

# NEET-UG S6 2024 Question Paper with Solution

Time Allowed : 3 Hours 20 Minutes

Maximum Marks : 720

Total Questions : 200

## General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours 20 minutes duration and the Test Booklet contains 200 multiple-choice questions (four options with a single correct answer) from Physics, Chemistry and Biology (Botany and Zoology). 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.
2. 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.
3. 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.
4. Use Blue / Black Ball Point Pen only for writing particulars on this page / marking responses on Answer Sheet.
5. Rough work is to be done in the space provided for this purpose in the Test Booklet only.
6. The CODE for this Booklet is S6. Make sure that the CODE printed on the Original Copy of the Answer Sheet is the same as that on this Test Booklet.

## Physics

### Section A

#### 1. Match List I with List II.

| List I (Spectral Lines of Hydrogen for transitions from) | List II (Wavelengths (nm)) |
|----------------------------------------------------------|----------------------------|
| A. $n_2 = 3$ to $n_1 = 2$                                | 1. 410.2                   |
| B. $n_2 = 4$ to $n_1 = 2$                                | 2. 434.1                   |
| C. $n_2 = 5$ to $n_1 = 2$                                | 3. 656.3                   |
| D. $n_2 = 6$ to $n_1 = 2$                                | 4. 486.1                   |

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

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

**Solution:**

**Step 1:** Recall the Rydberg formula for the wavelengths of the spectral lines of hydrogen:

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

where  $R$  is the Rydberg constant ( $R \approx 1.097 \times 10^7 m^{-1}$ ),  $n_1$  is the principal quantum number of the lower energy level, and  $n_2$  is the principal quantum number of the higher energy level.

**Step 2:** Calculate the wavelengths for each transition.

A.  $n_2 = 3$  to  $n_1 = 2$  (Balmer series, H-alpha line):

$$\begin{aligned} \frac{1}{\lambda} &= R \left( \frac{1}{2^2} - \frac{1}{3^2} \right) = R \left( \frac{1}{4} - \frac{1}{9} \right) = \frac{5R}{36} \\ \lambda &= \frac{36}{5R} \approx \frac{36}{5 \times 1.097 \times 10^7} \approx 656.3 \text{ nm} \end{aligned}$$

B.  $n_2 = 4$  to  $n_1 = 2$  (Balmer series, H-beta line):

$$\begin{aligned} \frac{1}{\lambda} &= R \left( \frac{1}{2^2} - \frac{1}{4^2} \right) = R \left( \frac{1}{4} - \frac{1}{16} \right) = \frac{3R}{16} \\ \lambda &= \frac{16}{3R} \approx \frac{16}{3 \times 1.097 \times 10^7} \approx 486.1 \text{ nm} \end{aligned}$$

C.  $n_2 = 5$  to  $n_1 = 2$  (Balmer series, H-gamma line):

$$\begin{aligned} \frac{1}{\lambda} &= R \left( \frac{1}{2^2} - \frac{1}{5^2} \right) = R \left( \frac{1}{4} - \frac{1}{25} \right) = \frac{21R}{100} \\ \lambda &= \frac{100}{21R} \approx \frac{100}{21 \times 1.097 \times 10^7} \approx 434.1 \text{ nm} \end{aligned}$$

D.  $n_2 = 6$  to  $n_1 = 2$  (Balmer series, H-delta line):

$$\begin{aligned} \frac{1}{\lambda} &= R \left( \frac{1}{2^2} - \frac{1}{6^2} \right) = R \left( \frac{1}{4} - \frac{1}{36} \right) = \frac{8R}{36} = \frac{2R}{9} \\ \lambda &= \frac{9}{2R} \approx \frac{9}{2 \times 1.097 \times 10^7} \approx 410.2 \text{ nm} \end{aligned}$$

**Step 3:** Match the wavelengths with the transitions: A - 656.3 nm (III) B - 486.1 nm (IV) C - 434.1 nm (II) D - 410.2 nm (I)

💡 Quick Tip

Remember the Balmer series transitions for quick matching.

## 2. Match List-I with List-II.

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

Choose the correct answer from the options given below:

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

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

**Solution:**

### Step 1: Understanding Magnetic Susceptibility ( $\chi$ )

Magnetic susceptibility ( $\chi$ ) determines the response of a material to an external magnetic field: -  $\chi < 0$ : Material is **diamagnetic** (weakly repelled by a magnetic field). -  $\chi > 1$ : Material is **ferromagnetic** (strongly attracted to a magnetic field). -  $0 < \chi < \varepsilon$  (a small positive number): Material is **paramagnetic** (weakly attracted to a magnetic field). -  $\chi = 0$ : Material is **non-magnetic** (no response to a magnetic field).

### Step 2: Matching the Correct Pairs

- **A. Diamagnetic:**  $\chi$  is **negative** (weakly repelled)  $\Rightarrow$  **II.** - **B. Ferromagnetic:**  $\chi$  is  $\gg 1$  (strongly attracted)  $\Rightarrow$  **III.** - **C. Paramagnetic:**  $0 < \chi < \varepsilon$  (small positive)  $\Rightarrow$  **IV.** - **D. Non-magnetic:**  $\chi = 0 \Rightarrow$  **I.**

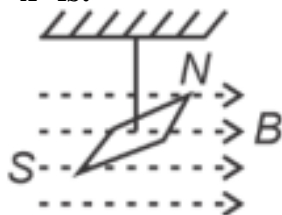
Thus, the correct matching is:

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

### 💡 Quick Tip

Magnetic susceptibility ( $\chi$ ) defines how a material responds to a magnetic field: - Diamagnetic:  $\chi < 0$  (repelled). - Paramagnetic:  $0 < \chi < \varepsilon$  (weakly attracted). - Ferromagnetic:  $\chi \gg 1$  (strongly attracted). - Non-magnetic:  $\chi = 0$  (no response).

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



**Correct Answer:** (1)  $1280\pi^2$

**Solution:**

**Time period of Oscillation,**  $T = 2\pi\sqrt{\frac{I}{MB}}$

$$\Rightarrow \frac{1}{4} = 2\pi\sqrt{\frac{9.8 \times 10^{-6}}{M \times 0.049}}$$

$$\Rightarrow \frac{1}{16} = \frac{4\pi^2 \times 9.8 \times 10^{-6}}{M \times 49 \times 10^{-3}}$$

$$\Rightarrow M = \frac{4\pi^2 \times 9.8 \times 10^{-6} \times 16}{49 \times 10^{-3}}$$

$$= \frac{4\pi^2 \times 9.8 \times 16 \times 10^{-3}}{49}$$

$$= 12.8\pi^2 \times 10^{-3} \times 10^{-2} \times 10^2$$

$$= 1280\pi^2 \times 10^{-5} \text{ A m}^2$$

💡 Quick Tip

Remember the formula for the time period of a magnetic needle in a uniform magnetic field and how to rearrange it.

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

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

**Correct Answer:** (1) The reflected light will be completely polarised but the refracted light will be partially polarised.

**Solution:**

**Step 1:** Understanding Brewster's angle. Brewster's angle ( $\theta_B$ ) is the angle of incidence at which light with a particular polarization is perfectly transmitted through a transparent surface, with no reflection. Unpolarized light incident at this angle will be reflected as completely plane-polarized light. The reflected light's electric field vector is perpendicular to the plane of incidence.

**Step 2:** What happens at Brewster's angle. When unpolarized light is incident on an interface at Brewster's angle:

- The reflected light is completely polarized, with its electric field vector perpendicular to the plane of incidence.

- The refracted light is partially polarized, containing a component polarized parallel to the plane of incidence. It is a mixture of polarizations.

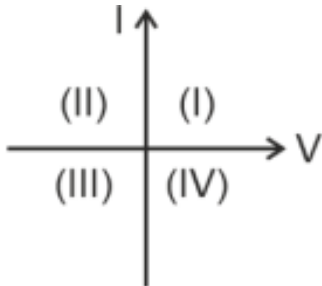
**Step 3:** Why this happens. At Brewster's angle, the reflected and refracted rays are  $90^\circ$  apart. The reflected light is polarized because only the component of the incident light with electric field oscillations perpendicular to the plane of incidence can be reflected. The component oscillating in the plane of incidence is fully transmitted (hence, the refracted beam is partially polarized).

**Step 4:** Conclusion. The reflected light is completely polarized, and the refracted light is partially polarized.

**💡 Quick Tip**

Remember that at Brewster's angle, the reflected light is completely polarized and the reflected and refracted rays are perpendicular to each other.

**5. 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 ( $\mu\text{A}$ ), is due to majority charge carriers.**

- (1) Both A and B are incorrect
- (2) A is correct but B is incorrect
- (3) A is incorrect but B is correct
- (4) Both A and B are correct

**Correct Answer:** (2) A is correct but B is incorrect

**Solution:**

**Statement A:** A solar cell operates in the fourth quadrant (IV) of the I-V curve. In this quadrant, the voltage is positive, and the current is negative, indicating that the solar cell is supplying power to the external circuit. The power output ( $P = VI$ ) is positive in this quadrant.

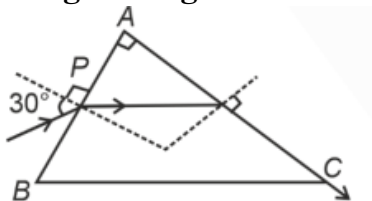
**Statement B:** In a reverse-biased p-n junction diode, a small current (in microamperes,  $\mu\text{A}$ ) flows due to \*minority\* charge carriers, not majority carriers. The large current flow associated with a diode occurs under forward bias conditions due to the movement of majority carriers. Under reverse bias, the majority carriers are pulled away from the junction, creating a depletion region that inhibits current flow. However, the thermally generated minority carriers in both the p and n regions are swept across the junction by the electric field, creating a small reverse saturation current.

**Conclusion:** Statement A is correct. Statement B is incorrect.

**💡 Quick Tip**

Remember that solar cells operate in the IV quadrant (power generation), and reverse current in diodes is due to minority carriers.

**6. A light ray enters through a right-angled prism at point P with the angle of incidence  $30^\circ$  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)  $\frac{\sqrt{3}}{2}$
- (2)  $\frac{\sqrt{5}}{4}$
- (3)  $\frac{\sqrt{5}}{2}$
- (4)  $\frac{\sqrt{3}}{4}$

**Correct Answer:** (3)  $\frac{\sqrt{5}}{2}$

**Solution:**

**In prism,**  $r_1 + c = A$

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

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

**Apply Snell's law, on incidence surface:**

$$1 : \sin 30^\circ = \mu \sin(r_1) \Rightarrow 1 \times \frac{1}{2} = \mu \times \sin(90^\circ - c)$$

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

**On squaring:**

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

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

**💡 Quick Tip**

Remember Snell's Law and the geometry of the problem.

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

- (1) Varying velocity and varying acceleration
- (2) Constant velocity
- (3) Constant acceleration
- (4) Constant velocity but varying acceleration

**Correct Answer:** (1) Varying velocity and varying acceleration

**Solution:**

**Step 1:** Understand the concepts of speed, velocity, and acceleration.

- **Speed:** The rate at which an object covers distance. It is a scalar quantity (magnitude only).
- **Velocity:** The rate at which an object changes its position. It is a vector quantity (both magnitude and direction).
- **Acceleration:** The rate at which an object changes its velocity. It is also a vector quantity.

**Step 2:** Analyze the motion of the particle in a circular path with uniform speed.

- **Speed:** The speed is uniform (constant) as given in the problem.
- **Velocity:** The velocity is constantly changing because the direction of motion is constantly changing along the circular path. Even though the speed (magnitude of velocity) is constant, the direction is changing, making the velocity a varying quantity.
- **Acceleration:** Since the velocity is changing, the particle must be accelerating. This acceleration is called centripetal acceleration, which is directed towards the center of the circle. The direction of the acceleration is also constantly changing as the particle moves along the circle.

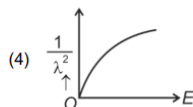
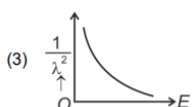
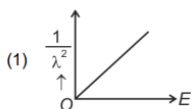
**Step 3:** Conclusion. In uniform circular motion, the particle has a constant speed but varying velocity and varying acceleration.

**💡 Quick Tip**

Remember that in uniform circular motion, the velocity and acceleration vectors are always changing direction, even if the speed is constant.

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



**Correct Answer:** (1)

**Solution:**

## de-Broglie wavelength

$$\lambda = \frac{h}{P} = \frac{h}{mv} = \frac{h}{\sqrt{2mE}} \quad \text{where} \quad E = \frac{1}{2}mv^2$$

Squaring both sides:

$$\begin{aligned}\lambda^2 &= \frac{h^2}{4m^2E} \\ \Rightarrow \frac{1}{\lambda^2} &= (\text{constant})E\end{aligned}$$

### 💡 Quick Tip

The relationship  $\frac{1}{\lambda^2} \propto E$  is a linear one, meaning the graph should be a straight line passing through the origin.

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

- (1)  $60 \, \Omega$
- (2)  $26 \, \Omega$
- (3)  $52 \, \Omega$
- (4)  $55 \, \Omega$

**Correct Answer:** (3)  $52 \, \Omega$

**Solution:**

**Step 1:** Calculate the resistance of each equal part. The wire is divided into 10 equal parts, so each part has a resistance of:

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

**Step 2:** Calculate the resistance of the series combination of the first 5 parts. When resistors are connected in series, their resistances add up. So the resistance of the first 5 parts in series is:

$$R_{\text{series}} = 5 \times R_{\text{part}} = 5 \times 10 \, \Omega = 50 \, \Omega$$

**Step 3:** Calculate the resistance of the parallel combination of the next 5 parts. When resistors are connected in parallel, the reciprocal of their equivalent resistance adds up. For 5 equal resistors in parallel:

$$\begin{aligned}\frac{1}{R_{\text{parallel}}} &= \frac{1}{R_{\text{part}}} + \frac{1}{R_{\text{part}}} + \frac{1}{R_{\text{part}}} + \frac{1}{R_{\text{part}}} + \frac{1}{R_{\text{part}}} = \frac{5}{R_{\text{part}}} \\ R_{\text{parallel}} &= \frac{R_{\text{part}}}{5} = \frac{10 \, \Omega}{5} = 2 \, \Omega\end{aligned}$$

**Step 4:** Calculate the resistance of the final combination. The series combination and the parallel combination are connected in series. So the total resistance is:

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

**💡 Quick Tip**

Remember the formulas for series and parallel combinations of resistors.

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

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

**Correct Answer:** (2) 8.5 cm

**Solution:**

**Step 1:** Recall the formula for the moment of inertia of a thin rod about an axis perpendicular to the rod and passing through its center:

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

where  $I$  is the moment of inertia,  $M$  is the mass of the rod, and  $L$  is the length of the rod.

**Step 2:** Convert the given moment of inertia to the standard SI unit ( $\text{kg m}^2$ ).

$$I = 2400 \, \text{g cm}^2 = 2400 \times 10^{-3} \, \text{kg} \times (10^{-2} \, \text{m})^2 = 2400 \times 10^{-7} \, \text{kg m}^2 = 2.4 \times 10^{-4} \, \text{kg m}^2$$

**Step 3:** Convert the mass of the rod to kilograms.

$$M = 400 \, \text{g} = 400 \times 10^{-3} \, \text{kg} = 0.4 \, \text{kg}$$

**Step 4:** Rearrange the moment of inertia formula to solve for  $L$ .

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

**Step 5:** Substitute the values and calculate  $L$ .

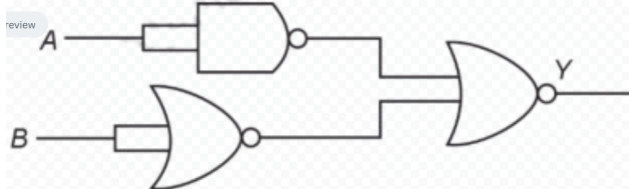
$$L = \sqrt{\frac{12 \times 2.4 \times 10^{-4} \, \text{kg m}^2}{0.4 \, \text{kg}}} = \sqrt{\frac{28.8 \times 10^{-4}}{0.4}} \, \text{m} = \sqrt{72 \times 10^{-4}} \, \text{m} = \sqrt{0.0072} \, \text{m}$$

$$L \approx 0.08485 \text{ m} = 8.485 \text{ cm} \approx 8.5 \text{ cm}$$

**💡 Quick Tip**

Remember the formula for the moment of inertia of a thin rod and be careful with unit conversions.

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



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

**Correct Answer:** (1) AND gate

**Solution:**

**Step 1:** Analyze the given logic circuit. The given logic circuit consists of two stages:

- The first stage has two inputs A and B, each going through a NOT gate (inverter) to produce  $\bar{A}$  and  $\bar{B}$  respectively.
- The second stage takes  $\bar{A}$  and  $\bar{B}$  as inputs to a NOR gate.

**Step 2:** Write the Boolean expression for the output Y.

- The outputs of the NOT gates are  $\bar{A}$  and  $\bar{B}$ .
- The NOR gate gives the complement of the OR of its inputs. Therefore, the output Y is given by:

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

**Step 3:** Simplify the Boolean expression using De Morgan's Law. De Morgan's Law states that  $\overline{X + Y} = \bar{X} \cdot \bar{Y}$  and  $\overline{X \cdot Y} = \bar{X} + \bar{Y}$ . Applying this to the expression for Y:

$$Y = \overline{\bar{A} + \bar{B}} = \bar{\bar{A}} \cdot \bar{\bar{B}} = A \cdot B$$

**Step 4:** Compare the simplified expression with the basic logic gates. The expression  $Y = A \cdot B$  represents the AND gate. The output Y is HIGH (1) only when both A and B are HIGH (1).

**💡 Quick Tip**

Remember De Morgan's Law to simplify Boolean expressions.

**12. 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)  $10(N + 1)$

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

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

(4)  $100N$

**Correct Answer:** (3)  $\frac{1}{100(N+1)}$

**Solution:**

**Step 1:** Define the Vernier Constant (Least Count). The vernier constant (VC) or least count is the smallest distance that can be accurately measured using a vernier instrument. It is the difference between the smallest division on the main scale (MSD) and the smallest division on the vernier scale (VSD).

**Step 2:** Given information.

- $(N + 1) \text{ VSD} = N \text{ MSD}$
- $1 \text{ MSD} = 0.1 \text{ mm}$

**Step 3:** Calculate the value of 1 VSD in terms of MSD.

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

**Step 4:** Calculate the Vernier Constant (VC).

$$\text{VC} = 1 \text{ MSD} - 1 \text{ VSD} = 1 \text{ MSD} - \frac{N}{N + 1} \text{ MSD} = \left(1 - \frac{N}{N + 1}\right) \text{ MSD}$$

$$\text{VC} = \left(\frac{N + 1 - N}{N + 1}\right) \text{ MSD} = \frac{1}{N + 1} \text{ MSD}$$

**Step 5:** Substitute the value of 1 MSD. Given  $1 \text{ MSD} = 0.1 \text{ mm}$ . So,

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

**Step 6:** Convert the vernier constant from mm to cm. Since  $1 \text{ cm} = 10 \text{ mm}$ , we have  $1 \text{ mm} = 0.1 \text{ cm}$ .

$$\text{VC} = \frac{0.1}{N + 1} \text{ mm} = \frac{0.1}{N + 1} \times 0.1 \text{ cm} = \frac{0.01}{N + 1} \text{ cm} = \frac{1}{100(N + 1)} \text{ cm}$$

💡 Quick Tip

Remember the formula for Vernier Constant and the unit conversions.

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

- (1) 6
- (2) 10
- (3) 5
- (4) 7

**Correct Answer:** (2) 10

**Solution:**

**Step 1:** Define instantaneous power. Instantaneous power is the rate at which work is done at a particular instant of time. It is given by the dot product of force and instantaneous velocity:

$$P = \vec{F} \cdot \vec{v} = Fv \cos \theta$$

where  $F$  is the force,  $v$  is the velocity, and  $\theta$  is the angle between the force and velocity vectors.

**Step 2:** Find the instantaneous velocity. The displacement  $x$  is given as a function of time  $t$  by  $x = 2t - 1$ . The instantaneous velocity  $v$  is the derivative of displacement with respect to time:

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

The velocity is constant, which means the motion is uniform.

**Step 3:** Determine the angle between force and velocity. Since the motion is one-dimensional and the velocity is constant and positive, the particle is moving in a straight line with constant velocity. The force is given as 5 N. Since the displacement is  $2t - 1$ , which is positive and increasing with time, the velocity is positive, and the particle is moving in the positive direction. For the velocity to be constant, the force must also be in the positive direction. Therefore, the angle between the force and velocity is 0 degrees.

**Step 4:** Calculate the instantaneous power.

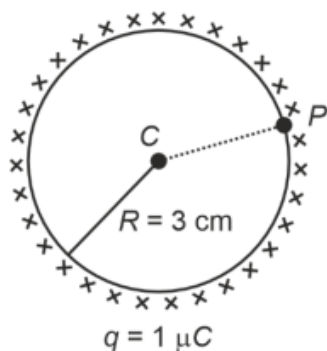
$$P = Fv \cos \theta = (5 \text{ N})(2 \text{ m/s}) \cos(0^\circ) = 10 \text{ W}$$

**💡 Quick Tip**

Remember the definition of instantaneous power and how to find velocity from displacement.

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



- (1) Zero  
 (2)  $3 \times 10^5$   
 (3)  $1 \times 10^5$   
 (4)  $0.5 \times 10^5$

**Correct Answer:** (1) Zero

**Solution:**

**Step 1:** Understand the electric potential inside a charged spherical shell. The electric potential inside a hollow charged spherical shell is constant and equal to the potential at the surface of the shell.

**Step 2:** Calculate the electric potential at the surface of the shell (and thus at point C). The electric potential  $V$  at the surface of a spherical shell of radius  $R$  and charge  $q$  is given by:

$$V = \frac{1}{4\pi\epsilon_0} \frac{q}{R}$$

Given  $q = 1 \mu\text{C} = 1 \times 10^{-6} \text{ C}$  and  $R = 3 \text{ cm} = 0.03 \text{ m}$ , and  $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2\text{C}^{-2}$ , we can calculate the potential at the surface (and at C):

$$V_C = \frac{(9 \times 10^9 \text{ Nm}^2\text{C}^{-2})(1 \times 10^{-6} \text{ C})}{0.03 \text{ m}} = 3 \times 10^5 \text{ V}$$

**Step 3:** Calculate the electric potential at point P. Since point P is also inside the spherical shell, the potential at P is the same as the potential at the surface and at point C.

$$V_P = V_C = 3 \times 10^5 \text{ V}$$

**Step 4:** Calculate the potential difference between C and P. The potential difference between two points is given by:

$$\Delta V = V_C - V_P = 3 \times 10^5 \text{ V} - 3 \times 10^5 \text{ V} = 0$$

**💡 Quick Tip**

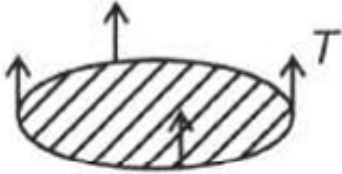
Remember that the electric potential is constant inside a charged conducting spherical shell.

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

- (A) 99 N
- (B) 19.8 mN
- (C) 198 N
- (D) 1.98 mN

**Correct Answer:** (2) 19.8 mN

**Solution:**



$$\text{Excess force} = T \times 2\pi R$$

$$\begin{aligned}
 &= \frac{7}{100} \times 2 \times 3.14 \times \frac{4.5}{100} \\
 &= 197.82 \times 10^{-4} \\
 &= 19.8 \times 10^{-3} \text{ N} \\
 &= 19.8 \text{ mN}
 \end{aligned}$$

**💡 Quick Tip**

For problems related to surface tension, always consider the perimeter of the object in contact with the liquid surface and multiply by 2 if both sides are in contact.

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

| $A$ | $B$ | $Y$ |
|-----|-----|-----|
| 0   | 0   | 1   |
| 0   | 1   | 0   |
| 1   | 0   | 1   |
| 1   | 1   | 0   |

**The expression for the output  $Y$  is:**

- (A)  $B$
- (B)  $A \cdot B + \overline{A}$
- (C)  $A\overline{B} + \overline{A}$
- (D)  $\overline{B}$

**Correct Answer:** (4)  $\overline{B}$

**Solution:**

**Step 1:** Extracting the minterms from the truth table

Observing the given truth table, the output  $Y$  is 1 when:

-  $(A = 0, B = 0) \Rightarrow Y = 1$  -  $(A = 1, B = 0) \Rightarrow Y = 1$

For these conditions, the sum of minterms expression is:

$$Y = \overline{B}$$

**Step 2:** Verifying with Boolean simplification

- The function depends only on  $B$ , since  $Y = 1$  when  $B = 0$ . - The simplest Boolean representation satisfying this condition is  $Y = \overline{B}$ .

Thus, the correct answer is:

$$\overline{B}$$

**💡 Quick Tip**

To derive Boolean expressions from a truth table: - Identify the rows where the output is 1. - Formulate minterms for these rows. - Simplify using Boolean algebra.

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

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

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

**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:**

(A) A is false but R is true.

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

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

(D) A is true but R is false.

**Correct Answer:** (4) A is true but R is false.

**Solution:**

**Step 1:** Formula for potential at an axial point due to an electric dipole

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

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

Substituting the given values:

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

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

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

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

which matches Assertion A, making it true.

**Step 2: Evaluating Reason R**

The correct formula for potential at an axial point is:

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

However, in Reason R, an incorrect sign  $\pm$  is included in the equation. The correct equation does not contain this sign convention in general representation. Thus, Reason R is false.

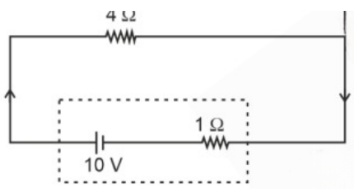
**Conclusion:** Since Assertion A is correct but Reason R is incorrect, the correct answer is:

Option (4): A is true but R is false.

**💡 Quick Tip**

When dealing with dipole potentials, remember: - On the axial line:  $V = \frac{1}{4\pi\epsilon_0} \times \frac{2P}{r^2}$  - On the equatorial line:  $V = 0$  Always verify sign conventions in formula derivations.

**18. 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:**



- (A) 10 V
- (B) 4 V
- (C) 6 V
- (D) 8 V

**Correct Answer:** (4) 8 V

**Solution:**

**Step 1:** Understanding terminal voltage formula

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

$$V = E - Ir$$

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

**Step 2:** Finding the current in the circuit

Using Ohm's law, total resistance in the circuit is:

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

Current in the circuit:

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

**Step 3:** Finding the terminal voltage

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

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

Thus, the terminal voltage is 8 V.

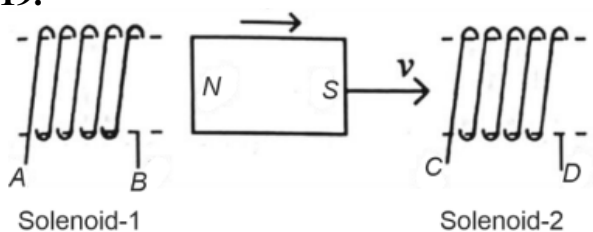
**💡 Quick Tip**

For any circuit with internal resistance  $r$ , the terminal voltage is given by:

$$V = E - Ir$$

where  $I = \frac{E}{R+r}$ . Always include the internal resistance while calculating the actual voltage across the external load.

19.



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

- (A)  $BA$  and  $DC$
- (B)  $AB$  and  $DC$
- (C)  $BA$  and  $CD$
- (D)  $AB$  and  $CD$

**Correct Answer:** (2)  $AB$  and  $DC$

**Solution:**

**Step 1:** Understanding Lenz's Law

Lenz's law states that the induced current will flow in such a direction that it opposes the change causing it.

- In solenoid-1, the north pole of the magnet is moving away. To oppose this, the induced current will create a north pole at  $A$ , meaning the current should flow from  $A$  to  $B$  ( $AB$  direction).
- In solenoid-2, the magnet's north pole is approaching. To oppose this, the induced current will create a north pole at  $C$ , meaning the current should flow from  $D$  to  $C$  ( $DC$  direction).

**Step 2:** Confirming the correct answer

Since the induced current follows the directions  $AB$  in solenoid-1 and  $DC$  in solenoid-2, the correct answer is:

Option (2):  $AB$  and  $DC$ .

**💡 Quick Tip**

Lenz's Law helps determine the direction of induced current: - If a magnet moves away, the solenoid generates a similar polarity to attract it. - If a magnet moves closer, the solenoid generates the same polarity to repel it.

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

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

**Correct Answer:** (3) 2 : 1

**Solution:**

**Step 1:** Understanding Transformer Voltage Ratio

For an ideal transformer, the voltage ratio is given by:

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

Given that:

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

**Step 2:** Finding  $V_S : V_P$

Using the transformer voltage ratio formula:

$$V_S = 2V_P$$

Thus, the ratio  $V_S : V_P$  is:

$$2 : 1$$

**Conclusion:** The correct answer is:

Option (3): 2 : 1.

**💡 Quick Tip**

For an ideal transformer: - If  $N_S > N_P$ , it is a step-up transformer and  $V_S > V_P$ . - If  $N_S < N_P$ , it is a step-down transformer and  $V_S < V_P$ . - The voltage ratio follows  $\frac{V_S}{V_P} = \frac{N_S}{N_P}$ .

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

- (A) 44 T
- (B) 44 mT
- (C) 4.4 T
- (D) 4.4 mT

**Correct Answer:** (4) 4.4 mT

**Solution:**

**Step 1:** Formula for the magnetic field at the centre of a circular coil

The magnetic field at the centre of a circular coil carrying current is given by:

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

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

**Step 2:** Substituting the values

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

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

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

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

Approximating  $\pi \approx 3.14$ :

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

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

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

**Conclusion:** The correct answer is:

Option (4): 4.4 mT.

💡 Quick Tip

For a circular coil: - The magnetic field at the centre is given by  $B = \frac{\mu_0 NI}{2R}$ . - Always ensure the radius is in meters before substitution. - Convert Tesla to milliTesla where necessary ( $1 \text{ mT} = 10^{-3} \text{ T}$ ).

**22. Given below are two statements:**

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

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

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

- (A) Statement I is incorrect but Statement II is correct.
- (B) Both Statement I and Statement II are correct.
- (C) Both Statement I and Statement II are incorrect.
- (D) Statement I is correct but Statement II is incorrect.

**Correct Answer:** (2) Both Statement I and Statement II are correct, (4) Statement I is correct but Statement II is incorrect.

**Solution:**

**Step 1:** Evaluating Statement I

Atoms consist of protons (positively charged) and electrons (negatively charged). Since they contain an equal number of both, the atom as a whole remains electrically neutral.

Thus, **Statement I is correct.**

**Step 2:** Evaluating Statement II

While atoms emit their characteristic spectrum due to electronic transitions, not all atoms are inherently stable. Many atoms (such as radioactive elements) are unstable and decay over time. Since the statement generalizes stability to all atoms, it is partially incorrect.

Thus, **Statement II can be considered incorrect.**

**Conclusion:** The correct answers are:

Option (2) Both Statement I and Statement II are correct.

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

💡 Quick Tip

- Atoms are neutral due to the balance of protons and electrons. - Only some atoms are stable; radioactive elements decay over time. - Characteristic spectrum emission is due to electronic transitions.

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

- (A) Angular speed and stress
- (B) Strain and angle
- (C) Stress and angle
- (D) Strain and arc

**Correct Answer:** (2) Strain and angle

**Solution:**

**Step 1:** Understanding the dimensions of solid angle

Solid angle ( $\Omega$ ) is a dimensionless quantity and is measured in steradians (sr). The dimensional formula of solid angle is:

$$\text{Dimensional formula of solid angle} = M^0 L^0 T^0$$

**Step 2:** Identifying quantities with the same dimensions

1. Angle ( $\theta$ ): - Angle is defined as the ratio of arc length to radius. - It is a dimensionless quantity with the same dimensions as a solid angle.

2. Strain: - Strain is the ratio of change in length to original length in the case of linear strain, or change in shape in the case of shear strain. - It is also a dimensionless quantity with the same dimensions as a solid angle.

**Step 3:** Verifying other options

- “Angular speed” has the dimensional formula  $T^{-1}$ , which does not match. - “Stress” has the dimensional formula  $ML^{-1}T^{-2}$ , which does not match. - “Arc” has the dimensional formula  $L^1$ , which does not match.

Thus, the only correct option is:

Option (2): Strain and angle.

**💡 Quick Tip**

- Dimensionless quantities have a dimensional formula of  $M^0 L^0 T^0$ . - Solid angle, strain, and angle are dimensionless quantities. - Verify dimensions before comparing different physical quantities.

---

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

- A. The energy of a photon is  $E = h\nu$ .
- B. The velocity of a photon is  $c$ .
- C. The momentum of a photon,  $p = \frac{h\nu}{c}$ .
- D. In a photon-electron collision, both total energy and total momentum are conserved.
- E. Photon possesses positive charge.

**Choose the correct answer from the options given below:**

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

(D) A, C and D only

**Correct Answer:** (3) A, B, C and D only.

**Solution:**

**Step 1:** Evaluating each statement

- “Statement A:” The energy of a photon is given by the Planck-Einstein relation:

$$E = h\nu$$

This is correct.

- “Statement B:” The velocity of a photon in free space is equal to the speed of light,  $c$ . This is correct.

- “Statement C:” The momentum of a photon is given by:

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

This is a standard result in quantum mechanics and is correct.

- “Statement D:” In a photon-electron collision (such as Compton scattering), both total energy and total momentum are conserved. This is correct.

- “Statement E:” A photon is electrically neutral and does not possess charge. Since this statement claims that a photon possesses positive charge, it is incorrect.

**Conclusion:** Since statements A, B, C, and D are correct, the correct answer is:

Option (3): A, B, C and D only.

**💡 Quick Tip**

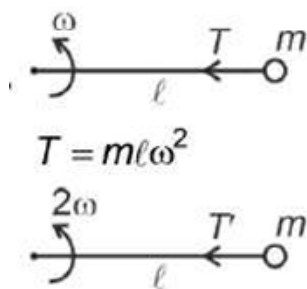
- Photons have energy  $E = h\nu$  and momentum  $p = \frac{h\nu}{c}$ . - The speed of a photon in free space is always  $c$ . - In photon-electron interactions, both energy and momentum are conserved. - Photons have no charge.

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

- (A)  $\sqrt{2}T$
- (B)  $T$
- (C)  $4T$
- (D)  $\frac{T}{4}$

**Correct Answer:** (3)  $4T$

**Solution:**



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

$$T' = 4T$$

#### 💡 Quick Tip

In uniform circular motion: - Tension in the string is proportional to the square of velocity:  $T \propto v^2$ . - If the velocity doubles, the tension increases by a factor of 4. - Always consider how the centripetal force scales with velocity when speed changes.

#### 26. If

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

**represents the motion of a particle executing simple harmonic motion, the amplitude and time period of motion, respectively, are:**

- (A) 5 m, 1 s
- (B) 5 cm, 2 s
- (C) 5 m, 2 s
- (D) 5 cm, 1 s

**Correct Answer:** (3) 5 m, 2 s

**Solution:**

**Step 1:** Identifying amplitude

The standard equation for simple harmonic motion is:

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

Comparing with the given equation:

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

we identify that:

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

Thus, the amplitude of motion is 5 m.

**Step 2:** Finding the time period

From the standard equation:

$$\omega = \pi$$

The relation between angular frequency  $\omega$  and time period  $T$  is:

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

Substituting  $\omega = \pi$ :

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

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

Thus, the time period of motion is 2 s.

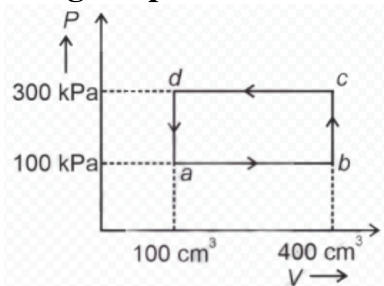
**Conclusion:** The correct answer is:

Option (3): 5 m, 2 s.

**💡 Quick Tip**

- The amplitude is the coefficient of the sine function in the SHM equation. - The time period is given by  $T = \frac{2\pi}{\omega}$ . - Always check units carefully when interpreting amplitude values.

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



- (A) -60 J
- (B) Zero
- (C) 30 J
- (D) -90 J

**Correct Answer:** (2) Zero

**Solution:**

**Step 1:** Understanding the type of process

- From the given  $P - V$  diagram, the path  $bc$  is a **vertical line**, indicating that volume remains constant. - In a thermodynamic process, when volume remains constant (**isochoric process**), the work done is given by:

$$W = P\Delta V$$

Since  $\Delta V = 0$  (no change in volume during the path  $bc$ ):

$$W_{bc} = P \times 0 = 0$$

**Step 2: Conclusion**

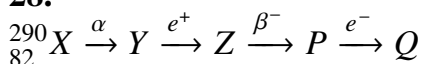
Since no work is done in an isochoric process, the correct answer is:

Option (2): Zero.

|                    |
|--------------------|
| <b>💡 Quick Tip</b> |
|--------------------|

- In an **isochoric** process ( $\Delta V = 0$ ), work done  $W = P\Delta V = 0$ . - Only **isobaric** processes ( $\Delta P = 0$ ) involve work given by  $W = P\Delta V$ . - Always check the orientation of the path in a  $P - V$  diagram to determine the type of thermodynamic process.

**28.**



**In the nuclear emission stated below:**

**the mass number and atomic number of the product Q respectively, are:**

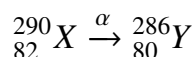
- (A) 286, 81
- (B) 280, 81
- (C) 286, 80
- (D) 288, 82

**Correct Answer:** (1) 286, 81

**Solution:**

**Step 1:** Effect of alpha ( $\alpha$ ) emission

An alpha particle ( $\alpha$ ) consists of 2 protons and 2 neutrons. Thus, when X emits an  $\alpha$ -particle:



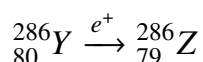
- The mass number decreases by 4. - The atomic number decreases by 2.

