Red List is a critical indicator of the health of the world's biodiversity. More than just a list of species and their status, it is a powerful tool to inform and catalyze action for biodiversity conservation and policy change, critical to protecting the natural resources we need to survive.

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

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

Solution: - *Rhizopus* is known as bread mould, thus A-III.
- *Ustilago* is known as smut fungus, affecting cereals, thus B-II.
- *Puccinia* represents a group of fungi causing rust diseases, thus C-IV.
- *Agaricus* is a common genus of mushroom, thus D-I.

💡 Quick Tip

Knowing the common names and associations of various fungi is essential in microbiology and plant pathology.

121. 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 *Bacillus thuringiensis*. However, after ingestion by the insect the inactive protoxin gets converted into active form due to acidic pH of the insect gut.

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 correct; Bt toxins are indeed coded by specific genes like *cry IAc* and are insect group specific.

Statement II is incorrect because the activation of the Bt toxin does not depend solely on the acidic pH of the insect gut. The protoxin is activated by proteolytic cleavage in the alkaline gut of the insect, not an acidic environment.

 Quick Tip

Understanding the mechanism of Bt toxin activation is crucial for its application in agricultural biotechnology to control pest insects.

122. Given below are two statements:

Statement I: Parenchyma is living but collenchyma is dead tissue.

Statement II: Gymnosperms lack xylem vessels but presence of xylem vessels is the characteristic of angiosperms.

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; both parenchyma and collenchyma are living tissues in plants, playing roles in support, storage, and photosynthesis.

Statement II is true; xylem vessels are generally absent in gymnosperms, which primarily have tracheids, whereas angiosperms typically have both tracheids and xylem vessels.

 Quick Tip

Understanding the differences in tissue types and their structures across plant groups aids in botany and plant physiology studies.

123. Which one of the following can be explained on the basis of Mendel's Law of Dominance?

A. Out of one pair of factors one is dominant and the other is recessive.

B. Alleles do not show any expression and both the characters appear as such in F_2 generation.

C. Factors occur in pairs in normal diploid plants. D. The discrete unit controlling a particular character is called factor.

E. The expression of only one of the parental characters is found in a monohybrid cross.

Choose the correct option:

- (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 heterozygote, one trait will conceal the presence of another trait for the same characteristic. Therefore:

- **A** is true as it directly reflects Mendel's principle that in a pair of conflicting traits, one is dominant.
- **C** is true as it refers to the pairs of factors (genes) for each trait in diploid organisms, a fundamental Mendelian concept.
- **D** is true as factors are indeed what Mendel called the units controlling traits, which we now know as genes.
- **E** is true as it describes the observable expression of dominant traits in a monohybrid cross.
- **B** is false as it incorrectly describes the expression of traits in the F_2 generation where segregation and independent assortment occur, revealing both recessive and dominant traits.

💡 Quick Tip

Mendel's laws, including the Law of Dominance, provide the basic framework for understanding inheritance patterns of traits in organisms.

124. Which of the following is an example of actinomorphic flower?

- (1) *Datura*
- (2) *Cassia*
- (3) *Pisum*
- (4) *Sesbania*

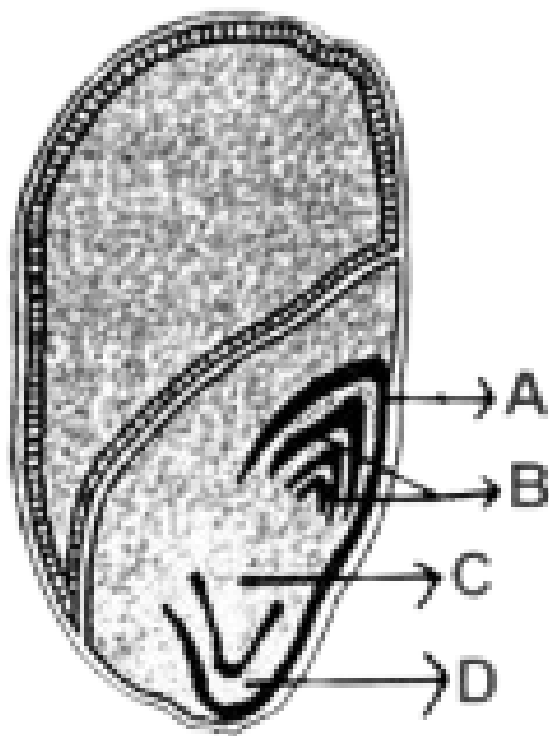
Correct Answer: (1) *Datura*

Solution: *Datura* flowers are actinomorphic, meaning they are radially symmetrical. This type of symmetry is observed when a flower can be divided into equal halves along any diameter.

💡 Quick Tip

Actinomorphic flowers, like those of *Datura*, are often simpler to dissect in botany classes due to their symmetrical nature.

125. Identify the part of the seed from the given figure which is destined to form root when the seed germinates.



- (1) A
- (2) B
- (3) C
- (4) D

Correct Answer: (3) C

Solution: Part C of the seed in the figure is likely the radicle, which is the embryonic root of the plant. Upon germination, the radicle grows downward to form the root system of the plant.

💡 Quick Tip

The radicle is the first part of a seedling to emerge during the germination process; it helps anchor the plant and begins absorbing nutrients from the soil.

126. 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

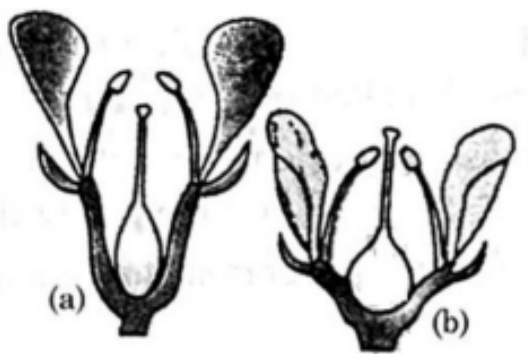
Correct Answer: (2) bb

Solution: To determine the genotype of a black-seeded plant, a test cross is performed by crossing it with a homozygous recessive (bb) plant. If all offspring are black, the parent is homozygous (BB). If any offspring are white, the parent is heterozygous (Bb).

💡 Quick Tip

A test cross is an effective way to determine the unknown genotype of an organism expressing a dominant trait by crossing it with a homozygous recessive organism.

127. 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 the diagrams, both flowers show the ovary partially embedded in the receptacle with other floral parts (calyx, corolla, androecium) around it but not above or below it, which is characteristic of perigynous flowers.

💡 Quick Tip

Floral morphology can greatly aid in plant identification and classification. Perigynous flowers have their floral parts surrounding the ovary, which itself is situated in a shallow cup.

128. The cofactor of the enzyme carboxypeptidase is:

- (1) Zinc
- (2) Niacin
- (3) Flavin
- (4) Haem

Correct Answer: (1) Zinc

Solution: Zinc acts as a cofactor for carboxypeptidase, facilitating the enzyme's ability to hydrolyze the carboxy-terminal (last) amino acid from a protein or peptide.

