Re-Examination of NEET (UG)-2024 Question Paper with Solutions

Time Allowed :3 Hours 20 mins	**Maximum Marks :**720	**Total Questions :**200

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours 20 minutes duration.
2. The question paper consists of 200 multiple-choice questions four options with a single correct answer.
3. There are four parts in the question paper consisting of Physics, Chemistry and Biology (Botany and Zoology)
4. Each subject will be divided into two sections, A and B which will have 35 and 15 questions respectively. Candidates will have to answer only 10 questions in B.
5. 4 marks are awarded for each correct answer and 1 mark is deducted for each wrong answer

PHYSICS

SECTION-A

1. The magnetic potential energy, when a magnetic bar of magnetic moment m is placed perpendicular to the magnetic field B, is:

(1) $-\frac{mB}{2}$

(2) Zero

(3) $-mB$

(4) mB

Correct Answer: (2) Zero

Solution:

The potential energy stored in an external magnetic field is given by:

$$U = -\mathbf{m} \cdot \mathbf{B}$$

Since the angle between the magnetic moment $\mathbf{m}$ and the magnetic field $\mathbf{B}$ is 90°, we have:

$$U = -mB\cos 90^\circ = 0.$$

Thus, the magnetic potential energy is zero.

Quick Tip

When dealing with magnetic potential energy, remember that the energy is zero when the magnetic moment is perpendicular to the magnetic field.

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2. A bob is whirled in a horizontal circle by means of a string at an initial speed of 10 rpm. If the tension in the string is quadrupled while keeping the radius constant, the new speed is:

(1) 20 rpm

(2) 40 rpm

(3) 5 rpm

(4) 10 rpm

Correct Answer: (1) 20 rpm

Solution:

In horizontal circular motion, the tension T is given by:

$$T = m\omega^2 r$$

For constant m and r, we have:

$$T \propto \omega^2$$

Given that the tension is quadrupled, we can write:

$$T' = 4T$$

Thus, the new angular velocity ω' is:

$$\omega' = \sqrt{4}\omega = 2\omega$$

Therefore, the new speed is:

$$\text{New speed} = 2 \times 10 = 20\,\text{rpm}.$$

Quick Tip

When tension in circular motion is changed, the speed is adjusted according to the square root of the ratio of the tensions.

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3. A metal cube of side 5 cm is charged with 6 C. The surface charge density on the cube is:

(1) $0.125 \times 10^{-3}\,\text{C m}^{-2}$

(2) $0.25 \times 10^{-3}\,\text{C m}^{-2}$

(3) $4 \times 10^{-3}\,\text{C m}^{-2}$

(4) $0.4 \times 10^{-3}\,\text{C m}^{-2}$

Correct Answer: (4) $0.4 \times 10^{-3}\,\text{C m}^{-2}$

Solution:

In metal, all the charge is present on the surface.

Given:

$$Q = 6\,\mu\text{C} = 6 \times 10^{-6}\,\text{C}$$

The total surface area S of the cube is:

$$S = 6a^2$$

where $a = 5\,\text{cm} = 5 \times 10^{-2}\,\text{m}$, so:

$$S = 6 \times (5 \times 10^{-2})^2 = 6 \times 25 \times 10^{-4} = 150 \times 10^{-4}\,\text{m}^2$$

Now, the surface charge density σ is given by:

$$\sigma = \frac{Q}{S} = \frac{6 \times 10^{-6}}{150 \times 10^{-4}} = 0.4 \times 10^{-3}\,\text{C m}^{-2}$$

Quick Tip

To calculate the surface charge density, remember to find the total surface area of the object and divide the charge by that area.

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4. The incorrect relation for a diamagnetic material (all the symbols carry their usual meaning and ϵ is a small positive number) is:

(1) $\mu < \mu_0$

(2) $0 < \mu < 1$

(3) $-1 < \epsilon < 0$

(4) $1 < \mu < 1 + \epsilon$

Correct Answer: (4) $1 < \mu < 1 + \epsilon$

Solution:

For diamagnetic materials, the magnetic permeability μ is less than the permeability of free space μ_0, i.e.,

$$\mu < \mu_0$$

It is also known that the magnetic susceptibility χ_m is negative and small for diamagnetic materials, implying that:

$$\chi_m = \mu - 1$$

Thus, μ must satisfy the relation $\mu < 1$. The given incorrect relation in option (4) violates this, as μ cannot be greater than 1.

Quick Tip

For diamagnetic materials, remember that their magnetic permeability is always less than that of free space, i.e., $\mu < 1$.