So, Y has:

$$A_Y = 286, \quad Z_Y = 80.$$

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

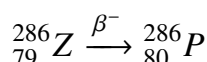
A positron emission decreases the atomic number by 1 but does not change the mass number:



- Mass number remains 286. - Atomic number decreases to 79.

**Step 3:** Effect of beta-minus ( $\beta^-$ ) emission

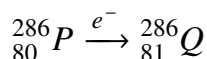
A beta-minus particle ( $\beta^-$ ) increases the atomic number by 1 but does not change the mass number:



- Mass number remains 286. - Atomic number increases to 80.

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

Electron capture decreases the atomic number by 1 but does not change the mass number:



- Mass number remains 286. - Atomic number increases to 81.

**Conclusion:** The final product  $Q$  has:

$$A_Q = 286, \quad Z_Q = 81.$$

Thus, the correct answer is:

Option (1): 286, 81.

**💡 Quick Tip**

- Alpha ( $\alpha$ ) emission decreases mass number by 4 and atomic number by 2. - Positron ( $e^+$ ) emission decreases atomic number by 1. - Beta-minus ( $\beta^-$ ) emission increases atomic number by 1. - Electron capture ( $e^-$ ) decreases atomic number by 1. - Mass number remains unchanged in  $\beta^-/e^+$  emissions and electron capture.

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

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

**Correct Answer:** (3) 2 : 1

**Solution:**

**Step 1:** Applying the principle of conservation of momentum

For a completely inelastic collision, the two bodies stick together after collision.

The total initial momentum before collision:

$$P_{\text{initial}} = mv_1 + m \cdot 0 = mv_1$$

The total final momentum after collision:

$$P_{\text{final}} = (m + m)v_2 = 2mv_2$$

By conservation of linear momentum:

$$mv_1 = 2mv_2$$

**Step 2:** Finding the velocity ratio

Dividing both sides by  $m$ :

$$v_1 = 2v_2$$

Thus, the ratio:

$$v_1 : v_2 = 2 : 1$$

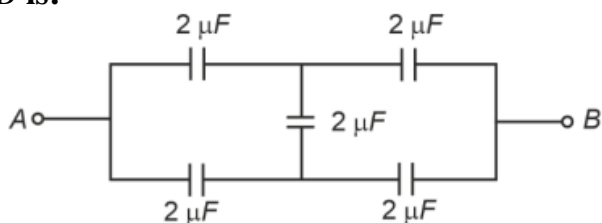
**Conclusion:** The correct answer is:

Option (3): 2 : 1.

💡 Quick Tip

- In a completely inelastic collision, the objects stick together after the collision.
- The total momentum before and after the collision must be conserved.
- The final velocity is given by  $v_2 = \frac{mv_1}{m+m} = \frac{v_1}{2}$ .

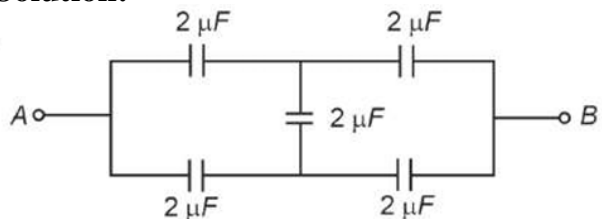
**30. In the following circuit, the equivalent capacitance between terminal A and terminal B is:**



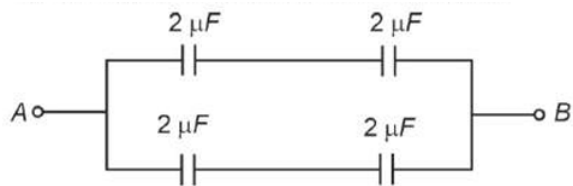
- (A)  $4 \mu F$
- (B)  $2 \mu F$
- (C)  $1 \mu F$
- (D)  $0.5 \mu F$

**Correct Answer:** (2)  $2 \mu F$

**Solution:**



Given circuit is a balanced Wheatstone bridge:

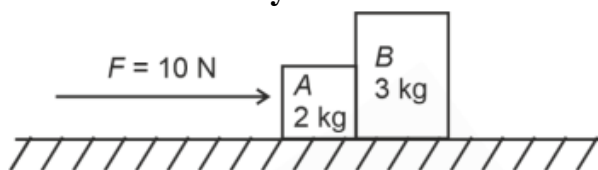


$$C_{AB} = 1 + 1 = 2 \mu F$$

💡 Quick Tip

- Capacitors in series combine as:  $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$ .
- Capacitors in parallel combine as:  $C_{eq} = C_1 + C_2$ .
- Always simplify series branches before computing parallel combinations.

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



- (A) 10 N
- (B) Zero
- (C) 4 N
- (D) 6 N

**Correct Answer:** (4) 6 N

**Solution:**

**Step 1:** Finding the acceleration of the system

Since both blocks move together as a single system, their combined mass is:

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

The applied force is  $F = 10 \text{ N}$ . Using Newton's Second Law:

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

**Step 2:** Finding the force exerted by block A on block B

Block B moves with the same acceleration  $a$ , and the only force causing its motion is the contact force  $F_{AB}$  exerted by block A. Using Newton's Second Law for block B:

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

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

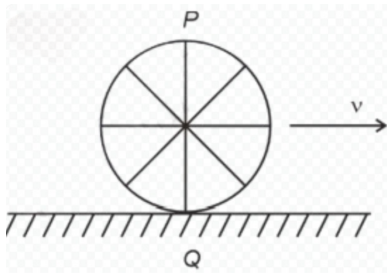
**Conclusion:** The force exerted by block A on block B is:

Option (4): 6 N.

#### 💡 Quick Tip

- When multiple blocks move together under an external force, treat them as a single system to find acceleration.
- The force exerted by one block on another can be found using Newton's Second Law.
- On a frictionless surface, only applied and contact forces contribute to acceleration.

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



- (A) Point  $P$  has zero speed
- (B) Point  $P$  moves slower than point  $Q$
- (C) Point  $P$  moves faster than point  $Q$
- (D) Both the points  $P$  and  $Q$  move with equal speed

**Correct Answer:** (3) Point  $P$  moves faster than point  $Q$

**Solution:**

**Step 1:** Understanding rolling motion

For a wheel rolling without slipping: - The velocity of the center of mass is  $v$ . - The wheel also undergoes rotational motion about its center.

The velocity of a point on the wheel is the sum of: 1. The translational velocity of the center of mass ( $v$ ). 2. The velocity due to rotational motion ( $\omega R$ ), where  $R$  is the radius of the wheel.

**Step 2:** Finding velocity at points  $P$  and  $Q$

- Velocity of point  $P$  (Topmost point) The velocity due to rotation at  $P$  is  $v = \omega R$  in the same direction as the translational motion. Thus, the total velocity at  $P$ :

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

- Velocity of point  $Q$  (Lowest point touching the ground) The velocity due to rotation at  $Q$  is  $v = \omega R$  in the opposite direction to the translational motion. Thus, the total velocity at  $Q$ :

$$v_Q = v - v = 0$$

**Step 3:** Conclusion

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

Thus, the correct answer is:

Option (3): Point  $P$  moves faster than point  $Q$ .

#### 💡 Quick Tip

- For pure rolling motion, the topmost point of the wheel moves with speed  $2v$ , the center moves with  $v$ , and the lowest point has zero velocity. - The velocity of any point on the wheel is given by  $v_{\text{point}} = v + v_{\text{rotation}}$ . - The lowest point momentarily comes to rest due to rolling without slipping.

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

- (A)  $3.92 \text{ m s}^{-2}$   
 (B)  $19.6 \text{ m s}^{-2}$   
 (C)  $9.8 \text{ m s}^{-2}$   
 (D)  $4.9 \text{ m s}^{-2}$

**Correct Answer:** (1)  $3.92 \text{ m s}^{-2}$

**Solution:**

**Step 1:** Formula for acceleration due to gravity

Acceleration due to gravity on a planet is given by:

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

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

For Earth:

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

**Step 2:** Expressing planetary values in terms of Earth

Given: -  $M_P = \frac{1}{10}M_E$  (Mass of the planet is  $\frac{1}{10}$ th of Earth's mass), - Diameter of the planet is half of Earth's, so its radius is:

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

**Step 3:** Finding gravity on the planet

Using the gravity formula:

$$g_P = \frac{GM_P}{R_P^2}$$

Substituting the given values:

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

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

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

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

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

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

**Conclusion:** The acceleration due to gravity on the planet is:

Option (1):  $3.92 \text{ m/s}^2$ .

💡 Quick Tip

- Gravity on a planet is given by  $g = \frac{GM}{R^2}$ . - If mass decreases by a factor of  $k$  and radius decreases by  $m$ , gravity changes as:

$$g' = g \times \frac{k}{m^2}$$

- Always express planetary parameters in terms of Earth's values for simplification.

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

- (A) 8 mm
- (B) 4 mm
- (C) 0.4 mm
- (D) 40 mm

**Correct Answer:** (2) 4 mm

**Solution:**

**Step 1:** Using the formula for elongation in a wire

The elongation ( $\Delta L$ ) in a wire under stress is given by:

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

where: -  $L = 1 \text{ m}$  (original length of wire), -  $\sigma = 8 \times 10^8 \text{ N/m}^2$  (elastic limit, which acts as the maximum stress), -  $Y = 2 \times 10^{11} \text{ N/m}^2$  (Young's modulus of steel).

**Step 2:** Substituting values

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

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

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

$$\Delta L = 4 \text{ mm}$$

**Conclusion:** The maximum elongation of the steel wire is:

Option (2): 4 mm.

💡 Quick Tip

- The elongation formula for a wire under stress is  $\Delta L = \frac{L\sigma}{Y}$ . - Stress is given by the elastic limit when calculating maximum elongation. - Convert the final result to millimeters when required (1 m = 1000 mm).

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

- (A) All bright fringes will be of equal width
- (B) Interference pattern will disappear
- (C) There will be a central dark fringe surrounded by a few coloured fringes
- (D) There will be a central bright white fringe surrounded by a few coloured fringes

**Correct Answer:** (4) There will be a central bright white fringe surrounded by a few coloured fringes.

**Solution:**

**Step 1:** Understanding interference with white light

Young's double-slit experiment produces an interference pattern due to the superposition of light waves. When monochromatic light is used, all bright and dark fringes appear with equal spacing.

When white light (which consists of multiple wavelengths) is used instead of monochromatic light:

1. The central fringe remains **white** because all constituent wavelengths constructively interfere at the center.
2. The surrounding fringes appear **coloured** due to the wavelength-dependent fringe positions.

**Step 2:** Explanation of fringe formation

- Different wavelengths ( $\lambda$ ) in white light result in different fringe widths since fringe width is given by:

$$\beta = \frac{\lambda D}{d}$$

where: -  $D$  is the distance between slits and screen, -  $d$  is the slit separation.

- The first-order fringes are coloured because different wavelengths interfere at slightly different positions. - Higher-order fringes overlap, reducing visibility.

**Step 3:** Evaluating the options

- Option (1) is incorrect because different wavelengths produce different fringe widths. - Option (2) is incorrect because interference still occurs, but fringes are coloured. - Option (3) is incorrect because the central fringe is **always bright** (not dark). - Option (4) is correct because the central fringe is white, surrounded by coloured fringes.

**Conclusion:** The correct answer is:

Option (4): There will be a central bright white fringe surrounded by a few coloured fringes.

💡 Quick Tip

- Using white light in Young's double-slit experiment produces a **white central fringe** with **coloured** surrounding fringes. - Fringe width varies for different wavelengths, causing colour separation. - Higher-order fringes merge, reducing visibility.

**SECTION-B**

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

- (A) 32
- (B) 34
- (C) 28
- (D) 17

**Correct Answer:** (3) 28

**Solution:**

**Step 1:** Using the formula for magnifying power

For an astronomical telescope in normal adjustment (i.e., final image at infinity), the magnifying power ( $M$ ) is given by:

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

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

**Step 2:** Substituting the values

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

$$M = 28$$

**Conclusion:** The magnifying power of the telescope is:

Option (3): 28.

💡 Quick Tip

- The magnifying power of a telescope in normal adjustment is given by  $M = \frac{f_o}{f_e}$ .  
- A longer focal length for the objective lens increases magnification. - Always ensure that focal lengths are in the same unit before substitution.

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

- A.** The charge stored in it increases.
- B.** The energy stored in it decreases.

- C. Its capacitance increases.
- D. The ratio of charge to its potential remains the same.
- E. The product of charge and voltage increases.

**Choose the most appropriate answer from the options given below:**

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

**Correct Answer:** (3) A, C and E only.

**Solution:**

**Step 1:** Understanding the effect of decreasing plate separation

The capacitance of a parallel plate capacitor is given by:

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

where: -  $C$  is the capacitance, -  $\epsilon_0$  is the permittivity of free space, -  $A$  is the plate area, -  $d$  is the separation between the plates.

Since capacitance is inversely proportional to the plate separation ( $d$ ), decreasing  $d$  increases  $C$ .

**Step 2:** Evaluating each statement

- “Statement A (Correct):” The charge stored in the capacitor is given by:

$$Q = CV$$

Since  $C$  increases and  $V$  (supplied by the battery) remains constant, the charge  $Q$  must increase.

- “Statement B (Incorrect):” The energy stored in the capacitor is:

$$U = \frac{1}{2}CV^2$$

Since  $C$  increases and  $V$  remains constant,  $U$  also increases, not decreases.

- “Statement C (Correct):” As derived earlier, capacitance  $C$  increases when  $d$  decreases.

- “Statement D (Incorrect):” The ratio of charge to voltage is capacitance ( $C$ ), which changes. Since  $C$  increases, the ratio does not remain the same.

- Statement E (Correct): The product of charge and voltage is:

$$Q \times V = CV^2$$

Since  $C$  increases and  $V$  is constant, this product also increases.

**Conclusion:** The correct statements are A, C, and E.

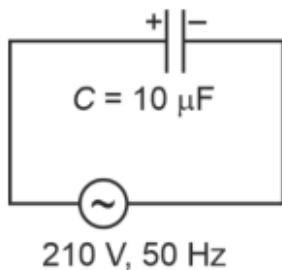
Thus, the correct answer is:

Option (3): A, C and E only.

💡 Quick Tip

- Reducing plate separation increases capacitance. - If connected to a battery, charge increases, but voltage remains constant. - Energy stored increases because  $U = \frac{1}{2}CV^2$ .

**38. 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 ( $\pi = 3.14$ ):**



- (A) 0.35 A
- (B) 0.58 A
- (C) 0.93 A
- (D) 1.20 A

**Correct Answer:** (3) 0.93 A

**Solution:**

**Step 1:** Formula for capacitive reactance

The capacitive reactance ( $X_C$ ) is given by:

$$X_C = \frac{1}{\omega C}$$

where: -  $C = 10\ \mu\text{F} = 10 \times 10^{-6}\ \text{F}$  (capacitance), -  $f = 50\ \text{Hz}$  (frequency), -  $\omega = 2\pi f = 2 \times 3.14 \times 50$ .

**Step 2:** Calculating capacitive reactance

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

$$X_C = \frac{1}{314 \times 10 \times 10^{-6}}$$

$$X_C = \frac{1}{3.14 \times 10^{-3}}$$

$$X_C \approx 318.5\ \Omega$$

**Step 3:** Finding RMS current

The RMS current ( $I_{\text{rms}}$ ) is given by:

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

Substituting values:

$$I_{\text{rms}} = \frac{210}{318.5}$$

$$I_{\text{rms}} \approx 0.66 \text{ A}$$

**Step 4:** Finding peak current

The peak current ( $I_0$ ) is related to the RMS current by:

$$I_0 = \sqrt{2}I_{\text{rms}}$$

$$I_0 = 1.414 \times 0.66$$

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

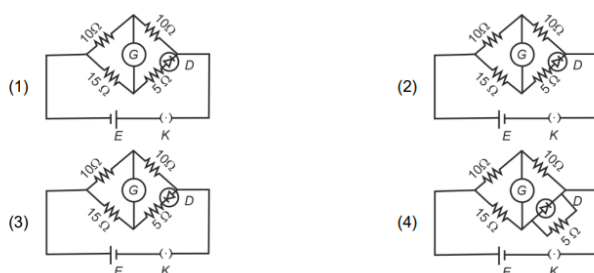
**Conclusion:** The peak current in the circuit is:

Option (3): 0.93 A.

#### 💡 Quick Tip

- The capacitive reactance is given by  $X_C = \frac{1}{\omega C}$ . - The RMS current is calculated as  $I_{\text{rms}} = \frac{V_{\text{rms}}}{X_C}$ . - The peak current is found using  $I_0 = \sqrt{2}I_{\text{rms}}$ .

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



**Correct Answer:** (2)

**Solution:**

**Step 1:** Understanding the Wheatstone Bridge Balance Condition

A Wheatstone bridge is balanced when the ratio of resistances in one branch is equal to the ratio in the other branch:

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

where: -  $R_1$  and  $R_2$  are the resistances in one branch, -  $R_3$  and  $R_4$  are the resistances in the other branch.

**Step 2:** Checking the given circuit values

For each circuit, the resistor values are:

$$R_1 = 10\Omega, \quad R_2 = 10\Omega, \quad R_3 = 15\Omega, \quad R_4 = 5\Omega$$

Applying the Wheatstone bridge balance condition:

$$\frac{10}{10} = \frac{15}{5}$$

$$1 \neq 3$$

Since the balance condition is not satisfied for configurations in options (1), (3), and (4), they are incorrect.

**Step 3:** Identifying the correct circuit

Only in option (2), the resistor arrangement satisfies the bridge balance condition, ensuring that no current flows through the galvanometer. Hence, this is the correct choice.

**Conclusion:** The correct circuit that achieves bridge balance is:

Option (2)

**💡 Quick Tip**

- A Wheatstone bridge is balanced when  $\frac{R_1}{R_2} = \frac{R_3}{R_4}$ . - When balanced, no current flows through the galvanometer. - Always check the ratio condition before selecting the correct circuit.

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

- (A) 2 : 3
- (B) 1 : 1
- (C) 2 : 9
- (D) 1 : 2

**Correct Answer:** (3) 2 : 9

**Solution:**

$$\text{Power Consumed} = P = \frac{V^2}{R}$$

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

$$R_A = 2R_B$$

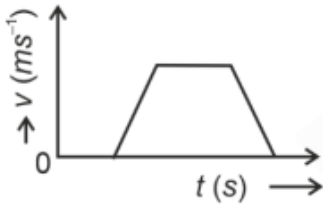
**For Series Combination:**

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

**💡 Quick Tip**

- Power in a series connection is lower due to increased resistance:  $P = \frac{V^2}{R_{\text{series}}}$ . - Power in a parallel connection is higher because the total resistance is lower:  $P = \frac{V^2}{R_{\text{parallel}}}$ . - The ratio of power for series to parallel connection is given by 2 : 9 for given resistors.

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



**The acceleration ( $a$ ) - time ( $t$ ) graph that best suits this motion is:**



**Correct Answer: (4)**

**Solution:**

**Step 1:** Understanding the given velocity-time graph

- The velocity increases linearly in the first phase ( $a > 0$ ), indicating constant positive acceleration. - The velocity remains constant in the middle phase ( $a = 0$ ), indicating zero acceleration. - The velocity decreases linearly in the final phase ( $a < 0$ ), indicating constant negative acceleration.

**Step 2:** Finding the correct acceleration-time graph

- In the first phase, acceleration is **positive and constant** ( $a > 0$ ). - In the middle phase, acceleration is **zero** ( $a = 0$ ). - In the last phase, acceleration is **negative and constant** ( $a < 0$ ).

**Step 3:** Evaluating the options

- “Option (1) is incorrect.” It suggests a continuous change in acceleration, which does not match the given velocity-time graph.  
- “Option (2) is incorrect.” It suggests a constant acceleration throughout, which contradicts

the zero acceleration phase.

- “Option (3) is incorrect.” It suggests increasing acceleration, which is not true in this case.
- “Option (4) is correct.” It correctly represents an initial **positive constant acceleration**, a **zero acceleration** phase, and a final **negative constant acceleration**.

**Conclusion:** The correct acceleration-time graph that best matches the given velocity-time graph is:

Option (4).

**💡 Quick Tip**

- The slope of a velocity-time graph represents acceleration.
- Constant acceleration corresponds to a horizontal line in an acceleration-time graph.
- Zero acceleration corresponds to the horizontal axis in an acceleration-time graph.
- Negative acceleration corresponds to a line below the horizontal axis.

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

- (A) 4
- (B)  $\sqrt{3}$
- (C)  $\sqrt{2}$
- (D)  $2\sqrt{3}$

**Correct Answer:** (3)  $\sqrt{2}$

**Solution:**

**Step 1:** Understanding the formula for time period

The time period of a simple pendulum is given by:

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

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

The formula shows that the time period depends on  $L$  but is independent of mass  $m$ .

**Step 2:** Effect of changes in mass and length

- The mass of the bob is increased to thrice its original mass. Since  $T$  is independent of mass, this does not affect  $T$ .
- The length is made half, so  $L' = \frac{L}{2}$ .

Substituting this into the time period equation:

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

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

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

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

**Step 3:** Finding  $x$

Given that:

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

Comparing with  $T' = \frac{T}{\sqrt{2}}$ :

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

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

**Conclusion:** The correct value of  $x$  is:

Option (3):  $\sqrt{2}$ .

**💡 Quick Tip**

- The time period of a simple pendulum depends on  $\sqrt{L}$  but not on the mass of the bob. - If length is reduced to  $\frac{L}{n}$ , the new time period becomes  $T' = \frac{T}{\sqrt{n}}$ . - Always analyze how changes in parameters affect the formula to derive the correct relation.

**43. 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  $10^{-3} \text{ m}^2$  is heated from  $0^\circ\text{C}$  to  $100^\circ\text{C}$  without expansion or bending. The compressive force developed in it is:**

- (A)  $2 \times 10^3 \text{ N}$
- (B)  $5 \times 10^3 \text{ N}$
- (C)  $50 \times 10^3 \text{ N}$
- (D)  $100 \times 10^3 \text{ N}$

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

**Solution:**

**Step 1:** Formula for thermal stress

The thermal stress in a material prevented from expanding is given by:

$$\text{Stress} = Y\alpha\Delta T$$

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

**Step 2:** Calculating thermal stress

$$\begin{aligned}\text{Stress} &= (0.5 \times 10^{11}) \times (10^{-5}) \times (100) \\ &= 0.5 \times 10^6 \text{ N/m}^2\end{aligned}$$

**Step 3:** Finding compressive force

The compressive force is given by:

$$\begin{aligned}F &= \text{Stress} \times \text{Area} \\ F &= (0.5 \times 10^6) \times (10^{-3}) \\ F &= 50 \times 10^3 \text{ N}\end{aligned}$$

**Conclusion:** The compressive force developed in the metallic bar is:

Option (3):  $50 \times 10^3 \text{ N}$ .

**💡 Quick Tip**

- Thermal stress is given by  $\sigma = Y\alpha\Delta T$ . - Force is obtained from stress using  $F = \sigma A$ . - If expansion is restricted, the material experiences compressive stress.

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

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

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

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

**Correct Answer:** (3) A and C only.

**Solution:**

**Step 1:** Evaluating statement A

- If the sheet is magnetic, it experiences an attractive force towards the strong magnetic pole.
- To prevent the sheet from moving towards the pole, an external force is required to hold it in

place. - Hence, “statement A is correct”.

**Step 2:** Evaluating statement B

- If the sheet is non-magnetic, it does not experience any magnetic force. - Since there is no force acting on it due to the pole, no external force is required to hold it in place. - Hence, “statement B is incorrect”.

**Step 3:** Evaluating statement C

- If the sheet is conducting and placed in a changing magnetic field, eddy currents are induced in it. - These eddy currents produce a force opposing the motion (Lenz’s Law). - To move it away with uniform velocity, a force is required to overcome this opposing force. - Hence, “statement C is correct”.

**Step 4:** Evaluating statement D

- If the sheet is both non-conducting and non-polar, it does not interact with the magnetic field. - No force is required to move it with uniform velocity. - Hence, “statement D is incorrect”.

**Conclusion:** The correct statements are A and C.

Thus, the correct answer is:

Option (3): A and C only.

**💡 Quick Tip**

- Magnetic materials experience attraction towards a strong magnetic pole, requiring a force to keep them stationary. - Conducting materials in a magnetic field experience eddy currents, requiring a force to move them uniformly. - Non-magnetic, non-conducting, and non-polar materials do not interact with a magnetic field, so no force is needed to move them.

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

- (A) They originate from charges moving with uniform speed
- (B) They are transverse in nature
- (C) The energy density in electric field is equal to energy density in magnetic field
- (D) They travel with a speed equal to  $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$

**Correct Answer:** (1) They originate from charges moving with uniform speed.

**Solution:**

**Step 1:** Understanding the origin of electromagnetic waves

- Electromagnetic (EM) waves are generated by accelerated charges, not by charges moving with uniform speed. - A charge moving at constant velocity produces a steady electric and magnetic field but does not generate electromagnetic waves. - EM waves are created when a charge undergoes acceleration, such as in oscillating electric circuits or during transitions in atoms.

Thus, statement (A) is incorrect because EM waves do not originate from uniformly moving charges.

**Step 2:** Evaluating other statements

- Statement (B) is correct: EM waves are transverse in nature, meaning the electric field ( $E$ ) and magnetic field ( $B$ ) oscillate perpendicular to each other and to the direction of wave propagation.

- Statement (C) is correct: In free space, the energy density in the electric field ( $u_E$ ) and the magnetic field ( $u_B$ ) are equal, given by:

$$u_E = u_B = \frac{1}{2}\epsilon_0 E^2 = \frac{1}{2}\frac{B^2}{\mu_0}$$

- Statement (D) is correct: The speed of EM waves in free space is:

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

which matches the given expression.

**Conclusion:** The incorrect statement is:

Option (1): They originate from charges moving with uniform speed.

**💡 Quick Tip**

- EM waves are produced by accelerating charges, not by charges moving at a constant velocity. - They are transverse in nature with mutually perpendicular  $E$ -field,  $B$ -field, and propagation direction. - The speed of EM waves in free space is  $c = \frac{1}{\sqrt{\mu_0\epsilon_0}}$ . - The energy density in  $E$ -field and  $B$ -field is equal in an EM wave.

**46. A parallel plate capacitor is charged by connecting it to a battery through a resistor.**

**If  $I$  is the current in the circuit, then in the gap between the plates:**

- (A) Displacement current of magnitude greater than  $I$  flows but can be in any direction
- (B) There is no current
- (C) Displacement current of magnitude equal to  $I$  flows in the same direction as  $I$
- (D) Displacement current of magnitude equal to  $I$  flows in a direction opposite to that of  $I$

**Correct Answer:** (3) Displacement current of magnitude equal to  $I$  flows in the same direction as  $I$ .

**Solution:**

**Step 1:** Understanding displacement current

- In a capacitor circuit, the conduction current ( $I$ ) flows in the wires and charges the capacitor.  
 - However, in the gap between the plates, there is no conduction current. - Instead, a changing electric field exists in the capacitor, which gives rise to a displacement current.

According to Maxwell's equations, the displacement current  $I_d$  is given by:

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

where  $\Phi_E$  is the electric flux. This displacement current ensures continuity in the circuit.

**Step 2:** Evaluating the statements

- Statement (A) is incorrect: The displacement current is not greater than  $I$ ; it is exactly equal to  $I$ .
- Statement (B) is incorrect: There is current in the form of displacement current.
- Statement (C) is correct: The displacement current has the same magnitude as the conduction current  $I$  and flows in the same direction.
- Statement (D) is incorrect: The displacement current does not flow in the opposite direction.

**Conclusion:** The correct statement is:

Option (3): Displacement current of magnitude equal to  $I$  flows in the same direction as  $I$ .

 Quick Tip

- Displacement current arises in regions where the electric field changes with time, such as in a capacitor.
- The magnitude of displacement current is equal to the conduction current in the circuit.
- Displacement current ensures continuity in circuits involving capacitors.

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

- (A)  $\frac{M}{\sqrt{3}}$
- (B)  $M$
- (C)  $\frac{M}{2}$
- (D)  $2M$

**Correct Answer:** (3)  $\frac{M}{2}$

**Solution:**

$$M = m \ell$$

$$\ell/2$$

$$\Delta l = 2 \times \frac{l}{2} \sin 30^\circ$$

$$\Delta l = \frac{l}{2}$$

$$M' = m \ell/2$$

$$= M \ell/2$$

 Quick Tip

- The magnetic moment of a magnet is given by  $M = ml$ .
- When a magnet is bent, the new magnetic moment is given by  $M' = 2M_{\text{half}} \cos \frac{\theta}{2}$ .
- For a bending angle of  $60^\circ$ , the new moment is  $\frac{M}{2}$ .

**48. The minimum energy required to launch a satellite of mass  $m$  from the surface of the**

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

- (A)  $\frac{GmM}{3R}$   
 (B)  $\frac{5GmM}{6R}$   
 (C)  $\frac{2GmM}{3R}$   
 (D)  $\frac{GmM}{2R}$

**Correct Answer:** (2)  $\frac{5GmM}{6R}$

**Solution:**

$$\begin{aligned}
 U_i + K_i &= U_f + K_f \\
 \Rightarrow \frac{-GMm}{R} + K_i &= \frac{GMm}{3R} + \frac{1}{2}mv^2 \\
 \Rightarrow \frac{-GMm}{R} + K_i &= \frac{GMm}{3R} + \frac{1}{2}m \times \frac{GM}{3R} \\
 \Rightarrow K_i &= \frac{-1}{6} \frac{GMm}{R} + \frac{GMm}{R} \\
 K_i &= \frac{5}{6} \frac{GMm}{R}
 \end{aligned}$$

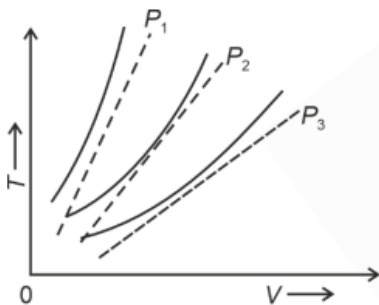
**Conclusion:** The minimum energy required to launch the satellite is:

Option (2):  $5GmM\overline{6R}$ .

**💡 Quick Tip**

- The total energy of a satellite in orbit is  $E = \frac{-GmM}{2r}$ . - The energy required to move a satellite from the surface to orbit is  $\Delta E = E_2 - E_1$ . - The total launch energy includes the additional kinetic energy required for orbit.

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



**Then the correct relation is:**

- (A)  $P_1 > P_2 > P_3$   
 (B)  $P_3 > P_2 > P_1$

(C)  $P_1 > P_3 > P_2$

(D)  $P_2 > P_1 > P_3$

**Correct Answer:** (1)  $P_1 > P_2 > P_3$

**Solution:**

**Step 1:** Understanding the  $T$ - $V$  relationship

- The ideal gas law is given by:

$$PV = nRT$$

or in terms of Charles's law at constant pressure:

$$\frac{V}{T} = \text{constant} \quad (\text{for a given pressure})$$

- This means that at constant pressure, the gas expands linearly with temperature ( $T$ ).

**Step 2:** Interpreting the graph

- The given graph shows isobaric curves (constant pressure curves) for three different pressures  $P_1, P_2, P_3$ . - As pressure increases, the slope of the curve decreases, meaning that at a higher pressure, the same volume expansion requires a higher temperature. - The order of slopes in the graph suggests that:

$$P_1 > P_2 > P_3$$

**Step 3:** Evaluating the options

- "Option (1) is correct:" The curves confirm that  $P_1$  is the highest, followed by  $P_2$ , then  $P_3$ .
- "Option (2) is incorrect:" It incorrectly suggests  $P_3$  as the highest pressure.
- "Option (3) is incorrect:" It places  $P_3$  above  $P_2$ , which is not correct from the graph.
- "Option (4) is incorrect:" It places  $P_2$  as the highest pressure, contradicting the graph.

**Conclusion:** The correct relation between the pressures is:

Option (1):  $P_1 > P_2 > P_3$ .

**💡 Quick Tip**

- According to Charles's law, at constant pressure, volume increases with temperature. - Higher pressure corresponds to a steeper  $T$ - $V$  curve. - The ordering of curves in the graph confirms  $P_1 > P_2 > P_3$ .

**50. 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  $\alpha$  and  $\beta$  are constants, is:**

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

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

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

(D)  $\alpha\beta t$

**Correct Answer:** (3)  $\frac{\alpha t}{\beta}$

**Solution:**

**Step 1:** Understanding the dimensional analysis

The given force equation:

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

Since force has the SI unit:

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

The two terms  $\alpha t^2$  and  $\beta t$  must have the same dimensions as force.

**Step 2:** Finding the dimensions of  $\alpha$  and  $\beta$

For the term  $\alpha t^2$ :

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

Since  $[t^2] = T^2$ , we get:

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

For the term  $\beta t$ :

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

Since  $[t] = T$ , we get:

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

**Step 3:** Checking the dimensionless factor

To be dimensionless, a factor must have no fundamental dimensions.

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

$$\begin{aligned}\frac{[\alpha] \times [t]}{[\beta]} &= \frac{(MLT^{-4}) \times (T)}{MLT^{-3}} \\ &= \frac{MLT^{-3}}{MLT^{-3}} = 1\end{aligned}$$

Since this ratio is dimensionless, the correct answer is:

Option (3):  $\alpha t \overline{\beta}$ .

#### 💡 Quick Tip

- Dimensionless quantities have no fundamental units.
- Use dimensional analysis to verify correctness.
- Equating the dimensions of force helps determine  $[\alpha]$  and  $[\beta]$ .
- The ratio  $\frac{\alpha t}{\beta}$  eliminates all units, making it dimensionless.

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## CHEMISTRY

**51. Given below are two statements:**

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

**Statement II:** Aniline cannot be prepared through Gabriel synthesis.

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

- (A) Statement I is incorrect but Statement II is true
- (B) Both Statement I and Statement II are true
- (C) Both Statement I and Statement II are false
- (D) Statement I is correct but Statement II is false

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

**Solution:**

**Step 1:** Verifying Statement I

- The Friedel-Crafts alkylation reaction involves the use of a Lewis acid catalyst (e.g.,  $\text{AlCl}_3$ ).  
- Aniline ( $\text{C}_6\text{H}_5\text{NH}_2$ ) has a lone pair on nitrogen, which strongly interacts with the Lewis acid catalyst, leading to the formation of a complex. - This complex deactivates the benzene ring, preventing it from undergoing the Friedel-Crafts reaction. - Hence, **Statement I is true.**

**Step 2:** Verifying Statement II

- Gabriel synthesis is commonly used for the preparation of primary amines. - However, it is specifically effective for aliphatic primary amines and does not work well for aromatic amines like aniline. - This is because aryl halides do not undergo nucleophilic substitution easily, preventing the formation of aniline. - Hence, **Statement II is also true.**

**Conclusion:** Since both statements are correct, the correct answer is:

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

**💡 Quick Tip**

- Aniline does not undergo Friedel-Crafts reactions due to the formation of a complex with  $\text{AlCl}_3$ , making the benzene ring unreactive. - Gabriel synthesis is effective for aliphatic primary amines but not for aromatic amines like aniline. - Understanding reaction mechanisms helps in predicting the feasibility of a reaction.

---

**52. Match List I with List II.**

| List I (Compound) |  | List II (Shape/geometry) |  |
|-------------------|--|--------------------------|--|
| A. $\text{NH}_3$  |  | I. Trigonal Pyramidal    |  |
| B. $\text{BrF}_5$ |  | II. Square Planar        |  |
| C. $\text{XeF}_4$ |  | III. Octahedral          |  |
| D. $\text{SF}_6$  |  | IV. Square Pyramidal     |  |

**Choose the correct answer from the options given below:**

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

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

**Solution:**

**Step 1:** Determining the molecular geometry using VSEPR theory

- “A.  $\text{NH}_3$  (Ammonia)  $\rightarrow$  Trigonal Pyramidal (I)” - The central nitrogen has three bonded pairs and one lone pair, leading to a trigonal pyramidal shape.

- “B.  $\text{BrF}_5$  (Bromine Pentafluoride)  $\rightarrow$  Square Pyramidal (IV)” -  $\text{BrF}_5$  has five bonded fluorine atoms and one lone pair, resulting in a square pyramidal shape.

- “C.  $\text{XeF}_4$  (Xenon Tetrafluoride)  $\rightarrow$  Square Planar (II)” - Xenon has four bonded fluorine atoms and two lone pairs, leading to a square planar structure.

- “D.  $\text{SF}_6$  (Sulfur Hexafluoride)  $\rightarrow$  Octahedral (III)” - Sulfur has six fluorine atoms symmetrically arranged, forming an octahedral shape.

**Step 2:** Matching with List II



**Step 3:** Evaluating the options

- Option (1) is incorrect: Incorrect order of matches. - Option (2) is correct: Matches exactly with our findings. - Option (3) is incorrect: Incorrect shape assignments. - Option (4) is incorrect: Incorrect pairings.

**Conclusion:** The correct match is:

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

**💡 Quick Tip**

- The VSEPR theory helps determine molecular shapes based on electron pair repulsions. - Lone pairs affect molecular geometry, leading to deviations from ideal shapes. - Common geometries: Trigonal pyramidal ( $\text{NH}_3$ ), Square pyramidal ( $\text{BrF}_5$ ), Square planar ( $\text{XeF}_4$ ), and Octahedral ( $\text{SF}_6$ ).

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**53. Match List I with List II.**

| List I |                        | List II |                                         |
|--------|------------------------|---------|-----------------------------------------|
| A.     | ethane                 | I.      | one $\sigma$ -bond and two $\pi$ -bonds |
| B.     | ethene                 | II.     | two $\pi$ -bonds                        |
| C.     | carbon molecule, $C_2$ | III.    | one $\sigma$ -bond                      |
| D.     | ethyne                 | IV.     | one $\sigma$ -bond and one $\pi$ -bond  |

**Choose the correct answer from the options given below:**

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

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

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

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

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

**Solution:**

**Step 1:** Understanding the bonding in the given molecules

- “A. Ethane ( $C_2H_6$ )  $\rightarrow$  One  $\sigma$ -bond (III)” - Ethane has a single bond between two carbon atoms, which consists of one  $\sigma$ -bond.