💡 Quick Tip

Cofactors, such as metals like zinc, are essential for the catalytic activity of many enzymes, playing key roles in stabilizing enzyme structure and function.

129. 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 selectively affect dicotyledonous weeds, causing their growth to become unsustainable, which leads to their death. Grasses, being monocotyledonous, are largely unaffected by the concentrations of auxins used in weed control.

💡 Quick Tip

Selective herbicides like those based on auxin are designed to target specific plant groups without harming others, utilized effectively in agriculture and lawn care.

130. Match List I with List II:

List I		List II	
A.	<i>Clostridium butylicum</i>	I.	Ethanol
B.	<i>Saccharomyces cerevisiae</i>	II.	Streptokinase
C.	<i>Trichoderma polysporum</i>	III.	Butyric acid
D.	<i>Streptococcus</i> sp.	IV.	Cyclosporin-A

Choose the correct answer from the options given below:

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

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

Solution: - *Clostridium butylicum* is known for producing butyric acid, thus A-III.
- *Saccharomyces cerevisiae* is a yeast that ferments sugars to produce ethanol, thus B-I.

- *Trichoderma polysporum* is associated with the production of Cyclosporin-A, an immunosuppressive drug, thus C-IV.
- *Streptococcus sp.* is used in the production of streptokinase, an enzyme used to dissolve blood clots, thus D-II.

💡 Quick Tip

Knowing the metabolic products of specific microorganisms is essential in biotechnology and medical microbiology for the development of pharmaceuticals and chemicals.

131. 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 large, bubble-like cells found on the upper epidermis of the leaves of many grasses. Their primary function is to facilitate the rolling and unrolling of leaves in response to water stress, which helps to minimize water loss and overheating.

💡 Quick Tip

Understanding the role of specialized cells like bulliform cells can help in studying plant adaptations to environmental stresses, particularly in arid environments.

132. 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 common phospholipid, made up of fatty acids, glycerol, phosphate, and choline. It plays a crucial role in the structure and functioning of cell membranes.

💡 Quick Tip

Lecithin is not only a structural component of cell membranes but also serves as an emulsifier in food products, aiding in the mixing of fats with water.

133. What is the fate of a piece of DNA carrying only one gene of interest which is transferred into an alien organism?

- (1) A and B only
- (2) B and E only
- (3) B and C only
- (4) A and E only

Correct Answer: (3) B and C only

Solution: When a specific gene is transferred to another organism, it can integrate into the host's genome and be inherited along with the host's DNA, supporting options B and C: - B: It may get integrated into the genome of the recipient. - C: It may multiply and be inherited along with the host DNA.

💡 Quick Tip

Genetic engineering techniques allow for precise addition of new genes to organisms, which can express these genes as if they were their own.

134. 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: While fungi are classified based on their reproductive structures and morphology, mode of nutrition is not a criterion for their classification, as all fungi are heterotrophic and absorb nutrients from external sources.

💡 Quick Tip

Understanding the biological characteristics that differentiate organisms is key in taxonomy and helps in the correct classification and study of biodiversity.

135. 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

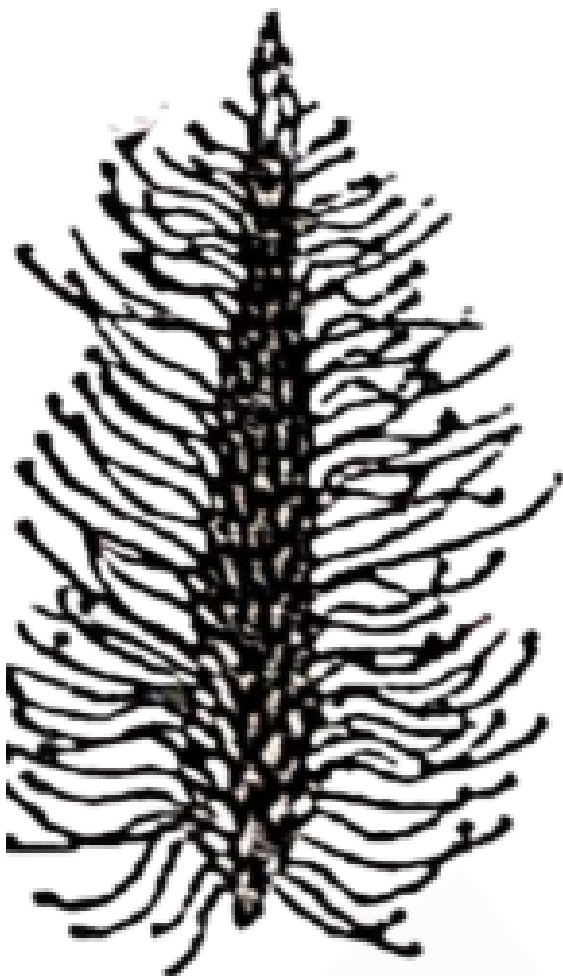
Solution: The component labeled as C in the figure represents a type of plant cell that has thin outer walls and highly thickened inner walls. This structure is typical of cells involved in water conduction, likely representing part of the xylem, specifically a vessel element or tracheid, which are known for having secondary thickening to aid in structural support and efficient water transport.

💡 Quick Tip

When analyzing plant tissues, it's important to note the cell wall thickness and the arrangement of cells to identify their function within the plant's anatomy.

SECTION-B

136. 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: The given figure depicts an inflorescence with flowers having prominently exposed stamens, characteristic of wind-pollinated plants. These plants typically have such features to enhance the dispersal of pollen by air.

💡 Quick Tip

Wind pollination is more common among grasses, many trees, and some flowering plants. Key features include exposed stamens and feathery stigmas to catch pollen from the air.

137. 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) Absciscic acid

Correct Answer: (2) Gibberellin

Solution: Gibberellins are known to promote stem elongation, cell division, and result in overall growth enhancement, making them ideal for application on sugarcane to increase both stalk length and yield.

💡 Quick Tip

Gibberellins are especially effective in breaking seed dormancy and stimulating growth, used extensively in agriculture to enhance crop yields and size.

138. Identify the step in tricarboxylic acid cycle, which does not involve oxidation of substrate.

- (1) Malic acid → Oxaloacetic acid
- (2) Succinic acid → Malic acid
- (3) Succinyl-CoA → Succinic acid
- (4) Isocitrate → α -ketoglutaric acid

Correct Answer: (3) Succinyl-CoA → Succinic acid

Solution: The conversion of Succinyl-CoA to Succinic acid in the TCA cycle involves the cleavage of CoA from Succinyl-CoA, releasing energy to form GTP or ATP, without involving direct oxidation of the substrate.

💡 Quick Tip

Understanding metabolic pathways like the TCA cycle is crucial for comprehending how cells produce energy and intermediates for various biosynthetic processes.

139. 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: In somatic hybridization, protoplasts (cells with the cell wall removed) from two

different plant varieties are fused to combine their genetic material, forming a hybrid cell that can potentially grow into a new plant.