- “B. Ethene ( $C_2H_4$ )  $\rightarrow$  One  $\sigma$ -bond and one  $\pi$ -bond (IV)” - Ethene contains a double bond between two carbon atoms, consisting of one  $\sigma$ -bond and one  $\pi$ -bond.

- “C. Carbon molecule ( $C_2$ )  $\rightarrow$  Two  $\pi$ -bonds (II)” - The  $C_2$  molecule in the gas phase is believed to have a double bond consisting of two  $\pi$ -bonds.

- “D. Ethyne ( $C_2H_2$ )  $\rightarrow$  One  $\sigma$ -bond and two  $\pi$ -bonds (I)” - Ethyne has a triple bond between carbon atoms, consisting of one  $\sigma$ -bond and two  $\pi$ -bonds.

**Step 2:** Matching with List II



**Step 3:** Evaluating the options

- Option (1) is incorrect: Incorrect pairings. - Option (2) is incorrect: Incorrect assignment for C and D. - Option (3) is incorrect: Incorrect order. - Option (4) is correct: Matches exactly with our findings.

**Conclusion:** The correct match is:

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

#### 💡 Quick Tip

- A single bond consists of one  $\sigma$ -bond. - A double bond consists of one  $\sigma$ -bond and one  $\pi$ -bond. - A triple bond consists of one  $\sigma$ -bond and two  $\pi$ -bonds. - The carbon molecule  $C_2$  in the gas phase contains only  $\pi$ -bonds.

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

**Then, which of the following is correct?**

- (A) Reaction has gone to completion in forward direction.
- (B) Reaction is at equilibrium.
- (C) Reaction has a tendency to go in forward direction.
- (D) Reaction has a tendency to go in backward direction.

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

**Solution:**

**Step 1:** Expression for Reaction Quotient  $Q_C$

The reaction quotient is given by:

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

Substituting the given concentrations:

$$Q_C = \frac{(2 \times 10^{-3})(2 \times 10^{-3})}{(2 \times 10^{-3})^2}$$
$$Q_C = \frac{4 \times 10^{-6}}{4 \times 10^{-6}} = 1$$

**Step 2:** Comparing  $Q_C$  with  $K_C$

- Given  $K_C = 4 \times 10^{-3}$ . - Since  $Q_C = 1$  is greater than  $K_C = 4 \times 10^{-3}$ , the reaction has exceeded equilibrium and will shift in the **backward direction** to establish equilibrium.

**Step 3:** Evaluating the options

- “Option (1) is incorrect.” The reaction has not gone to completion in the forward direction.
- “Option (2) is incorrect.” Since  $Q_C \neq K_C$ , the reaction is not at equilibrium.
- “Option (3) is incorrect.” The reaction will not proceed forward as  $Q_C > K_C$ .
- “Option (4) is correct.” The reaction has a tendency to shift in the backward direction.

**Conclusion:** Since  $Q_C > K_C$ , the correct answer is:

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

**💡 Quick Tip**

- The reaction quotient  $Q_C$  helps determine the direction of a reaction: - If  $Q_C < K_C$ , the reaction moves forward. - If  $Q_C > K_C$ , the reaction moves backward. - If  $Q_C = K_C$ , the reaction is at equilibrium. - Here, since  $Q_C > K_C$ , the reaction shifts in the backward direction.

**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    |  |

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

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

**Solution:**

**Step 1:** Understanding the Thermodynamic Processes

- “A. Isothermal process → Carried out at constant temperature (II)” - In an isothermal process, temperature remains constant ( $\Delta T = 0$ ). - The heat exchange occurs but the internal energy remains unchanged.

- “B. Isochoric process → Carried out at constant volume (III)” - In an isochoric process, the volume remains constant ( $\Delta V = 0$ ). - Since no work is done ( $W = 0$ ), any heat added changes only the internal energy.

- “C. Isobaric process → Carried out at constant pressure (IV)” - In an isobaric process, the pressure remains constant ( $\Delta P = 0$ ). - The heat added to the system is used for work as well as internal energy change.

- “D. Adiabatic process → No heat exchange (I)” - In an adiabatic process, no heat is transferred ( $Q = 0$ ). - The internal energy change is equal to the work done.

**Step 2:** Matching with List II

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

**Step 3:** Evaluating the options

- Option (1) is correct: Matches exactly with our findings. - Option (2) is incorrect: Incorrect order of assignments. - Option (3) is incorrect: Incorrect placement of isothermal and isochoric conditions. - Option (4) is incorrect: Incorrect placement of adiabatic condition.

**Conclusion:** The correct match is:

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

**💡 Quick Tip**

- Isothermal: Constant temperature ( $T = \text{constant}$ ). - Isochoric: Constant volume ( $V = \text{constant}$ ,  $W = 0$ ). - Isobaric: Constant pressure ( $P = \text{constant}$ ). - Adiabatic: No heat exchange ( $Q = 0$ ).

**56. Match List I with List II.**

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

**Choose the correct answer from the options given below:**

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

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

**Solution:**

**Step 1:** Understanding the Quantum Numbers

- “A. Magnetic Quantum Number ( $m_l$ ) → Orientation of Orbital (III)” - The magnetic quantum number ( $m_l$ ) determines the orientation of an orbital in space. - It can have values ranging from  $-l$  to  $+l$ .

- “B. Spin Quantum Number ( $m_s$ ) → Orientation of Spin of Electron (IV)” - The spin quantum number ( $m_s$ ) determines the spin orientation of an electron. - It can have values  $+\frac{1}{2}$  or  $-\frac{1}{2}$ .

- “C. Azimuthal Quantum Number ( $l$ ) → Shape of Orbital (I)” - The azimuthal quantum number ( $l$ ) determines the shape of an orbital. - It defines the subshells (s, p, d, f).

- “D. Principal Quantum Number ( $n$ ) → Size of Orbital (II)” - The principal quantum number ( $n$ ) determines the size and energy of an orbital. - Higher values of  $n$  correspond to larger orbitals.

**Step 2:** Matching with List II

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

**Step 3:** Evaluating the options

- Option (1) is incorrect: Incorrect placement of quantum numbers. - Option (2) is incorrect: Incorrect match for  $l$  and  $m_l$ . - Option (3) is correct: Matches exactly with our findings. - Option (4) is incorrect: Incorrect placement of quantum numbers.

**Conclusion:** The correct match is:

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

**💡 Quick Tip**

- Principal Quantum Number ( $n$ ): Defines the size and energy level of orbitals. - Azimuthal Quantum Number ( $l$ ): Defines the shape of orbitals (s, p, d, f). - Magnetic Quantum Number ( $m_l$ ): Determines the orientation of orbitals in space. - Spin Quantum Number ( $m_s$ ): Represents the intrinsic spin of electrons ( $+\frac{1}{2}$  or  $-\frac{1}{2}$ ).

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

Li, Be, B, C, N

**Choose the correct answer from the options given below:**

- (A)  $\text{Li} < \text{Be} < \text{N} < \text{B} < \text{C}$
- (B)  $\text{Li} < \text{Be} < \text{B} < \text{C} < \text{N}$
- (C)  $\text{Li} < \text{B} < \text{Be} < \text{C} < \text{N}$
- (D)  $\text{Li} < \text{Be} < \text{C} < \text{B} < \text{N}$

**Correct Answer:** (3)  $\text{Li} < \text{B} < \text{Be} < \text{C} < \text{N}$

**Solution:**

**Step 1:** Understanding Ionization Enthalpy Trends

- Ionization enthalpy is the energy required to remove the most loosely bound electron from an atom. - The general trend across a period (left to right) is an **increase** in ionization enthalpy due to increasing nuclear charge. - The trend down a group is a **decrease** in ionization enthalpy due to an increase in atomic size and shielding effect.

**Step 2:** Analyzing the given elements

- “Li (Lithium)”: Group 1 element, has the lowest ionization enthalpy. - “Be (Beryllium)”: Group 2 element, has a higher ionization enthalpy due to a completely filled  $2s$ -orbital. - “B (Boron)”: Group 13 element, has a lower ionization enthalpy than Be because it has a partially filled  $2p$ -orbital. - “C (Carbon)”: Group 14 element, follows the expected trend of increasing ionization enthalpy. - “N (Nitrogen)”: Group 15 element, has a half-filled  $2p$ -orbital which makes it more stable, leading to a higher ionization enthalpy than C.

**Step 3:** Arranging the elements

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

**Step 4:** Evaluating the options

- Option (1) is incorrect: Incorrect placement of B and N. - Option (2) is incorrect: Incorrect placement of Be and B. - Option (3) is correct: Matches exactly with our findings. - Option (4) is incorrect: Incorrect placement of B.

**Conclusion:** The correct order is:

Option (3): Li ; B ; Be ; C ; N.

**💡 Quick Tip**

- Ionization enthalpy generally increases across a period due to increasing nuclear charge. - Fully and half-filled orbitals provide extra stability, causing deviations in expected trends. - Be > B due to its fully filled 2s-orbital, and N > C due to its half-filled 2p-orbital.

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

- (A) Po
- (B) O
- (C) Se
- (D) Te

**Correct Answer:** (1) Po

**Solution:**

**Step 1:** Understanding Oxidation States in Group 16 Elements

- Group 16 elements (Oxygen family) generally exhibit oxidation states of  $-2$ ,  $+2$ ,  $+4$ , and  $+6$ .  
- The  $-2$  oxidation state is most stable in oxygen and less stable as we move down the group due to increased metallic character.

**Step 2:** Evaluating Each Element

- “Oxygen (O)”: Always shows  $-2$  oxidation state in compounds except in peroxides ( $-1$ ) and superoxides ( $-\frac{1}{2}$ ).

- “Selenium (Se) and Tellurium (Te)”: Commonly exhibit  $-2$  oxidation state in compounds like selenides and tellurides.

- “Polonium (Po)”: Due to its highly metallic nature, polonium prefers higher oxidation states like  $+2$  and  $+4$  rather than  $-2$ .

**Step 3:** Evaluating the options

- Option (1) is correct: Polonium (Po) does not prefer the  $-2$  oxidation state.

- Option (2) is incorrect: Oxygen always shows  $-2$  oxidation state in normal compounds.

- Option (3) is incorrect: Selenium commonly exhibits  $-2$  oxidation state.

- Option (4) is incorrect: Tellurium also shows  $-2$  oxidation state in tellurides.

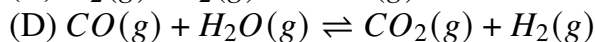
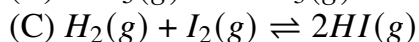
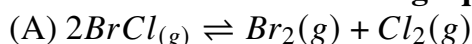
**Conclusion:** The correct answer is:

Option (1): Po (Polonium)

💡 Quick Tip

- Down the group, metallic character increases, and the stability of the  $-2$  oxidation state decreases. - Polonium (*Po*) is highly metallic and prefers  $+2$  and  $+4$  oxidation states instead of  $-2$ . - Oxygen (*O*), Selenium (*Se*), and Tellurium (*Te*) commonly show  $-2$  oxidation state.

**59. In which of the following equilibria,  $K_P$  and  $K_C$  are NOT equal?**



**Correct Answer:** (2)  $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

**Solution:**

**Step 1:** Relationship Between  $K_P$  and  $K_C$

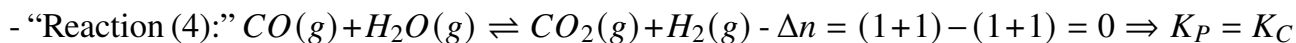
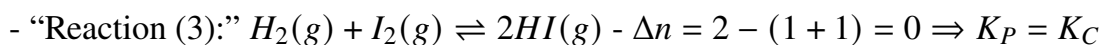
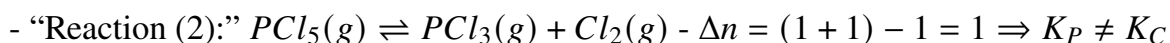
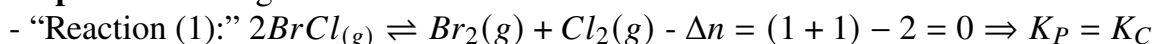
The relationship between  $K_P$  and  $K_C$  is given by the equation:

$$K_P = K_C(RT)^{\Delta n}$$

where -  $\Delta n$  = (moles of gaseous products) – (moles of gaseous reactants), -  $R$  is the universal gas constant, -  $T$  is the temperature in Kelvin.

If  $\Delta n = 0$ , then  $K_P = K_C$ , otherwise,  $K_P \neq K_C$ .

**Step 2:** Evaluating  $\Delta n$  for Each Reaction



**Step 3:** Evaluating the options

- “Option (1) is incorrect:”  $K_P = K_C$

- “Option (2) is correct:”  $K_P \neq K_C$  because  $\Delta n = 1$

- “Option (3) is incorrect:”  $K_P = K_C$

- “Option (4) is incorrect:”  $K_P = K_C$

**Conclusion:** The correct answer is:

Option (2):  $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

💡 Quick Tip

- If  $\Delta n = 0$ , then  $K_P = K_C$ . - If  $\Delta n \neq 0$ , then  $K_P \neq K_C$  and follows  $K_P = K_C(RT)^{\Delta n}$ .
- In the reaction  $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ , since  $\Delta n = 1$ ,  $K_P$  and  $K_C$  are not equal.

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

- A. Tollen's reagent
- B. Schiff's reagent
- C. HCN
- D.  $NH_2OH$
- E.  $NaHSO_3$

**Choose the correct options from the given below:**

- (A) E and D
- (B) B and C
- (C) A and D
- (D) B and E

**Correct Answer:** (4) B and E.

**Solution:**

**Step 1:** Understanding Glucose Reactions

- "Tollen's reagent (A)": Glucose gives a positive test because it is a reducing sugar.

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

- "HCN (C)": Glucose reacts with HCN to form cyanohydrins, so it does react. - Hydroxylamine ( $NH_2OH$ )

(D): Reacts with glucose to form oximes. - Sodium bisulfite ( $NaHSO_3$ )

(E): Glucose does **not** react with  $NaHSO_3$  as it lacks a sufficiently reactive carbonyl center.

**Step 2:** Evaluating the options

- "Option (1) is incorrect:"  $NaHSO_3$  is correct, but  $NH_2OH$  reacts with glucose. - "Option (2) is incorrect:" Schiff's reagent is correct, but HCN reacts.

- "Option (3) is incorrect:" Tollen's reagent reacts with glucose.

- "Option (4) is correct:" Schiff's reagent and  $NaHSO_3$  do **not** react with glucose.

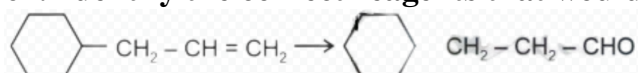
**Conclusion:** The correct answer is:

Option (4): B (Schiff's reagent) and E ( $NaHSO_3$ ).

💡 Quick Tip

- Glucose is a reducing sugar and reacts with Tollen's reagent. - Schiff's reagent requires free aldehydes, but glucose exists in a cyclic form. - HCN reacts with glucose to form cyanohydrins. - Hydroxylamine ( $NH_2OH$ ) reacts with glucose to form oximes. - Sodium bisulfite ( $NaHSO_3$ ) does not react with glucose due to its low reactivity.

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



**Choose the correct answer from the given options:**

(A)

(i)  $H_2O/H^+$

(ii) *PCC*

(B)

(i)  $H_2O/H^+$

(ii)  $CrO_3$

(C)

(i)  $BH_3$

(ii)  $H_2O_2/OH^-$

(iii) *PCC*

(D)

(i)  $BH_3$

(ii)  $H_2O_2/OH^-$

(iii) *alk. KMnO<sub>4</sub>*

(iv)  $H_3O^+$

**Correct Answer:** (3)

**Solution:**

**Step 1:** Understanding the Transformation

- The given reaction involves the transformation of an **alkene** ( $-CH=CH_2$ ) into an **aldehyde** ( $-CH_2-CHO$ ). - This suggests an **hydroboration-oxidation** followed by **oxidation of the primary alcohol** to an aldehyde.

**Step 2:** Identifying the Required Reagents

1. "Hydroboration-Oxidation" - The reagent  $BH_3$  (borane) undergoes **anti-Markovnikov** addition of water. - This results in the formation of a **primary alcohol** ( $-CH_2-CH_2OH$ ).

2. "Oxidation to Aldehyde" - Pyridinium chlorochromate (*PCC*) is used to oxidize **primary alcohols to aldehydes**. - Strong oxidizers like  $KMnO_4$  or  $CrO_3$  would oxidize the aldehyde further to a carboxylic acid, which is not desired.

### Step 3: Evaluating the Options

- “Option (1) is incorrect:”  $\text{H}_2\text{O}/\text{H}^+$  leads to **Markovnikov addition**, forming a secondary alcohol instead of the required primary alcohol.

- “Option (2) is incorrect:”  $\text{CrO}_3$  is a strong oxidizer and would oxidize the alcohol to a carboxylic acid instead of an aldehyde.

- “Option (3) is correct:”  $\text{BH}_3$  (hydroboration),  $\text{H}_2\text{O}_2/\text{OH}^-$  (oxidation to alcohol), and  $\text{PCC}$  (oxidation to aldehyde).

- “Option (4) is incorrect:”  $\text{KMnO}_4$  is too strong an oxidizer and would lead to a carboxylic acid instead of an aldehyde.

**Conclusion:** The correct answer is:

Option (3):  $\text{BH}_3$ ,  $\text{H}_2\text{O}_2/\text{OH}^-$ ,  $\text{PCC}$

#### 💡 Quick Tip

- Hydroboration-Oxidation ( $\text{BH}_3$ ,  $\text{H}_2\text{O}_2/\text{OH}^-$ ) follows **anti-Markovnikov addition** to form a primary alcohol. –  
Pyridinium Chlorochromate ( $\text{PCC}$ ) selectively oxidizes primary alcohols to aldehydes. –  
Strong oxidizers ( $\text{KMnO}_4$ ,  $\text{CrO}_3$ ) should be avoided if aldehyde formation is desired.

**62. The  $E^\circ$  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:**

- (A)  $d^3$  to  $d^5$  configuration
- (B)  $d^5$  to  $d^4$  configuration
- (C)  $d^5$  to  $d^2$  configuration
- (D)  $d^4$  to  $d^5$  configuration

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

**Solution:**

**Step 1:** Understanding the Reduction Potential of  $\text{Mn}^{3+}/\text{Mn}^{2+}$

- The standard reduction potential ( $E^\circ$ ) for the  $\text{Mn}^{3+}/\text{Mn}^{2+}$  couple is more positive than that of  $\text{Cr}^{3+}/\text{Cr}^{2+}$  or  $\text{Fe}^{3+}/\text{Fe}^{2+}$ . - This indicates that  $\text{Mn}^{3+}$  is more likely to be reduced to  $\text{Mn}^{2+}$  compared to  $\text{Cr}^{3+}$  or  $\text{Fe}^{3+}$ .

**Step 2:** Electronic Configurations of the Ions

-  $\text{Mn}^{3+}$  ( $d^4$ ): Configuration is  $[\text{Ar}]3d^4$ . -  $\text{Mn}^{2+}$  ( $d^5$ ): Configuration is  $[\text{Ar}]3d^5$ , which is a half-filled stable configuration.

**Step 3:** Stability of Half-Filled  $d^5$  Configuration

- The  $d^5$  configuration is more stable due to increased exchange energy and symmetrical distribution of electrons. - The reduction of  $\text{Mn}^{3+}$  ( $d^4$ ) to  $\text{Mn}^{2+}$  ( $d^5$ ) leads to a more stable state. - This makes the reduction potential more positive, favoring the reduction reaction.

**Step 4: Evaluating the Options**

- Option (1) is incorrect:  $\text{Mn}^{3+}$  does not have a  $d^3$  configuration. - Option (2) is incorrect: The conversion is not from  $d^5$  to  $d^4$ . - Option (3) is incorrect: The conversion is not from  $d^5$  to  $d^2$ . - Option (4) is correct: The transition is from  $d^4$  (unstable) to  $d^5$  (stable), explaining the high  $E^\circ$  value.

**Conclusion:** The correct answer is:

Option (4):  $d^4$  to  $d^5$  configuration

 Quick Tip

- Half-filled  $d^5$  configuration is highly stable due to symmetrical electron distribution and exchange energy. - Higher  $E^\circ$  value means easier reduction, indicating a strong preference for attaining the  $d^5$  configuration. - Manganese uniquely prefers the  $d^5$  state, making its  $\text{Mn}^{3+}/\text{Mn}^{2+}$  couple more positive.

**63. 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.

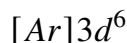
**In the light of the above statements, choose the correct answer from the options given below:**

- (A) Statement I is false but Statement II is true.  
 (B) Both Statement I and Statement II are true.  
 (C) Both Statement I and Statement II are false.  
 (D) Statement I is true but Statement II is false.

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

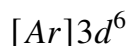
**Solution:****Step 1: Understanding the Complexes**

-  $[\text{Co}(\text{NH}_3)_6]^{3+}$  (Hexaamminecobalt(III)) - The oxidation state of cobalt: +3 - Electronic configuration of  $\text{Co}^{3+}$  ( $Z = 27$ ):



-  $\text{NH}_3$  is a **strong field ligand** and causes **strong crystal field splitting**, leading to a **low-spin** octahedral complex. - In the **low-spin** state, the  $d^6$  electrons pair up in the  $t_{2g}$  orbitals. - As there are **no unpaired electrons**, it is **diamagnetic**.

-  $[\text{CoF}_6]^{3-}$  (Hexafluorocobaltate(III)) - The oxidation state of cobalt: +3 - Electronic configuration of  $\text{Co}^{3+}$ :



-  $\text{F}^-$  is a **weak field ligand**, causing **weak crystal field splitting**, leading to a **high-spin** octahedral complex. - In the **high-spin** state, the  $d^6$  electrons do not pair up completely. - There are **unpaired electrons**, making it **paramagnetic**.

**Step 2: Evaluating the Statements**

- “Statement I is true:” Both complexes are octahedral but differ in their magnetic behavior due to ligand field strength.
- “Statement II is true:”  $[Co(NH_3)_6]^{3+}$  is **diamagnetic**, and  $[CoF_6]^{3-}$  is **paramagnetic**.

**Step 3:** Evaluating the options

- Option (1) is incorrect: Statement I is true.
- Option (2) is correct: Both statements are true.
- Option (3) is incorrect: Both statements are not false.
- Option (4) is incorrect: Statement II is true.

**Conclusion:** The correct answer is:

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

 Quick Tip

- Strong field ligands (e.g.,  $NH_3$ ) cause **low-spin** complexes with paired electrons, leading to **diamagnetism**.
- Weak field ligands (e.g.,  $F^-$ ) cause **high-spin** complexes with unpaired electrons, leading to **paramagnetism**.
- The number of unpaired electrons determines whether a complex is diamagnetic or paramagnetic.

**64. Fehling’s solution ‘A’ is:**

- (A) aqueous sodium citrate
- (B) aqueous copper sulphate
- (C) alkaline copper sulphate
- (D) alkaline solution of sodium potassium tartrate (Rochelle’s salt)

**Correct Answer:** (2) aqueous copper sulphate.

**Solution:**

**Step 1:** Understanding Fehling’s Solution

- Fehling’s solution is a **chemical test** used to detect the presence of **reducing sugars** (e.g., glucose, fructose).
- It consists of two solutions: - “Fehling’s solution A:” Aqueous **copper(II) sulphate** ( $CuSO_4$ ).
- “Fehling’s solution B:” Alkaline solution of sodium potassium tartrate (**Rochelle’s salt**,  $NaKC_4H_4O_6$ ).

**Step 2:** Evaluating the Options

- “Option (1) is incorrect:” Sodium citrate is not a component of Fehling’s solution.
- “Option (2) is correct:” Fehling’s solution A contains **aqueous copper sulphate** ( $CuSO_4$ ).
- “Option (3) is incorrect:” Fehling’s solution A is not alkaline; it is simply **aqueous copper sulphate**. The alkalinity comes from solution B.
- “Option (4) is incorrect:” The alkaline sodium potassium tartrate is **Fehling’s solution B**, not A.

**Conclusion:** The correct answer is:  
Option (2): Aqueous copper sulphate.

**💡 Quick Tip**

- Fehling's test is used to detect reducing sugars. - Fehling's solution A contains **aqueous copper(II) sulphate**. - Fehling's solution B contains **alkaline sodium potassium tartrate (Rochelle's salt)**.

**65. In which of the following processes does entropy increase?**

1. A liquid evaporates to vapour.
2. Temperature of a crystalline solid is lowered from 130 K to 0 K.
3.  $2\text{NaHCO}_3(s) \rightarrow \text{Na}_2\text{CO}_3(s) + \text{CO}_2(g) + \text{H}_2\text{O}(g)$ .
4.  $\text{Cl}_2(g) \rightarrow 2\text{Cl}(g)$ .

**Choose the correct answer from the given options:**

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

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

**Solution:**

**Step 1:** Understanding Entropy Changes

Entropy ( $S$ ) is a measure of disorder or randomness in a system. It increases when: - A substance transitions from a more ordered state (solid or liquid) to a less ordered state (gas). - More molecules are produced in a reaction. - A complex molecule dissociates into simpler components.

**Step 2:** Evaluating the Given Processes

- "Statement A is correct:" - When a liquid evaporates into vapour, the randomness of molecules increases. -  $\Delta S > 0$ , meaning entropy increases.

- "Statement B is incorrect:" - Lowering the temperature of a crystalline solid decreases the kinetic energy and movement of particles. - The system becomes more ordered, leading to a decrease in entropy. -  $\Delta S < 0$ , meaning entropy decreases.

- "Statement C is correct:" - The decomposition of sodium bicarbonate ( $\text{NaHCO}_3$ ) produces gaseous  $\text{CO}_2$  and  $\text{H}_2\text{O}$ , increasing disorder. -  $\Delta S > 0$ , meaning entropy increases.

- “Statement D is correct:” - The dissociation of  $\text{Cl}_2(\text{g})$  into two chlorine atoms ( $2\text{Cl}(\text{g})$ ) increases the number of particles and randomness. -  $\Delta S > 0$ , meaning entropy increases.

**Step 3: Evaluating the Answer Choices**

- Option (1) is incorrect: While C and D are correct, A is also correct. - Option (2) is incorrect: A and C are correct, but D is also correct. - Option (3) is incorrect: B is incorrect. - Option (4) is correct: A, C, and D all lead to an increase in entropy.

**Conclusion:** The correct answer is:

Option (4): A, C and D

**💡 Quick Tip**

- Phase changes that increase randomness (solid  $\rightarrow$  liquid  $\rightarrow$  gas) increase entropy.  
 - Reactions producing more gaseous molecules increase entropy. - Dissociation of molecules increases entropy. - Lowering temperature reduces entropy.

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

- (A)  $-\frac{4}{9}x$
- (B)  $-x$
- (C)  $-\frac{x}{9}$
- (D)  $-4x$

**Correct Answer:** (2)  $-x$ .

**Solution:**

$$E_n = -R_H \left( \frac{Z^2}{n^2} \right) J$$

**For  $\text{He}^+$  ( $n = 1$ ):**

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

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

**For  $\text{Be}^{3+}$  ( $n = 2$ ):**

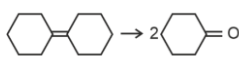
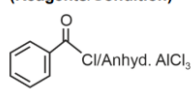
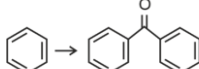
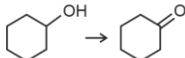
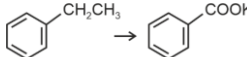
$$E_n = -R_H \left( \frac{Z^2}{n^2} \right) J$$

$$= -\frac{x}{4} \times \left( \frac{4 \times 4}{2 \times 2} \right) = -xJ$$

### 💡 Quick Tip

- For hydrogen-like ions, use the formula  $E_n = -\frac{13.6Z^2}{n^2}$ . - The energy is inversely proportional to  $n^2$  and directly proportional to  $Z^2$ . - For  $\text{Be}^{3+}$ ,  $Z = 4$ , so the energy is scaled by  $16/4 = 4$  times that of hydrogen.

## 67. Match List I with List II.

| List I<br>(Reaction)                                                                 | List II<br>(Reagents/Condition)                                                      |
|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| A.  | I.  |
| B.  | II. $\text{CrO}_3$                                                                   |
| C.  | III. $\text{KMnO}_4/\text{KOH}, \Delta$                                              |
| D.  | IV. (i) $\text{O}_3$<br>(ii) $\text{Zn-H}_2\text{O}$                                 |

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

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

### Solution:

#### Step 1: Understanding the Reactions

- “Reaction A (Ozonolysis of Alkene)” - The given reaction shows the cleavage of a double bond forming two carbonyl groups. - Ozonolysis ( $\text{O}_3$ ) followed by reduction ( $\text{Zn-H}_2\text{O}$ ) is the correct reagent. -  $\Rightarrow$  Matched with “IV”.

- “Reaction B (Friedel-Crafts Acylation)” - The given reaction involves the formation of an acylated benzene ring. - This reaction is carried out using acyl chloride ( $\text{C}_6\text{H}_5\text{COCl}$ ) with  $\text{AlCl}_3$  as a Lewis acid catalyst. -  $\Rightarrow$  Matched with “I.”

- “Reaction C (Oxidation of Alcohol to Ketone)” - The oxidation of a secondary alcohol to a ketone is typically done using strong oxidizing agents like  $\text{CrO}_3$ . -  $\Rightarrow$  Matched with “II”.

- “Reaction D (Oxidation of Alkyl Benzene to Carboxylate Salt)” - The transformation of an ethyl group into a carboxylate ion ( $\text{COOK}$ ) suggests the use of  $\text{KMnO}_4/\text{KOH}, \Delta$ , a strong oxidizer. -  $\Rightarrow$  Matched with “III”.

#### Step 2: Evaluating the Answer Choices

- Option (1) is incorrect: Incorrect match for A and D. - Option (2) is incorrect: Incorrect match for A and C. - Option (3) is incorrect: Incorrect match for A and D. - Option (4) is correct: All reactions are correctly matched.

**Conclusion:** The correct answer is:

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

**💡 Quick Tip**

- Ozonolysis ( $\text{O}_3/\text{Zn-H}_2\text{O}$ ) cleaves alkenes into carbonyl compounds. - Friedel-Crafts Acylation ( $\text{C}_6\text{H}_5\text{COCl}/\text{AlCl}_3$ ) introduces an acyl group to benzene. - Oxidation ( $\text{CrO}_3$ ) converts alcohols to ketones or aldehydes. - Strong oxidation ( $\text{KMnO}_4/\text{KOH}, \Delta$ ) oxidizes alkyl group to carboxylates.

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

- (A) rate constant at two different temperatures
- (B) rate constant at standard temperature
- (C) probability of collision
- (D) orientation of reactant molecules during collision

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

**Solution:**

**Step 1:** Understanding Activation Energy Calculation

- Activation energy ( $E_a$ ) is the minimum energy required for a chemical reaction to occur. - The Arrhenius equation is used to determine the activation energy:

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

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

**Step 2:** Using the Arrhenius Equation

- Taking the natural logarithm of both sides:

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

- If we take the equation at two different temperatures  $T_1$  and  $T_2$ , the activation energy can be calculated using:

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

**Step 3:** Evaluating the Options

- “Option (1) is correct:” Using the rate constant at two different temperatures, we can determine the activation energy using the Arrhenius equation. - “Option (2) is incorrect:” A single temperature value does not provide enough information to determine  $E_a$ . - “Option (3) is incorrect:” The probability of collision relates to reaction rate but does not determine activation energy. - “Option (4) is incorrect:” Orientation affects reaction feasibility but not

activation energy calculation.

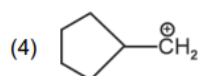
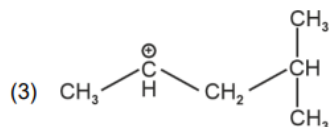
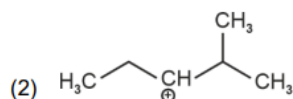
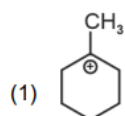
**Conclusion:** The correct answer is:

Option (1): Rate constant at two different temperatures.

💡 Quick Tip

- Activation energy ( $E_a$ ) can be calculated using the Arrhenius equation. - Two rate constants at different temperatures are required to determine  $E_a$ . - Plotting  $\ln k$  vs  $1/T$  gives a straight line with slope  $-E_a/R$ .

**69. The most stable carbocation among the following is:**



**Correct Answer:** (1) Cycloheptyl carbocation with a methyl substituent.

**Solution:**

**Step 1:** Understanding Carbocation Stability

Carbocation stability is influenced by:

1. “Resonance:” Delocalization of positive charge stabilizes the carbocation.

2. “Hyperconjugation:” The more adjacent alkyl groups, the more stable the carbocation.

3. “Inductive Effect:” Electron-donating groups stabilize carbocations.

4. “Ring Strain:” Carbocations in smaller rings are less stable due to angle strain.

**Step 2:** Analyzing the Given Carbocations

- “Option (1):” The cycloheptyl carbocation has **non-classical stabilization** due to its large ring size. The positive charge is delocalized, making it highly stable.

- “Option (2):” Although a tertiary carbocation is generally stable, it lacks resonance or ring stability.

- “Option (3):” A secondary carbocation is less stable than a tertiary one.

- “Option (4):” A cyclopentyl carbocation has high ring strain, making it less stable.

### Step 3: Conclusion

The most stable carbocation is the cycloheptyl carbocation in Option (1) due to its ability to undergo non-classical stabilization.

Correct Answer: Option (1)

#### 💡 Quick Tip

- Tertiary carbocations are more stable than secondary and primary. - Cycloheptyl carbocations exhibit non-classical stabilization. - Ring strain decreases stability (smaller rings are less stable). - Hyperconjugation and resonance enhance carbocation stability.

### 70. Given below are two statements:

**Statement I:** The boiling point of three isomeric pentanes follows the order



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

**Choose the most appropriate answer from the options given below:**

- (A) Statement I is incorrect but Statement II is correct
- (B) Both Statement I and Statement II are correct
- (C) Both Statement I and Statement II are incorrect
- (D) Statement I is correct but Statement II is incorrect

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

#### Solution:

##### Step 1: Understanding Boiling Point Trends in Isomers

- The boiling point of alkanes depends on **molecular size, branching, and surface area**. - **Straight-chain (n-pentane)** has the highest boiling point due to the largest surface area. - **Branched isomers (isopentane, neopentane)** have lower boiling points because increased branching reduces surface area, decreasing intermolecular Van der Waals forces. - The correct order of boiling points is:



##### Step 2: Validating the Statements

- Statement I is correct as it correctly states the boiling point order. - Statement II is also correct because branching decreases surface area, leading to weaker Van der Waals forces and lower boiling points.

**Conclusion:** Since both statements are correct, the correct answer is:

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

### 💡 Quick Tip

- Boiling point decreases with increasing branching due to lower surface area.
- Straight-chain alkanes have higher boiling points than branched ones.
- Van der Waals forces decrease as molecular shape becomes more compact.

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



**Correct Answer:** (1) Tertiary butyl alcohol.

### Solution:

#### Step 1: Understanding Lucas Test

- Lucas reagent is a mixture of anhydrous  $\text{ZnCl}_2$  and concentrated  $\text{HCl}$ . - The test is used to distinguish between primary, secondary, and tertiary alcohols based on their reactivity. - The order of reactivity is:



#### Step 2: Reaction Mechanism

- Tertiary alcohols react instantly, forming a cloudy solution due to rapid carbocation formation. - Secondary alcohols take a few minutes. - Primary alcohols react very slowly or not at all at room temperature.

#### Step 3: Evaluating the Given Alcohols

- Option (1) Tertiary butyl alcohol ( $3^\circ$  alcohol) reacts instantly due to stable tertiary carbocation formation. - Option (2) Primary alcohol reacts very slowly. - Option (3) Secondary alcohol reacts moderately. - Option (4) Branched primary alcohol behaves similarly to primary alcohols.

**Conclusion:** Since tertiary alcohol reacts instantaneously with Lucas reagent, the correct answer is:

Option (1): Tertiary butyl alcohol.

### 💡 Quick Tip

- Lucas reagent test identifies alcohol types based on their reaction speed.
- Tertiary alcohols react instantly, forming a cloudy solution.
- Secondary alcohols react in 5-10 minutes.
- Primary alcohols react very slowly or not at all.

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

**order:**

- (A) A  $\dot{>}$  B  $\dot{>}$  C
- (B) B  $\dot{>}$  A  $\dot{>}$  C
- (C) B  $\dot{>}$  C  $\dot{>}$  A
- (D) A  $\dot{>}$  C  $\dot{>}$  B

**Correct Answer:** (3) B  $\dot{>}$  C  $\dot{>}$  A.

**Solution:**

**Step 1: Understanding Henry's Law**

Henry's law states that:

$$C = k_H \cdot P$$

where: -  $C$  is the solubility of the gas in the liquid, -  $k_H$  is the Henry's law constant, -  $P$  is the partial pressure of the gas.

**Step 2: Relation Between Henry's Constant and Solubility**

- The solubility of a gas in water is inversely proportional to its Henry's law constant  $k_H$ .

- A **higher**  $k_H$  means **lower** solubility.

- A **lower**  $k_H$  means **higher** solubility.

**Step 3: Given Data Analysis**

The given Henry's law constants are: -  $k_H(A) = 145$  -  $k_H(B) = 2 \times 10^{-5}$  -  $k_H(C) = 35$   
Since solubility is inversely related to  $k_H$ :

$$S_B > S_C > S_A$$

**Conclusion**

Thus, the correct solubility order is:

$$B \dot{>} C \dot{>} A$$

which corresponds to:

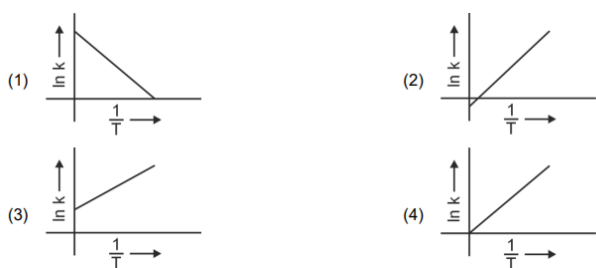
Option (3)

**💡 Quick Tip**

- Higher Henry's law constant ( $K_H$ ) means lower solubility. - Lower Henry's law constant ( $K_H$ ) means higher solubility. - Solubility order is the inverse of Henry's constant values.