💡 Quick Tip

Somatic hybridization is a valuable technique in genetic engineering and plant breeding, allowing for the combination of desirable traits from two different plant species or varieties.

140. 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: The DNA in chloroplasts is indeed circular and double stranded, similar to bacterial DNA, reflecting their evolutionary origins from endosymbiotic bacteria.

💡 Quick Tip

Chloroplast DNA contains genes essential for photosynthesis and other chloroplast functions, and is an example of an organelle exhibiting endosymbiotic gene transfer.

141. Match List I with List II:

List I		List II	
A.	Robert May	I.	Species-Area relationship
B.	Alexander von Humboldt	II.	Long term ecosystem experiment using outdoor plots
C.	Paul Ehrlich	III.	Global species diversity at about 7 million
D.	David Tilman	IV.	Rivet popper hypothesis

Choose the correct answer from the options given below:

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

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

Solution: - A, Robert May: Known for his work on mathematical models in ecology, matching III.

- B, Alexander von Humboldt: Known for the Species-Area relationship, thus B-I.

- C, Paul Ehrlich: Known for his work on the population, environment, and rivet popper hypothesis, so C-IV.

- D, David Tilman: Noted for his long-term ecosystem experiments, thus D-II.

 Quick Tip

Familiarizing oneself with key ecological theories and the scientists behind them can provide a deeper understanding of environmental and conservation issues.

142. 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: - **A** is correct as asexual reproduction often involves the release of biflagellate zoospores.

- **B** is incorrect as sexual reproduction can also be isogamous or anisogamous, not strictly oogamous.

- **C** is correct, with mannitol and laminarin being typical storage carbohydrates.

- **D** is correct, identifying the key pigments found in Phaeophyceae.

- **E** is correct, as vegetative cells typically have a cellulosic wall with an algin coating.

 Quick Tip

Phaeophyceae, or brown algae, show great diversity in reproduction and pigment composition, important for their ecological roles in marine environments.

143. Given below are two statements:

Statement I: In C₃ plants, some O₂ binds to RuBisCO, hence CO₂ fixation is decreased.

Statement II: In C₄ plants, mesophyll cells show very little photorespiration while bundle sheath cells do not show photorespiration.

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 C₃ plants, the enzyme RuBisCO can bind to oxygen leading to photorespiration, which reduces the efficiency of photosynthesis.

Statement II is false because while it's true that C₄ plants show reduced photorespiration due to the spatial separation of initial CO₂ fixation and the Calvin cycle, bundle sheath cells do indeed perform photosynthesis but with minimal photorespiration.

💡 Quick Tip

Understanding the differences in photosynthetic pathways among C₃ and C₄ plants can help in studying their adaptations to environments with varying temperatures and concentrations of atmospheric CO₂.

144. Which of the following statement is correct regarding the process of replication in *E.coli*?

- (1) The DNA dependent DNA polymerase catalyzes polymerization in one direction that is 3' → 5'
- (2) The DNA dependent RNA polymerase catalyzes polymerization in one direction, that is 5' → 3'
- (3) The DNA dependent DNA polymerase catalyzes polymerization in 5' → 3' as well as 3' → 5' direction
- (4) The DNA dependent DNA polymerase catalyzes polymerization in 5' → 3' direction

Correct Answer: (4) The DNA dependent DNA polymerase catalyzes polymerization in 5' → 3' direction

Solution: DNA polymerase in *E.coli* synthesizes new DNA strands by adding nucleotides only in the 5' to 3' direction. This enzyme cannot synthesize in the 3' to 5' direction, nor can it synthesize bi-directionally.

💡 Quick Tip

The 5' to 3' directionality of DNA polymerase is critical for the accuracy of DNA replication, as it ensures proper proofreading and error correction mechanisms during the process.

145. Match List I with List II:

List I		List II	
A.	Rose	I.	Twisted aestivation
B.	Pea	II.	Perigynous flower
C.	Cotton	III.	Drupe
D.	Mango	IV.	Marginal placentation

Choose the correct answer from the options given below:

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

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

Solution: Understanding the characteristics of each plant.

Rose has a perigynous flower, which means that the ovary is positioned in the middle, and the other floral parts (sepals, petals, stamens) are attached around the ovary. Hence, A matches with II (Perigynous flower).

Pea has marginal placentation, where the ovules are borne on the margins of the ovary. Thus, B matches with IV (Marginal placentation).

Cotton has twisted aestivation, where the petals are arranged in a spiral manner with overlapping edges. Therefore, C matches with I (Twisted aestivation).

Mango produces a drupe, which is a fleshy fruit with a single seed enclosed by a hard endocarp. Hence, D matches with III (Drupe).

Thus, the correct match is:

- A-II: Rose has a perigynous flower.
- B-IV: Pea has marginal placentation.
- C-I: Cotton has twisted aestivation.
- D-III: Mango has a drupe.

💡 Quick Tip

Aestivation, placentation, and fruit types are important botanical features used to classify plants and understand their reproductive biology.

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

Solution: - A, Citric acid cycle occurs in the mitochondrial matrix.

- B, Glycolysis occurs in the cytoplasm.
- C, The electron transport system takes place in the intermembrane space of mitochondria.
- D, Proton gradient is formed across the inner mitochondrial membrane.

 Quick Tip

Understanding where each metabolic process takes place helps in comprehending cellular energy dynamics and the role of mitochondria in energy production.

147. Match List I with List II:

List I (Types of Stamens)		List II (Example)	
A.	Monadelphous	I.	Citrus
B.	Diadelphous	II.	Pea
C.	Polyadelphous	III.	Lily
D.	Epiphyllous	IV.	China-rose

(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: - A, Monoadelphous stamens are found in China-rose where stamens are united into one group.

- B, Diadelphous stamens, such as those in Pea, have stamens united into two groups.

- C, Polyadelphous stamens are seen in Citrus, with stamens united into more than two groups.

- D, Epiphyllous stamens, where stamens are attached to petals, are found in Lily.

 Quick Tip

The classification of stamen structures helps in identifying and categorizing plants, crucial for botanical studies and understanding plant reproductive biology.

148. 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-III, B-II, 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:** - A, Frederick Griffith is known for discovering the principle of transformation.
 - B, Francois Jacob & Jacques Monod elucidated the Lac operon model, explaining gene regulation.
 - C, Har Gobind Khorana made fundamental contributions to understanding the genetic code and protein synthesis.
 - D, Meselson & Stahl demonstrated the semi-conservative mode of DNA replication.

💡 Quick Tip

Familiarity with the landmark experiments and discoveries in genetics can provide a deep understanding of molecular biology and genetic engineering.

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

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

- Solution:** - A, GLUT-4, is a glucose transporter, hence matches IV.
 - B, Insulin, is a hormone, hence matches I.
 - C, Trypsin, is an enzyme, hence matches II.
 - D, Collagen, serves as an intercellular ground substance, hence matches III.

💡 Quick Tip

Recognizing the function of proteins like GLUT-4, insulin, trypsin, and collagen is fundamental in understanding their roles in cellular and physiological processes.