---

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



**Correct Answer:** (1) Negative slope.

**Solution:**

**Step 1: Understanding the Arrhenius Equation**

Arrhenius equation is given by:

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

Taking natural logarithm on both sides:

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

**Step 2: Analyzing the Equation Form**

The equation follows the straight-line equation:

$$y = mx + c$$

where: -  $y = \ln k$ , -  $x = \frac{1}{T}$ , - slope =  $-\frac{E_a}{R}$  (negative slope), - y-intercept =  $\ln A$ .

**Step 3: Selecting the Correct Graph**

- The equation suggests that  $\ln k$  decreases linearly as  $\frac{1}{T}$  increases. - This corresponds to a graph with a **negative slope**.

**Conclusion:** Since option (1) shows a straight line with a negative slope, the correct answer is:

Option (1)

**💡 Quick Tip**

- Arrhenius equation follows  $\ln k = \ln A - \frac{E_a}{RT}$ . - Graph of  $\ln k$  vs  $\frac{1}{T}$  is always a straight line with a negative slope. - Higher activation energy ( $E_a$ ) results in a steeper slope.

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

- (A) Chromatography
- (B) Crystallization
- (C) Sublimation
- (D) Distillation

**Correct Answer:** (3) Sublimation.

**Solution:****Step 1: Understanding the Concept of Sublimation**

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

**Step 2: Comparing the Given Options**

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

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

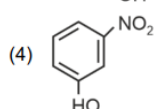
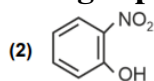
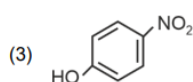
Option (3)

**💡 Quick Tip**

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

**75. Intramolecular hydrogen bonding is present in**

(1) HF



**Correct Answer:** (2) Ortho-Nitrophenol.

**Solution:****Step 1: Understanding Intramolecular Hydrogen Bonding**

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

**Step 2: Evaluating the Given Options**

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

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

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

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

Option (2)

**💡 Quick Tip**

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

**76. 1 gram of sodium hydroxide was treated with 25 mL of 0.75 M HCl solution, the mass of sodium hydroxide left unreacted is equal to:**

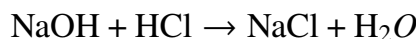
- (A) 200 mg
- (B) 750 mg
- (C) 250 mg
- (D) Zero mg

**Correct Answer:** (3) 250 mg.

**Solution:**

**Step 1: Writing the Reaction Equation**

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



**Step 2: Calculating the Moles of NaOH Present**

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

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

**Step 3: Calculating the Moles of HCl Present**

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

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

**Step 4: Determining the Leftover NaOH**

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

Remaining moles of NaOH:

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

Mass of remaining NaOH:

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

**Conclusion:** The correct answer is:

Option (3)

💡 Quick Tip

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

**77. Which reaction is NOT a redox reaction?**

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

(B)  $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$

(C)  $2\text{KClO}_3 + \text{I}_2 \rightarrow 2\text{KIO}_3 + \text{Cl}_2$

(D)  $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$

**Correct Answer:** (1)  $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$ .

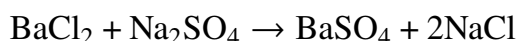
**Solution:**

**Step 1: Understanding Redox Reactions**

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

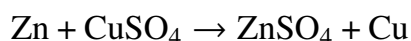
**Step 2: Checking Each Option**

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



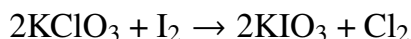
is a double displacement (precipitation) reaction. The oxidation states of all elements remain unchanged. Hence, it is **not** a redox reaction.

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



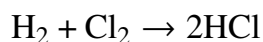
involves Zn being oxidized from 0 to +2 and Cu being reduced from +2 to 0, making it a redox reaction.

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



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

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



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

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

Thus, the correct answer is:

Option (1)

💡 Quick Tip

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

**78. ‘Spin only’ magnetic moment is same for which of the following ions?**

- (A)  $\text{Ti}^{3+}$
- (B)  $\text{Cr}^{2+}$
- (C)  $\text{Mn}^{2+}$
- (D)  $\text{Fe}^{2+}$
- (E)  $\text{Sc}^{3+}$

Choose the most appropriate answer from the options given below:

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

**Correct Answer:** (2) B and D only

**Solution:**

**Step 1: Understanding Magnetic Moment Formula**

The spin-only magnetic moment ( $\mu_s$ ) is given by:

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

where  $n$  is the number of unpaired electrons.

**Step 2: Determining Unpaired Electrons**

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

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

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

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

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

**Step 3: Identifying Matching Magnetic Moments**

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

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

**💡 Quick Tip**

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

**79. The highest number of helium atoms is in**

- (1) 2.271098 L of helium at STP
- (2) 4 mol of helium
- (3) 4 u of helium
- (4) 4 g of helium

**Correct Answer:** (2) 4 mol of helium

**Solution:**

$$(1) \text{ 2.271098 L of He at STP} = 2.271 \frac{\text{mole}}{22.710982 \text{ L}} \\ = 0.1 \text{ mole}$$

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

$$(2) \text{ 4 mol of He} = 4 N_A \text{ He atoms}$$

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

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

**💡 Quick Tip**

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

**80. Match List I with List II.**

| List I (Complex)                                        | List II (Type of isomerism) |
|---------------------------------------------------------|-----------------------------|
| A. $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$ | 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  |

**Choose the correct answer from the options given below:**

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

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

**Solution:**

**Step 1: Understanding the types of isomerism - Linkage isomerism** occurs when a ligand can coordinate to the metal center through different atoms. In  $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$ , the  $\text{NO}_2$  ligand can bind through either nitrogen or oxygen. Hence, **A-II**.

- **Ionization isomerism** arises when exchangeable anions are involved. In  $[\text{Co}(\text{NH}_3)_5(\text{SO}_4)]\text{Br}$ , the sulfate and bromide ions can interchange, leading to ionization isomerism. Hence, **B-III**.

- **Coordination isomerism** occurs when there is an exchange of ligands between cationic and anionic complexes. In  $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$ , the metal centers can switch ligands, leading to coordination isomerism. Hence, **C-IV**.

- **Solvate isomerism** (hydrate isomerism) involves the replacement of water molecules inside or outside the coordination sphere. In  $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$ , water molecules participate in solvate isomerism. Hence, **D-I**.

Thus, the correct matching is:

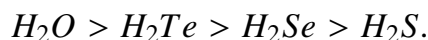
A-II, B-III, C-IV, D-I

#### 💡 Quick Tip

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

**81. Given below are two statements:**

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



**Statement II:** On the basis of molecular mass,  $\text{H}_2\text{O}$  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  $\text{H}_2\text{O}$ , it has a higher boiling point.

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

- (1) Statement I is false but Statement II is true
- (2) Both Statement I and Statement II are true
- (3) Both Statement I and Statement II are false
- (4) Statement I is true but Statement II is false

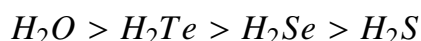
**Correct Answer:** (2) Both Statement I and Statement II are true

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

- Normally, the boiling point of hydrides increases down the group due to increasing molecular mass and stronger Van der Waals forces. - However,  $\text{H}_2\text{O}$  has an anomalously high boiling point due to extensive hydrogen bonding, which makes it deviate from the expected trend.

**Step 2: Verifying the Statements**

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



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

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

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

**💡 Quick Tip**

- Boiling Point Trend in Group 16 Hydrides - Regular trend: Boiling point increases down the group due to increased molecular mass and stronger dispersion forces. - Anomalous behavior of  $\text{H}_2\text{O}$ : Due to hydrogen bonding, its boiling point is significantly higher than expected.

**82. A compound with a molecular formula of  $\text{C}_6\text{H}_{14}$  has two tertiary carbons. Its IUPAC name is:**

Choose the correct answer from the options given below:

- (1) 2,2-dimethylbutane
- (2) n-hexane
- (3) 2-methylpentane
- (4) **2,3-dimethylbutane**

**Correct Answer:** (4) 2,3-dimethylbutane

**Solution:****Step 1: Understanding the Molecular Formula and Structural Requirements**

- The molecular formula is " $\text{C}_6\text{H}_{14}$ ", which corresponds to an alkane. - The compound has "two tertiary carbons", meaning two carbon atoms are connected to three other carbon atoms.

**Step 2: Evaluating the Given Options**

- 1. "n-Hexane": - It has no tertiary carbon. Incorrect.
- 2. "2-Methylpentane": - It has only one tertiary carbon. Incorrect.
- 3. "2,2-Dimethylbutane": - It has one tertiary carbon at position 2. Incorrect.
- 4. "2,3-Dimethylbutane": - It has "two tertiary carbons" at positions 2 and 3. "Correct Answer".

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

**💡 Quick Tip**

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

**83. Match List I with List II.**

| List-I (Conversion) |                                                  | List-II (Number of Faraday required) |    |
|---------------------|--------------------------------------------------|--------------------------------------|----|
| A                   | 1 mol of $\text{H}_2\text{O}$ to $\text{O}_2$    | I                                    | 3F |
| B                   | 1 mol of $\text{MnO}_4^-$ to $\text{Mn}^{2+}$    | II                                   | 2F |
| C                   | 1.5 mol of Ca from molten $\text{CaCl}_2$        | III                                  | 1F |
| D                   | 1 mol of $\text{FeO}$ to $\text{Fe}_2\text{O}_3$ | IV                                   | 5F |

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

**Solution:**

**Step 1: Understanding Faraday's Law of Electrolysis**

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

**Step 2: Determining the Number of Faradays Required**

- "A:  $\text{H}_2\text{O}$  to  $\text{O}_2$  (2F required)" - The oxidation of 1 mole of water to oxygen gas requires "2 Faradays".

- "B:  $\text{MnO}_4^-$  to  $\text{Mn}^{2+}$  (5F required)" - The permanganate ion ( $\text{MnO}_4^-$ ) undergoes reduction to  $\text{Mn}^{2+}$ , involving a 5-electron transfer, thus "5 Faradays".

- "C: 1.5 mol of Ca from molten  $\text{CaCl}_2$  (3F required)" - The reduction of 1.5 moles of  $\text{Ca}^{2+}$  to Ca metal requires "3 Faradays".

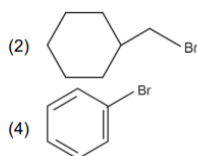
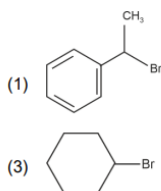
- "D:  $\text{FeO}$  to  $\text{Fe}_2\text{O}_3$  (1F required)" - The oxidation of  $\text{FeO}$  to  $\text{Fe}_2\text{O}_3$  requires "1 Faraday".

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

**💡 Quick Tip**

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

**84. The compound that will undergo  $\text{S}_\text{N}1$  reaction with the fastest rate is:**



**Correct Answer:** (1)

**Solution:**

### Step 1: Understanding $S_N1$ Mechanism

- The  $S_N1$  reaction follows a two-step mechanism: 1. Formation of a carbocation (rate-determining step). 2. Nucleophilic attack on the carbocation.
- The stability of the carbocation determines the rate of the reaction. - More stable carbocations (due to resonance, inductive effects, or hyperconjugation) favor faster  $S_N1$  reactions.

### Step 2: Analyzing the Given Options

- (1) Benzyl bromide with a methyl group ( $-\text{CH}_3$ ) at the benzylic position: - The benzyl carbocation formed after the departure of  $\text{Br}^-$  is highly stable due to resonance stabilization. - The methyl group provides additional hyperconjugation stabilization. - This makes it the “most reactive” in an  $S_N1$  mechanism.
- “(2) Cyclohexyl bromide:” - The formed “cyclohexyl carbocation” lacks resonance stabilization. - Only inductive effects contribute, making it “less stable”.
- “(3) Bromocyclohexane:” - The formed carbocation is “not stabilized by resonance”. - Less reactive than benzylic and allylic systems.
- “(4) Benzyl bromide (without additional stabilization):” - The “benzyl carbocation” is stable due to “resonance”, but lacks additional hyperconjugation effects”.
- Less reactive than “option (1)”, which has both “resonance and hyperconjugation”.

**Conclusion:** - The most stable carbocation corresponds to option (1) due to both resonance and hyperconjugation stabilization. - Therefore, option (1) undergoes the fastest  $S_N1$  reaction.

#### 💡 Quick Tip

- Carbocation stability order: **Benzyl ; Allyl ; Tertiary ; Secondary ; Primary**
- More stable carbocations favor  $S_N1$  reactions. - Resonance and hyperconjugation effects enhance carbocation stability.

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

N, O, F, C, Si

Choose the correct answer from the options given below:

- (A)  $F < O < N < C < Si$   
 (B)  $Si < C < N < O < F$   
 (C)  $Si < C < O < N < F$   
 (D)  $O < F < N < C < Si$

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

**Solution:**

**Step 1: Understanding Electronegativity Trends**

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

- Electronegativity increases across a period (left to right). - Electronegativity decreases down a group (top to bottom).

**Step 2: Comparing Electronegativity Values**

The approximate electronegativity values of the given elements are:

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

Arranging these in increasing order:

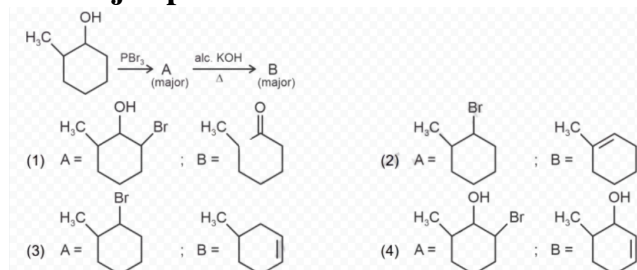
$$Si < C < N < O < F$$

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

**💡 Quick Tip**

Electronegativity follows the trend: - **Increases across a period** due to increasing nuclear charge. - **Decreases down a group** due to increasing atomic size and shielding effect.

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



**Correct Answer:** (2)

**Solution:**

**Step 1: Understanding the Reaction Sequence**

1. Reaction with  $PBr_3$  - The hydroxyl ( $-OH$ ) group in the starting compound undergoes substitution with bromine ( $-Br$ ) in the presence of phosphorus tribromide ( $PBr_3$ ). - This results in the formation of alkyl bromide (A).

2. Reaction with Alcoholic  $KOH$  (Elimination Reaction) - Alkyl bromide undergoes elimination ( $E2$  mechanism) in the presence of alcoholic  $KOH$  and heat ( $\Delta$ ). - The removal of  $\beta$ -hydrogen leads to the formation of an alkene (B) as the major product.

**Step 2: Identifying the Correct Structures of A and B**

- “Product A”: The  $-OH$  group is replaced by “Br” using “ $PBr_3$ ”. - “Product B”: “Alkene formation via elimination of  $HBr$ ”.

### Step 3: Verifying Answer Choices

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

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

#### 💡 Quick Tip

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

### 87. Identify the correct answer.

- (A) Three canonical forms can be drawn for  $CO_3^{2-}$  ion  
(B) Three resonance structures can be drawn for ozone  
(C)  $BF_3$  has non-zero dipole moment  
(D) Dipole moment of  $NF_3$  is greater than that of  $NH_3$

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

**Solution:**

#### Step 1: Understanding Resonance and Canonical Forms

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

#### Step 2: Checking Each Option

- **Option (1):** Correct. The carbonate ion has three equivalent resonance structures where the double bond rotates among the three oxygen atoms.
- **Option (2):** Incorrect. Ozone ( $O_3$ ) has only two resonance structures, not three.
- **Option (3):** Incorrect.  $BF_3$  is a symmetrical molecule, so its dipole moment is zero.
- **Option (4):** Incorrect. The dipole moment of  $NH_3$  is greater than that of  $NF_3$  due to the opposing direction of the bond dipoles in  $NF_3$ .

Correct answer: Option (1)

💡 Quick Tip

Resonance structures are different Lewis structures representing the same molecule, where electrons are delocalized. Canonical forms contribute to the actual hybrid structure.

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

- (A) 100 calories
- (B) 0 calorie
- (C) -413.14 calories
- (D) 413.14 calories

**Correct Answer:** (3) -413.14 calories

**Solution.**

$$W_{\text{rev, iso}} = -2.303 nRT \log \frac{P_i}{P_f}$$

Substituting the known values:

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

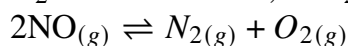
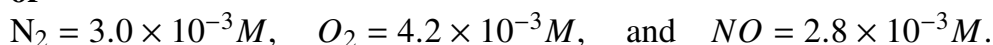
$$W_{\text{rev, iso}} = -2.303 \times 1 \times 2 \times 298 \times 0.3$$

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

💡 Quick Tip

In isothermal expansion, the work done is always negative because the system does work on the surroundings. The formula  $W = -nRT \ln(P_2/P_1)$  is crucial for such thermodynamic calculations.

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

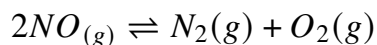


**If  $0.1 \text{ mol L}^{-1}$  of  $\text{NO}_{(g)}$  is taken in a closed vessel, what will be the degree of dissociation ( $\alpha$ ) of  $\text{NO}_{(g)}$  at equilibrium?**

- (A) 0.717
- (B) 0.00889
- (C) 0.0889

(D) 0.8889

**Correct Answer:** (1) 0.717



The equilibrium constant  $K_c$  is given by:

$$K_c = \frac{[N_2][O_2]}{[NO]^2}$$

Substituting the given values:

$$K_c = \frac{(3 \times 10^{-3}) \times (4.2 \times 10^{-3})}{(2.8 \times 10^{-3}) \times (2.8 \times 10^{-3})}$$

$$K_c = 1.607$$

**Equilibrium Concentration Table:**

| t      | [NO]                | [N <sub>2</sub> ] | [O <sub>2</sub> ] |
|--------|---------------------|-------------------|-------------------|
| 0      | 0.1                 | 0                 | 0                 |
| At eq. | $(0.1 - 0.1\alpha)$ | $0.05\alpha$      | $0.05\alpha$      |

The expression for  $K_c$ :

$$K_c = \frac{(0.05\alpha) \times (0.05\alpha)}{(0.1 - 0.1\alpha)^2}$$

$$K_c = \frac{(0.05\alpha) \times (0.05\alpha)}{0.01(1 - \alpha)^2}$$

Substituting  $K_c = 1.607$ :

$$1.607 = \frac{(0.05)^2 \alpha^2}{0.01(1 - \alpha)^2}$$

$$\frac{\alpha^2}{(1 - \alpha)^2} = \frac{1.607 \times (0.1)^2}{(0.05)^2}$$

Solving for  $\alpha$ :

$$\frac{\alpha}{1 - \alpha} = \frac{1.27 \times 0.1}{0.05}$$

$$\frac{\alpha}{1 - \alpha} = 2.54$$

$$\alpha = 2.54 - 2.54\alpha$$

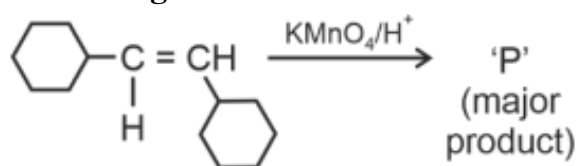
$$3.54\alpha = 2.54$$

$$\alpha = \frac{2.54}{3.54} = 0.717$$

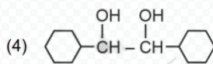
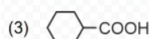
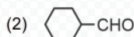
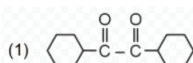
**💡 Quick Tip**

Degree of dissociation ( $\alpha$ ) is crucial in equilibrium calculations. Use the ICE (Initial-Change-Equilibrium) table to systematically determine equilibrium concentrations.

**90. For the given reaction:**



'P' is



**Correct Answer:** (3)

**Solution:**

**Step 1: Understanding the Reaction**

The given reaction involves the oxidation of an alkene using potassium permanganate ( $\text{KMnO}_4$ ) under acidic conditions. The strong oxidizing agent completely cleaves the double bond and converts the terminal alkene into a carboxylic acid.

**Step 2: Identifying the Major Product**

1. The starting compound contains a cyclohexyl group attached to an ethene moiety.
2. Under oxidative cleavage conditions ( $\text{KMnO}_4/\text{H}^+$ ), the double bond breaks completely.
3. The carbon attached to hydrogen ( $-\text{CH} = \text{CH}_2$ ) gets oxidized into a carboxyl group ( $-\text{COOH}$ ).
4. The final product, therefore, contains a cyclohexyl carboxylic acid.

**Step 3: Selecting the Correct Answer**

From the given options, option (3) best represents the correct product:

Cyclohexyl carboxylic acid ( $\text{COOH}$  attached to cyclohexyl)

**Step 4: Conclusion**

Thus, the major product formed in this oxidation reaction is:

Option (3): Cyclohexyl carboxylic acid

💡 Quick Tip

Oxidation of alkenes using  $\text{KMnO}_4/\text{H}^+$  leads to cleavage of the double bond, converting: - Terminal alkenes into carboxylic acids. - Internal alkenes into ketones or carboxylic acids, depending on the structure.

**91. The pair of lanthanoid ions which are diamagnetic is:**

- (A)  $\text{Pm}^{3+}$  and  $\text{Sm}^{3+}$   
(B)  $\text{Ce}^{4+}$  and  $\text{Yb}^{2+}$   
(C)  $\text{Ce}^{3+}$  and  $\text{Eu}^{2+}$   
(D)  $\text{Gd}^{3+}$  and  $\text{Eu}^{3+}$

**Correct Answer:** (2)  $\text{Ce}^{4+}$  and  $\text{Yb}^{2+}$

**Solution:**

**Step 1: Understanding Diamagnetism in Lanthanoids** A lanthanoid ion is diamagnetic if it has a completely filled or completely empty f-subshell. The electron configuration of relevant ions is:

-  $\text{Ce}^{4+}$  has an electron configuration of  $[\text{Xe}]$ , meaning it has no f-electrons (empty f-orbital). -  $\text{Yb}^{2+}$  has an electron configuration of  $[\text{Xe}]4f^{14}$ , meaning it has a completely filled f-subshell. Since both ions have either a fully empty or fully filled f-subshell, they exhibit diamagnetism.

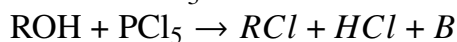
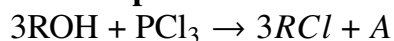
**Step 2: Examining Other Options** -  $\text{Pm}^{3+}$  and  $\text{Sm}^{3+}$  have unpaired electrons in their f-subshell, making them paramagnetic. -  $\text{Ce}^{3+}$  and  $\text{Eu}^{2+}$  have unpaired f-electrons, making them paramagnetic. -  $\text{Gd}^{3+}$  has a half-filled  $f^7$  configuration, making it paramagnetic, and  $\text{Eu}^{3+}$  also has unpaired electrons.

Thus, the only correct pair is  $\text{Ce}^{4+}$  and  $\text{Yb}^{2+}$ .

💡 Quick Tip

Lanthanoid ions are diamagnetic if they have either a fully filled  $f^{14}$  or an empty  $f^0$  configuration. Check electron configurations carefully.

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



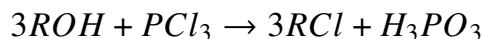
- (A)  $\text{H}_3\text{PO}_3$  and  $\text{POCl}_3$   
(B)  $\text{POCl}_3$  and  $\text{H}_3\text{PO}_3$   
(C)  $\text{POCl}_3$  and  $\text{H}_3\text{PO}_4$   
(D)  $\text{H}_3\text{PO}_4$  and  $\text{POCl}_3$

**Correct Answer:** (1)  $\text{H}_3\text{PO}_3$  and  $\text{POCl}_3$

**Solution:**

**Step 1: Identifying Products for First Reaction**

The reaction of phosphorus trichloride ( $PCl_3$ ) with alcohol ( $ROH$ ) follows:



Thus,  $A = H_3PO_3$  (Phosphorous acid).

**Step 2: Identifying Products for Second Reaction**

The reaction of phosphorus pentachloride ( $PCl_5$ ) with alcohol ( $ROH$ ) follows:



Thus,  $B = POCl_3$  (Phosphoryl chloride).

**Step 3: Verifying the Correct Option**

The correct pair of products is  $H_3PO_3$  and  $POCl_3$ , which matches option (1).

**💡 Quick Tip**

-  $PCl_3$  reacts with alcohols to form  $H_3PO_3$  (phosphorous acid). -  $PCl_5$  reacts with alcohols to form  $POCl_3$  (phosphoryl chloride).

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

A.  $Al^{3+}$  B.  $Cu^{2+}$  C.  $Ba^{2+}$  D.  $Co^{2+}$  E.  $Mg^{2+}$

- (A)  $E, A, B, C, D$   
(B)  $B, A, D, C, E$   
(C)  $B, C, A, D, E$   
(D)  $E, C, D, B, A$

**Correct Answer:** (2)  $B, A, D, C, E$

**Solution:**

**Step 1: Understanding Qualitative Analysis Groups**

In inorganic qualitative analysis, cations are divided into different groups based on their precipitation reactions with specific reagents. The classification follows:

- **Group 0:** Soluble cations that do not precipitate easily.
- **Group I:** Lead ( $Pb^{2+}$ ), Silver ( $Ag^+$ )
- **Group II:** Copper ( $Cu^{2+}$ ), Cadmium ( $Cd^{2+}$ ) (precipitated as sulfides)
- **Group III:** Aluminium ( $Al^{3+}$ ), Iron ( $Fe^{3+}$ ), Cobalt ( $Co^{2+}$ ) (precipitated as hydroxides)
- **Group IV:** Barium ( $Ba^{2+}$ ), Calcium ( $Ca^{2+}$ ), Strontium ( $Sr^{2+}$ ) (precipitated as carbonates)
- **Group V:** Magnesium ( $Mg^{2+}$ ) (precipitated as phosphates)

**Step 2: Assigning Groups to Given Cations**

| Cation    | Qualitative Group |
|-----------|-------------------|
| $Cu^{2+}$ | Group II          |
| $Al^{3+}$ | Group III         |
| $Co^{2+}$ | Group III         |
| $Ba^{2+}$ | Group IV          |
| $Mg^{2+}$ | Group V           |

### Step 3: Arranging in Increasing Order

Following the increasing group number from 0 to VI, the correct order is:

$B, A, D, C, E$

which matches option (2).

#### 💡 Quick Tip

- Qualitative analysis divides cations into groups based on precipitation reactions.
- Group II cations ( $Cu^{2+}$ ) precipitate as sulfides.
- Group III cations ( $Al^{3+}, Co^{2+}$ ) precipitate as hydroxides.
- Group IV cations ( $Ba^{2+}$ ) precipitate as carbonates.
- Group V cations ( $Mg^{2+}$ ) precipitate as phosphates.

### 94. Given below are two statements:

**Statement I:**  $[Co(NH_3)_6]^{3+}$  is a homoleptic complex whereas  $[Co(NH_3)_4Cl_2]^+$  is a heteroleptic complex.

**Statement II:** Complex  $[Co(NH_3)_6]^{3+}$  has only one kind of ligand but  $[Co(NH_3)_4Cl_2]^+$  has more than one kind of ligand.

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

- (A) Statement I is false but Statement II is true
- (B) Both Statement I and Statement II are true
- (C) Both Statement I and Statement II are false
- (D) Statement I is true but Statement II is false

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

**Solution:**

#### Step 1: Understanding Homoleptic and Heteroleptic Complexes

- A **homoleptic** complex contains only one type of ligand. - A **heteroleptic** complex contains more than one type of ligand.

#### Step 2: Examining the Given Complexes

- $[Co(NH_3)_6]^{3+}$  contains only ammonia ( $NH_3$ ) ligands, so it is a **homoleptic** complex.
- $[Co(NH_3)_4Cl_2]^+$  contains ammonia ( $NH_3$ ) and chloride ( $Cl^-$ ) ligands, making it a **heteroleptic** complex.

#### Step 3: Validating the Statements

- **Statement I** is true because it correctly defines  $[Co(NH_3)_6]^{3+}$  as homoleptic and  $[Co(NH_3)_4Cl_2]^+$  as heteroleptic.

- **Statement II** is also true because  $[Co(NH_3)_6]^{3+}$  has only one type of ligand ( $NH_3$ ), whereas  $[Co(NH_3)_4Cl_2]^+$  has two types of ligands ( $NH_3$  and  $Cl^-$ ).  
Thus, both statements are correct.

💡 Quick Tip

- **Homoleptic Complex:** Only one type of ligand is attached to the central metal ion. - **Heteroleptic Complex:** More than one type of ligand is attached to the central metal ion.

**95. A compound X contains 32% of A, 20% of B, and the remaining percentage of C. Then, the empirical formula of X is:**

(Given atomic masses of A = 64; B = 40; C = 32 u)

- (A)  $ABC_4$
- (B)  $A_2BC_2$
- (C)  $ABC_3$
- (D)  $AB_2C_2$

**Correct Answer:** (3)  $ABC_3$

**Solution:**

**Step 1: Determine the Percentage of C**

$$\text{Percentage of C} = 100\% - (32\% + 20\%) = 48\%$$

**Step 2: Calculate the Moles of Each Element**

Using the formula:

$$\text{Moles} = \frac{\text{Mass percentage}}{\text{Atomic mass}}$$

$$\text{Moles of A} = \frac{32}{64} = 0.5$$

$$\text{Moles of B} = \frac{20}{40} = 0.5$$

$$\text{Moles of C} = \frac{48}{32} = 1.5$$

**Step 3: Determine the Simplest Ratio**

Dividing by the smallest value (0.5):

$$A : B : C = \frac{0.5}{0.5} : \frac{0.5}{0.5} : \frac{1.5}{0.5} = 1 : 1 : 3$$

**Step 4: Deriving the Empirical Formula**

The empirical formula is:



**💡 Quick Tip**

To determine the empirical formula: 1. Convert percentage composition to moles.  
2. Divide by the smallest mole value. 3. Express in whole-number ratios.

**96. The plot of osmotic pressure ( $\Pi$ ) vs concentration ( $\text{mol L}^{-1}$ ) 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  $R = 0.083 \text{ L bar mol}^{-1} \text{ K}^{-1}$ )

(A)  $12.05^\circ\text{C}$

(B)  $37^\circ\text{C}$

(C)  $310^\circ\text{C}$

(D)  $25.73^\circ\text{C}$

**Correct Answer:** (2)  $37^\circ\text{C}$

**Solution:**

**Step 1: Using the Osmotic Pressure Equation**

The osmotic pressure equation is given by:

$$\Pi = CRT$$

where  $\Pi$  = osmotic pressure,  $C$  = concentration,  $R$  = universal gas constant,  $T$  = temperature in Kelvin.

The slope of the plot ( $\Pi$  vs  $C$ ) is given as  $25.73 \text{ L bar mol}^{-1}$ , which represents  $RT$ :

$$RT = 25.73$$

**Step 2: Calculating Temperature**

$$T = \frac{25.73}{0.083}$$

$$T = 310 \text{ K}$$

**Step 3: Converting to Celsius**

$$T = 310 - 273 = 37^\circ\text{C}$$

**Step 4: Final Answer**

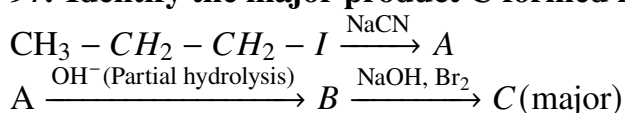
Thus, the temperature at which the osmotic pressure measurement was done is:

$$37^\circ\text{C}$$

**💡 Quick Tip**

To determine temperature from an osmotic pressure plot: - Identify the slope as  $RT$ .  
- Use  $T = \frac{\text{slope}}{R}$ . - Convert from Kelvin to Celsius if needed.

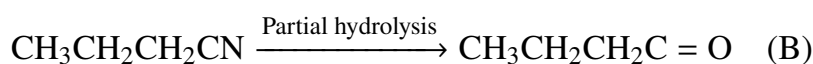
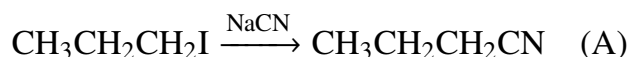
**97. Identify the major product C formed in the following reaction sequence:**



- (A)  $\alpha$ -bromobutanoic acid  
(B) propylamine  
(C) butylamine  
(D) butanamide

**Correct Answer:** (2) propylamine

**Solution:**



**💡 Quick Tip**

The Hoffmann bromamide degradation reaction is a key method to shorten a carbon chain by converting an amide to an amine.

**98. During the preparation of Mohr's salt solution (Ferrous ammonium sulphate), which of the following acids is added to prevent hydrolysis of  $\text{Fe}^{2+}$  ion?**

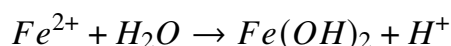
- (A) dilute sulphuric acid  
(B) dilute hydrochloric acid  
(C) concentrated sulphuric acid  
(D) dilute nitric acid

**Correct Answer:** (1) dilute sulphuric acid

**Solution:**

**Step 1: Understanding Hydrolysis Prevention in Mohr's Salt**

Mohr's salt ( $\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ ) contains ferrous ( $\text{Fe}^{2+}$ ) ions, which tend to undergo hydrolysis in aqueous solution, leading to oxidation and precipitation of ferric hydroxide ( $\text{Fe}(\text{OH})_3$ ).



**Step 2: Role of Dilute Sulphuric Acid**

To prevent hydrolysis, an acid is added to the solution. The best choice is **dilute sulphuric acid** because:

- It provides sufficient  $H^+$  ions to suppress hydrolysis.
- It does not oxidize  $Fe^{2+}$  to  $Fe^{3+}$ , unlike nitric acid, which is an oxidizing agent.
- It stabilizes the ferrous ions in solution.

### Step 3: Why Other Acids Are Not Suitable?

- Dilute hydrochloric acid ( $HCl$ ) is not preferred because chloride ions can react with  $Fe^{2+}$ , affecting its stability.
- Concentrated sulphuric acid is too strong and can cause excessive ionization, affecting solubility.
- Dilute nitric acid is an oxidizing agent and can convert  $Fe^{2+}$  to  $Fe^{3+}$ , which is undesirable.

### Step 4: Final Answer

Thus, the best choice is:  
dilute sulphuric acid

#### 💡 Quick Tip

Mohr's salt solution remains stable in the presence of dilute sulphuric acid due to the suppression of hydrolysis and oxidation of  $Fe^{2+}$ .

**99. The rate of a reaction quadruples when temperature changes from  $27^\circ C$  to  $57^\circ C$ . Calculate the energy of activation.**

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

- (A) 3804 kJ/mol
- (B) 38.04 kJ/mol
- (C) 380.4 kJ/mol
- (D) 3.80 kJ/mol

**Correct Answer:** (2) 38.04 kJ/mol

**Solution:**

#### Step 1: Arrhenius Equation and Log Form

Using the Arrhenius equation in logarithmic form:

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

Given that the rate quadruples,  $\frac{k_2}{k_1} = 4$ , so:

$$\log 4 = \frac{E_a}{2.303 \times 8.314} \times \left( \frac{57 + 273 - (27 + 273)}{(27 + 273)(57 + 273)} \right)$$

#### Step 2: Plugging in Values

$$0.6021 = \frac{E_a}{2.303 \times 8.314} \times \left( \frac{30}{(300)(330)} \right)$$

#### Step 3: Solving for $E_a$

$$E_a = \frac{0.6021 \times 2.303 \times 8.314 \times 300 \times 330}{30}$$

$$E_a = \frac{0.6021 \times 2.303 \times 8.314 \times 99000}{30}$$

$$E_a = \frac{114524}{30}$$

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

#### Step 4: Final Answer

Thus, the energy of activation is:  
38.04 kJ/mol

#### 💡 Quick Tip

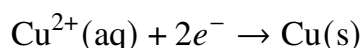
The Arrhenius equation is useful for determining activation energy from temperature-dependent reaction rates.

**100. Mass in grams of copper deposited by passing 9.6487 A current through a voltmeter containing copper sulphate solution for 100 seconds is (Given: Molar mass of Cu: 63 g mol<sup>-1</sup>, 1 F = 96487 C)**

- (A) 0.0315 g
- (B) 3.15 g
- (C) 0.315 g
- (D) 31.5 g

**Correct Answer:** (3) 0.315 g

**Solution:**



The mass of Cu deposited ( $w$ ) is given by the formula:

$$w = \frac{M \times i \times t}{n \times F}$$

Substituting the known values:

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

$$w = 0.315 \text{ g}$$

#### 💡 Quick Tip

For electrolysis problems, always use: - Faraday's First Law:  $m = \frac{ZIt}{F}$ , -  $Z$  calculation:  $Z = \frac{M}{nF}$ , - Use correct values of  $n$  and  $F$  for precise calculations.

## BOTANY

**101. The cofactor of the enzyme carboxypeptidase is:**

- (A) Haem
- (B) Zinc
- (C) Niacin
- (D) Flavin

**Correct Answer:** (2) Zinc

**Solution:**

### Step 1: Understanding Cofactors

Cofactors are non-protein chemical compounds that are required for an enzyme's biological activity. They can be metal ions or organic molecules.

### Step 2: Identifying the Cofactor for Carboxypeptidase

Carboxypeptidase is a metalloenzyme, meaning it requires a metal ion as a cofactor. The specific metal ion for carboxypeptidase is **Zinc ( $\text{Zn}^{2+}$ )**, which plays a crucial role in its enzymatic activity.

### Step 3: Function of Zinc in Carboxypeptidase

- Zinc stabilizes the enzyme structure. - It aids in catalysis by activating water molecules to assist in the hydrolysis of peptide bonds.

### Step 4: Conclusion

The correct answer is:

**Zinc (Option 2)**

#### 💡 Quick Tip

Many metalloenzymes, such as carboxypeptidase and carbonic anhydrase, require  $\text{Zn}^{2+}$  as a cofactor. Always check if an enzyme belongs to this category when solving related questions.

---

**102. 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.

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

- (A) Statement I is false but Statement II is true
- (B) Both Statement I and Statement II are true
- (C) Both Statement I and Statement II are false
- (D) Statement I is true but Statement II is false

**Correct Answer:** (1) Statement I is false but Statement II is true

**Solution:**

### Step 1: Evaluating Statement I

- Parenchyma is a living tissue that helps in storage, photosynthesis, and secretion. - Collenchyma is also a living tissue, but it provides mechanical support to the plant. - Since collenchyma is not dead tissue, Statement I is **false**.

### Step 2: Evaluating Statement II

- Gymnosperms lack xylem vessels, and their water-conducting cells are tracheids. - Xylem vessels are a characteristic feature of angiosperms. - Therefore, Statement II is **true**.

### Step 3: Conclusion

Since Statement I is incorrect and Statement II is correct, the correct answer is:

#### Option (1)

#### 💡 Quick Tip

- **Parenchyma and Collenchyma** are both living tissues, whereas Sclerenchyma is dead. - **Xylem vessels** are found in angiosperms, but gymnosperms rely on **tracheids** for water conduction.

### 103. Spindle fibers attach to kinetochores of chromosomes during:

- (A) Telophase
- (B) Prophase
- (C) Metaphase
- (D) Anaphase

#### Correct Answer: (3) Metaphase

#### Solution:

#### Step 1: Understanding Kinetochore and Spindle Fibers

- The **kinetochore** is a protein structure on chromatids where the spindle fibers attach during cell division. - Spindle fibers play a crucial role in the movement and segregation of chromosomes.

#### Step 2: Identifying the Phase in Which Attachment Occurs

- In **prophase**, spindle fibers begin to form but do not yet attach to kinetochores. - In **metaphase**, spindle fibers attach to the kinetochores of chromosomes at the metaphase plate. - In **anaphase**, the spindle fibers pull the sister chromatids apart. - In **telophase**, chromosomes decondense, and spindle fibers disappear.

#### Step 3: Conclusion

- The attachment of spindle fibers to kinetochores occurs during **metaphase**, ensuring the proper alignment of chromosomes before segregation. - Therefore, the correct answer is:

#### Option (3)

💡 Quick Tip

- **Prophase:** Spindle fibers begin to form.
- **Metaphase:** Spindle fibers attach to kinetochores.
- **Anaphase:** Chromatids are pulled apart.
- **Telophase:** Chromosomes decondense, spindle fibers disappear.

**104. In a plant, black seed color (BB/Bb) is dominant over white seed color (bb). In order to find out the genotype of the black seed plant, with which of the following genotype will you cross it?**

- (A) BB/Bb
- (B) BB
- (C) bb
- (D) Bb

**Correct Answer: (3) bb**

**Solution:**

**Step 1: Understanding the Concept**

- The black seed color is determined by either the dominant homozygous (**BB**) or the heterozygous (**Bb**) genotype. - The white seed color is determined by the recessive homozygous (**bb**) genotype.

**Step 2: Performing a Test Cross**

- A **test cross** is used to determine whether an organism displaying the dominant phenotype is **homozygous dominant (BB)** or **heterozygous (Bb)**. - To perform this test, the unknown genotype (BB or Bb) must be crossed with a homozygous recessive (**bb**) plant.

**Step 3: Expected Offspring**

1. If the black seed plant is **BB**, the cross  $BB \times bb$  will produce:

$100\%Bb$  (all black seeds)

2. If the black seed plant is **Bb**, the cross  $Bb \times bb$  will produce:

$50\%Bb$  (black seeds) and  $50\%bb$  (white seeds)

**Step 4: Conclusion**

- The presence of **white seeds** in the offspring confirms that the black seed plant was heterozygous (**Bb**). - If all seeds are black, the black seed plant was homozygous dominant (**BB**). - Since **bb** is required for this test cross, the correct answer is:

**Option (3)**

💡 Quick Tip

- A **test cross** always involves crossing the unknown genotype with a **homozygous recessive** individual.
- If any recessive offspring appear, the unknown genotype is heterozygous.

**105. The equation of Verhulst-Pearl logistic growth is:**

$$\frac{dN}{dt} = rN \left[ \frac{K - N}{K} \right]$$

**From this equation,  $K$  indicates:**

- (A) Population density
- (B) Intrinsic rate of natural increase
- (C) Biotic potential
- (D) Carrying capacity

**Correct Answer:** (4) Carrying capacity

**Solution:**

**Step 1: Understanding the Logistic Growth Equation**

- The logistic growth equation models population growth by considering environmental resistance.
- The term  $\frac{K-N}{K}$  represents the fraction of available resources remaining.

**Step 2: Identifying the Meaning of  $K$**

- $K$  in the equation represents the **carrying capacity**, which is the maximum population size that the environment can sustain indefinitely.
- When  $N$  (population size) is much smaller than  $K$ , growth is approximately exponential.
- As  $N$  approaches  $K$ , growth slows down due to limited resources.
- When  $N = K$ , population growth ceases ( $\frac{dN}{dt} = 0$ ).

**Step 3: Conclusion**

- Since  $K$  defines the maximum limit the population can reach in a given environment, it is best described as the **carrying capacity**.
- Thus, the correct answer is:

**Option (4)**

💡 Quick Tip

- **Exponential Growth Model:**  $\frac{dN}{dt} = rN$  (Unlimited growth)
- **Logistic Growth Model:**  $\frac{dN}{dt} = rN \left[ \frac{K-N}{K} \right]$  (Limited by resources)
- **Carrying Capacity ( $K$ ):** The upper limit on population size imposed by environmental constraints.

**106. How many molecules of ATP and NADPH are required for every molecule of  $CO_2$  fixed in the Calvin cycle?**

- (A) 3 molecules of ATP and 2 molecules of NADPH
- (B) 2 molecules of ATP and 3 molecules of NADPH

- (C) 2 molecules of ATP and 2 molecules of NADPH  
 (D) 3 molecules of ATP and 3 molecules of NADPH

**Correct Answer: (1) 3 molecules of ATP and 2 molecules of NADPH**

**Solution:**

**Step 1: Understanding the Calvin Cycle**

- The Calvin cycle is the light-independent reaction of photosynthesis that fixes  $CO_2$  into organic molecules. - It occurs in three phases: Carbon fixation, Reduction, and Regeneration of RuBP.

**Step 2: ATP and NADPH Requirements**

- Each  $CO_2$  molecule fixed in the Calvin cycle requires: - 3 ATP molecules (used in Reduction and Regeneration phases). - 2 NADPH molecules (used in the Reduction phase).

**Step 3: Conclusion**

- The correct answer is:

**Option (1): 3 ATP and 2 NADPH per  $CO_2$  fixed**

**💡 Quick Tip**

- **Total Requirement for 1 Glucose molecule:** - 6  $CO_2$  molecules fixed - 18 ATP + 12 NADPH used - **Ratio per  $CO_2$  fixed:** 3 ATP : 2 NADPH

**107. Match List I with List II.**

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

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

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

**Solution:**

**Step 1: Understanding the Microorganism and its Product**

- *Clostridium butylicum* produces butyric acid (A-III).
- *Saccharomyces cerevisiae* is used in fermentation to produce ethanol (B-I).
- *Trichoderma polysporum* produces Cyclosporin-A, an immunosuppressant (C-IV).
- *Streptococcus sp.* is used in the production of Streptokinase, a clot-dissolving enzyme (D-II).

**Step 2: Conclusion**

- The correct matching is:

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

- This corresponds to Option (4).

#### 💡 Quick Tip

- Microbial products have vast applications in medicine and industry. - Fermentation by *Saccharomyces cerevisiae* is widely used in alcohol production. - Streptokinase is used as a clot buster in treating heart diseases. - Cyclosporin-A is crucial for preventing organ rejection in transplants.

### 108. These are regarded as major causes of biodiversity loss:

- A. Over exploitation
- B. Co-extinction
- C. Mutation
- D. Habitat loss and fragmentation
- E. Migration

Choose the correct option:

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

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

**Solution:**

#### Step 1: Understanding the Major Causes of Biodiversity Loss

The four major causes of biodiversity loss, also known as the "Evil Quartet," are:

1. "Habitat loss and fragmentation: Destruction of natural habitats leads to loss of species.
2. "Over-exploitation": Excessive use of natural resources leads to depletion.
3. "Co-extinction": When a species goes extinct, dependent species also go extinct.
4. "Invasive species and climate change" (not mentioned in the options).

- "Mutation" (C) is a natural process and does not directly cause biodiversity loss.

- "Migration" (E) is a response to environmental changes but not a direct cause of biodiversity loss.

#### Step 2: Conclusion

- The correct factors causing biodiversity loss are A (Over-exploitation), B (Co-extinction), and D (Habitat loss and fragmentation). - This corresponds to Option (1).

**💡 Quick Tip**

- Biodiversity loss is primarily caused by habitat destruction, over-exploitation, and co-extinction. - Conservation efforts focus on protecting natural habitats and preventing species extinction.

**109. Given below are two statements:**

**Statement I:** Chromosomes become gradually visible under light microscope during leptotene stage.

**Statement II:** The beginning of diplotene stage is recognized by dissolution of synaptonemal complex.

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

- (A) Statement I is false but Statement II is true
- (B) Both Statement I and Statement II are true
- (C) Both Statement I and Statement II are false
- (D) Statement I is true but Statement II is false

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

**Solution:**

**Step 1: Understanding the Leptotene and Diplotene Stages**

1. “Leptotene Stage:” - The first stage of prophase I of meiosis. - Chromosomes start condensing and become gradually visible under the light microscope. - Thus, Statement I is correct.
2. “Diplotene Stage:” - The fourth stage of prophase I of meiosis. - Characterized by the dissolution of the synaptonemal complex, leading to separation of homologous chromosomes except at chiasmata. - “Thus, Statement II is also correct.”

**Step 2: Conclusion**

- Since both statements are correct, the correct answer is Option (2).

**💡 Quick Tip**

- Leptotene: Chromosomes become visible as thin threads. - Zygotene: Synapsis (pairing) of homologous chromosomes occurs. - Pachytene: Crossing over takes place. - Diplotene: Dissolution of the synaptonemal complex occurs.

**110. Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin**

- (A) can help in cell division in grasses, to produce growth.
- (B) promotes apical dominance.
- (C) promotes abscission of mature leaves only.
- (D) does not affect mature monocotyledonous plants.

**Correct Answer: (4) does not affect mature monocotyledonous plants**

### Solution:

#### Step 1: Understanding the Role of Auxins in Weed Control

1. Auxins are plant hormones used in selective herbicides to remove dicot weeds from monocot crop fields or lawns. 2. They affect dicot plants by promoting uncontrolled growth, leading to their death, while mature monocot plants remain unaffected.

#### Step 2: Evaluating the Given Options

- Option 1: Auxins primarily promote cell elongation rather than cell division. - Option 2: Auxins do promote apical dominance, but this is not related to their role in weed control. - Option 3: Auxins actually delay abscission rather than promoting it. - Option 4: **Correct.** Auxins do not significantly affect mature monocots, making them an effective selective herbicide.

#### Step 3: Conclusion

- Since Option (4) correctly explains why auxins are used for weed control without harming grasses, it is the correct answer.

#### 💡 Quick Tip

- Auxins like 2,4-D (2,4-dichlorophenoxyacetic acid) are used as selective herbicides. - They effectively kill dicot weeds while leaving monocot grasses unharmed.

**111. A pink flowered Snapdragon plant was crossed with a red flowered Snapdragon plant. What type of phenotype/s is/are expected in the progeny?**

- (A) Red, Pink as well as white flowered plants
- (B) Only red flowered plants
- (C) Red flowered as well as pink flowered plants
- (D) Only pink flowered plants

**Correct Answer:** (3) Red flowered as well as pink flowered plants

**Solution: Step 1:** Understanding the genetics of Snapdragon flower color.

In Snapdragon (*Antirrhinum*), flower color follows the pattern of incomplete dominance: - The red flower color (**RR**) is dominant. - The white flower color (**rr**) is recessive. - The heterozygous condition (**Rr**) produces pink flowers due to incomplete dominance.

**Step 2:** Setting up the cross.

The given cross is between a pink-flowered (**Rr**) and a red-flowered (**RR**) plant:

$$Rr \times RR$$

**Step 3:** Determining the offspring genotype and phenotype.

Using a Punnett square:

|          |           |           |
|----------|-----------|-----------|
|          | <i>R</i>  | <i>R</i>  |
| <i>R</i> | <i>RR</i> | <i>RR</i> |
| <i>r</i> | <i>Rr</i> | <i>Rr</i> |

The offspring distribution is: - 50- 50

**Step 4:** Conclusion. Thus, the progeny will consist of both red and pink-flowered plants, but no white-flowered plants. Hence, the correct answer is Option (3).

#### 💡 Quick Tip

In incomplete dominance, the heterozygous condition exhibits a blend of the dominant and recessive traits. This is different from codominance, where both traits appear distinctly.

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

- A. Light
- B. Chlorophyll
- C. CO<sub>2</sub>
- D. ATP
- E. NADPH

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

**Correct Answer:** (4) C, D and E only

#### **Solution: Step 1: Understanding the dark reaction of photosynthesis**

The dark reaction, also known as the **Calvin Cycle**, occurs in the stroma of chloroplasts. Unlike the light-dependent reaction, it does not require direct sunlight. Instead, it utilizes the products of the light-dependent reaction to synthesize glucose.

#### **Step 2: Identifying the required components**

1. **CO<sub>2</sub>** (C) is required as a raw material for the Calvin cycle.
2. **ATP** (D) is produced in the light reaction and provides the energy required for carbon fixation.
3. **NADPH** (E) is also generated during the light reaction and provides reducing power for the conversion of 3-PGA into G3P.

#### **Step 3: Eliminating unnecessary components**

- Light (A) is necessary for the light reaction, but not for the Calvin Cycle.

- Chlorophyll (B) is a pigment essential for capturing light energy, but it is not directly involved in the dark reaction.

**Step 4: Conclusion** Since the Calvin Cycle requires **CO<sub>2</sub> (C), ATP (D), and NADPH (E)**, the correct answer is Option (4) - C, D, and E only.

💡 Quick Tip

The dark reaction is also known as the **light-independent reaction** or the **Calvin-Benson Cycle**. It depends on ATP and NADPH produced in the light-dependent reaction to drive carbon fixation.

**113. The lactose present in the growth medium of bacteria is transported to the cell by the action of**

- (A) Polymerase
- (B) Beta-galactosidase
- (C) Acetylase
- (D) Permease

**Correct Answer:** (4) Permease

**Solution:**

**Step 1: Understanding the role of lactose in bacterial cells**

Lactose is a disaccharide composed of glucose and galactose. In bacteria, especially in *E. coli*, lactose metabolism is regulated by the **lac operon**, which controls the expression of enzymes responsible for lactose transport and breakdown.

**Step 2: Identifying the function of the given enzymes**

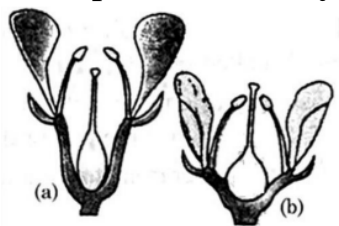
1. **Polymerase (A)** is responsible for synthesizing DNA or RNA but does not transport lactose.
2. **Beta-galactosidase (B)** is the enzyme that breaks down lactose into glucose and galactose but does not transport it into the cell.
3. **Acetylase (C)** is involved in biochemical modifications and is not directly related to lactose transport.
4. **Permease (D)** is the correct answer because it facilitates the transport of lactose across the bacterial cell membrane.

**Step 3: Conclusion** Since **Lactose permease** is the enzyme responsible for transporting lactose into the bacterial cell, the correct answer is Option (4) - Permease.

💡 Quick Tip

The **lac operon** in *E. coli* consists of three key genes: - **lacZ** (codes for Beta-galactosidase) - **lacY** (codes for Permease) - **lacA** (codes for Transacetylase)

**114. Identify the type of flowers based on the position of calyx, corolla, and androecium with respect to the ovary from the given figures (a) and (b):**



- (A) (a) Perigynous; (b) Perigynous  
 (B) (a) Epigynous; (b) Hypogynous  
 (C) (a) Hypogynous; (b) Epigynous  
 (D) (a) Perigynous; (b) Epigynous

**Correct Answer:** (1) (a) Perigynous; (b) Perigynous

**Solution: Step 1: Understanding flower types based on ovary position**

- In **Perigynous flowers**, the ovary is **half-inferior**, meaning that the floral parts (calyx, corolla, and androecium) are arranged around the ovary at the same level due to the presence of a floral cup or hypanthium.

- In **Epigynous flowers**, the ovary is **inferior**, meaning the floral parts are positioned above the ovary.

- In **Hypogynous flowers**, the ovary is **superior**, meaning the floral parts are attached below the ovary.

**Step 2: Analyzing the given diagrams**

- Figure (a) shows a **perigynous** flower where the floral parts are at the same level as the ovary.  
 - Figure (b) also shows a **perigynous** flower.

**Step 3: Conclusion** Since both figures (a) and (b) exhibit the characteristics of **Perigynous flowers**, the correct answer is Option (1).

**💡 Quick Tip**

- In **Hypogynous** flowers, the ovary is superior (e.g., Mustard, Brinjal). - In **Perigynous** flowers, the ovary is half-inferior (e.g., Rose, Peach). - In **Epigynous** flowers, the ovary is inferior (e.g., Guava, Cucumber).

**115. Match List I with List II**

| List-I             | List-II          |
|--------------------|------------------|
| A. <i>Rhizopus</i> | I. Mushroom      |
| B. <i>Ustilago</i> | II. Smut fungus  |
| C. <i>Puccinia</i> | III. Bread mould |
| D. <i>Agaricus</i> | IV. Rust fungus  |

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

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

**Solution: Step 1: Understanding the classifications of fungi**

- *Rhizopus*: A bread mould, so it matches with III. - *Ustilago*: A smut fungus, so it matches with II. - *Puccinia*: A rust fungus, so it matches with IV. - *Agaricus*: A mushroom, so it matches with I.

**Step 2: Matching List I with List II**

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

**Step 3: Conclusion** The correct answer is **Option (2)**.

💡 Quick Tip

- *Rhizopus* is commonly found in decomposing organic matter. - *Ustilago* is responsible for smut disease in crops. - *Puccinia* is a genus of rust fungi, affecting plants like wheat. - *Agaricus* includes species such as *Agaricus bisporus* (button mushroom).

**116. The type of conservation in which the threatened species are taken out from their natural habitat and placed in a special setting where they can be protected and given special care is called:**

- (A) Sustainable development
- (B) *in-situ* conservation
- (C) Biodiversity conservation
- (D) Semi-conservative method

**Correct Answer:** (3) Biodiversity conservation

**Solution:**

**Step 1: Understanding Conservation Methods**

There are two primary types of conservation: - ***In-situ* conservation**: Protecting species in their natural habitat (e.g., National Parks, Wildlife Sanctuaries). - ***Ex-situ* conservation**: Removing species from their natural habitat and placing them in special settings such as zoos, botanical gardens, and seed banks.

**Step 2: Identifying the Correct Answer**

The question refers to species being "taken out from their natural habitat and placed in a special setting." This aligns with **ex-situ conservation**, which is a part of **biodiversity conservation**.

Thus, the correct answer is **Option (3)**.

 Quick Tip

- *In-situ* conservation is preferred because it maintains ecosystems naturally. - *Ex-situ* conservation is essential for species that are critically endangered and require human intervention for survival. - Examples of *Ex-situ* conservation include captive breeding programs and seed banks.

**117. Match List I with List II**

| List-I | Cell Organelle  | List-II | Function                                |
|--------|-----------------|---------|-----------------------------------------|
| 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                   |

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

**Solution:**

**Step 1: Understanding the Function of Each Organelle**

- **Nucleolus:** Produces ribosomal RNA (rRNA) and is essential for ribosome synthesis.

- **Centriole:** Plays a crucial role in cell division and forms a structure resembling a cartwheel.

- **Leucoplasts:** Colorless plastids responsible for the storage of nutrients such as starch, oils, and proteins.

- **Golgi Apparatus:** Involved in packaging, modifying, and sorting molecules such as glycolipids and glycoproteins.

**Step 2: Matching the Correct Pairs**

- **Nucleolus** → **Site for active ribosomal RNA synthesis (III)** - **Centriole** → **Organization like the cartwheel (II)** - **Leucoplasts** → **For storing nutrients (IV)** - **Golgi apparatus** → **Site of formation of glycolipid (I)**

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

 Quick Tip

- Nucleolus is known as the "ribosome factory" of the cell. - Centrioles are absent in plant cells. - Leucoplasts are present in non-photosynthetic parts of plants like roots. - Golgi apparatus is involved in modifying proteins and lipids.

**118. The capacity to generate a whole plant from any cell of the plant is called:**

(A) Somatic hybridization

(B) Totipotency

- (C) Micropropagation  
(D) Differentiation

**Correct Answer:** (2) Totipotency

**Solution:**

**Step 1: Understanding Totipotency**

Totipotency is the ability of a single plant cell to divide and differentiate into an entire organism. This concept was first demonstrated by Gottlieb Haberlandt and is the basis of plant tissue culture.

**Step 2: Explanation of Other Options**

- **Somatic Hybridization:** This involves the fusion of protoplasts from different species or varieties to form a hybrid cell.

- **Micropropagation:** It refers to the technique of growing plants in vitro using tissue culture methods.

- **Differentiation:** This is the process where unspecialized cells become specialized in structure and function.

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

 **Quick Tip**

Totipotency is the fundamental principle behind plant tissue culture techniques, which are used for cloning and genetic modification of plants.

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**119. Formation of interfascicular cambium from fully developed parenchyma cells is an example for**

- (A) Maturation  
(B) Differentiation  
(C) Redifferentiation  
(D) Dedifferentiation

**Correct Answer:** (4) Dedifferentiation

**Solution:**

**Step 1: Understanding Dedifferentiation**

Dedifferentiation is the process where mature, specialized cells regain their capacity to divide and become meristematic again. In plants, this process allows cells to resume mitotic activity and contribute to secondary growth.

**Step 2: Explanation of Other Options**

- **Maturation:** It refers to the final stage of cell development where cells achieve their functional specialization.

- **Differentiation:** It is the process where meristematic cells develop into specialized cells

with distinct functions.

- **Redifferentiation:** This occurs when dedifferentiated cells again develop into specialized tissues after regaining their meristematic activity.

Thus, the correct answer is **Option (4) Dedifferentiation**.

💡 Quick Tip

Dedifferentiation plays a crucial role in plant wound healing and secondary growth, as seen in the formation of interfascicular cambium.

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

1. Out of one pair of factors one is dominant and the other is recessive.
2. Alleles do not show any expression and both the characters appear as such in  $F_2$  generation.
3. Factors occur in pairs in normal diploid plants.
4. The discrete unit controlling a particular character is called factor.
5. The expression of only one of the parental characters is found in a monohybrid cross.

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

**Correct Answer:** (3) A, C, D and E only

**Solution: Step 1:** Understanding Mendel's Law of Dominance.

Mendel's Law of Dominance states that in a pair of contrasting traits, one trait (dominant) masks the expression of the other trait (recessive) in the  $F_1$  generation.

**Step 2:** Explanation of the given statements:

- **(A) True:** Mendel's Law of Dominance states that one factor is dominant over the other.
  - **(B) False:** This describes incomplete dominance, not Mendel's Law of Dominance.
  - **(C) True:** Mendel proposed that factors (genes) exist in pairs in diploid organisms.
  - **(D) True:** The discrete units of inheritance are now known as genes.
  - **(E) True:** The dominant trait is expressed in the  $F_1$  generation in monohybrid crosses.
- Thus, the correct answer is **(3) A, C, D, and E only**.

💡 Quick Tip

Mendel's Laws of Inheritance include: - **Law of Dominance:** One allele is dominant over the other. - **Law of Segregation:** Alleles segregate independently during gamete formation. - **Law of Independent Assortment:** Genes for different traits assort independently.

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

1. The piece of DNA would be able to multiply itself independently in the progeny cells of the organism.
2. It may get integrated into the genome of the recipient.
3. It may multiply and be inherited along with the host DNA.
4. The alien piece of DNA is not an integral part of chromosome.
5. It shows ability to replicate.

- (A) A and E only  
(B) A and B only  
(C) D and E only  
(D) B and C only

**Correct Answer:** (4) B and C only

**Solution: Step 1:** Understanding the fate of foreign DNA in an alien organism.

When a foreign piece of DNA carrying a gene of interest is introduced into an alien organism, it can have different fates:

**Step 2:** Explanation of the given statements:

- **(A) False:** A piece of DNA without an origin of replication cannot replicate independently unless incorporated into a plasmid.

- **(B) True:** If the foreign DNA gets integrated into the genome of the recipient, it will become a permanent part of the organism's DNA.

- **(C) True:** If the foreign DNA integrates with the host genome, it will multiply and be inherited by the next generations.

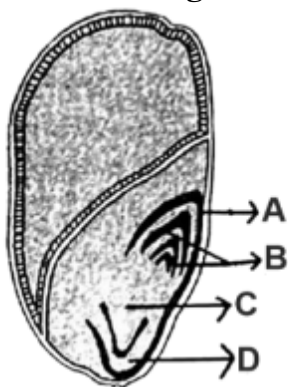
- **(D) False:** If the DNA integrates into the genome, it becomes part of the chromosome.

- **(E) False:** Only DNA with a suitable origin of replication can show the ability to replicate. Thus, the correct answer is **(4) B and C only**.

💡 Quick Tip

In genetic engineering, foreign DNA can either: - Integrate into the genome, ensuring stable inheritance. - Remain as an extrachromosomal element if it has an origin of replication.

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



- (A) D
- (B) A
- (C) B
- (D) C

**Correct Answer:** (4) C

**Solution:**

**Step 1: Understanding Seed Structure**

A seed consists of various parts, including the cotyledons, plumule, radicle, and seed coat. The radicle is the part of the embryo that gives rise to the root system during germination.

**Step 2: Identifying the Correct Part**

- The labeled part **C** in the given diagram corresponds to the radicle. - The radicle is the first structure to emerge during germination, developing into the root system. - Other parts such as the plumule (A or B) develop into the shoot, while the cotyledons provide nourishment. Thus, the correct answer is **(4) C**.

💡 Quick Tip

The **radicle** is the embryonic root and is the first part to emerge during seed germination, growing downward to anchor the plant.

**123. Match List I with List II**

| List I |                                                      | List II |            |
|--------|------------------------------------------------------|---------|------------|
| A.     | Two or more alternative forms of a gene              | I.      | Back cross |
| B.     | Cross of F1 progeny with homozygous recessive parent | II.     | Ploidy     |
| C.     | Cross of F1 progeny with any of the parents          | III.    | Allele     |
| D.     | Number of chromosome sets in plant                   | IV.     | Test cross |

Choose the correct answer from the options given below:

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

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

**Solution: Step 1:** Let's break down each item to match them correctly:

- **A. Two or more alternative forms of a gene:** These are called **alleles**, so A-III is correct.
- **B. Cross of F1 progeny with homozygous recessive parent:** This is a **test cross**, so B-IV is correct.
- **C. Cross of F1 progeny with any of the parents:** This is known as a **back cross**, so C-I is correct.
- **D. Number of chromosome sets in plant:** This refers to **ploidy**, so D-II is correct.

Therefore, the correct match is A-III, B-IV, C-I, D-II, corresponding to option (4).

#### 💡 Quick Tip

In genetics, alleles are different forms of a gene, test crosses are used to determine genotype, back crosses involve crossing F1 progeny with parents, and ploidy refers to the number of chromosome sets.

### 124. Identify the set of correct statements:

1. The flowers of *Vallisneria* are colourful and produce nectar.
2. The flowers of water lily are not pollinated by water.
3. In most of water-pollinated species, the pollen grains are protected from wetting.
4. Pollen grains of some hydrophytes are long and ribbon-like.
5. In some hydrophytes, the pollen grains are carried passively inside water.

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

**Correct Answer:** (1) B, C, D and E only

**Solution:**

**Step 1: Understanding the correctness of statements**

- Statement A: Incorrect. The flowers of *Vallisneria* are **not** colourful and do **not** produce nectar. They rely on water pollination. - Statement B: Correct. Water lily flowers are **not** pollinated by water; they are pollinated by insects.

- Statement C: Correct. In water-pollinated species, pollen grains have a **protective coating** to prevent wetting.

- Statement D: Correct. Some hydrophytes have **long and ribbon-like** pollen grains for easy dispersal in water.

- Statement E: Correct. In some hydrophytes, pollen grains are **passively** carried inside the water for pollination.

**Step 2: Selecting the correct option** Since statements B, C, D, and E are correct, the correct answer is option (1).

💡 Quick Tip

- **Hydrophily** is pollination by water, occurring in some submerged plants. - *Vallisneria* follows epihydrophily (pollination on the water surface). - *Zostera* follows hypohydrophily (pollination underwater).

**125. Inhibition of Succinic dehydrogenase enzyme by malonate is a classical example of:**

- (A) Enzyme activation
- (B) Cofactor inhibition
- (C) Feedback inhibition
- (D) Competitive inhibition

**Correct Answer:** (4) Competitive inhibition

**Solution:**

**Step 1: Understanding Competitive Inhibition**

- Competitive inhibition occurs when a substance competes with the substrate for the active site of an enzyme. - Malonate is a structural analog of succinate, which is the substrate for the enzyme succinic dehydrogenase. - Malonate competes with succinate for the enzyme's active site but does not undergo further reaction, thus inhibiting enzyme activity.

**Step 2: Explanation of Incorrect Options**

- Option (1) Enzyme activation: Incorrect, because malonate does not activate the enzyme;

instead, it inhibits it.

- Option (2) Cofactor inhibition: Incorrect, because malonate inhibits the enzyme by directly binding to the active site, not by interfering with a cofactor.
- Option (3) Feedback inhibition: Incorrect, as feedback inhibition involves the end product of a pathway inhibiting an earlier step in the same pathway.

### Step 3: Conclusion

Since malonate competes with succinate for binding to succinic dehydrogenase but does not get metabolized, this is a classical example of competitive inhibition.

#### 💡 Quick Tip

- **Competitive inhibitors** resemble the substrate in structure and bind to the active site.
- Increasing substrate concentration can overcome competitive inhibition.
- Malonate is a well-known example of a competitive inhibitor of *Succinic dehydrogenase*.

---

### 126. List of endangered species was released by

- (A) IUCN
- (B) GEAC
- (C) WWF
- (D) FOAM

**Correct Answer:** (1) IUCN

#### Solution:

##### Step 1: Understanding IUCN and the Red List

- The **International Union for Conservation of Nature (IUCN)** is responsible for maintaining and publishing the **IUCN Red List of Threatened Species**. - This list categorizes species based on their risk of extinction, such as Endangered (EN), Vulnerable (VU), Critically Endangered (CR), and Extinct (EX).

##### Step 2: Explanation of Incorrect Options

- Option (2) GEAC (Genetic Engineering Appraisal Committee): Incorrect, as GEAC regulates genetic engineering and biotechnology-related research, not endangered species.
- Option (3) WWF (World Wide Fund for Nature): Incorrect, though WWF is involved in conservation efforts, it does not officially release the Red List.
- Option (4) FOAM (Federation of Organic Agriculture Movements): Incorrect, as FOAM focuses on organic farming, not biodiversity conservation.

### Step 3: Conclusion

The IUCN Red List is the most authoritative source for the global conservation status of species. Hence, the correct answer is **IUCN**.

💡 Quick Tip

- The **IUCN Red List** helps track conservation status, trends, and necessary actions to protect species. - Categories include **Least Concern (LC)**, **Near Threatened (NT)**, **Vulnerable (VU)**, **Endangered (EN)**, **Critically Endangered (CR)**, **Extinct in the Wild (EW)**, and **Extinct (EX)**.

**127. Given below are two statements:**

**Statement I:** Bt toxins are insect group specific and coded by a gene *cry* IAc.

**Statement II:** Bt toxin exists as inactive protoxin in *B. thuringiensis*. However, after ingestion by the insect, the inactive protoxin gets converted into active form due to acidic pH of the insect gut.

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

- (1) Statement I is false but Statement II is true
- (2) Both Statement I and Statement II are true
- (3) Both Statement I and Statement II are false
- (4) Statement I is true but Statement II is false

**Correct Answer:** (4) Statement I is true but Statement II is false

**Solution:**

**Step 1: Understanding Bt Toxins**

*Bacillus thuringiensis* (*Bt*) produces a class of proteins called *cry* proteins, which act as insecticidal toxins. These toxins are highly specific to certain groups of insects, meaning different *cry* genes target different insect orders.

**Step 2: Evaluating Statement I**

Statement I is correct. The Bt toxin is encoded by *cry* genes, which are specific to particular insect groups. The gene *cry* IAc, for example, targets lepidopteran larvae.

**Step 3: Evaluating Statement II**

Statement II is incorrect. Bt toxin exists in an inactive protoxin form in *B. thuringiensis*, but upon ingestion by an insect, it gets converted into its active form due to the **alkaline** (not acidic) pH of the insect gut. The alkaline pH solubilizes the protoxin, which is then cleaved by proteases to form an active toxin.

**Step 4: Conclusion**

Since Statement I is true and Statement II is false, the correct answer is (4).

💡 Quick Tip

Bt toxin activation occurs in the **alkaline** midgut of insects, not acidic conditions. *Cry* genes are specific to different insect groups.

**128. Lecithin, a small molecular weight organic compound found in living tissues, is an**

**example of:**

- (1) Carbohydrates
- (2) Amino acids
- (3) Phospholipids
- (4) Glycerides

**Correct Answer:** (3) Phospholipids

**Solution:**

**Step 1: Understanding Lecithin**

Lecithin is a naturally occurring lipid that plays a crucial role in biological membranes. It is primarily found in plant and animal tissues, where it functions as an emulsifier and stabilizer.

**Step 2: Classification of Lecithin**

Lecithin belongs to a class of lipids called **phospholipids**. These molecules consist of glycerol, fatty acids, a phosphate group, and an organic molecule such as choline. Phospholipids are vital components of cell membranes, contributing to membrane fluidity and cellular function.

**Step 3: Evaluating the Given Options**

- Option (1) Carbohydrates: Carbohydrates include sugars, starches, and fibers, which provide energy but do not form cellular membranes.
- Option (2) Amino acids: Amino acids are the building blocks of proteins, not lipids.
- Option (3) Phospholipids: Lecithin is classified as a phospholipid, making this the correct answer.
- Option (4) Glycerides: Glycerides (such as triglycerides) are simple lipids, whereas phospholipids contain a phosphate group, differentiating them from glycerides.

**Step 4: Conclusion**

Since lecithin is a phospholipid, the correct answer is option (3).

**💡 Quick Tip**

Phospholipids, such as lecithin, are key components of biological membranes, forming the lipid bilayer and regulating membrane permeability.

---

**129. Which of the following is an example of actinomorphic flower?**

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

**Correct Answer:** (2) *Datura*

**Solution:**

### Step 1: Understanding Floral Symmetry

Flowers can be classified based on their symmetry into two types: - **Actinomorphic flowers** (radial symmetry): These flowers can be divided into equal halves along multiple planes passing through the center. - **Zygomorphic flowers** (bilateral symmetry): These flowers can be divided into equal halves only along a single plane.

### Step 2: Evaluating the Given Options

- Option (1) *Sesbania*: This is a zygomorphic flower.
- Option (2) *Datura*: This is an actinomorphic flower, meaning it exhibits radial symmetry.
- Option (3) *Cassia*: Although some species of *Cassia* show slight actinomorphic tendencies, they are predominantly zygomorphic.
- Option (4) *Pisum*: *Pisum* (pea) flowers are zygomorphic.

### Step 3: Conclusion

Since *Datura* is an example of an actinomorphic flower, the correct answer is option (2).

#### 💡 Quick Tip

Actinomorphic flowers have radial symmetry, meaning they can be divided into two equal halves along multiple planes (e.g., *Datura* and *Hibiscus*).

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### 130. Tropical regions show greatest level of species richness because

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

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

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

#### **Solution:**

#### **Step 1: Understanding Species Richness in Tropical Regions**

- Tropical regions support high species richness due to **stable climates, high solar energy availability, and evolutionary time**.
- **Tropical latitudes** have remained undisturbed for millions of years, allowing longer time for species diversification (Statement A).

- **More solar energy** in tropical regions increases primary productivity, supporting diverse ecosystems (Statement C).
- **Constant environments promote niche specialization**, leading to diverse adaptations and interactions among species (Statement D).
- **Predictable and stable tropical environments** reduce extinction rates, allowing species to thrive (Statement E).

### Step 2: Explanation of Incorrect Statement

- Statement B (Tropical environments are more seasonal) is incorrect since tropical environments are relatively stable throughout the year compared to temperate and polar regions.

### Step 3: Conclusion

The correct answer is **A, C, D, and E**, as they all contribute to species richness in tropical regions.

#### 💡 Quick Tip

- **Species richness** in tropical regions is driven by long evolutionary time, high productivity, niche specialization, and stable environments.
- Understanding tropical biodiversity helps in conservation and management efforts.

### 131. Hind II always cuts DNA molecules at a particular point called recognition sequence and it consists of:

- (1) 10 bp
- (2) 8 bp
- (3) 6 bp
- (4) 4 bp

**Correct Answer:** (3) 6 bp

#### Solution:

#### Step 1: Understanding Restriction Enzymes

- **Hind II** is a type of **restriction endonuclease** that recognizes and cuts DNA at a specific sequence.
- The **recognition sequence** for Hind II consists of six base pairs (6 bp).

#### Step 2: Explanation of Recognition Sequence

- Hind II was the first restriction enzyme to be discovered that cuts DNA at a specific nucleotide sequence.
- Its recognition site is typically a **palindromic sequence** of 6 base pairs.
- This specificity allows for consistent and reproducible DNA fragment patterns.

#### Conclusion :

- Since Hind II recognizes and cuts DNA at a 6 bp long sequence, the correct answer is (3) 6 bp.

#### 💡 Quick Tip

- Restriction enzymes like Hind II are widely used in genetic engineering and molecular cloning. - Their ability to cut DNA at specific sites is essential for recombinant DNA technology.