150. In an ecosystem if the Net Primary Productivity (NPP) of first trophic level is $100x$ ($\text{kcal m}^{-2} \text{yr}^{-1}$), what would be the GPP (Gross Primary Productivity) of the third trophic level of the same ecosystem?

- (1) $\frac{x}{10}$ ($\text{kcal m}^{-2} \text{yr}^{-1}$)
- (2) x ($\text{kcal m}^{-2} \text{yr}^{-1}$)
- (3) $10x$ ($\text{kcal m}^{-2} \text{yr}^{-1}$)
- (4) $\frac{100x}{3}$ ($\text{kcal m}^{-2} \text{yr}^{-1}$)

Correct Answer: (3) $10x \text{ (kcal m}^{-2} \text{ yr}^{-1}\text{)}$

Solution: Given that each trophic level in an ecosystem typically captures about 10% of the energy available from the level below it, the third trophic level would be receiving about $10x \text{ kcal m}^{-2} \text{ yr}^{-1}$ from the first level if we consider efficiency and energy transfer through each subsequent level.

 Quick Tip

Understanding energy transfer between trophic levels helps in assessing the productivity and sustainability of different ecosystems.

ZOOLOGY

SECTION-A

151. 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.

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: FSH primarily stimulates the Sertoli cells in males, not the Leydig cells as stated in Assertion A, making it false. Reason R correctly describes the hormonal functions in males and females, making it true.

 Quick Tip

Understanding hormone actions is crucial for grasping physiological interactions in both reproductive and non-reproductive contexts.

152. Match List I with List II:

List I		List II	
A.	Pons	I.	Provides additional space for Neurons, regulates posture and balance.
B.	Hypothalamus	II.	Controls respiration and gastric secretions.
C.	Medulla	III.	Connects different regions of the brain.
D.	Cerebellum	IV.	Neuro secretory cells

Choose the correct answer from the options given below:

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

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

Solution: - A, Pons controls respiration and other autonomic functions.
- B, Hypothalamus is known for housing neuro secretory cells that regulate hormonal activities.
- C, Medulla connects different brain regions and involves in reflex actions.
- D, Cerebellum aids in balance, coordination, and motor control.

 Quick Tip

The brain's complexity is mirrored in the specialized functions of its various parts, understanding which helps in both medical and psychological contexts.

153. 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 pancreas and increases blood glucose levels.

 Quick Tip

Differentiating between steroid and peptide hormones is fundamental for understanding their mechanisms of action and implications for treatments.

154. Which of the following is not a component of Fallopian tube?

- (1) Uterine fundus
- (2) Isthmus
- (3) Infundibulum
- (4) Ampulla

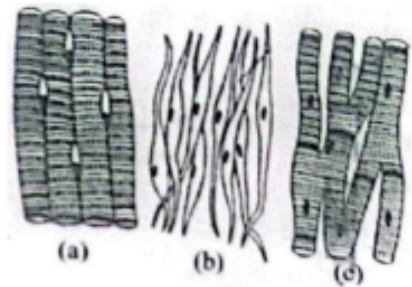
Correct Answer: (1) Uterine fundus

Solution: The uterine fundus is part of the uterus, not a component of the Fallopian tube. The Fallopian tube includes the isthmus, infundibulum, and ampulla.

💡 Quick Tip

Understanding the anatomical structures of the female reproductive system is crucial for studying reproductive health and related medical conditions.

155. Three types of muscles are given as a, b, and c. Identify the correct matching pair along with their location in the human body:



Choose the correct answer from the options given below:

- (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: Smooth muscle is found in organs like the stomach, skeletal muscle in areas like the triceps, and cardiac muscle in the heart. This categorization reflects the typical locations and functions of these muscle types.

💡 Quick Tip

Muscle types are distinguished by their structure and function: smooth muscles for involuntary movements, skeletal muscles for voluntary movements, and cardiac muscles for heart contractions.

156. Match List I with List II:

List I		List II	
A.	Expiratory capacity	I.	Expiratory reserve volume + Tidal volume + Inspiratory reserve volume
B.	Functional residual capacity	II.	Tidal volume + Expiratory reserve volume
C.	Vital capacity	III.	Tidal volume + Inspiratory reserve volume
D.	Inspiratory capacity	IV.	Expiratory reserve volume + Residual volume

Choose the correct answer from the options given below:

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

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

Solution: Step 1: Understanding the respiratory volumes and capacities.

Expiratory capacity (A) is the total volume of air that can be exhaled after a normal inhalation. This includes tidal volume and expiratory reserve volume, so A-II.

Functional residual capacity (B) is the volume of air remaining in the lungs after normal exhalation. It is the sum of expiratory reserve volume and residual volume, hence B-IV.

Vital capacity (C) is the total volume of air that can be exhaled after a maximum inhalation, which is the sum of tidal volume, inspiratory reserve volume, and expiratory reserve volume, so C-I.

Inspiratory capacity (D) is the maximum amount of air that can be inhaled after a normal exhalation, which is the sum of tidal volume and inspiratory reserve volume, hence D-III.

💡 Quick Tip

Understanding lung capacities and volumes is crucial for assessing respiratory health and diagnosing pulmonary conditions.

157. The flippers of the Penguins and Dolphins are the example of the:

- (1) Adaptive radiation
- (2) Natural selection
- (3) Convergent evolution
- (4) Divergent evolution

Correct Answer: (3) Convergent evolution

Solution: The flippers of penguins and dolphins represent convergent evolution where unrelated species develop similar traits due to similar environmental pressures, despite different evolutionary backgrounds.

💡 Quick Tip

Convergent evolution is an important concept in evolutionary biology, highlighting how similar environmental pressures can lead to similar adaptations in different species.

158. 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-II, B-III, 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: - A, Lipase, breaks down fats and matches with II, ester bond.

- B, Nuclease, breaks down nucleic acids and matches with IV, phosphodiester bond.

- C, Protease, breaks down proteins and matches with I, peptide bond.

- D, Amylase, breaks down starch and matches with III, glycosidic bond.

💡 Quick Tip

Knowing the substrate specificities of various enzymes helps in understanding their roles in digestion and metabolism.

159. The "Ti plasmid" of *Agrobacterium tumefaciens* stands for:

Choose the correct answer from the options given below:

- (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" of *Agrobacterium tumefaciens* is known for its ability to induce tumors in plants. It is utilized in genetic engineering for gene insertion due to its natural ability to transfer genes to plant cells.

 Quick Tip

The Ti plasmid is a key tool in plant genetic engineering, enabling the introduction of new traits into plant genomes.

160. 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: - A, Axoneme, is the structural framework of cilia and flagella, matching with II.
- B, Cartwheel pattern, is characteristic of the centriole, matching with I.
- C, Crista, is a feature of mitochondria, involved in cellular respiration, matching with IV.
- D, Satellite, pertains to specific regions on chromosomes, thus matching with III.

 Quick Tip

Understanding cell structure components like axonemes and cristae is crucial for grasping cell function and organellar roles.

161. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?

Choose the correct answer from the options given below:

- (1) Genetic recombination
- (2) Genetic drift
- (3) Gene migration
- (4) Constant gene pool

Correct Answer: (4) Constant gene pool

Solution: A constant gene pool, implying no changes in allele frequencies due to migration, mutation, or selection, will not disrupt Hardy-Weinberg equilibrium, which assumes a closed population.

 Quick Tip

The Hardy-Weinberg principle is foundational in population genetics, helping to understand how evolutionary pressures influence allele frequencies.

162. Given below are two statements:

Statement I: In the nephron, the descending limb of 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.

- (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) Both Statement I and Statement II are false

Solution: Step 1: Analyzing Statement I.

Statement I says that the descending limb of the loop of Henle is impermeable to water and permeable to electrolytes. This is false because the descending limb is permeable to water but impermeable to electrolytes. The primary function of the descending limb is to allow water to be reabsorbed into the bloodstream.

Step 2: Analyzing Statement II.

Statement II mentions that the proximal convoluted tubule (PCT) is lined by simple columnar brush border epithelium and increases the surface area for reabsorption. This statement is also false. The proximal convoluted tubule is lined by simple cuboidal epithelium with a brush border of microvilli that increase the surface area for reabsorption. However, it is not columnar epithelium.

Thus, both statements are false.

 Quick Tip

The nephron's structure is specialized for different functions in the kidney; understanding these can aid in comprehending renal physiology.

163. Match List I with List II:

List I		List II	
A.	α -1 antitrypsin	I.	Cotton bollworm
B.	Cry IAb	II.	ADA deficiency
C.	Cry IAc	III.	Emphysema
D.	Enzyme replacement therapy	IV.	Corn borer

Choose the correct answer from the options given below:

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

- **A, α -1 antitrypsin**, is associated with **Emphysema** due to its deficiency leading to lung damage, matching with **III**.
- **B, Cry IAb** and **C, Cry IAc**, are Bt toxin genes used in genetically modified crops to target pests like the **Corn borer (IV)** and **Cotton bollworm (I)**, respectively.
- **D, Enzyme replacement therapy**, is a treatment for **ADA deficiency**, matching with **II**.

💡 Quick Tip

Bt toxins such as Cry IAb and Cry IAc are specific to their target pests and are important tools in agricultural biotechnology for pest resistance.

164. Following are the stages of cell division:

- A. Gap 2 phase
- B. Cytokinesis
- C. Synthesis phase
- D. Karyokinesis
- E. Gap 1 phase

Choose the correct sequence of stages from the options given below:

- (1) 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 for cell division phases is:

- E, Gap 1 phase, initial growth phase before DNA synthesis.
- C, Synthesis phase, where DNA is replicated.
- A, Gap 2 phase, preparation for mitosis.
- D, Karyokinesis, division of the cell's nucleus.
- B, Cytokinesis, division of the cell's cytoplasm.

💡 Quick Tip

Understanding the cell cycle phases is crucial for appreciating cellular growth, replication, and division mechanisms.

165. 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: Anal cerci in cockroaches are located on the 10th segment of the abdomen, serving as sensory structures to detect air movements.

💡 Quick Tip

Anal cerci are significant in the study of entomology as they provide insights into insect anatomy and sensory adaptations.

166. Match List I with List II:

List I		List II	
A.	Down's syndrome	I.	11 th chromosome
B.	α -Thalassemia	II.	X chromosome
C.	β -Thalassemia	III.	21 st chromosome
D.	Klinefelter's syndrome	IV.	16 th chromosome

Choose the correct answer from the options given below:

- (1) A-II, B-III, C-IV, D-I
- (2) A-II, B-IV, C-I, D-III
- (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: A, Down's syndrome, is characterized by an extra copy of chromosome 21, matching with III.

B, α -Thalassemia, and C, β -Thalassemia, involve the 16th chromosome (IV) and 11th chromosome (I), respectively, affecting hemoglobin production.

D, Klinefelter's syndrome, involves the presence of an extra 'X' chromosome in males, matching with II.

💡 Quick Tip

Genetic disorders such as Down's syndrome and thalassemia highlight the importance of chromosomes in genetic health and disease.

167. 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: Step 1: Understanding the concept of natural/traditional contraceptive methods.

Natural or traditional contraceptive methods rely on behavioral and biological practices to prevent pregnancy without the use of medical or chemical products. Examples include coitus interruptus (withdrawal method), periodic abstinence (avoiding intercourse during fertile periods), and lactational amenorrhea (postpartum infertility that occurs when a woman is breastfeeding).

Step 2: Identifying the incorrect option.

Vaults, which are mentioned in option (D), refer to cervical caps, a type of barrier contraceptive device and not a natural method. Hence, (D) Vaults is not a natural/traditional contraceptive method.

💡 Quick Tip

Remember, traditional methods usually involve timing or certain behaviors, not physical devices or pharmaceuticals.

168. 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: Matching diseases with their causative agents.

- A. Typhoid is caused by a bacterium, so A-IV.
- B. Leishmaniasis is caused by a protozoan, so B-III.
- C. Ringworm is caused by fungi, making C-I.
- D. Filariasis is caused by a nematode (worm), thus D-II.

 Quick Tip

Linking diseases to their pathogens can help simplify these types of matching questions.

169. 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: Matching items from List I with List II.

- A. Pleurobrachia belongs to the phylum Ctenophora, so A-II.
- B. Radula is a characteristic of mollusks, making B-I.
- C. Stomochord is found in Hemichordata, thus C-IV.
- D. Air bladder is associated with bony fishes (Osteichthyes), so D-III.

 Quick Tip

When matching organisms with characteristics or classifications, knowing unique features linked to each group helps in quick identification.

170. Match List I with List II:

List I		List II	
A.	Common cold	I.	Plasmodium
B.	Haemozoin	II.	Typhoid
C.	Widal test	III.	Rhinoviruses
D.	Allergy	IV.	Dust mites

Choose the correct answer from the options given below :

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

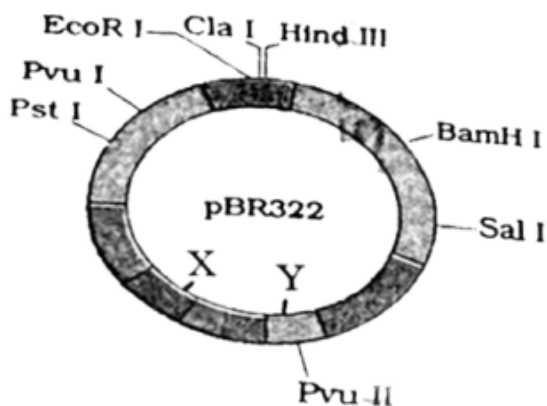
Solution: Matching the medical terms with their relevant causes or tests.

- A. Common cold is primarily caused by Rhinoviruses, so A-III.
- B. Haemozoin is a byproduct of the malaria parasite, Plasmodium, thus B-I.
- C. Widal test is used for the diagnosis of Typhoid, making C-II.
- D. Allergies can be triggered by various allergens, including dust mites, hence D-IV.