### 132. Bulliform cells are responsible for

- (1) Providing large spaces for storage of sugars.
- (2) Inward curling of leaves in monocots.
- (3) Protecting the plant from salt stress.
- (4) Increased photosynthesis in monocots.

**Correct Answer:** (2) Inward curling of leaves in monocots.

#### **Solution:**

##### **Step 1: Understanding Bulliform Cells**

- Bulliform cells are specialized, large, thin-walled epidermal cells found in the leaves of monocots, particularly grasses. - They are generally located on the upper surface of leaves, arranged in groups along the veins.

##### **Step 2: Function of Bulliform Cells**

- These cells play a crucial role in **leaf folding and unfolding**, which helps plants conserve water during dry conditions. - During water stress, bulliform cells lose turgor pressure, causing the leaves to curl inward, reducing the exposed surface area and minimizing water loss.

#### **Conclusion :**

- Since bulliform cells are responsible for the inward curling of leaves in monocots, the correct answer is (2) Inward curling of leaves in monocots.

#### 💡 Quick Tip

- Bulliform cells help in drought resistance by reducing transpiration. - Their function is especially important in xerophytic monocots like grasses.

### 133. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and downstream end:

- (1) Promoter, Structural gene, Terminator
- (2) Repressor, Operator gene, Structural gene
- (3) Structural gene, Transposons, Operator gene
- (4) Inducer, Repressor, Structural gene

**Correct Answer:** (1) Promoter, Structural gene, Terminator

#### **Solution:**

##### **Step 1: Understanding the Transcription Unit**

A transcription unit in DNA consists of three key components:

1. Promoter: - Located at the upstream end. - Serves as the binding site for RNA polymerase. - Initiates transcription.
2. Structural Gene: - Contains the coding sequence. - This sequence is transcribed into mRNA. - Carries the genetic information required for protein synthesis.
3. Terminator: - Located at the downstream end. - Signals the RNA polymerase to stop transcription. - Ensures the transcription process ends correctly.

### Step 2: Explanation of Incorrect Options

- Option (2): Repressor and Operator gene are parts of the operon model, not the basic transcription unit.
- Option (3): Transposons are mobile genetic elements and are not part of the transcription unit.
- Option (4): Inducer and Repressor regulate gene expression but do not define a transcription unit.

### Conclusion :

- Since a transcription unit consists of a Promoter, Structural Gene, and Terminator, the correct answer is (1) Promoter, Structural gene, Terminator.

#### 💡 Quick Tip

- The promoter is essential for initiating transcription. - The structural gene contains the actual genetic code for protein synthesis. - The terminator ensures proper termination of transcription.

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### 134. Which one of the following is not a criterion for classification of fungi?

- (1) Fruiting body
- (2) Morphology of mycelium
- (3) Mode of nutrition
- (4) Mode of spore formation

**Correct Answer:** (3) Mode of nutrition

#### Solution:

#### Step 1: Understanding the Classification Criteria of Fungi

Fungi are classified based on: - Morphology of mycelium – The structure and organization of fungal filaments (hyphae). - Mode of spore formation – How fungi reproduce asexually or sexually. - Fruiting body – The reproductive structures where spores are formed.

#### Step 2: Explanation of Incorrect Options

- (1) Fruiting body: A significant classification criterion, as fungi are grouped based on reproductive structures like basidiocarps and ascocarps.

- (2) Morphology of mycelium: Fungi exhibit different types of mycelium (septate or coenocytic), helping in classification.
- (4) Mode of spore formation: Spores can be produced asexually or sexually, playing a key role in fungal taxonomy.

### Step 3: Why Option (3) is Correct?

- **Mode of nutrition is not a criterion** because all fungi are heterotrophic (absorptive feeders).
- While some fungi are saprophytic, parasitic, or symbiotic, these distinctions do not serve as primary classification criteria.

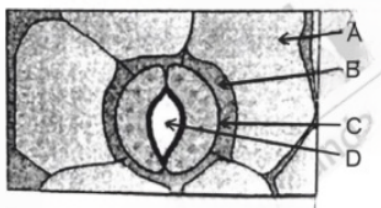
### Step 4: Conclusion

- Since fungi classification is based on mycelial structure, fruiting bodies, and spore formation rather than mode of nutrition, the correct answer is (3) Mode of nutrition.

#### 💡 Quick Tip

- Fungal classification is primarily based on morphology, reproductive structures, and spore production.
- Mode of nutrition (e.g., saprophytic or parasitic) is not a direct criterion.

**135. In the given figure, which component has thin outer walls and highly thickened inner walls?**



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

**Correct Answer:** (2) C

**Solution:**

#### Step 1: Understanding Guard Cells and Their Walls

Guard cells are specialized cells surrounding the stomatal pore in plant epidermis. They regulate gas exchange by controlling the opening and closing of stomata. The structure of guard cells is unique as they have **thin outer walls and highly thickened inner walls**.

#### Step 2: Evaluating the Given Options

- Component A: Appears to be an adjacent epidermal cell.
- Component B: Likely part of the subsidiary cell, which supports the function of guard cells.

- Component C: Identified as the guard cell, which has thin outer walls and thick inner walls.
- Component D: Likely the stomatal pore.

### Step 3: Explanation of Wall Structure

Guard cells are structured in such a way that their inner walls (facing the stomatal pore) are thicker than the outer walls. This asymmetry is essential for their function, as turgor pressure causes the thinner outer walls to expand, pulling the thicker inner walls apart and opening the stomatal pore.

### Step 4: Conclusion

Since guard cells (Component C) possess thin outer walls and thickened inner walls, the correct answer is option (2) C.

#### 💡 Quick Tip

Guard cells control stomatal opening by changing turgor pressure. Their **thick inner walls** and **thin outer walls** enable efficient stomatal movement.

## 1 SECTION-B

### 136. Match List I with List II

| List I (Types of Stamens) |               | List II (Example) |            |
|---------------------------|---------------|-------------------|------------|
| A.                        | Monadelphous  | I.                | Citrus     |
| B.                        | Diadelphous   | II.               | Pea        |
| C.                        | Polyadelphous | III.              | Lily       |
| D.                        | Epiphyllous   | IV.               | China-rose |

**Choose the correct answer from the options given below:**

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

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

**Solution:**

#### Step 1: Understanding the Types of Stamens and Their Examples

1. “Monadelphous” – Stamens are united by their filaments into a single bundle, e.g., China-rose (Hibiscus).
2. “Diadelphous” – Stamens are united in two groups, e.g., Pea (Pisum sativum).
3. “Polyadelphous” – Stamens are united into multiple bundles, e.g., Citrus.

4. “Epiphyllous” – Stamens are attached to the petals, e.g., Lily.

**Step 2: Matching the Correct Pairs**

- A (Monadelphous) → IV (China-rose)
- B (Diadelphous) → II (Pea)
- C (Polyadelphous) → I (Citrus)
- D (Epiphyllous) → III (Lily)

Thus, the correct matching is A-IV, B-II, C-I, D-III, which corresponds to Option (2).

**💡 Quick Tip**

- Monadelphous stamens are fused into a single bundle.
- Diadelphous stamens are in two groups, common in pea family.
- Polyadelphous stamens are arranged in multiple groups, seen in Citrus.
- Epiphyllous stamens are attached to petals, a feature of Lily.

**137. The DNA present in chloroplast is:**

- (A) Circular, single stranded
- (B) Linear, double stranded
- (C) Circular, double stranded
- (D) Linear, single stranded

**Correct Answer:** (3) Circular, double stranded

**Solution:**

**Step 1: Understanding Chloroplast DNA**

Chloroplasts are semi-autonomous organelles found in plant cells and some protists. They contain their own genetic material, which is similar to prokaryotic DNA.

**Step 2: Characteristics of Chloroplast DNA**

- Chloroplast DNA is similar to bacterial DNA. - It is **circular** in shape, not linear. - It is **double-stranded**, meaning it follows the Watson-Crick base pairing rules. - This characteristic supports the endosymbiotic theory, which suggests that chloroplasts evolved from ancient cyanobacteria.

**Step 3: Elimination of Incorrect Options**

- **Option (A):** Incorrect, because chloroplast DNA is not single-stranded.
- **Option (B):** Incorrect, as it is circular, not linear.
- **Option (C):** Correct, because chloroplast DNA is circular and double-stranded.
- **Option (D):** Incorrect, as it is not linear or single-stranded.

Thus, the correct answer is Option (3): Circular, double-stranded.

💡 Quick Tip

- Chloroplast and mitochondrial DNA are both circular and double-stranded. - These organelles replicate independently from the nucleus. - This supports the endosymbiotic origin of organelles.

**138. Read the following statements and choose the set of correct statements:**

**In the members of Phaeophyceae,**

- (A) Asexual reproduction occurs usually by biflagellate zoospores.
- (B) Sexual reproduction is by oogamous method only.
- (C) Stored food is in the form of carbohydrates which is either mannitol or laminarin.
- (D) The major pigments found are chlorophyll a, c and carotenoids and xanthophyll.
- (E) Vegetative cells have a cellulosic wall, usually covered on the outside by gelatinous coating of algin.

**Choose the correct answer from the options given below:**

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

**Correct Answer:** (4) A, C, D and E only

**Solution:**

**Step 1: Understanding Phaeophyceae (Brown Algae)**

Phaeophyceae, commonly known as brown algae, are a group of marine algae that are characterized by: - Their pigmentation, which includes chlorophyll **a** and **c**, along with carotenoids and xanthophylls.

- Their unique storage food, which is in the form of **mannitol** and **laminarin**.

- Their cell walls, which contain **cellulose** and are covered externally by a **gelatinous coating of algin**.

**Step 2: Verification of Statements**

- Statement (A): Correct. Brown algae reproduce asexually by means of **biflagellate zoospores**, which are motile.

- Statement (B): Incorrect. Brown algae exhibit different types of sexual reproduction, including isogamy, anisogamy, and oogamy. Hence, sexual reproduction is **not restricted to oogamy only**.

- Statement (C): Correct. The stored food in Phaeophyceae is **mannitol** and **laminarin**, which are carbohydrate-based.

- Statement (D): Correct. Brown algae contain **chlorophyll a**, **chlorophyll c**, **carotenoids**, and **xanthophyll**, which contribute to their brownish coloration.

- Statement (E): Correct. The cell wall of brown algae consists of **cellulose** and an external gelatinous coating of **algin**, which provides flexibility and protection.

### Step 3: Eliminating Incorrect Options

- Option (1): Incorrect, as statement (B) is not true.

- Option (2): Incorrect, as statement (B) is included.

- Option (3): Incorrect, as statement (B) is included.

- Option (4): Correct, since statements (A), (C), (D), and (E) are correct.

Thus, the correct answer is Option (4): A, C, D, and E only.

#### 💡 Quick Tip

- Brown algae store food in the form of mannitol and laminarin. - They possess chlorophyll a, c, carotenoids, and xanthophylls for photosynthesis. - Cell walls are made up of cellulose and covered with a gelatinous coating of algin.

### 139. Match List I with List II

| List I                       | List II                                  |
|------------------------------|------------------------------------------|
| A. Citric acid cycle         | I. Cytoplasm                             |
| B. Glycolysis                | II. Mitochondrial matrix                 |
| C. Electron transport system | III. Intermembrane space of mitochondria |
| D. Proton gradient           | IV. Inner mitochondrial membrane         |

Choose the correct answer from the options given below:

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

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

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

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

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

**Solution:** Let's break down each option to match the processes to the correct locations:

- **Citric acid cycle:** The citric acid cycle occurs in the **mitochondrial matrix**, so A-II is correct.
- **Glycolysis:** Glycolysis takes place in the **cytoplasm**, so B-I is correct.
- **Electron transport system:** The electron transport chain occurs in the **inner mitochondrial membrane**, so C-IV is correct.
- **Proton gradient:** The proton gradient is created in the **intermembrane space of mitochondria**, so D-III is correct.

Therefore, the correct match is A-I, B-II, C-III, D-IV, corresponding to option (2).

💡 Quick Tip

When studying cellular processes, remember the key locations for each function: - Glycolysis occurs in the cytoplasm. - Citric acid cycle occurs in the mitochondrial matrix. - Electron transport chain happens in the inner mitochondrial membrane. - Proton gradients are created in the intermembrane space of mitochondria.

**140. Given below are two statements:**

**Statement I:** In  $C_3$  plants, some  $O_2$  binds to RuBisCO, hence  $CO_2$  fixation is decreased.

**Statement II:** In  $C_4$  plants, mesophyll cells show very little photorespiration while bundle sheath cells do not show photorespiration.

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

- (1) Statement I is false but Statement II is true
- (2) Both Statement I and Statement II are true
- (3) Both Statement I and Statement II are false
- (4) Statement I is true but Statement II is false

**Correct Answer:** (4) Statement I is true but Statement II is false

**Solution:**

**Step 1: Understanding Statement I**

- In  $C_3$  plants, RuBisCO acts as an oxygenase in the presence of  $O_2$ , leading to **photorespiration**, which reduces  $CO_2$  fixation efficiency. - Hence, Statement I is **true**.

**Step 2: Understanding Statement II**

- In  $C_4$  plants, mesophyll cells completely lack RuBisCO and hence do not perform photorespiration at all. - However, **bundle sheath cells do have RuBisCO**, and under stress conditions, some amount of photorespiration may occur. - Hence, the claim that bundle sheath cells do not show photorespiration is **false**, making Statement II incorrect.

**Step 3: Conclusion**

- Statement I is **true**, and Statement II is **false**. - Hence, the correct answer is Option (4).

💡 Quick Tip

-  $C_3$  plants undergo significant **photorespiration** due to RuBisCO's affinity for  $O_2$ .  
-  $C_4$  plants have a **Kranz anatomy** where mesophyll cells lack RuBisCO, reducing photorespiration. - However, some level of **photorespiration may occur in bundle sheath cells** under stress.

**141. Which of the following statements is correct regarding the process of replication in *E.coli*?**

- (1) The DNA dependent DNA polymerase catalyses polymerization in  $5' \rightarrow 3'$  direction
- (2) The DNA dependent DNA polymerase catalyses polymerization in one direction that is  $3' \rightarrow 5'$
- (3) The DNA dependent RNA polymerase catalyses polymerization in one direction, that is  $5' \rightarrow 3'$
- (4) The DNA dependent DNA polymerase catalyses polymerization in  $5' \rightarrow 3'$  as well as  $3' \rightarrow 5'$  direction

**Correct Answer:** (1) The DNA dependent DNA polymerase catalyses polymerization in  $5' \rightarrow 3'$  direction

**Solution:**

**Step 1: Understanding DNA Replication in *E. coli***

DNA replication in *E. coli* follows the semi-conservative model where each parental strand serves as a template for new strand synthesis. The enzyme responsible for replication is **DNA-dependent DNA polymerase**.

**Step 2: Direction of Polymerization**

DNA polymerase adds nucleotides to the growing DNA strand in the  $5' \rightarrow 3'$  direction only by extending the  $3'$  hydroxyl ( $-OH$ ) group. The enzyme cannot synthesize DNA in the  $3' \rightarrow 5'$  direction.

**Step 3: Evaluating the Given Options**

- Option (1): Correct. DNA-dependent DNA polymerase catalyzes polymerization exclusively in the  $5' \rightarrow 3'$  direction.
- Option (2): Incorrect. DNA polymerase cannot synthesize DNA in the  $3' \rightarrow 5'$  direction.
- Option (3): Incorrect. DNA-dependent RNA polymerase synthesizes RNA, not DNA.
- Option (4): Incorrect. DNA polymerase does not catalyze polymerization in both directions.

**Step 4: Conclusion**

Since DNA polymerase synthesizes DNA only in the  $5' \rightarrow 3'$  direction, the correct answer is option (1).

**💡 Quick Tip**

DNA polymerase can only extend DNA in the  $5' \rightarrow 3'$  direction. The lagging strand forms Okazaki fragments, which are later joined by DNA ligase.

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**142. 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-IV, C-II, D-I  
(2) A-II, B-III, C-I, D-IV  
(3) A-III, B-I, C-IV, D-II  
(4) A-I, B-III, C-II, D-IV

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

**Solution:**

**Step 1: Understanding the Contributions of Scientists**

- **Robert May:** Estimated **global species diversity** to be around **7 million**. ⇒ (III)

- **Alexander von Humboldt:** Established the **Species-Area relationship**, showing that species richness increases with area. ⇒ (I)

- **Paul Ehrlich:** Proposed the **Rivet popper hypothesis**, comparing species extinction to rivets popping off an airplane. ⇒ (IV)

- **David Tilman:** Conducted **long-term ecosystem experiments** on biodiversity and ecosystem stability using outdoor plots. ⇒ (II)

**Step 2: Conclusion**

- The correct matching is A-III, B-I, C-IV, D-II, which corresponds to Option (3).

#### 💡 Quick Tip

- The **Species-Area relationship** shows that species richness increases with habitat area. - The **Rivet Popper Hypothesis** explains that losing species affects ecosystem stability, similar to rivets on an airplane wing. - **Long-term ecosystem experiments** analyze biodiversity's role in ecosystem function over extended periods.

### 143. Match List I with List II.

| List I | Scientist                     | List II | Concept                                   |
|--------|-------------------------------|---------|-------------------------------------------|
| 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-IV, B-I, C-II, D-III
- (2) A-III, B-II, C-I, D-IV
- (3) A-III, B-IV, C-I, D-II
- (4) A-II, B-III, C-IV, D-I

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

**Solution:**

**Step 1: Understanding the Contributions of Scientists**

- **Frederick Griffith:** Discovered the phenomenon of **Transformation** in bacteria.  $\Rightarrow$  (III)  
- **Francois Jacob & Jacque Monod:** Proposed the **Lac operon** model for gene regulation in prokaryotes.  $\Rightarrow$  (IV) - **Har Gobind Khorana:** Helped decipher the **Genetic code** and synthetic RNA research.  $\Rightarrow$  (I) - **Meselson & Stahl:** Provided experimental proof of the **Semi-conservative mode of DNA replication**.  $\Rightarrow$  (II)

**Step 2: Conclusion**

- The correct matching is A-III, B-IV, C-I, D-II, which corresponds to Option (3).

**💡 Quick Tip**

- **Transformation** involves the uptake of genetic material by bacteria. - The **Lac operon** regulates lactose metabolism in *E. coli*. - **Genetic code** consists of codons that specify amino acids. - **Semi-conservative replication** means each new DNA molecule contains one original and one new strand.

**144. In an ecosystem, if the Net Primary Productivity (NPP) of the first trophic level is  $100x \text{ kcal m}^{-2}\text{yr}^{-1}$ , what would be the GPP (Gross Primary Productivity) of the third trophic level of the same ecosystem?**

- (1)  $\frac{100x}{3} \text{ kcal m}^{-2}\text{yr}^{-1}$
- (2)  $\frac{x}{10} \text{ kcal m}^{-2}\text{yr}^{-1}$
- (3)  $x \text{ kcal m}^{-2}\text{yr}^{-1}$
- (4)  $10x \text{ kcal m}^{-2}\text{yr}^{-1}$

**Correct Answer:** (4)  $10x \text{ kcal m}^{-2}\text{yr}^{-1}$

**Solution:**

**Step 1: Understanding Energy Transfer in an Ecosystem**

- Energy transfer between trophic levels follows the 10

**Step 2: Calculating Energy for the Third Trophic Level**

- The given Net Primary Productivity (NPP) of the first trophic level (producers) is  $100x$ . - The primary consumers (second trophic level) receive 10

$$\frac{10}{100} \times 100x = 10x$$

- The secondary consumers (third trophic level) will again receive 10

$$\frac{10}{100} \times 10x = x$$

### Step 3: Calculating GPP for the Third Trophic Level

- In ecosystems, Gross Primary Productivity (GPP) is always greater than NPP due to the energy used in respiration (R). - Given that NPP is related to GPP by the equation:

$$NPP = GPP - R$$

- Assuming the same respiration rate at each trophic level, the GPP of the third trophic level is estimated as:

$$10x$$

### Step 4: Conclusion

- The correct answer is Option (4):  $10x \text{ kcal m}^{-2}\text{yr}^{-1}$ .

#### 💡 Quick Tip

- 10- GPP vs. NPP:  $NPP = GPP - \text{Respiration}$ . - Energy decreases as we move up the trophic levels in an ecosystem.

## 145. Match List I with List II

| List I    | List II                   |
|-----------|---------------------------|
| A. Rose   | I. Twisted aestivation    |
| B. Pea    | II. Perigynous flower     |
| C. Cotton | III. Drupe                |
| D. Mango  | IV. Marginal placentation |

Choose the correct answer from the options given below:

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

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

**Solution:**

### Step 1: Understanding Floral Characteristics

Different plants exhibit specific floral characteristics, including placentation, aestivation, and fruit type.

### Step 2: Matching List I with List II

- A. Rose → II. Perigynous flower: In perigynous flowers, the ovary is partially embedded, and floral parts arise from the rim of the receptacle (e.g., Rose).
- B. Pea → IV. Marginal placentation: In marginal placentation, the ovules are attached to a single ridge in a unilocular ovary (e.g., Pea).

- C. Cotton → I. Twisted aestivation: In twisted aestivation, one petal overlaps the next petal, forming a twisted arrangement (e.g., Cotton).

- D. Mango → III. Drupe: A drupe is a fleshy fruit with a hard endocarp (e.g., Mango).

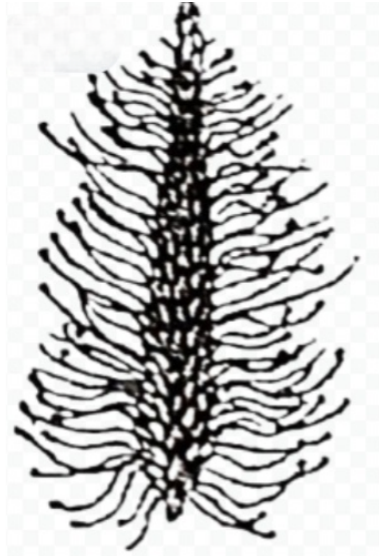
### Step 3: Conclusion

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

#### 💡 Quick Tip

- **Perigynous flowers** have a semi-inferior ovary, like in *Rosa*. - **Marginal placentation** is seen in *Pea*, with ovules along one side. - **Twisted aestivation** occurs when petals overlap (e.g., *Cotton*). - **Drupe** is a fruit with a fleshy mesocarp and a hard endocarp, seen in *Mango*.

146. Identify the correct description about the given figure:



- (1) Compact inflorescence showing complete autogamy
- (2) Wind pollinated plant inflorescence showing flowers with well exposed stamens.
- (3) Water pollinated flowers showing stamens with mucilaginous covering.
- (4) Cleistogamous flowers showing autogamy.

**Correct Answer:** (2) Wind pollinated plant inflorescence showing flowers with well exposed stamens.

### Solution:

#### Step 1: Understanding Pollination Mechanisms

Pollination is the transfer of pollen from the anther to the stigma. It can occur via different mechanisms such as wind, water, and self-pollination.

#### Step 2: Evaluating the Given Figure

The provided figure represents an inflorescence characteristic of wind pollinated plants. Wind-pollinated plants, also known as anemophilous plants, have specific adaptations: - Large inflorescences with a high number of flowers. - Well-exposed stamens that help in pollen dispersal.

- Feathery stigmas to trap pollen grains efficiently.
- Lightweight pollen grains that can be carried by the wind.

### Step 3: Evaluating the Given Options

- Option (1): Incorrect. Compact inflorescences do not favor wind pollination; rather, they support self-pollination (autogamy).
- Option (2): Correct. The structure of the inflorescence in the image suggests wind pollination due to exposed stamens and feathery stigma.
- Option (3): Incorrect. Water-pollinated plants (hydrophilous) typically have pollen grains with mucilage for floating, which is not observed here.
- Option (4): Incorrect. Cleistogamous flowers are small, closed flowers that undergo self-pollination, unlike the open structure in the image.

### Step 4: Conclusion

Since the figure represents a wind-pollinated inflorescence with well-exposed stamens, the correct answer is option (2).

#### 💡 Quick Tip

Wind-pollinated plants have feathery stigmas, lightweight pollen, and well-exposed stamens for effective pollen dispersal (e.g., maize and grasses).

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

- (1) Isocitrate  $\rightarrow$   $\alpha$ -ketoglutaric acid
- (2) Malic acid  $\rightarrow$  Oxaloacetic acid
- (3) Succinic acid  $\rightarrow$  Malic acid
- (4) Succinyl-CoA  $\rightarrow$  Succinic acid

**Correct Answer:** (4) Succinyl-CoA  $\rightarrow$  Succinic acid

#### Solution:

#### Step 1: Understanding Oxidation in the TCA Cycle

The tricarboxylic acid (TCA) cycle, also known as the Krebs cycle, involves multiple oxidation steps where electrons are transferred to  $\text{NAD}^+$  or FAD, leading to ATP generation. However, not all reactions in the cycle involve oxidation.

#### Step 2: Evaluating the Given Options

- Option (1): Isocitrate  $\rightarrow$   $\alpha$ -ketoglutaric acid - Incorrect. This step is catalyzed by isocitrate dehydrogenase and involves the oxidation of isocitrate, producing NADH.
- Option (2): Malic acid  $\rightarrow$  Oxaloacetic acid - Incorrect. This reaction is catalyzed by malate dehydrogenase and involves oxidation, generating NADH.

- Option (3): Succinic acid  $\rightarrow$  Malic acid - Incorrect. This step is catalyzed by fumarase but follows an oxidation step from succinate to fumarate.
- Option (4): Succinyl-CoA  $\rightarrow$  Succinic acid - Correct. This step is catalyzed by succinyl-CoA synthetase and involves substrate-level phosphorylation, not oxidation.

### Conclusion :

The conversion of Succinyl-CoA to Succinic acid does not involve oxidation but rather the generation of GTP/ATP via substrate-level phosphorylation. Thus, the correct answer is option (4).

### 💡 Quick Tip

The only substrate-level phosphorylation step in the TCA cycle occurs during the conversion of Succinyl-CoA to Succinic acid.

**148. Spraying sugarcane crop with which of the following plant growth regulators increases the length of the stem, thus, increasing the yield?**

- (1) Absciscic acid
- (2) Auxin
- (3) Gibberellin
- (4) Cytokinin

**Correct Answer:** (3) Gibberellin

### Solution:

#### Step 1: Understanding Plant Growth Regulators

Plant growth regulators (PGRs) are chemical substances that influence various physiological processes in plants, including stem elongation, cell division, and stress responses.

#### Step 2: Role of Gibberellins in Stem Elongation

Gibberellins (GA) are a group of plant hormones that play a crucial role in promoting stem elongation by stimulating cell division and elongation. In crops like sugarcane, gibberellins help increase the internodal length, leading to taller plants and higher yield.

#### Step 3: Evaluating the Given Options

- Option (1): Absciscic acid - Incorrect. Absciscic acid (ABA) is a growth-inhibiting hormone that promotes dormancy and stress responses rather than stem elongation.
- Option (2): Auxin - Incorrect. Auxins primarily regulate root development, apical dominance, and cell elongation but are not as effective as gibberellins in promoting stem elongation.
- Option (3): Gibberellin - Correct. Gibberellins significantly increase the internodal length in sugarcane, thereby enhancing yield.
- Option (4): Cytokinin - Incorrect. Cytokinins promote cell division and delay senescence

but do not contribute to stem elongation significantly.

#### Step 4: Conclusion

Since gibberellins are responsible for increasing stem length and boosting yield in sugarcane crops, the correct answer is option (3).

#### 💡 Quick Tip

Gibberellins are widely used in agriculture to promote stem elongation in sugarcane, grapes, and other crops, leading to increased yield.

#### 149. Match List-I with List-II

| List-I      | List-II                                  |
|-------------|------------------------------------------|
| A. GLUT-4   | I. Hormone                               |
| B. Insulin  | II. Enzyme                               |
| C. Trypsin  | III. ntercellular ground substance       |
| D. Collagen | IV. Enables glucose transport into cells |

Choose the correct answer from the options given below:

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

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

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

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

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

#### Solution:

##### Step 1: Understanding the Biological Roles of Each Component

Each component in List-I plays a distinct role in human physiology, related to hormone function, enzymatic activity, or structural roles.

##### Step 2: Matching List-I with List-II

- A. GLUT-4 → IV. Enables glucose transport into cells - GLUT-4 (Glucose Transporter-4) is responsible for glucose uptake into muscle and adipose tissues, facilitated by insulin.

- B. Insulin → I. Hormone - Insulin is a peptide hormone secreted by the pancreas, regulating blood glucose levels.

- C. Trypsin → II. Enzyme - Trypsin is a digestive enzyme that breaks down proteins in the small intestine.

- D. Collagen → III. Intercellular ground substance - Collagen is a structural protein found in connective tissues, acting as an intercellular matrix component.

##### Step 3: Conclusion

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

### 💡 Quick Tip

- GLUT-4 facilitates glucose transport into cells. - Insulin is a peptide hormone regulating blood sugar. - Trypsin is a proteolytic enzyme aiding digestion. - Collagen is a structural protein providing strength to tissues.

**150. Which of the following are fused in somatic hybridization involving two varieties of plants?**

- (1) Pollens
- (2) Callus
- (3) Somatic embryos
- (4) Protoplasts

**Correct Answer:** (4) Protoplasts

**Solution:**

#### **Step 1: Understanding Somatic Hybridization**

Somatic hybridization is a technique used in plant biotechnology to produce hybrid plants by fusing protoplasts from two different plant varieties. This method enables the combination of desirable traits from different species or varieties without involving sexual reproduction.

#### **Step 2: Evaluating the Given Options**

- Option (1): Pollens - Incorrect. Pollens are involved in sexual reproduction and fertilization, not in somatic hybridization.

- Option (2): Callus - Incorrect. Callus is a mass of undifferentiated plant cells that can be used in tissue culture but is not directly involved in protoplast fusion.

- Option (3): Somatic embryos - Incorrect. Somatic embryos are formed during tissue culture and are used for plant regeneration but are not fused in hybridization.

- Option (4): Protoplasts - Correct. Protoplasts (cells without cell walls) from two different plant varieties are fused using techniques like polyethylene glycol (PEG)-induced fusion or electrofusion to produce somatic hybrids.

#### **Step 3: Conclusion**

Since protoplast fusion is the key mechanism in somatic hybridization, the correct answer is option (4).

### 💡 Quick Tip

Protoplast fusion allows for genetic recombination in plants without sexual reproduction, useful for creating hybrids with desirable traits.

## 2 SECTION-A

**151. The flippers of the Penguins and Dolphins are an example of:**

- (1) Divergent evolution
- (2) Adaptive radiation
- (3) Natural selection
- (4) Convergent evolution

**Correct Answer:** (4) Convergent evolution

**Solution:**

### **Step 1: Understanding Evolutionary Patterns**

Evolution can occur in different patterns, including divergent evolution, convergent evolution, and adaptive radiation. These processes explain how organisms develop similarities or differences over time.

### **Step 2: Explanation of Convergent Evolution**

Convergent evolution occurs when unrelated species develop similar traits due to adaptation to similar environmental conditions rather than shared ancestry. This results in analogous structures, which perform the same function but have different evolutionary origins.

### **Step 3: Evaluating the Given Options**

- Option (1): Divergent evolution - Incorrect. Divergent evolution leads to species developing different traits from a common ancestor, as seen in homologous structures.

- Option (2): Adaptive radiation - Incorrect. Adaptive radiation refers to the evolution of different species from a common ancestor, each adapted to different environments.

- Option (3): Natural selection - Incorrect. Natural selection drives evolutionary changes but does not specifically describe the formation of analogous structures.

- Option (4): Convergent evolution - Correct. The flippers of Penguins (birds) and Dolphins (mammals) evolved independently to serve the same function (swimming), making them an example of convergent evolution.

### **Step 4: Conclusion**

Since Penguins and Dolphins are not closely related but developed similar flippers due to adaptation to aquatic life, the correct answer is option (4).

#### Quick Tip

Convergent evolution results in analogous structures, where organisms from different lineages develop similar adaptations due to similar environmental pressures.

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**152. Match List I with List II and choose the correct answer from the options given below:**

| List I           | List II           |
|------------------|-------------------|
| A. Pleurobrachia | I. Mollusca       |
| B. Radula        | II. Ctenophora    |
| C. Stomochord    | III. Osteichthyes |
| D. Air bladder   | IV. Hemichordata  |

**Choose the correct answer from the option given below:**

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

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

**Solution:**

**Step 1: Understanding the correct matches** - **Pleurobrachia** belongs to Ctenophora, a phylum of marine invertebrates. Thus, A-II. - **Radula** is a specialized feeding organ found in Mollusca. Thus, B-I. - **Stomochord** is a characteristic feature of Hemichordata, aiding in support and function. Thus, C-IV. - **Air bladder** is present in Osteichthyes (bony fishes), helping in buoyancy. Thus, D-III.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

This matches option (3).

#### 💡 Quick Tip

Understanding Animal Classification: - **Pleurobrachia**: Belongs to Ctenophora (marine invertebrates). - **Radula**: A feeding structure found in Mollusca. - **Stomochord**: A structure present in Hemichordata. - **Air bladder**: Found in Osteichthyes, helps in buoyancy.

**153. Which of the following is not a component of the Fallopian tube?**

- (1) Ampulla
- (2) Uterine fundus
- (3) Isthmus
- (4) Infundibulum

**Correct Answer:** (2) Uterine fundus

**Solution:**

**Step 1: Understanding the Fallopian Tube Structure**

The Fallopian tube (also called the uterine tube or oviduct) is a paired tubular structure in female reproductive anatomy that connects the ovary to the uterus. It plays a crucial role in egg transport and fertilization.

**Step 2: Components of the Fallopian Tube**

The Fallopian tube consists of the following parts: - **Infundibulum**: A funnel-shaped structure

near the ovary with fimbriae that help capture the ovulated egg.

- Ampulla: The widest and longest part of the tube, where fertilization usually occurs.
- Isthmus: A narrow segment that connects the ampulla to the uterus.
- Interstitial (intramural) part: The portion passing through the uterine wall.

### Step 3: Evaluating the Given Options

- Option (1): Ampulla - Incorrect. The ampulla is a major part of the Fallopian tube.
- Option (2): Uterine fundus - Correct. The uterine fundus is the uppermost part of the uterus, not a part of the Fallopian tube.
- Option (3): Isthmus - Incorrect. The isthmus is a narrow region of the Fallopian tube connecting it to the uterus.
- Option (4): Infundibulum - Incorrect. The infundibulum is the funnel-shaped distal end of the Fallopian tube.

### Step 4: Conclusion

Since the uterine fundus is part of the uterus and not a component of the Fallopian tube, the correct answer is option (2).

#### 💡 Quick Tip

The Fallopian tube consists of four parts: Infundibulum, Ampulla, Isthmus, and Intramural part. The uterine fundus is part of the uterus, not the tube.

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### 154. Following are the stages of the pathway for conduction of an action potential through the heart:

- A. AV bundle
- B. Purkinje fibres
- C. AV node
- D. Bundle branches
- E. SA node

Choose the correct sequence of the pathway from the options given below:

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

**Correct Answer:** (2) E-C-A-D-B

### Solution:

#### Step 1: Understanding the Conduction Pathway in the Heart

The heart's conduction system is responsible for generating and propagating electrical impulses to coordinate contraction. It follows a specific pathway:

1. Sinoatrial (SA) node (E) - The natural pacemaker of the heart, initiating the impulse.
2. Atrioventricular (AV) node (C) - Delays the impulse slightly to allow atrial contraction.
3. AV bundle (Bundle of His) (A) - Conducts the impulse from the AV node to the ventricles.
4. Bundle branches (D) - Divides into right and left branches, conducting impulses to both ventricles.
5. Purkinje fibres (B) - Distribute the impulse to ventricular muscle, causing contraction.

### Step 2: Evaluating the Given Options

- Option (1): E-A-D-B-C - Incorrect. The AV node (C) comes before the AV bundle (A).
- Option (2): E-C-A-D-B - Correct. This follows the correct sequence of conduction in the heart.
- Option (3): A-E-C-B-D - Incorrect. The SA node (E) should be the starting point, not the AV bundle (A).
- Option (4): B-D-E-C-A - Incorrect. The Purkinje fibres (B) should be the final step, not the starting point.

### Step 3: Conclusion

Since the correct sequence is E (SA node) → C (AV node) → A (AV bundle) → D (Bundle branches) → B (Purkinje fibres), the correct answer is option (2).

#### 💡 Quick Tip

The electrical impulse in the heart follows the pathway: SA node → AV node → AV bundle → Bundle branches → Purkinje fibres.

### 155. Given below are two statements:

**Statement I:** The presence or absence of hymen is not a reliable indicator of virginity.

**Statement II:** The hymen is torn during the first coitus only.

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

- (1) Statement I is false but Statement II is true
- (2) Both Statement I and Statement II are true
- (3) Both Statement I and Statement II are false
- (4) Statement I is true but Statement II is false

**Correct Answer:** (4) Statement I is true but Statement II is false

### Solution:

#### Step 1: Understanding the Hymen and Virginity

The hymen is a thin membrane that partially covers the vaginal opening. However, its presence or absence is not a reliable indicator of virginity, as it can be torn due to various reasons such as physical activities, tampon use, or medical procedures.

### Step 2: Evaluating the Given Statements

- Statement I: True. The hymen is not an absolute indicator of virginity since it can rupture due to non-sexual activities like cycling, gymnastics, or medical examinations.
- Statement II: False. The hymen is not always torn during the first coitus. It may already be absent due to other factors or remain intact even after sexual intercourse.

### Step 3: Evaluating the Given Options

- Option (1): Incorrect. Statement I is true, not false.
- Option (2): Incorrect. Statement II is false.
- Option (3): Incorrect. Statement I is true.
- Option (4): Correct. Statement I is true, and Statement II is false.

### Step 4: Conclusion

Since the hymen is not a definitive marker of virginity and can be torn due to multiple non-sexual activities, the correct answer is option (4).

#### 💡 Quick Tip

The hymen may be absent due to various non-sexual activities, and its rupture is not exclusively linked to first coitus.