💡 Quick Tip

Familiarity with common medical tests and their associated diseases is crucial for accurate diagnosis and treatment.

171. 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: Step 1: Analyzing the diagram and understanding the functions of genes 'X' and 'Y' in pBR322.

pBR322 is a commonly used plasmid vector in genetic engineering with multiple restriction sites. It contains two key genes, 'X' and 'Y', which are essential for its function as a cloning vector.

Step 2: Identifying the roles of 'X' and 'Y'.

The gene 'X' in pBR322 is known for controlling the copy number of the plasmid itself within the bacterial cell, which is crucial for ensuring the plasmid is replicated efficiently. The gene 'Y', on the other hand, is involved in the replication process of the plasmid, assisting in the replication mechanism.

💡 Quick Tip

Understanding the genetic makeup and function of cloning vectors like pBR322 is crucial for effective genetic manipulation and cloning practices.

172. 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
- (4) Statement I is false but Statement II is true

Correct Answer: (3) Statement I is true but Statement II is false

Solution: Step 1: Analyzing Statement I. The hymen's condition can be affected by various non-sexual activities such as physical exercise or tampon use, making it an unreliable indicator of virginity. Therefore, Statement I is true.

Step 2: Analyzing Statement II. The hymen can tear during various activities, not just during the first coitus. It may remain intact even after sexual intercourse. Thus, Statement II is false.

💡 Quick Tip

Understanding human anatomy and the variability of physiological features is essential for accurate medical and societal perceptions.

173. Following are the stages of pathway for conduction of an action potential through the heart:

- A. AV bundle**
- B. Purkinje fibres**
- C. AV node**
- D. Bundle branches**
- E. SA node**

Choose the correct sequence of pathway from the options given below

- (1) 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: Understanding the pathway of the cardiac conduction system.

The sequence of action potential conduction in the heart starts at the SA node, moves to the AV node, then to the AV bundle, through the bundle branches, and finally to the Purkinje fibers. This ensures the coordinated contraction of the heart chambers.

💡 Quick Tip

The SA node is known as the pacemaker of the heart because it initiates the heart-beat and controls the heart rate.

174. Given below are some stages of human evolution. Arrange them in correct sequence (Past to Recent):

A. Homo habilis

B. Homo sapiens

C. Homo neanderthalensis

D. Homo erectus

Choose the correct sequence of human evolution from the options given below:

(1) 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: Arranging the stages of human evolution in chronological order.

The correct sequence from the earliest to the most recent is:

- Homo habilis

- Homo erectus

- Homo neanderthalensis

- Homo sapiens

This order reflects the evolutionary development from more primitive to more advanced forms of early humans.

💡 Quick Tip

Always arrange evolutionary stages based on fossil evidence and chronological findings in paleontology.

175. Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?

(1) Low $p\text{CO}_2$ and High H^+ concentration

(2) Low $p\text{CO}_2$ and High temperature

(3) High $p\text{O}_2$ and High $p\text{CO}_2$

(4) High $p\text{O}_2$ and Lesser H^+ concentration

Correct Answer: (4) High pO_2 and Lesser H^+ concentration

Solution: Understanding the Factors Influencing Oxyhaemoglobin Formation:

The formation of oxyhaemoglobin, the complex of oxygen and hemoglobin, is influenced by several physiological factors. This process is essential for transporting oxygen from the lungs to the tissues.

Analysis of Each Factor:

Partial Pressure of Oxygen pO_2 : Higher pO_2 increases the affinity of hemoglobin for oxygen, facilitating the formation of oxyhaemoglobin. In the alveoli, where oxygen concentration is high due to fresh air intake, the pO_2 is naturally higher, promoting this binding.

Partial Pressure of Carbon Dioxide pCO_2 : Lower pCO_2 reduces the competition between carbon dioxide and oxygen for binding sites on hemoglobin, further enhancing oxygen binding.

Hydrogen Ion Concentration H^+ : Lower H^+ concentration, or a higher pH, shifts the oxygen-hemoglobin dissociation curve to the left (known as the Bohr effect). This shift increases hemoglobin's affinity for oxygen, facilitating the formation of oxyhaemoglobin.

Detailed Analysis of Options: Option (1) Low pCO_2 and High H^+ concentration is not favorable because high H^+ concentration (or low pH) would decrease hemoglobin's oxygen affinity.

Option (2) Low pCO_2 and High temperature: While lower pCO_2 is favorable, higher temperatures actually decrease the affinity of hemoglobin for oxygen, promoting oxygen release rather than uptake in tissues.

Option (3) High pO_2 and High pCO_2 : While high pO_2 is favorable, high pCO_2 would lower hemoglobin's oxygen affinity due to competitive inhibition and a shift in pH.

Option (4) High pO_2 and Lesser H^+ concentration: This is the most favorable condition in the alveoli for oxyhaemoglobin formation. High pO_2 enhances oxygen loading, and lesser H^+ concentration increases hemoglobin's affinity for oxygen, facilitating efficient oxygen transport.

💡 Quick Tip

Remember that oxyhaemoglobin formation is influenced by the oxygen-hemoglobin dissociation curve, which shifts based on conditions like pO_2 , pCO_2 , pH, and temperature.

176. 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-I, D-III

(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: Step 1: Matching the subphases of Prophase I with their specific characteristics.

- Leptotene: Chromosomes appear as thin threads, so D-III. - Zygotene: Synaptonemal complex forms, marking the pairing of homologous chromosomes, so C-I.

- Pachytene: Recombination nodules appear, indicating the occurrence of genetic recombination, so B-IV.

- Diakinesis: Terminalisation of chiasmata completes, where the chiasma move to the ends of the chromosomes, so A-II.

 Quick Tip

Understanding the sequence and characteristics of meiotic phases can aid in comprehending genetic variation and inheritance.

177. Which of the following statements is incorrect?

(A) A bio-reactor provides optimal growth conditions for achieving the desired product.

(B) Most commonly used bio-reactors are of stirring type.

(C) Bio-reactors are used to produce small scale bacterial cultures.

(D) Bio-reactors have an agitator system, an oxygen delivery system, and foam control system.

Correct Answer: (C) Bio-reactors are used to produce small scale bacterial cultures.

Solution: Step 1: Identifying the incorrect statement about bio-reactors. Bio-reactors are designed for both small and large-scale production of cultures, not exclusively for small scale as suggested in statement (C). They are highly versatile and can be adapted for various sizes and types of production, making (C) the incorrect statement.

 Quick Tip

Bio-reactors are critical in biotechnological applications where precise control of the environment is necessary to optimize the growth and productivity of biological systems.

178. 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: Evaluating each statement based on animal classification.

A. True - Annelids possess a well-formed coelom and are classified as true coelomates.

B. False - Poriferans do not have a body cavity and are neither coelomates nor pseudocoelomates.

C. False - Aschelminthes are pseudocoelomates, not acoelomates. They have a body cavity that is not lined with mesoderm on all sides.

D. False - Platyhelminthes are acoelomates, having no body cavity at all.

💡 Quick Tip

Understanding the anatomical characteristics of different phyla helps in correctly categorizing them as coelomates, pseudocoelomates, or acoelomates.

179. 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 option given below:

- (1) A-III, B-I, C-IV, D-II
- (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: Matching the types of IUDs and Implants with their specific categories.

Non-medicated IUD: Lippes loop, so A-III.

Copper releasing IUD: Multiload 375, so B-I.

Hormone releasing IUD: LNG-20, so C-IV.

Implants: These typically release progestogens, so D-II.

💡 Quick Tip

Understanding the different types of IUDs and their active components can help in providing appropriate contraceptive advice.

180. Which one is the correct product of DNA dependent RNA polymerase to the given template?

DNA Template: 3'TACATGGCAAATATCCATTCA5'

- (1) 5'AUGUACCGUUUAAUGGUUAAG3'
- (2) 5'AUUGUAAAGUUUAUGGUAAGU3'
- (3) 5'AUUGUACCGUUUAAUGGGAAGU3'
- (4) 5'ATGTACCGTTTATAGGTAAGT3'

Correct Answer: (1) 5'AUGUACCGUUUAAUGGUUAAG3'

Solution: Step 1: Transcribing the DNA template to RNA.

The RNA polymerase reads the DNA template strand and synthesizes an RNA strand by replacing thymine (T) with uracil (U) and complementing the other bases accordingly:

- A -> U
- T -> A
- C -> G
- G -> C

💡 Quick Tip

Remember that RNA polymerase reads the DNA template from 3' to 5', producing an RNA strand from 5' to 3'.

181. 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.

- (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: Evaluating the relationship between Assertion A and Reason R.

The assertion highlights the importance of breast-feeding in early infant development, while the reason correctly states that colostrum, which is rich in antibodies, is crucial for developing the baby's immune system. This makes the reason a correct and direct explanation of the assertion.

💡 Quick Tip

Colostrum, the first form of milk produced by the mammary glands, is sometimes referred to as "liquid gold" for its nutritional and antibody-rich composition.

182. 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: Matching the types of joints with their descriptions.

- Fibrous joints: Found in the skull, these joints allow no movement, so A-III.
- Cartilaginous joints: Commonly found between adjacent vertebrae, allowing limited movement, so B-I.
- Hinge joints: Example includes the knee, which assists in locomotion, so C-IV.
- Ball and socket joints: Example includes the humerus and pectoral girdle, allowing rotational movement, so D-II.

 Quick Tip

Knowing the mechanical functionality and anatomical location of different joint types is crucial for understanding their role in the human body's mobility.

183. 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: Matching the species with their common names.

Pterophyllum: Known as the angel fish, so A-III.

Myxine: Known as the hag fish, so B-I.

Pristis: Commonly referred to as the saw fish, so C-II.

Exocoetus: Known as the flying fish, so D-IV.

 Quick Tip

Familiarizing yourself with the common names of species helps in easier identification and understanding of their ecological roles and adaptations.

184. 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.	Erythroxyllum
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: Matching the substances with their sources or uses.

Cocaine is derived from Erythroxyllum, so A-III.

Heroin is derived from Papaver somniferum, so B-IV.

Morphine, used as a sedative in surgery, also comes from Papaver somniferum, so C-I.

Marijuana is associated with Cannabis sativa, so D-II.

 Quick Tip

Knowing the scientific sources of drugs can aid in understanding their pharmacological effects and potential uses or abuses.

185. 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 correct 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: Identifying autoimmune disorders.

Myasthenia gravis, Rheumatoid arthritis, and Systemic Lupus Erythematosus are all autoimmune diseases where the body's immune system mistakenly attacks its own tissues. Gout is related to uric acid metabolism, and Muscular dystrophy is a genetic disorder, not autoimmune.

💡 Quick Tip

Autoimmune diseases often involve the body's immune system attacking normal components as if they were foreign.

SECTION-B

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 eye balls.
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: Matching the medical conditions with their hormonal imbalances.

Exophthalmic goiter involves hypersecretion of thyroid hormones causing symptoms like protruding eyeballs, so A-III.

Acromegaly results from excessive secretion of growth hormone, so B-IV.

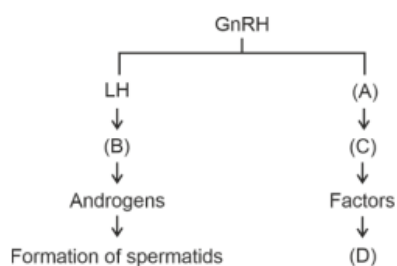
Cushing's syndrome is characterized by an excess of cortisol, leading to symptoms like moon face and hyperglycemia, so C-I.

Cretinism results from hypo-secretion of thyroid hormone, affecting growth, so D-II.

💡 Quick Tip

Connecting endocrine disorders with their specific hormonal imbalances can clarify their physiological effects and guide appropriate treatments.

187. 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: Step 1: GnRH induces the secretion of FSH and LH from the pituitary gland.

Step 2: FSH stimulates Sertoli cells which support spermatogenesis. Leydig cells, stimulated by LH, produce testosterone that further aids this process.

Step 3: Spermiogenesis is the final stage of spermatogenesis, where spermatids mature into spermatozoa.

💡 Quick Tip

Remember, FSH and LH play distinct yet collaborative roles in the regulation of spermatogenesis, with FSH directly influencing Sertoli cells and LH targeting Leydig cells.

188. Given below are two statements:

Statement I: Mitochondria and chloroplasts both have double membranes bound organelles.

Statement II: The inner membrane of mitochondria is relatively less permeable, as compared to chloroplast.

- (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: Confirm that both mitochondria and chloroplasts are indeed double-membraned organelles—Statement I is correct.

Step 2: The inner membrane of mitochondria is highly impermeable to maintain the proton gradient essential for ATP synthesis, more so than chloroplast membranes—Statement II is incorrect.

 Quick Tip

Understanding the structural and functional differences between organelles is crucial for grasping their roles in cellular metabolism.

189. Given below are two statements:

Statement I: The cerebral hemispheres are connected by nerve tract known as corpus callosum.

Statement II: The brain stem consists of the medulla oblongata, pons and cerebrum.

- (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: The corpus callosum does connect the cerebral hemispheres—Statement I is correct.

Step 2: The brain stem includes the medulla oblongata, pons, and midbrain, not the cerebrum, making Statement II incorrect.

 Quick Tip

Always double-check anatomical terms in neurobiology, as they are crucial for understanding brain function and connectivity.

190. 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: Step 1: RNA polymerase III is responsible for transcribing genes encoding tRNAs and some snRNAs, hence matches with IV.

Step 2: Termination of transcription in prokaryotes often involves the rho factor, an essential termination protein, thus matches with III.

Step 3: Splicing of exons in mRNA is facilitated by snRNPs (small nuclear Ribonucleoproteins), perfectly matches with I.