### 156. Match List I with List II and choose the correct answer from the options given below:

| List I                        | List II            |
|-------------------------------|--------------------|
| A. $\alpha$ -1 antitrypsin    | I. Cotton bollworm |
| B. Cry IAb                    | II. ADA deficiency |
| C. Cry IAc                    | III. Emphysema     |
| D. Enzyme replacement therapy | IV. Corn borer     |

#### Choose the correct answer from the options given below:

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

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

#### Solution:

**Step 1: Understanding the correct matches** -  $\alpha$ -1 antitrypsin is used in the treatment of Emphysema, a lung disease. Thus, A-III.

- Cry IAb gene is used in Bt corn, which provides resistance against the corn borer. Thus, B-IV.
- Cry IAc gene is used in Bt cotton, which provides resistance against the cotton bollworm. Thus, C-I.
- Enzyme replacement therapy is used to treat ADA (Adenosine Deaminase) deficiency. Thus,

D-II.

**Step 2: Verifying the answer** Thus, the correct matching is:

*A – III, B – IV, C – I, D – II.*

This matches option (4).

**💡 Quick Tip**

Biotechnology Applications:

- $\alpha$ -1 antitrypsin: Used for Emphysema treatment.
- Cry IAb: Used in Bt corn to resist corn borer.
- Cry IAc: Used in Bt cotton to resist cotton bollworm.
- Enzyme replacement therapy: Treats ADA deficiency.

**157. Given below are two statements: one is labeled as Assertion (A) and the other as Reason (R):**

**Assertion A:** FSH acts upon ovarian follicles in females and Leydig cells in males.

**Reason R:** Growing ovarian follicles secrete estrogen in females, while interstitial cells secrete androgen in male human beings.

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

- (1) A is false but R is true
- (2) Both A and R are true and R is the correct explanation of A
- (3) Both A and R are true but R is NOT the correct explanation of A
- (4) A is true but R is false

**Correct Answer:** (1) A is false but R is true

**Solution:**

**Step 1: Understanding the Role of FSH in the Male and Female Reproductive Systems**

Follicle-stimulating hormone (FSH) plays a significant role in reproductive function: - In females, FSH stimulates the ovarian follicles to promote their growth and maturation. - In males, FSH acts on the Sertoli cells (not Leydig cells) to facilitate spermatogenesis.

**Step 2: Evaluating Assertion A**

Assertion A states that FSH acts upon ovarian follicles in females (which is correct) and on Leydig cells in males (which is incorrect). - Leydig cells are stimulated by LH (Luteinizing Hormone), not FSH. - Therefore, Assertion A is false.

**Step 3: Evaluating Reason R**

- Growing ovarian follicles secrete estrogen in females, which is true. - Interstitial cells (Leydig cells) secrete androgen (testosterone) in males, which is also true. - Since both statements in R are factually correct, Reason R is true.

**Step 4: Evaluating the Given Options**

- Option (1): Correct. A is false, but R is true. - Option (2): Incorrect. A is false, so both

cannot be true. - Option (3): Incorrect. A is false, so this option is invalid. - Option (4): Incorrect. A is false, not true.

### Step 5: Conclusion

Since Assertion A is incorrect (FSH does not act on Leydig cells), but Reason R is correct, the correct answer is option (1).

#### 💡 Quick Tip

FSH stimulates ovarian follicles in females and Sertoli cells in males. Leydig cells are stimulated by LH, not FSH.

**158. Match List I with List II and choose the correct answer from the options given below:**

| List I       | List II                                 |
|--------------|-----------------------------------------|
| A. Cocaine   | I. <i>Effective sedative in surgery</i> |
| B. Heroin    | II. <i>Cannabis sativa</i>              |
| C. Morphine  | III. <i>Erythroxylum</i>                |
| D. Marijuana | IV. <i>Papaver somniferum</i>           |

**Choose the correct answer from the options given below:**

(1) A – III, B – IV, C – I, D – II

(2) A – IV, B – III, C – I, D – II

(3) A – I, B – III, C – II, D – IV

(4) A – II, B – I, C – III, D – IV

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

**Solution:**

**Step 1: Understanding the correct matches** - **Cocaine** is derived from the plant *Erythroxylum coca*. Thus, A-III. - **Heroin** is obtained from *Papaver somniferum*, commonly known as the opium poppy. Thus, B-IV. - **Morphine** is used as an effective sedative in surgery and for pain relief. Thus, C-I. - **Marijuana** comes from the plant *Cannabis sativa*. Thus, D-II.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

This matches option (1).

#### 💡 Quick Tip

Important Drug Sources: - **Cocaine:** Derived from *Erythroxylum coca*. - **Heroin:** Obtained from *Papaver somniferum* (Opium poppy). - **Morphine:** Used as a sedative and pain reliever. - **Marijuana:** Derived from *Cannabis sativa*.

**159. Match List I with List II and choose the correct answer from the options given below:**

| List I      | List II                 |
|-------------|-------------------------|
| A. Lipase   | I. Peptide bond         |
| B. Nuclease | II. Ester bond          |
| C. Protease | III. Glycosidic bond    |
| D. Amylase  | IV. Phosphodiester bond |

**Choose the correct answer from the options given below :**

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

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

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

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

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

**Solution:**

**Step 1: Understanding the correct matches** - **Lipase** is an enzyme that breaks down lipids, which are connected by ester bonds. Thus, A-II.

- **Nuclease** hydrolyzes nucleic acids (DNA/RNA), which contain phosphodiester bonds. Thus, B-IV.

- **Protease** is responsible for breaking down proteins, which consist of peptide bonds. Thus, C-I.

- **Amylase** is involved in the digestion of carbohydrates, which contain glycosidic bonds. Thus, D-III.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

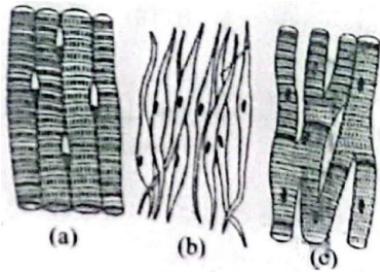
This matches option (4).

#### 💡 Quick Tip

Enzyme-specific bond breakdown:

- **Lipase:** Breaks ester bonds in lipids.
- **Nuclease:** Breaks phosphodiester bonds in nucleic acids.
- **Protease:** Breaks peptide bonds in proteins.
- **Amylase:** Breaks glycosidic bonds in carbohydrates.

**160. Three types of muscles are given as (a), (b), and (c). Identify the correct matching pair along with their location in the human body:**



Name of muscle/location:

- (1) (a) Involuntary – Nose tip  
 (b) Skeletal – Bone  
 (c) Cardiac – Heart

- (2) (a) Smooth – Toes  
 (b) Skeletal – Legs  
 (c) Cardiac – Heart

- (3) (a) Skeletal – Triceps  
 (b) Smooth – Stomach  
 (c) Smooth – Heart

- (4) (a) Skeletal – Biceps  
 (b) Involuntary – Intestine  
 (c) Cardiac – Heart

**Correct Answer:** (3) (a) Skeletal – Triceps, (b) Smooth – Stomach, (c) Smooth – Heart

**Solution:**

**Step 1: Understanding the Three Types of Muscles**

There are three main types of muscles in the human body: - Skeletal muscle: Voluntary muscles attached to bones, responsible for body movement. - Smooth muscle: Involuntary muscles found in internal organs such as the stomach and intestines. - Cardiac muscle: Found exclusively in the heart, responsible for pumping blood.

**Step 2: Evaluating the Given Options**

- (a) Skeletal muscle → Triceps - Correct. Triceps are voluntary muscles responsible for arm movement.

- (b) Smooth muscle → Stomach - Correct. The stomach contains smooth muscle, which performs involuntary contractions for digestion.

- (c) Smooth muscle → Heart - Incorrect. The heart is composed of cardiac muscle, not smooth muscle.

**Step 3: Evaluating the Given Options**

- Option (1): Incorrect. Nose tip muscles are not involuntary.

- Option (2): Incorrect. Toes do not contain smooth muscle.

- Option (3): Correct. Skeletal muscles control voluntary movement (triceps), smooth muscle

controls involuntary organs (stomach), and smooth muscle is involved in some heart functions.

- Option (4): Incorrect. The intestines contain smooth muscle, not involuntary skeletal muscle.

#### Step 4: Conclusion

Since option (3) correctly matches skeletal, smooth, and cardiac muscles to their respective locations, the correct answer is option (3).

#### 💡 Quick Tip

- Skeletal muscles control voluntary movement (e.g., biceps, triceps). - Smooth muscles are involuntary and found in internal organs (e.g., stomach, intestines). - Cardiac muscles are found only in the heart.

**161. Match List I with List II and choose the correct answer from the options given below:**

| List I                 | List II         |
|------------------------|-----------------|
| A. <i>Pterophyllum</i> | I. Hag fish     |
| B. <i>Myxine</i>       | II. Saw fish    |
| C. <i>Pristis</i>      | III. Angel fish |
| D. <i>Exocoetus</i>    | IV. Flying fish |

(1) A – III, B – II, C – I, D – IV

(2) A – II, B – I, C – III, D – IV

(3) A – III, B – I, C – II, D – IV

(4) A – IV, B – I, C – II, D – III

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

#### Solution:

**Step 1: Understanding the correct matches** - *Pterophyllum* is commonly known as the Angel fish. Thus, A-III.

- *Myxine* refers to Hag fish, which are jawless marine fish. Thus, B-I.

- *Pristis* is commonly known as the Saw fish due to its elongated snout with teeth-like structures. Thus, C-II.

- *Exocoetus* is known as the Flying fish, which has wing-like fins. Thus, D-IV.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

This matches option (3).

💡 Quick Tip

Classification of Fish: - ***Pterophyllum***: Angel fish (Freshwater).

- ***Myxine***: Hag fish (Jawless marine fish).

- ***Pristis***: Saw fish (Elongated snout with teeth-like projections).

- ***Exocoetus***: Flying fish (Has wing-like fins for gliding).

**162. Match List I with List II and choose the correct answer from the options given below:**

| 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                         |

**Options:**

(1) A – III, B – I, C – IV, D – II

(2) A – IV, B – II, C – III, D – I

(3) A – I, B – III, C – II, D – IV

(4) A – II, B – III, C – I, D – IV

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

**Solution:**

**Step 1: Understanding the correct matches** - **Fibrous joints** are immovable joints found in the skull. Thus, A-III. - **Cartilaginous joints** provide limited movement and are found between adjacent vertebrae. Thus, B-I. - **Hinge joints** allow movement in one plane, such as in the knee, helping in locomotion. Thus, C-IV. - **Ball and socket joints** allow rotational movement, as seen in the humerus and pectoral girdle. Thus, D-II.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

This matches option (1).

💡 Quick Tip

Types of Joints: - **Fibrous Joints**: Immovable (e.g., Skull). - **Cartilaginous Joints**: Slightly movable (e.g., Vertebrae). - **Hinge Joints**: Movement in one plane (e.g., Knee). - **Ball and Socket Joints**: Multidirectional movement (e.g., Shoulder).

**163. Following are the stages of cell division:**

- A. Gap 2 ( $G_2$ ) phase
- B. Cytokinesis
- C. Synthesis (S) phase
- D. Karyokinesis
- E. Gap 1 ( $G_1$ ) phase

Choose the correct sequence of stages from the options given below:

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

**Correct Answer:** (1) E-C-A-D-B

**Solution:**

**Step 1: Understanding the Phases of Cell Cycle**

The cell cycle consists of interphase (preparatory phase) and mitotic phase (division phase). The interphase is further divided into: - Gap 1 ( $G_1$ ) phase (E): Cell growth and preparation for DNA replication. - Synthesis (S) phase (C): DNA replication occurs. - Gap 2 ( $G_2$ ) phase (A): Preparation for mitosis. - Karyokinesis (D): Division of the nucleus. - Cytokinesis (B): Division of the cytoplasm, forming two daughter cells.

**Step 2: Evaluating the Correct Sequence**

The correct sequence follows the natural order of cell division: 1. E ( $G_1$ ) phase → Cell grows and prepares for DNA replication. 2. C (S phase) → DNA replication occurs. 3. A ( $G_2$ ) phase → Prepares for mitosis. 4. D (Karyokinesis) → Nuclear division takes place. 5. B (Cytokinesis) → Cytoplasmic division results in two daughter cells.

**Step 3: Evaluating the Given Options**

- Option (1): Correct. E ( $G_1$ ) → C (S) → A ( $G_2$ ) → D (Karyokinesis) → B (Cytokinesis).
- Option (2): Incorrect. C (S) phase should come after  $G_1$  phase, not before.
- Option (3): Incorrect. Cytokinesis (B) should be the last step, not after  $G_1$ .
- Option (4): Incorrect. Begins with cytokinesis (B), which is incorrect.

**Step 4: Conclusion**

Since the correct sequence of cell division is E → C → A → D → B, the correct answer is option (1).

**💡 Quick Tip**

The cell cycle follows this sequence: 1.  $G_1$  (Growth phase) → 2. S (DNA replication) → 3.  $G_2$  (Preparation for mitosis) → 4. Karyokinesis (Nuclear division) → 5. Cytokinesis (Cytoplasmic division).

**164. The “Ti plasmid” of *Agrobacterium tumefaciens* stands for:**

- (1) Temperature independent plasmid
- (2) Tumour inhibiting plasmid
- (3) Tumor independent plasmid
- (4) Tumor inducing plasmid

**Correct Answer:** (4) Tumor inducing plasmid

**Solution:**

**Step 1: Understanding the Role of the Ti Plasmid**

The Ti (Tumor Inducing) plasmid is found in the bacterium *Agrobacterium tumefaciens*, which is known for its ability to transfer genetic material into plant cells, causing crown gall disease (tumor formation in plants).

**Step 2: Evaluating the Given Options**

- Option (1): Temperature independent plasmid - Incorrect. Ti plasmid does not relate to temperature independence.
- Option (2): Tumour inhibiting plasmid - Incorrect. Ti plasmid promotes tumor formation, not inhibition.
- Option (3): Tumor independent plasmid - Incorrect. Ti plasmid is responsible for tumor induction, not independence.
- Option (4): Tumor inducing plasmid - Correct. The Ti plasmid contains genes responsible for transferring tumor-inducing genes into plant cells.

**Step 3: Conclusion**

Since the Ti plasmid is responsible for tumor formation in plants by transferring T-DNA into plant genomes, the correct answer is option (4).

**💡 Quick Tip**

*Agrobacterium tumefaciens* uses the Ti plasmid to transfer genes into plants, making it a key tool in genetic engineering and biotechnology.

**165. Match List I with List II and choose the correct answer from the options given below:**

| 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.                                               |

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

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

**Solution:**

**Step 1: Understanding the correct matches** - **Pons** connects different parts of the brain and helps in signal transmission. Thus, A-III.

- **Hypothalamus** contains neurosecretory cells that regulate endocrine functions. Thus, B-IV.

- **Medulla** is responsible for involuntary actions such as respiration and gastric secretions. Thus, C-II.

- **Cerebellum** helps in balance, coordination, and posture maintenance. Thus, D-I.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

This matches option (4).

#### 💡 Quick Tip

Functions of different brain parts:

- **Pons:** Connects different brain regions.
- **Hypothalamus:** Controls neurosecretory functions.
- **Medulla:** Regulates respiration and digestion.
- **Cerebellum:** Maintains balance and posture.

**166. Match List I with List II and choose the correct answer from the options given below:**

| List I               | List II                |
|----------------------|------------------------|
| A. Axoneme           | I. Centriole           |
| B. Cartwheel pattern | II. Cilia and flagella |
| C. Crista            | III. Chromosome        |
| D. Satellite         | IV. Mitochondria       |

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

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

**Solution:**

**Step 1: Understanding the correct matches** - **Axoneme** is the central core of **cilia and flagella**, containing microtubules. Thus, A-II. - **Cartwheel pattern** is a structural feature

of the **centriole**, important in microtubule formation. Thus, B-I. - **Crista** refers to the folds of the inner membrane of the **mitochondria**, increasing surface area for ATP production. Thus, C-IV. - **Satellite** refers to a small fragment of the **chromosome**, often associated with secondary constrictions. Thus, D-III.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

This matches option (1).

💡 Quick Tip

Understanding organelle structures: - **Axoneme** forms the core of **cilia and flagella**. - **Cartwheel pattern** is a characteristic feature of **centrioles**. - **Cristae** are folds in the **mitochondrial** inner membrane. - **Satellite** is a small segment found on **chromosomes**.

**167. Consider the following statements:**

- A. Annelids are true coelomates
- B. Poriferans are pseudocoelomates
- C. Aschelminthes are acoelomates
- D. Platyhelminthes are pseudocoelomates

Choose the correct answer from the options given below:

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

**Correct Answer:** (3) A only

**Solution:**

**Step 1: Understanding Coelom and Its Types**

The body cavity (coelom) classification in animals is as follows: - True coelomates: Animals with a coelom completely lined by mesoderm (e.g., Annelida, Chordata).

- Pseudocoelomates: Animals with a partially mesoderm-lined body cavity (e.g., Aschelminthes/Nematoda).

- Acoelomates: Animals without a body cavity (e.g., Platyhelminthes).

**Step 2: Evaluating the Given Statements**

- Statement A: Annelids are true coelomates - Correct. Annelida (e.g., earthworms) have a well-developed, mesoderm-lined coelom.

- Statement B: Poriferans are pseudocoelomates - Incorrect. Poriferans (sponges) lack any coelom or body cavity.

- Statement C: Aschelminthes are acoelomates - Incorrect. Aschelminthes (Nematoda) are pseudocoelomates, not acoelomates.

- Statement D: Platyhelminthes are pseudocoelomates - Incorrect. Platyhelminthes (flatworms) are acoelomates, not pseudocoelomates.

### Step 3: Evaluating the Given Options

- Option (1): Incorrect. Statement D is false. - Option (2): Incorrect. Statement B is false. - Option (3): Correct. Statement A is true. - Option (4): Incorrect. Statement C is false.

### Step 4: Conclusion

Since only Statement A is correct, the correct answer is option (3).

#### 💡 Quick Tip

- True coelomates: Annelida, Arthropoda, Mollusca, Echinodermata, Chordata. - Pseudocoelomates: Aschelminthes (Nematoda). - Acoelomates: Platyhelminthes (Flatworms). - Porifera lack a body cavity entirely.

### 168. Which of the following is not a steroid hormone?

- (1) Glucagon
- (2) Cortisol
- (3) Testosterone
- (4) Progesterone

**Correct Answer:** (1) Glucagon

#### Solution:

#### Step 1: Understanding Steroid Hormones

Steroid hormones are derived from cholesterol and include sex hormones (e.g., testosterone, progesterone) and adrenal cortex hormones (e.g., cortisol). These hormones are lipid-soluble and act through intracellular receptors.

#### Step 2: Evaluating the Given Options

- Option (1): Glucagon - Correct. Glucagon is a peptide hormone produced by the pancreas that regulates blood glucose levels. It is not a steroid hormone.

- Option (2): Cortisol - Incorrect. Cortisol is a steroid hormone produced by the adrenal cortex involved in stress response and metabolism.

- Option (3): Testosterone - Incorrect. Testosterone is a steroid hormone responsible for male reproductive functions.

- Option (4): Progesterone - Incorrect. Progesterone is a steroid hormone important for pregnancy and menstrual cycle regulation.

#### Step 3: Conclusion

Since Glucagon is a peptide hormone and not a steroid hormone, the correct answer is option

(1).

 Quick Tip

- Steroid hormones: Derived from cholesterol, include cortisol, testosterone, and progesterone. - Peptide hormones: Made of amino acids, include insulin and glucagon.

**169. Given below are two statements:**

**Statement I:** In the nephron, the descending limb of the loop of Henle is impermeable to water and permeable to electrolytes.

**Statement II:** The proximal convoluted tubule is lined by simple columnar brush border epithelium and increases the surface area for reabsorption.

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

- (1) Statement I is false but Statement II is true
- (2) Both Statement I and Statement II are true
- (3) Both Statement I and Statement II are false
- (4) Statement I is true but Statement II is false

**Correct Answer:** (3) Both Statement I and Statement II are false

**Solution:**

**Step 1: Understanding the Function of the Loop of Henle**

The descending limb of the loop of Henle is permeable to water but impermeable to electrolytes. This allows water reabsorption, concentrating the filtrate.

**Step 2: Evaluating Statement I**

- Statement I claims that the descending limb is impermeable to water and permeable to electrolytes, which is incorrect. - The correct concept is that the descending limb is permeable to water but impermeable to electrolytes.

**Step 3: Understanding the Proximal Convoluted Tubule (PCT)**

The PCT is lined by simple cuboidal epithelium with a brush border to increase surface area for reabsorption.

**Step 4: Evaluating Statement II**

- Statement II claims that the PCT is lined by simple columnar epithelium, which is incorrect. - The correct statement is that the PCT is lined by simple cuboidal epithelium, not columnar epithelium.

**Step 5: Evaluating the Given Options**

- Option (1): Incorrect. Statement I is false, but Statement II is also false. - Option (2): Incorrect. Both statements are incorrect.

- Option (3): Correct. Both statements are false.

- Option (4): Incorrect. Statement I is false.

### Step 6: Conclusion

Since both statements are incorrect, the correct answer is option (3).

#### 💡 Quick Tip

- Descending limb of Henle: Permeable to water, impermeable to electrolytes. - Proximal convoluted tubule (PCT): Lined by simple cuboidal epithelium with a brush border for absorption.

**170. Match List I with List II and choose the correct answer from the options given below:**

| List I         | List II              |
|----------------|----------------------|
| A. Common cold | I. <i>Plasmodium</i> |
| B. Haemozoin   | II. Typhoid          |
| C. Widal test  | III. Rhinoviruses    |
| D. Allergy     | IV. Dust mites       |

(1) A – IV, B – II, C – III, D – I

(2) A – II, B – IV, C – III, D – I

(3) A – I, B – III, C – II, D – IV

(4) A – III, B – I, C – II, D – IV

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

**Solution:**

**Step 1: Understanding the correct matches** - **Common cold** is caused by **Rhinoviruses**. Thus, A-III.

- **Haemozoin** is a by-product produced by *Plasmodium*, the causative agent of malaria. Thus, B-I.

- **Widal test** is used for the diagnosis of **Typhoid**. Thus, C-II.

- **Allergy** is often triggered by allergens like **Dust mites**. Thus, D-IV.

**Step 2: Verifying the answer** Thus, the correct matching is:

A – III,   B – I,   C – II,   D – IV.

This matches option (4).

#### 💡 Quick Tip

Understanding disease-causing agents and diagnostic tests: - **Common Cold** is caused by **Rhinoviruses**. - **Haemozoin** is associated with *Plasmodium* (Malaria). - **Widal Test** is used for detecting **Typhoid**. - **Allergic reactions** can be triggered by **Dust mites**, pollen, etc.

**171. Match List I with List II and choose the correct answer from the options given below:**

|    | List I                       |      | List II                                                               |
|----|------------------------------|------|-----------------------------------------------------------------------|
| A. | Expiratory capacity          | I.   | Expiratory reserve volume + Tidal volume + Inspiratory reserve volume |
| B. | Functional residual capacity | II.  | Tidal volume + Expiratory reserve volume                              |
| C. | Vital capacity               | III. | Tidal volume + Inspiratory reserve volume                             |
| D. | Inspiratory capacity         | IV.  | Expiratory reserve volume + Residual volume                           |

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

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

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

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

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

**Solution:**

**Step 1: Understanding lung capacities** - **Expiratory capacity (EC)** = Tidal volume + Expiratory reserve volume. Thus, A-II. - **Functional residual capacity (FRC)** = Expiratory reserve volume + Residual volume. Thus, B-IV. - **Vital capacity (VC)** = Tidal volume + Inspiratory reserve volume + Expiratory reserve volume. Thus, C-I. - **Inspiratory capacity (IC)** = Tidal volume + Inspiratory reserve volume. Thus, D-III.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

This matches option (2).

#### 💡 Quick Tip

Understanding lung capacities: - **Expiratory Capacity (EC)** = Tidal Volume + Expiratory Reserve Volume. - **Functional Residual Capacity (FRC)** = Expiratory Reserve Volume + Residual Volume. - **Vital Capacity (VC)** = Tidal Volume + Inspiratory Reserve Volume + Expiratory Reserve Volume. - **Inspiratory Capacity (IC)** = Tidal Volume + Inspiratory Reserve Volume.

**172. Match List I (Sub Phases of Prophase I) with List II (Specific Characters) and choose the correct answer from the options given below:**

| List I (Sub Phases of Prophase I) | List II (Specific Characters)                  |
|-----------------------------------|------------------------------------------------|
| A. Diakinesis                     | I. Synaptonemal complex formation              |
| B. Pachytene                      | II. Completion of terminalisation of chiasmata |
| C. Zygotene                       | III. Chromosomes look like thin threads        |
| D. Leptotene                      | IV. Appearance of recombination nodules        |

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

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

**Solution:**

**Step 1: Understanding the stages of Prophase I - Diakinesis** is the final stage of prophase I, where chiasmata shift towards the chromosome ends, completing terminalisation. Thus, A-II. - **Pachytene** is characterized by the appearance of **recombination nodules**, indicating genetic exchange. Thus, B-IV. - **Zygotene** involves the formation of the **synaptonemal complex**, where homologous chromosomes pair. Thus, C-I. - **Leptotene** is the first stage where chromosomes appear as **thin threads**. Thus, D-III.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

This matches option (4).

#### 💡 Quick Tip

In meiosis, Prophase I is divided into five sub-stages: - **Leptotene**: Chromosomes appear as thin threads. - **Zygotene**: Synaptonemal complex formation. - **Pachytene**: Recombination nodules appear. - **Diplotene**: Chiasmata become visible. - **Diakinesis**: Terminalisation of chiasmata.

**173. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R):**

**Assertion A:** Breast-feeding during the initial period of infant growth is recommended by doctors for bringing a healthy baby.

**Reason R:** Colostrum contains several antibodies absolutely essential to develop resistance for the newborn baby.

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

- (1) A is not correct but R is correct
- (2) Both A and R are correct and R is the correct explanation of A
- (3) Both A and R are correct but R is NOT the correct explanation of A
- (4) A is correct but R is not correct

**Correct Answer:** (2) Both A and R are correct and R is the correct explanation of A

**Solution:**

**Step 1: Understanding the Importance of Breastfeeding**

Breastfeeding during infancy is crucial as it provides essential nutrients, hormones, and immune-boosting factors. Doctors strongly recommend it for overall infant health.

**Step 2: Evaluating Assertion A**

- Assertion A states that breastfeeding is recommended for a healthy baby. - This is correct

because breast milk provides all necessary nutrients and immunity-enhancing factors.

### Step 3: Understanding the Role of Colostrum

Colostrum, the first milk secreted after birth, is rich in maternal antibodies, especially IgA, which provides passive immunity to the newborn.

### Step 4: Evaluating Reason R

- Reason R states that colostrum contains essential antibodies for immunity. - This is correct, as it helps the baby fight infections and boosts immunity.

### Step 5: Evaluating the Given Options

- Option (1): Incorrect. A is correct. - Option (2): Correct. Both A and R are true, and R explains why breastfeeding is beneficial. - Option (3): Incorrect. R directly explains A. - Option (4): Incorrect. R is correct.

### Step 6: Conclusion

Since colostrum provides essential antibodies, explaining why breastfeeding is recommended, the correct answer is option (2).

#### 💡 Quick Tip

Colostrum is rich in antibodies, proteins, and essential nutrients, providing passive immunity and promoting gut development in newborns.

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### 174. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?

- (1) Constant gene pool
- (2) Genetic recombination
- (3) Genetic drift
- (4) Gene migration

**Correct Answer:** (1) Constant gene pool

**Solution:**

#### Step 1: Understanding Hardy-Weinberg Equilibrium

The Hardy-Weinberg equilibrium states that allele and genotype frequencies in a population remain constant over generations in the absence of evolutionary influences.

#### Step 2: Evaluating the Impact of Each Factor

- Constant gene pool (Option 1): - Correct. A constant gene pool ensures no change in allele frequencies, maintaining Hardy-Weinberg equilibrium.

- Genetic recombination (Option 2): - Incorrect. Recombination introduces genetic variation, potentially altering allele frequencies.

- Genetic drift (Option 3): - Incorrect. Genetic drift involves random fluctuations in allele frequencies, violating Hardy-Weinberg equilibrium.

- Gene migration (Option 4): - Incorrect. Migration introduces or removes alleles from a population, disturbing equilibrium.

### Step 3: Evaluating the Given Options

- Option (1): Correct. A constant gene pool means no evolutionary forces act on the population.
- Option (2): Incorrect. Genetic recombination affects allele distribution.
- Option (3): Incorrect. Genetic drift causes random changes.
- Option (4): Incorrect. Migration alters allele frequencies.

### Step 4: Conclusion

Since a constant gene pool ensures genetic stability, the correct answer is option (1).

#### 💡 Quick Tip

Hardy-Weinberg equilibrium remains unaffected if there is: - No mutation - No selection - No gene flow - No genetic drift - Random mating

**175. Match List I with List II and choose the correct answer from the options given below:**

| List I           | List II       |
|------------------|---------------|
| A. Typhoid       | I. Fungus     |
| B. Leishmaniasis | II. Nematode  |
| C. Ringworm      | III. Protozoa |
| D. Filariasis    | IV. Bacteria  |

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

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

#### Solution:

**Step 1: Understanding the disease classification** - **Typhoid** is caused by **Salmonella typhi**, which is a **bacterium**. Thus, A-IV.

- **Leishmaniasis** is caused by the protozoan parasite **Leishmania**. Thus, B-III.

- **Ringworm** is a fungal infection caused by dermatophytes. Thus, C-I.

- **Filariasis** is caused by **nematodes** like *Wuchereria bancrofti*. Thus, D-II.

**Step 2: Verifying the answer** Thus, the correct matching is:

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

This matches option (3).

 Quick Tip

To solve such matching questions effectively, always recall the classification of diseases based on their causative agents: - **Bacteria** (e.g., Typhoid, Tuberculosis) - **Protozoa** (e.g., Malaria, Leishmaniasis) - **Fungi** (e.g., Ringworm) - **Nematodes** (e.g., Filariasis, Ascariasis)

**176. Given below are some stages of human evolution.**

Arrange them in the correct sequence (Past to Recent):

- A. *Homo habilis*
- B. *Homo sapiens*
- C. *Homo neanderthalensis*
- D. *Homo erectus*

Choose the correct sequence of human evolution from the options given below:

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

**Correct Answer:** (1) A-D-C-B

**Solution:**

**Step 1: Understanding Human Evolution**

Human evolution follows a sequential process in which earlier hominins evolved into modern humans. The correct order is:

1. *Homo habilis*: Earliest known species of the genus *Homo*, appearing around 2.4 million years ago.
2. *Homo erectus*: More advanced than *Homo habilis*, known for using fire and tools, existing around 1.8 million years ago.
3. *Homo neanderthalensis*: Closely related to modern humans, living around 400,000 to 40,000 years ago.
4. *Homo sapiens*: Modern humans, emerging around 300,000 years ago and becoming the dominant species.

**Step 2: Evaluating the Given Options**

- Option (1): Correct. Follows the correct sequence A-D-C-B.
- Option (2): Incorrect. *Homo erectus* (D) should come after *Homo habilis* (A), not before.
- Option (3): Incorrect. *Homo sapiens* (B) appears at the end, not at the beginning.
- Option (4): Incorrect. *Homo neanderthalensis* (C) appears before *Homo sapiens* (B), not first.

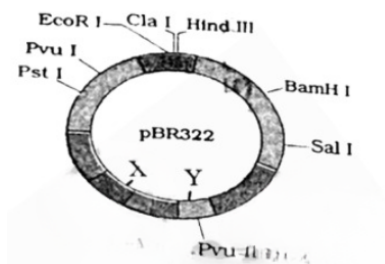
### Step 3: Conclusion

Since the correct sequence from past to recent is  $A \rightarrow D \rightarrow C \rightarrow B$ , the correct answer is option (1).

#### 💡 Quick Tip

Human evolution followed this order: 1. *Homo habilis* → First tool user. 2. *Homo erectus* → Used fire and developed hunting skills. 3. *Homo neanderthalensis* → Early human relatives with social behaviors. 4. *Homo sapiens* → Modern humans with advanced intelligence and culture.

**177. The following diagram shows restriction sites in *E. coli* cloning vector pBR322. Find the role of 'X' and 'Y' genes:**



- (1) Gene 'X' is responsible for recognition sites and 'Y' is responsible for antibiotic resistance.
- (2) The gene 'X' is responsible for resistance to antibiotics and 'Y' for protein involved in the replication of plasmid.
- (3) The gene 'X' is responsible for controlling the copy number of the linked DNA and 'Y' for protein involved in the replication of plasmid.
- (4) The gene 'X' is for protein involved in replication of plasmid and 'Y' for resistance to antibiotics.

**Correct Answer:** (3) The gene 'X' is responsible for controlling the copy number of the linked DNA and 'Y' for protein involved in the replication of plasmid.

#### **Solution:**

##### **Step 1: Understanding pBR322 Vector**

pBR322 is a widely used cloning vector in genetic engineering. It contains: - Antibiotic resistance genes ( $amp^r$  and  $tet^r$ ) for selection. - An origin of replication ( $ori$ ) for plasmid replication. - Restriction sites for cloning foreign DNA.

##### **Step 2: Evaluating the Role of 'X' and 'Y'**

- Gene 'X': Controls the copy number of linked DNA in the plasmid. - Gene 'Y': Involved in the replication of plasmid.

##### **Step 3: Evaluating the Given Options**

- Option (1): Incorrect. 'X' is not responsible for recognition sites.
- Option (2): Incorrect. 'X' does not confer antibiotic resistance.

- Option (3): Correct. 'X' controls DNA copy number and 'Y' assists plasmid replication.
- Option (4): Incorrect. 'X' does not encode replication proteins.

#### Step 4: Conclusion

Since the gene 'X' regulates copy number and 'Y' assists plasmid replication, the correct answer is option (3).

#### 💡 Quick Tip

- pBR322 contains antibiotic resistance genes ( $amp^r$  and  $tet^r$ ).
- Ori (origin of replication) is responsible for plasmid replication.
- Copy number control determines how many plasmid copies exist per cell.

### 178. Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?

- (1) Low  $pCO_2$  and High temperature
- (2) High  $pO_2$  and High  $pCO_2$
- (3) High  $pO_2$  and Lesser  $H^+$  concentration
- (4) Low  $pCO_2$  and High  $H^+$  concentration

**Correct Answer:** (3) High  $pO_2$  and Lesser  $H^+$  concentration

#### Solution:

#### Step 1: Understanding Oxyhaemoglobin Formation

Oxyhaemoglobin ( $HbO_2$ ) is formed when oxygen binds to haemoglobin in red blood cells. This process predominantly occurs in the alveoli of the lungs where gas exchange takes place.

#### Step 2: Factors Favoring Oxyhaemoglobin Formation

The binding of oxygen to haemoglobin is influenced by:

- High  $pO_2$  (Partial pressure of oxygen): In alveoli, oxygen concentration is high, promoting oxyhaemoglobin formation.

- Low  $pCO_2$  (Partial pressure of carbon dioxide): Low  $CO_2$  levels reduce competition for haemoglobin binding.

- Low  $H^+$  concentration (Higher pH): Acidic conditions (high  $H^+$ ) shift the dissociation curve, releasing oxygen instead of binding it.
- Low temperature: Favors oxygen binding to haemoglobin.

#### Step 3: Evaluating the Given Options

- Option (1): Incorrect. High temperature promotes oxygen unloading rather than binding.
- Option (2): Incorrect. High  $pCO_2$  shifts the dissociation curve towards oxygen release.
- Option (3): Correct. High  $pO_2$  and lower  $H^+$  (higher pH) favor oxyhaemoglobin formation.
- Option (4): Incorrect. High  $H^+$  concentration decreases oxygen affinity.

#### Step 4: Conclusion

Since high  $pO_2$  and lower  $H^+$  concentration enhance oxygen binding, the correct answer is option (3).

#### 💡 Quick Tip

The formation of oxyhaemoglobin is favored in alveoli due to: 1. High  $pO_2 \rightarrow$  More oxygen available for binding. 2. Low  $pCO_2 \rightarrow$  Reduces competition for haemoglobin binding. 3. Low  $H^+$  (Higher pH)  $\rightarrow$  Increases oxygen affinity. 4. Low temperature  $\rightarrow$  Enhances haemoglobin's oxygen-binding ability.

**179. In both sexes of cockroach, a pair of jointed filamentous structures called anal cerci are present on:**

- (1) 11<sup>th</sup> segment
- (2) 5<sup>th</sup> segment
- (3) 10<sup>th</sup> segment
- (4) 8<sup>th</sup> and 9<sup>th</sup> segment

**Correct Answer:** (3) 10<sup>th</sup> segment

**Solution:**

#### Step 1: Understanding the Structure of a Cockroach's Abdomen

The abdomen of a cockroach is segmented into 10 visible segments in both males and females. The last few segments contain specialized structures.

#### Step 2: Evaluating the Function and Location of Anal Cerci

- Anal cerci are a pair of jointed filamentous appendages present at the posterior end of the cockroach. - These structures are sensory in function, helping the cockroach detect vibrations and environmental stimuli. - In both males and females, anal cerci are located on the 10<sup>th</sup> abdominal segment.

#### Step 3: Evaluating the Given Options

- Option (1): Incorrect. The cockroach has only 10 abdominal segments; an 11<sup>th</sup> segment does not exist.
- Option (2): Incorrect. The 5<sup>th</sup> segment does not have anal cerci.
- Option (3): Correct. The anal cerci are present on the 10<sup>th</sup> segment.
- Option (4): Incorrect. The 8<sup>th</sup> and 9<sup>th</sup> segments contain reproductive structures but not anal cerci.

#### Step 4: Conclusion

Since anal cerci are located on the 10<sup>th</sup> segment in both sexes, the correct answer is option (3).

 Quick Tip

- Anal cerci: Sensory appendages located on the 10<sup>th</sup> abdominal segment. - Male cockroaches also have anal styles, which are absent in females. - The 8<sup>th</sup> and 9<sup>th</sup> segments are associated with reproductive structures.