Step 4: The TATA box is a promotor element found in many genes, essential for forming the transcription initiation complex, correctly matches with II.

💡 Quick Tip

The TATA box, typically found about 25-35 bases upstream of the transcription start site, plays a critical role in positioning RNA polymerase II for accurate transcription initiation.

191. 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: Step 1: The Mesozoic Era, famously known as the "Age of Reptiles", also saw the dominance of birds, hence matches with III.

Step 2: The Proterozoic Era witnessed the emergence of the first complex life, including lower invertebrates, accurately matching with I.

Step 3: The Cenozoic Era, termed the "Age of Mammals", reflects the dominance of mammals after the dinosaurs' extinction, correctly aligns with IV.

Step 4: The Paleozoic Era is well known for its diverse marine life and the early development of fish and amphibians, thus matches with II.

💡 Quick Tip

Understanding the major geological and biological milestones of each era helps in painting a comprehensive picture of Earth's evolutionary history.

192. 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:

1. $|B^i|/|A^i|/ii$

2. $|B|B|/|A|A|/ii$

3. $|A|B|/|iA|/|B^i|$
4. $|A^i|/|B^i|/|A^i|$
5. $i|B^i|/|A|/|A|B$

Choose the most appropriate answer from the options given below :

- (1) A only
- (2) B only
- (3) C & B only
- (4) D & E only

Correct Answer: (1) A only

Solution: Step 1: Considering blood group genetics, for a child to have O blood type, each parent must contribute an i allele.

Step 2: Father with B⁺ can be either IBIB or IBi. Mother with A⁺ can be either IAIA or IAi.

Step 3: Since the child is O⁺, the only possible combination for parents is IBi (father) and IAi (mother), thus making option (A) IBi/IAi correct.

 Quick Tip

In blood group inheritance, the i allele is recessive and must be inherited from both parents for a child to have blood type O.

193. 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: Step 1: Crop is used for storing food in cockroaches, so A matches with IV.

Step 2: Gastric caeca are found at the junction of the foregut and midgut, serving as digestive glands, so B matches with II.

Step 3: Malpighian tubules, which are excretory structures, are located at the junction of the midgut and hindgut, so C matches with III.

Step 4: Gizzard, part of the digestive tract, is involved in the grinding of food, so D matches with I.

 Quick Tip

Understanding the functional anatomy of cockroach digestion can clarify how nutrients are processed and waste is managed.

194. Regarding catalytic cycle of an enzyme action, select the correct sequential steps:

- A. Substrate enzyme complex formation
- B. Free enzyme ready to bind with another substrate
- C. Release of products
- D. Chemical bonds of the substrate broken
- E. Substrate binding to active site

- (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: Step 1: Substrate binds to the enzyme's active site, E.

Step 2: This binding forms the substrate-enzyme complex, A.

Step 3: Chemical bonds within the substrate are then broken, D.

Step 4: Leading to the release of the products from the enzyme, C.

Step 5: The enzyme is then free again to bind with another substrate, B.

 Quick Tip

Memorizing the sequence of enzyme action can significantly help in understanding various biochemical reactions.

195. 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.

- (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: Step 1: Analyzing each statement based on non-chordate characteristics:

A is incorrect as non-chordates do not have pharynx perforated by gill slits, typical of chordates.

B is correct, as non-chordates lack a notochord.

C is incorrect, non-chordates generally have a ventral nervous system, not dorsal.

D is correct, non-chordates that possess a heart, generally have it positioned dorsally.

E is correct, as non-chordates do not possess a post-anal tail.

 Quick Tip

Understanding fundamental differences between chordates and non-chordates is crucial in zoology, especially regarding structural anatomy.

196. Given below are two statements:

Statement I: Bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced.

Statement II: Both bone marrow and thymus provide microenvironments for the development and maturation of T-lymphocytes.

- (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: Step 1: Statement I is correct as bone marrow is indeed the primary lymphoid organ responsible for the production of all types of blood cells, including lymphocytes.

Step 2: Statement II is also correct. The bone marrow is involved in the early stages of T-lymphocyte development, while the thymus is responsible for the subsequent maturation and differentiation of these cells.

 Quick Tip

Bone marrow and thymus play complementary roles in the development of T-lymphocytes, a key component of the adaptive immune system.

197. Match List I with List II:

List I		List II	
A.	P wave	I.	Heart muscles are electrically silent.
B.	QRS complex	II.	Depolarisation of ventricles.
C.	T wave	III.	Depolarisation of atria.
D.	T-P gap	IV.	Repolarisation of ventricles.

Choose the correct answer from the options given below :

- (1) A-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: Step 1: The P wave corresponds to the depolarization of the atria, so A matches with III. **Step 2:** The QRS complex represents the depolarization of the ventricles, matching B with II. **Step 3:** The T wave indicates the repolarization of the ventricles, so C matches with IV. **Step 4:** The T-P gap, a period where the heart muscles are relatively silent electrically, aligns D with I.

💡 Quick Tip

Memorizing the electrocardiogram (ECG) components can significantly aid in understanding cardiac physiology and diagnosing related disorders.

198. 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: Step 1: Statement I is false because the competitive exclusion principle states that two species competing for the *same* limiting resources cannot coexist at constant population values.

Step 2: Statement II is true as it correctly summarizes that during such competition, the species that is less efficient at using the resources will likely be outcompeted.

💡 Quick Tip

The competitive exclusion principle is fundamental in understanding how species interactions shape community structure.

199. Choose the correct statement given below regarding juxta medullary nephron.

- (1) Juxta medullary nephrons are located in the columns of Bertini.
(2) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.
(3) Loop of Henle of juxta medullary nephron runs deep into medulla.

(4) Juxta medullary nephrons outnumber the cortical nephrons.

Correct Answer: (3) Loop of Henle of juxta medullary nephron runs deep into medulla.

Solution: Juxta medullary nephrons have their renal corpuscles near the cortex-medulla junction and are characterized by their long loops of Henle, which extend deep into the renal medulla. This aids in the concentration of urine, a key feature distinguishing them from cortical nephrons.

 Quick Tip

The deep penetration of the loop of Henle into the medulla allows juxta medullary nephrons to effectively concentrate urine and play a crucial role in maintaining water balance in the body.

200. 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-I, B-III, C-IV, D-II
- (2) A-III, B-II, C-I, D-IV
- (3) A-III, B-IV, C-I, D-II
- (4) A-IV, B-II, C-I, D-III

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

Solution: Step 1: Unicellular glandular epithelium refers to individual cells capable of secretion, such as goblet cells, so A matches with III.

Step 2: Compound epithelium is found covering body surfaces or lining cavities, not typically associated with glandular function, making B match with IV.

Step 3: Multicellular glandular epithelium includes structures such as the salivary glands, so C matches with I.

Step 4: Endocrine glandular epithelium, like that found in the pancreas, secretes hormones directly into the bloodstream, so D matches with II.

 Quick Tip

Knowing the structure and function of different epithelial tissues helps in understanding their roles in secretion and absorption in various organs.