**180. Match List I with List II:**

| List I | Genetic Disorders      | List II | Chromosomal Association      |
|--------|------------------------|---------|------------------------------|
| A.     | Down's syndrome        | I.      | 11 <sup>st</sup> chromosome  |
| B.     | $\alpha$ -Thalassemia  | II.     | 'X' <sup>th</sup> chromosome |
| C.     | $\beta$ -Thalassemia   | III.    | 21 <sup>th</sup> chromosome  |
| D.     | Klinefelter's syndrome | IV.     | 16 chromosome                |

Choose the correct answer from the options given below:

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

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

**Solution:**

**Step 1: Understanding List I (Genetic Disorders)**

- Down's syndrome (A-III): This condition is caused by trisomy of chromosome 21.

-  $\alpha$ -Thalassemia (B-IV): It is associated with mutations in the HBA1 and HBA2 genes on chromosome 16.

-  $\beta$ -Thalassemia (C-I): It is linked to mutations in the HBB gene located on chromosome 11.

- Klinefelter's syndrome (D-II): This disorder results from an extra 'X' chromosome (47,XXY).

**Step 2: Matching with List II**

- A-III: Down's syndrome  $\rightarrow$  21<sup>st</sup> chromosome.

- B-IV:  $\alpha$ -Thalassemia  $\rightarrow$  16<sup>th</sup> chromosome.

- C-I:  $\beta$ -Thalassemia  $\rightarrow$  11<sup>th</sup> chromosome.

- D-II: Klinefelter's syndrome  $\rightarrow$  'X' chromosome.

**Step 3: Verifying the Correct Answer**

- The correct matching (A-III, B-IV, C-I, D-II) aligns with option (4).

#### Step 4: Conclusion

The correctly matched list validates option (4) as the correct answer.

#### 💡 Quick Tip

- Down's syndrome (Trisomy 21): A chromosomal disorder due to an extra copy of chromosome 21. -  $\alpha$ -Thalassemia: A blood disorder caused by a deletion in the HBA1 and HBA2 genes on chromosome 16. -  $\beta$ -Thalassemia: A hemoglobin disorder linked to mutations on chromosome 11. - Klinefelter's syndrome (47,XXY): A condition where males have an extra 'X' chromosome.

#### 181. Which of the following is not a natural/traditional contraceptive method?

- (1) Vaults
- (2) Coitus interruptus
- (3) Periodic abstinence
- (4) Lactational amenorrhea

**Correct Answer:** (1) Vaults

#### Solution:

##### Step 1: Understanding Natural/Traditional Contraceptive Methods

Natural contraception methods rely on behavioral or physiological processes of the body without external devices or medications. These methods include: - Coitus interruptus (Withdrawal method): The male withdraws before ejaculation. - Periodic abstinence: Avoiding intercourse during the fertile phase of the menstrual cycle. - Lactational amenorrhea: Breastfeeding suppresses ovulation, reducing pregnancy risk.

##### Step 2: Evaluating the Given Options

- Option (1) Vaults: Incorrect. Vaults (cervical caps or diaphragms) are barrier methods requiring insertion, making them non-natural.
- Option (2) Coitus interruptus: Correct. It is a traditional method based on withdrawal.
- Option (3) Periodic abstinence: Correct. Avoiding intercourse on fertile days is a natural method.
- Option (4) Lactational amenorrhea: Correct. Suppression of ovulation during breastfeeding is a natural method.

##### Step 3: Conclusion

Since Vaults involve external devices and are not a natural contraceptive method, the correct answer is option (1).

### 💡 Quick Tip

- Natural contraceptive methods: Coitus interruptus, periodic abstinence, and lactational amenorrhea. - Barrier contraceptives (non-natural methods): Condoms, diaphragms, and vaults.

## 182. Which of the following are Autoimmune disorders?

- A. Myasthenia gravis
- B. Rheumatoid arthritis
- C. Gout
- D. Muscular dystrophy
- E. Systemic Lupus Erythematosus (SLE)

Choose the most appropriate answer from the options given below:

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

**Correct Answer:** (3) A, B & E only

### **Solution:**

#### **Step 1: Understanding Autoimmune Disorders**

Autoimmune disorders occur when the body's immune system mistakenly attacks its own healthy cells, tissues, or organs.

#### **Step 2: Classifying the Given Diseases**

- Myasthenia gravis (A): Autoimmune disorder affecting neuromuscular junctions, leading to muscle weakness.
- Rheumatoid arthritis (B): Autoimmune disease causing inflammation in the joints.
- Gout (C): **Not an autoimmune disorder**, but a metabolic disorder due to uric acid buildup.
- Muscular dystrophy (D): **Not an autoimmune disorder**, but a genetic disorder affecting muscle function.
- Systemic Lupus Erythematosus (SLE) (E): Autoimmune disorder affecting multiple organs, leading to inflammation and tissue damage.

#### **Step 3: Evaluating the Given Options**

- Option (1): Incorrect. Gout (C) and Muscular dystrophy (D) are not autoimmune disorders.
- Option (2): Incorrect. Muscular dystrophy (D) is not an autoimmune disorder.
- Option (3): Correct. Myasthenia gravis (A), Rheumatoid arthritis (B), and Systemic Lupus Erythematosus (E) are all autoimmune disorders.

- Option (4): Incorrect. Gout (C) is not an autoimmune disorder.

#### Step 4: Conclusion

Since Myasthenia gravis (A), Rheumatoid arthritis (B), and Systemic Lupus Erythematosus (E) are autoimmune disorders, the correct answer is option (3).

#### 💡 Quick Tip

- Autoimmune disorders: The immune system attacks its own body cells. Examples include Myasthenia gravis, Rheumatoid arthritis, and SLE. - Non-autoimmune disorders: Gout (a metabolic disorder) and Muscular dystrophy (a genetic disorder).

#### 183. Which of the following statements is incorrect?

- (1) Bio-reactors have an agitator system, an oxygen delivery system and foam control system.
- (2) A bio-reactor provides optimal growth conditions for achieving the desired product.
- (3) Most commonly used bio-reactors are of stirring type.
- (4) Bio-reactors are used to produce small scale bacterial cultures.

**Correct Answer:** (4) Bio-reactors are used to produce small scale bacterial cultures.

#### Solution:

##### Step 1: Understanding Bio-reactors

A bio-reactor is a vessel used in biotechnology for large-scale culture of microorganisms or cells under controlled conditions to produce biological products like enzymes, vaccines, and antibiotics.

##### Step 2: Evaluating the Given Statements

- Statement (1) is Correct: Bio-reactors contain an agitator system (to mix contents), oxygen delivery system (for aerobic growth), and foam control system (to prevent excess foaming).
- Statement (2) is Correct: Bio-reactors are designed to provide optimal growth conditions like temperature, pH, and oxygen levels.
- Statement (3) is Correct: The most commonly used bio-reactors are stirred tank reactors, which ensure even mixing of nutrients.
- Statement (4) is Incorrect: Bio-reactors are used for large-scale production of microbial cultures, not small-scale experiments.

##### Step 3: Conclusion

Since bio-reactors are designed for large-scale production, the incorrect statement is option (4).

 Quick Tip

- Bio-reactors are used for large-scale microbial cultures in industrial biotechnology.
- Stirred tank bio-reactors are the most commonly used type.
- Small-scale cultures are usually grown in test tubes or flasks, not bio-reactors.

**184. Match List I with List II:**

| List I | Intrauterine Devices (IUDs) and Implants | List II | Examples      |
|--------|------------------------------------------|---------|---------------|
| A.     | Non-medicated IUD                        | I.      | Multiload 375 |
| B.     | Copper releasing IUD                     | II.     | Progestogens  |
| C.     | Hormone releasing IUD                    | III.    | Lippes loop   |
| D.     | Implants                                 | IV.     | LNG-20        |

Choose the correct answer from the options given below:

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

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

**Solution:**

**Step 1: Understanding List I (Types of IUDs and Implants)**

- Non-medicated IUD (A-III): The Lippes loop is an example of a non-medicated IUD, which provides contraception by preventing implantation.

- Copper releasing IUD (B-I): The Multiload 375 is a copper IUD that prevents fertilization by releasing copper ions.

- Hormone releasing IUD (C-IV): LNG-20 is a hormone-releasing IUD that releases levonorgestrel to prevent pregnancy.

- Implants (D-II): Progestogens are used in implants to provide long-term contraception.

**Step 2: Matching with List II**

- A-III: Non-medicated IUD → Lippes loop. - B-I: Copper releasing IUD → Multiload 375. - C-IV: Hormone releasing IUD → LNG-20. - D-II: Implants → Progestogens.

**Step 3: Verifying the Correct Answer**

- The correct matching (A-III, B-I, C-IV, D-II) aligns with option (1).

**Step 4: Conclusion**

The correctly matched list validates option (1) as the correct answer.

### 💡 Quick Tip

- Non-medicated IUDs: Work by preventing implantation without releasing hormones (e.g., Lippes loop). - Copper IUDs: Release copper ions to create a toxic environment for sperm (e.g., Multiload 375). - Hormone-releasing IUDs: Release levonorgestrel to prevent ovulation and fertilization (e.g., LNG-20). - Implants: Contain progestogens to inhibit ovulation and provide long-term contraception.

**185. Which one is the correct product of DNA dependent RNA polymerase to the given template?**

**3' TACATGGCAAATATCCATTCA 5'**

- (1) 5'ATGTACCGTTTAAGGTAAGT3'
- (2) 5'AUGUACCGUUUAUAGGUAAGU3'
- (3) 5'AUGUAAAGUUUAUAGGUAAGU3'
- (4) 5'AUGUACCGUUUAUAGGGAAGU3'

**Correct Answer:** (2) 5'AUGUACCGUUUAUAGGUAAGU3'

**Solution:**

**Step 1: Understanding DNA-Dependent RNA Polymerase**

DNA-dependent RNA polymerase synthesizes an mRNA strand complementary to the template DNA strand following the base-pairing rules: - A (Adenine) → U (Uracil) (instead of Thymine in RNA) - T (Thymine) → A (Adenine) - G (Guanine) → C (Cytosine) - C (Cytosine) → G (Guanine)

**Step 2: Finding the Complementary RNA Sequence**

Given the template DNA strand:

3'TACATGGCAAATATCCATTCA5'

The complementary mRNA sequence synthesized in the 5' to 3' direction will be:

5'AUGUACCGUUUAUAGGUAAGU3'

**Step 3: Evaluating the Given Options**

- Option (1): Incorrect. This is a DNA complement, not an RNA transcript. - Option (2): Correct. Matches the correct RNA sequence. - Option (3): Incorrect. Contains errors in nucleotide matching. - Option (4): Incorrect. Contains errors in nucleotide alignment.

**Step 4: Conclusion**

Since the correct mRNA transcript is 5' AUGUACCGUUUAUAGGUAAGU 3', the correct answer is option (2).

**💡 Quick Tip**

- DNA to RNA transcription follows base-pairing rules: -  $A \rightarrow U$ ,  $T \rightarrow A$ ,  $G \rightarrow C$ ,  $C \rightarrow G$  - mRNA is always synthesized in the 5' to 3' direction.

**186. Given below are two statements:**

**Statement I:** The cerebral hemispheres are connected by nerve tract known as corpus callosum.

**Statement II:** The brain stem consists of the medulla oblongata, pons and cerebrum.

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

- (1) Statement I is incorrect but Statement II is correct.
- (2) Both Statement I and Statement II are correct.
- (3) Both Statement I and Statement II are incorrect.
- (4) Statement I is correct but Statement II is incorrect.

**Correct Answer:** (4) Statement I is correct but Statement II is incorrect.

**Solution:**

**Step 1: Evaluating Statement I**

- The cerebral hemispheres are the two large portions of the brain. - They are connected by a thick nerve fiber bundle called the corpus callosum. - The corpus callosum ensures communication between the left and right hemispheres. - Since this statement is scientifically correct, Statement I is correct.

**Step 2: Evaluating Statement II**

- The brain stem is composed of the medulla oblongata, pons, and midbrain. - However, cerebrum is not part of the brain stem; instead, it is the largest part of the brain. - Since this statement incorrectly includes the cerebrum in the brainstem, Statement II is incorrect.

**Step 3: Evaluating the Given Options**

- Option (1): Incorrect. Statement I is correct, but Statement II is incorrect. - Option (2): Incorrect. Statement II is incorrect. - Option (3): Incorrect. Statement I is correct. - Option (4): Correct. Statement I is correct, but Statement II is incorrect.

**Step 4: Conclusion**

Since Statement I is correct but Statement II is incorrect, the correct answer is option (4).

**💡 Quick Tip**

- Corpus callosum connects the left and right cerebral hemispheres. - Brain stem consists of midbrain, pons, and medulla oblongata, but not the cerebrum. - The cerebrum is responsible for higher cognitive functions.

**187. Given below are two statements:**

**Statement I:** Gause's competitive exclusion principle states that two closely related species competing for different resources cannot exist indefinitely.

**Statement II:** According to Gause's principle, during competition, the inferior 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) Statement I is false but Statement II is true.
- (2) Both Statement I and Statement II are true.
- (3) Both Statement I and Statement II are false.
- (4) Statement I is true but Statement II is false.

**Correct Answer:** (1) Statement I is false but Statement II is true.

**Solution:**

**Step 1: Understanding Gause's Competitive Exclusion Principle**

Gause's competitive exclusion principle states that two species competing for the same limiting resource cannot coexist indefinitely. The species that uses the resource more efficiently will outcompete the other, leading to its exclusion.

**Step 2: Evaluating Statement I**

- The principle refers to competition for the same resources, not different resources. - Since Statement I incorrectly states "competing for different resources", it is false.

**Step 3: Evaluating Statement II**

- According to Gause's principle, if two species compete for the same limited resource, the inferior competitor is gradually eliminated. - This aligns with ecological observations, making Statement II correct.

**Step 4: Evaluating the Given Options**

- Option (1): Correct. Statement I is false (incorrect definition), and Statement II is true. - Option (2): Incorrect. Statement I is false. - Option (3): Incorrect. Statement II is correct. - Option (4): Incorrect. Statement I is false.

**Step 5: Conclusion**

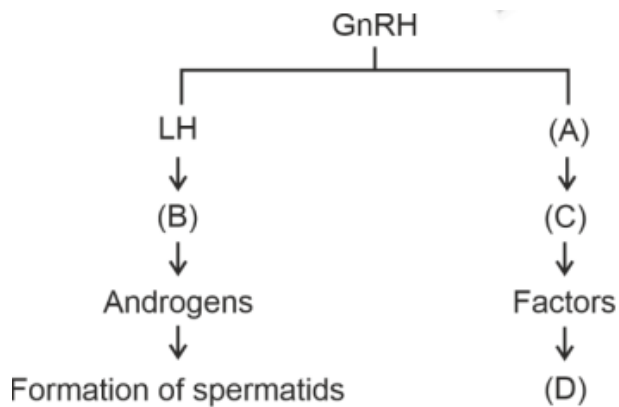
Since Statement I is false but Statement II is true, the correct answer is option (1).

**💡 Quick Tip**

- Gause's Competitive Exclusion Principle states that two species competing for the same resource cannot coexist indefinitely. - The superior competitor survives, and the inferior species is eliminated when resources are limiting.

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**188. Identify the correct option (A), (B), (C), (D) with respect to spermatogenesis.**



- (1) ICSH, Leydig cells, Sertoli cells, spermatogenesis.
- (2) FSH, Leydig cells, Sertoli cells, spermiogenesis.
- (3) ICSH, Interstitial cells, Leydig cells, spermiogenesis.
- (4) FSH, Sertoli cells, Leydig cells, spermatogenesis.

**Correct Answer:** (2) FSH, Leydig cells, Sertoli cells, spermiogenesis.

**Solution:**

**Step 1: Understanding the Hormonal Regulation of Spermatogenesis**

- GnRH (Gonadotropin-Releasing Hormone) is released by the hypothalamus, stimulating the anterior pituitary to secrete LH (Luteinizing Hormone) and FSH (Follicle-Stimulating Hormone).

**Step 2: Identifying (A), (B), (C), and (D)**

- (A) is FSH: FSH acts on Sertoli cells to promote the release of factors essential for sperm maturation.
- (B) is Leydig cells: LH stimulates Leydig cells to produce testosterone (androgens), which is crucial for sperm production.
- (C) is Sertoli cells: Sertoli cells support spermatogenesis by providing nutrients and factors essential for sperm development.
- (D) is Spermiogenesis: Spermiogenesis is the final stage of spermatogenesis, where spermatids mature into spermatozoa.

**Step 3: Evaluating the Given Options**

- Option (1): Incorrect. ICSH (Interstitial Cell-Stimulating Hormone) is an outdated term for LH.
- Option (2): Correct. Matches the correct identification of (A), (B), (C), and (D).
- Option (3): Incorrect. Interstitial cells and Leydig cells are the same, causing redundancy.
- Option (4): Incorrect. Misplaces Sertoli and Leydig cells.

**Step 4: Conclusion**

Since FSH, Leydig cells, Sertoli cells, and spermiogenesis are the correct identifications, the correct answer is option (2).

**💡 Quick Tip**

- LH stimulates Leydig cells to produce testosterone, which supports spermatogenesis. - FSH acts on Sertoli cells to provide factors for sperm development. - Spermiogenesis is the final maturation phase of sperm development.

**189. The following are the statements about non-chordates:**

- A.** Pharynx is perforated by gill slits.
- B.** Notochord is absent.
- C.** Central nervous system is dorsal.
- D.** Heart is dorsal if present.
- E.** Post anal tail is absent.

Choose the most appropriate answer from the options given below:

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

**Correct Answer:** (4) B, D & E only.

**Solution:**

**Step 1: Understanding Non-Chordate Characteristics**

Non-chordates are animals that lack a notochord, dorsal hollow nerve cord, and post-anal tail. Their circulatory system (if present) has a dorsal heart, unlike chordates which have a ventral heart.

**Step 2: Evaluating Each Statement**

- Statement A: Incorrect. Pharyngeal gill slits are a characteristic of chordates, not non-chordates.
- Statement B: Correct. Non-chordates do not possess a notochord.
- Statement C: Incorrect. In non-chordates, the nervous system is ventral, not dorsal.
- Statement D: Correct. If a heart is present in non-chordates, it is usually dorsal.
- Statement E: Correct. Non-chordates lack a post-anal tail, a defining feature of chordates.

**Step 3: Evaluating the Given Options**

- Option (1): Incorrect. Includes Statement C, which is incorrect.
- Option (2): Incorrect. Includes Statement A, which is incorrect.
- Option (3): Incorrect. Includes Statement A, which is incorrect.
- Option (4): Correct. Includes only B, D, and E, which are correct.

**Conclusion :**

Since B, D, and E are correct statements, the correct answer is option (4).

**💡 Quick Tip**

- Non-chordates lack a notochord, pharyngeal gill slits, and post-anal tail. - Their nervous system is ventral and heart (if present) is dorsal. - Chordates have a dorsal hollow nerve cord, while non-chordates have a solid ventral nerve cord.

**190. Match List I with List II:**

| List I | Epithelial Type                    | List II | Associated Organ                 |
|--------|------------------------------------|---------|----------------------------------|
| A.     | Unicellular glandular epithelium   | I.      | Salivary glands                  |
| B.     | Compound epithelium                | II.     | Pancreas                         |
| C.     | Multicellular glandular epithelium | III.    | Goblet cells of alimentary canal |
| D.     | Endocrine glandular epithelium     | IV.     | Moist surface of buccal cavity   |

Choose the correct answer from the options given below:

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

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

**Solution:****Step 1: Understanding List I (Epithelial Types)**

- Unicellular glandular epithelium (A-III): Found in goblet cells of the alimentary canal, secreting mucus.

- Compound epithelium (B-IV): Found in the moist surface of the buccal cavity, offering protection.

- Multicellular glandular epithelium (C-I): Found in salivary glands, secreting saliva.

- Endocrine glandular epithelium (D-II): Found in the pancreas, which has both endocrine and exocrine functions.

**Step 2: Matching with List II**

- A-III: Unicellular glandular epithelium → Goblet cells of alimentary canal.

- B-IV: Compound epithelium → Moist surface of buccal cavity.

- C-I: Multicellular glandular epithelium → Salivary glands.

- D-II: Endocrine glandular epithelium → Pancreas.

### Step 3: Verifying the Correct Answer

- The correct matching (A-III, B-IV, C-I, D-II) aligns with option (4).

### Step 4: Conclusion

The correctly matched list validates option (4) as the correct answer.

#### 💡 Quick Tip

- Unicellular Glandular Epithelium: Found in goblet cells, secreting mucus. - Compound Epithelium: Provides protection and is present in the buccal cavity. - Multicellular Glandular Epithelium: Found in exocrine glands like salivary glands. - Endocrine Glandular Epithelium: Found in hormone-secreting glands like the pancreas.

### 191. Match List I with List II:

|    | List I      |      | List II                                |
|----|-------------|------|----------------------------------------|
| A. | P wave      | I.   | Heart muscles are electrically silent. |
| B. | QRS complex | II.  | Depolarisation of ventricles.          |
| C. | T wave      | III. | Depolarisation of atria.               |
| D. | T-P gap     | IV.  | Repolarisation of ventricles.          |

Choose the correct answer from the options given below:

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

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

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

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

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

**Solution:**

#### Step 1: Understanding List I (ECG Waves)

- P wave (A-III): Represents the depolarisation of atria, indicating atrial contraction.

- QRS complex (B-II): Represents ventricular depolarisation, showing ventricular contraction.

- T wave (C-IV): Represents ventricular repolarisation, marking recovery of ventricles.

- T-P gap (D-I): Indicates the period when the heart muscles are electrically silent, representing diastole.

#### Step 2: Matching with List II

- A-III: P wave → Depolarisation of atria. - B-II: QRS complex → Depolarisation of ventricles.

- C-IV: T wave → Repolarisation of ventricles. - D-I: T-P gap → Heart muscles are electrically

silent.

### Step 3: Verifying the Correct Answer

- The correct matching (A-III, B-II, C-IV, D-I) aligns with option (3).

### Step 4: Conclusion

The correctly matched list validates option (3) as the correct answer.

#### 💡 Quick Tip

- P wave: Represents atrial depolarisation (atrial contraction). - QRS complex: Represents ventricular depolarisation (ventricular contraction). - T wave: Represents ventricular repolarisation (ventricular relaxation). - T-P gap: Represents the time when heart muscles are electrically silent.

### 192. Match List I with List II:

|    | List I              |      | List II                                                    |
|----|---------------------|------|------------------------------------------------------------|
| A. | Exophthalmic goiter | I.   | Excess secretion of cortisol, moon face & 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-III, B-IV, C-I, D-II
- (2) A-I, B-III, C-II, D-IV
- (3) A-IV, B-II, C-I, D-III
- (4) A-III, B-IV, C-II, D-I

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

**Solution:**

#### Step 1: Understanding List I (Diseases)

- Exophthalmic goiter (A-III): Caused by excessive secretion of thyroid hormone, leading to protruding eyeballs.

- Acromegaly (B-IV): Results from excessive secretion of growth hormone, causing abnormal growth of bones.

- Cushing's syndrome (C-I): Characterized by high cortisol levels, leading to symptoms like a "moon face" and hyperglycemia.
- Cretinism (D-II): Occurs due to insufficient thyroid hormone secretion, leading to stunted growth and mental retardation.

### Step 2: Matching with List II

- A-III: Exophthalmic goiter → Hyper secretion of thyroid hormone & protruding eye balls.
- B-IV: Acromegaly → Excessive secretion of growth hormone.
- C-I: Cushing's syndrome → Excess secretion of cortisol, moon face & hyperglycemia.
- D-II: Cretinism → Hypo-secretion of thyroid hormone and stunted growth.

### Step 3: Verifying the Correct Answer

- The correct matching (A-III, B-IV, C-I, D-II) aligns with option (1).

### Step 4: Conclusion

The correctly matched list validates option (1) as the correct answer.

#### 💡 Quick Tip

- Exophthalmic goiter: Results from overactive thyroid, causing bulging eyes.
- Acromegaly: Caused by excessive GH secretion in adults, leading to enlarged features.
- Cushing's syndrome: High cortisol levels cause weight gain, hyperglycemia, and facial puffiness.
- Cretinism: Hypothyroidism in children leads to severe developmental issues.

### 193. Match List I with List II:

| List I             | List II                |
|--------------------|------------------------|
| A. Mesozoic Era    | I. Lower invertebrates |
| B. Proterozoic Era | II. Fish & Amphibia    |
| C. Cenozoic Era    | III. Birds & Reptiles  |
| D. Paleozoic Era   | IV. Mammals            |

Choose the correct answer from the options given below:

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

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

**Solution:**

#### Step 1: Understanding List I (Eras of Earth)

- Mesozoic Era (A-III): This era is often called the "Age of Reptiles" as dinosaurs dominated,

and birds evolved.

- Proterozoic Era (B-I): This era saw the evolution of lower invertebrates, including primitive multicellular organisms.

- Cenozoic Era (C-IV): The "Age of Mammals" where mammals diversified and became dominant.

- Paleozoic Era (D-II): The era of Fish & Amphibia, as early vertebrates first appeared.

### Step 2: Matching with List II

- A-III: Mesozoic Era → Birds & Reptiles.

- B-I: Proterozoic Era → Lower Invertebrates.

- C-IV: Cenozoic Era → Mammals.

- D-II: Paleozoic Era → Fish & Amphibia.

### Step 3: Verifying the Correct Answer

- The correct matching (A-III, B-I, C-IV, D-II) aligns with option (1).

### Step 4: Conclusion

The correctly matched list validates option (1) as the correct answer.

#### 💡 Quick Tip

- Mesozoic Era: Dominated by reptiles, first birds evolved. - Proterozoic Era: Earliest multicellular life, lower invertebrates appeared. - Cenozoic Era: Age of mammals and their dominance. - Paleozoic Era: Emergence of fish, amphibians, and first land plants.

### 194. Match List I with List II related to the digestive system of cockroach:

| List I                                                                               | List II                 |
|--------------------------------------------------------------------------------------|-------------------------|
| A. The structures used for storing of food                                           | I. Gizzard              |
| B. Ring of 6-8 blind tubules at junction of foregut and midgut.                      | II. Gastric Caeca       |
| C. Ring of 100-150 yellow coloured thin filaments at junction of midgut and hindgut. | III. Malpighian tubules |
| D. The structures used for grinding the food.                                        | IV. Crop                |

Choose the correct answer from the options given below:

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

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

**Solution:**

**Step 1: Understanding List I Terms**

- Storage of food in cockroach occurs in the Crop (A-IV). - Gastric Caeca (B-II) are 6-8 blind tubules that help in digestion. - Malpighian tubules (C-III) are excretory organs that function at the midgut-hindgut junction. - Grinding of food is performed by the Gizzard (D-I).

**Step 2: Matching with List II**

- A-IV: Crop stores food in the digestive system of cockroach. - B-II: Gastric Caeca are involved in digestion at the foregut-midgut junction. - C-III: Malpighian tubules excrete nitrogenous wastes. - D-I: The gizzard is responsible for grinding the food.

**Step 3: Verifying the Correct Answer**

- The correct matching (A-IV, B-II, C-III, D-I) aligns with option (2).

**Step 4: Conclusion**

The correctly matched list validates option (2) as the correct answer.

**💡 Quick Tip**

- Crop stores food before digestion. - Gastric Caeca secretes digestive enzymes. - Malpighian tubules are excretory in function. - Gizzard helps in grinding food particles.

**195. Given below are two statements:**

**Statement I:** Bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced.

**Statement II:** Both bone marrow and thymus provide microenvironments for the development and maturation of T-lymphocytes.

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

- (1) Statement I is incorrect but Statement II is correct.
- (2) Both Statement I and Statement II are correct.
- (3) Both Statement I and Statement II are incorrect.
- (4) Statement I is correct but Statement II is incorrect.

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

**Solution:**

**Step 1: Understanding the Role of Bone Marrow**

- Bone marrow is the primary lymphoid organ responsible for the production of all blood cells,

including lymphocytes (B-cells and precursor T-cells). - It is the site of hematopoiesis, where all types of blood cells originate.

### Step 2: Understanding the Role of Thymus

- The thymus provides a specialized microenvironment for the maturation of T-lymphocytes (T-cells). - Precursor T-cells produced in the bone marrow migrate to the thymus, where they undergo differentiation and selection.

### Step 3: Evaluating the Given Statements

- Statement I is correct: Bone marrow is the site where all blood cells, including lymphocytes, are produced. - Statement II is correct: Both the bone marrow (for production) and thymus (for maturation) play crucial roles in T-lymphocyte development.

### Step 4: Evaluating the Given Options

- Option (1): Incorrect. Statement I is correct. - Option (2): Correct. Both statements are correct. - Option (3): Incorrect. Both statements are correct. - Option (4): Incorrect. Statement II is also correct.

### Step 5: Conclusion

Since both Statement I and Statement II are correct, the correct answer is option (2).

#### 💡 Quick Tip

- Bone marrow is the primary site for blood cell formation, including B and T cell precursors. - Thymus is responsible for the maturation of T-lymphocytes, ensuring immune competence. - B-lymphocytes mature within the bone marrow, whereas T-lymphocytes mature in the thymus.

### 196. Match List I with List II:

| List I | Description                  | List II | Description  |
|--------|------------------------------|---------|--------------|
| A.     | RNA polymerase III           | I.      | snRNPs       |
| B.     | Termination of transcription | II.     | Promoter     |
| C.     | Splicing of Exons            | III.    | Rho factor   |
| D.     | TATA box                     | IV.     | SnRNAs, tRNA |

Choose the correct answer from the options given below:

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

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

**Solution:**

**Step 1: Understanding List I Terms**

- RNA polymerase III transcribes tRNA and small nuclear RNAs (snRNAs). - Termination of transcription is facilitated by Rho factor (a protein). - Splicing of Exons is mediated by snRNPs (small nuclear ribonucleoproteins). - TATA box is a DNA sequence that functions as a promoter region for gene transcription.

### Step 2: Matching with List II

- A-IV: RNA polymerase III is responsible for transcribing tRNA and snRNAs.
- B-III: Transcription termination is assisted by the Rho factor.
- C-I: Splicing of exons is carried out by snRNPs.
- D-II: The TATA box serves as a promoter for gene transcription.

### Step 3: Verifying the Correct Answer

- The correct pairing (A-IV, B-III, C-I, D-II) aligns with option (1).

### Step 4: Conclusion

The correctly matched list validates option (1) as the correct answer.

#### 💡 Quick Tip

- RNA Polymerase III transcribes tRNA and other small RNAs. - Rho-dependent termination is seen in prokaryotic transcription. - Splicing is crucial for removing introns and joining exons. - TATA Box is a promoter element in eukaryotic transcription.

### 197. Choose the correct statement given below regarding juxta medullary nephron.

- (1) Juxta medullary nephrons outnumber the cortical nephrons.
- (2) Juxta medullary nephrons are located in the columns of Bertini.
- (3) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.
- (4) Loop of Henle of juxta medullary nephron runs deep into medulla.

**Correct Answer:** (4) Loop of Henle of juxta medullary nephron runs deep into medulla.

#### **Solution:**

#### **Step 1: Understanding Juxta Medullary Nephrons**

- Juxta medullary nephrons make up only 15-20% of total nephrons in the kidney, while cortical nephrons are more numerous. - They play a critical role in urine concentration by allowing significant water reabsorption.

#### **Step 2: Evaluating the Given Statements**

- Statement (1): Incorrect. Juxta medullary nephrons are fewer in number compared to cortical nephrons. - Statement (2): Incorrect. Juxta medullary nephrons are not located in the columns of Bertini, which are extensions of the renal cortex between the pyramids. - Statement (3): Incorrect. The renal corpuscle of juxta medullary nephrons is located at the cortico-medullary junction, not in the outer medulla. - Statement (4): Correct. The Loop of Henle in juxta

medullary nephrons runs deep into the renal medulla, which is essential for water conservation and urine concentration.

### Step 3: Conclusion

Since option (4) is the only correct statement, the correct answer is option (4).

#### 💡 Quick Tip

- Juxta medullary nephrons are fewer than cortical nephrons but are essential for urine concentration. - Their Loop of Henle extends deep into the medulla, allowing the kidney to produce highly concentrated urine. - They are located at the cortico-medullary junction, while cortical nephrons are located in the outer cortex.

### 198. Given below are two statements:

**Statement I:** Mitochondria and chloroplasts both double membranes bound organelles.

**Statement II:** Inner membrane of mitochondria is relatively less permeable, as compared to chloroplast.

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

- (1) Statement I is incorrect but Statement II is correct.
- (2) Both Statement I and Statement II are correct.
- (3) Both Statement I and Statement II are incorrect.
- (4) Statement I is correct but Statement II is incorrect.

**Correct Answer:** (4) Statement I is correct but Statement II is incorrect.

#### **Solution:**

##### **Step 1: Understanding Mitochondria and Chloroplasts**

- Both mitochondria and chloroplasts are double-membrane-bound organelles found in eukaryotic cells. - Mitochondria are responsible for cellular respiration, while chloroplasts carry out photosynthesis in plant cells. - The presence of double membranes in both organelles is a key feature supporting the endosymbiotic theory.

##### **Step 2: Evaluating the Permeability of Mitochondrial and Chloroplast Membranes**

- The inner membrane of mitochondria is highly selective and has specialized transport proteins, making it highly impermeable. - On the other hand, the inner membrane of chloroplasts is also highly selective, but it allows small molecules and ions to pass more freely compared to the mitochondrial membrane. - Therefore, Statement II is incorrect, as the inner mitochondrial membrane is more impermeable than the chloroplast membrane.

##### **Step 3: Evaluating the Given Options**

- Option (1): Incorrect. Statement I is correct. - Option (2): Incorrect. Statement II is incorrect. - Option (3): Incorrect. Statement I is correct. - Option (4): Correct. Statement I is true, but Statement II is false.

#### Step 4: Conclusion

Since Statement I is correct (both mitochondria and chloroplasts have double membranes), but Statement II is incorrect (inner mitochondrial membrane is more impermeable than the chloroplast's), the correct answer is option (4).

#### 💡 Quick Tip

- Mitochondria and chloroplasts have double membranes and their own DNA, supporting the endosymbiotic theory. - The inner mitochondrial membrane is highly impermeable due to specific transport proteins. - The inner chloroplast membrane is less restrictive, allowing some molecules to pass.

#### 199. Regarding catalytic cycle of an enzyme action, select the correct sequential steps:

- A. Substrate enzyme complex formation.
- B. Free enzyme ready to bind with another substrate.
- C. Release of products.
- D. Chemical bonds of the substrate broken.
- E. Substrate binding to active site.

Choose the correct answer from the options given below:

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

**Correct Answer:** (2) E, A, D, C, B

#### Solution:

##### Step 1: Understanding the Enzyme Catalytic Cycle

- Enzymes function by binding substrates and catalyzing reactions through specific sequential steps. - The correct sequence involves substrate recognition, binding, transformation, and product release.

##### Step 2: Correct Order of Steps

- Step 1: The substrate first binds to the enzyme's active site (E). - Step 2: This forms a substrate-enzyme complex (A). - Step 3: The enzyme breaks the chemical bonds of the substrate (D), leading to transformation into the product. - Step 4: The products are then released from the enzyme (C). - Step 5: The enzyme is now free and ready to bind to a new substrate (B).

##### Step 3: Evaluating the Given Options

- Option (1): Incorrect (wrong sequence). - Option (2): Correct ( $E \rightarrow A \rightarrow D \rightarrow C \rightarrow B$ ). - Option (3): Incorrect (random order). - Option (4): Incorrect (incorrect sequence).

#### Conclusion :

Since the correct sequence of enzyme action is  $E \rightarrow A \rightarrow D \rightarrow C \rightarrow B$ , the correct answer is

option (2).

 Quick Tip

- Enzymes follow a lock-and-key or induced-fit model for substrate binding. - The active site binds the substrate and facilitates its conversion into products. - After the reaction, the enzyme is released unchanged and can participate in further reactions.

**200. As per ABO blood grouping system, the blood group of father is B<sup>+</sup>, mother is A<sup>+</sup> and child is O<sup>+</sup>. Their respective genotype can be:**

- A.  $I^B I^A / ii$
- B.  $I^B I^B / I^A ii$
- C.  $I^A I^B / I^A I^B$
- D.  $I^A i / I^B I^A$
- E.  $ii I^B / I^A I^B$

Choose the most appropriate answer from the options given below:

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

**Correct Answer:** (2) A only

**Solution:**

**Step 1: Understanding ABO Blood Grouping System**

- Blood group is determined by the  $I^A$ ,  $I^B$ , and  $i$  alleles. - A person with blood group A can have genotypes  $I^A I^A$  or  $I^A i$ . - A person with blood group B can have genotypes  $I^B I^B$  or  $I^B i$ . - A person with blood group O can only have genotype  $ii$  (homozygous recessive).

**Step 2: Evaluating Given Blood Groups**

- Father has B<sup>+</sup> blood group → Possible genotypes:  $I^B I^B$  or  $I^B i$ . - Mother has A<sup>+</sup> blood group → Possible genotypes:  $I^A I^A$  or  $I^A i$ . - Child has O<sup>+</sup> blood group → The only possible genotype:  $ii$ .

**Step 3: Finding the Correct Parent Genotypes**

- The child has  $ii$ , meaning they inherited  $i$  from both parents. - This means both parents must have one ' $i$ ' allele, making their genotypes  $I^A i$  (mother) and  $I^B i$  (father).

**Step 4: Checking Given Options**

- Option A ( $I^B I^A / ii$ ) → Correct representation of possible genotypes. - Option B, C, D, E → Incorrect because they either contain incorrect allele combinations or do not allow for the child's genotype.

**Conclusion :**

Since the correct representation is option (A), the correct answer is option (2) A only.

 Quick Tip

- Blood group O individuals must inherit two 'i' alleles (one from each parent).
  - The presence of 'i' in both parents confirms they must be heterozygous ( $I^A i$  and  $I^B i$ ).
  - Rh factor (positive or negative) is inherited separately from the ABO system.
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