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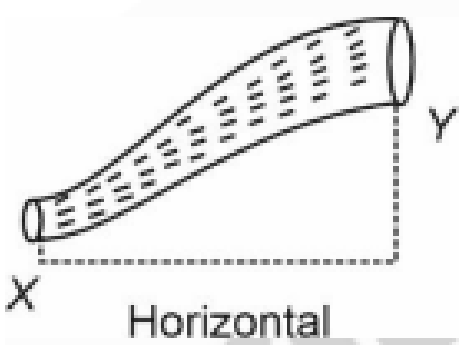
5. An ideal fluid is flowing in a non-uniform cross-sectional tube XY (as shown in the figure) from end X to end Y. If K_1 and K_2 are the kinetic energy per unit volume of the fluid at X and Y respectively, then the correct option is:



(1) $K_1 = K_2$

(2) $2K_1 = K_2$

(3) $K_1 > K_2$

(4) $K_1 < K_2$

Correct Answer: (3) $K_1 > K_2$

Solution:

According to Bernoulli's principle, the total mechanical energy of an ideal fluid remains constant along a streamline, which includes the kinetic energy per unit volume, potential energy per unit volume, and the pressure:

$$\frac{1}{2}\rho v^2 + \rho g h + P = \text{constant}$$

Where: ρ is the density of the fluid, v is the velocity of the fluid, g is the acceleration due to gravity, h is the height above a reference level, P is the pressure at that point.

Apply Bernoulli's principle between points X and Y:

$$P + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

Since the height h does not change between X and Y in this case (the tube is horizontal), we have:

$$\frac{1}{2}\rho v_1^2 = \frac{1}{2}\rho v_2^2$$

Therefore, the kinetic energy at X is greater than at Y.

Quick Tip

When dealing with ideal fluids, Bernoulli's principle helps relate the velocity and pressure along a streamline, and in most cases, the kinetic energy decreases as the fluid's velocity decreases.

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6. The escape velocity for Earth is v. A planet having 9 times mass that of Earth and radius 16 times that of Earth, has the escape velocity of:

(1) $\frac{v}{3}$

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

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

(4) $\frac{9v}{4}$

Correct Answer: (3) $\frac{3v}{4}$

Solution:

The escape velocity of an object is given by the formula:

$$v_e = \sqrt{\frac{2GM}{R}}$$

Where: G is the gravitational constant, M is the mass of the object, R is the radius of the object.

For the new planet, we are given:

$$M' = 9M_e \quad \text{and} \quad R' = 16R_e$$

Thus, the escape velocity v_e' for the new planet is:

$$v_e' = \sqrt{\frac{2G(9M_e)}{16R_e}} = \frac{3}{4} \times v$$

Therefore, the escape velocity for the new planet is $\frac{3}{4} \times v$.

Quick Tip

To find the escape velocity for a different planet, remember it is proportional to the square root of the mass and inversely proportional to the square root of the radius.

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7. An electron and an alpha particle are accelerated by the same potential difference. Let λ_e and λ_α denote the de-Broglie wavelengths of the electron and the alpha particle, respectively, then:

(1) $\lambda_e > \lambda_\alpha$

(2) $\lambda_e = 4\lambda_\alpha$

(3) $\lambda_e = \lambda_\alpha$

(4) $\lambda_e < \lambda_\alpha$

Correct Answer: (1) $\lambda_e > \lambda_\alpha$

Solution:

The de-Broglie wavelength λ is given by the relation:

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mqV}}$$

Where:

- h is Planck's constant,

- p is the momentum of the particle,

- m is the mass of the particle,

- q is the charge of the particle,

- V is the potential difference.

For the electron and alpha particle, the wavelengths are:

$$\lambda_e = \frac{h}{\sqrt{2m_e q_e V}} \quad \text{and} \quad \lambda_\alpha = \frac{h}{\sqrt{2m_\alpha q_\alpha V}}$$

Since the alpha particle has much greater mass than the electron ($m_\alpha \gg m_e$), the de-Broglie wavelength of the electron is greater than that of the alpha particle. Thus, we can conclude:

$$\lambda_e > \lambda_\alpha$$

Therefore, the correct option is (1).

Quick Tip

In de-Broglie wavelength calculations, the mass of the particle has a strong influence. A particle with a smaller mass will have a larger wavelength. Hence, the electron, being much lighter, has a larger wavelength compared to the alpha particle.

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8. An object moving along horizontal x-direction with kinetic energy 10 J is displaced through $x = (3\hat{i} + 3\hat{j})$ m by the force $\mathbf{F} = (-2\hat{i} + 3\hat{j})$ N. The kinetic energy of the object at the end of the displacement x is:

(1) 10 J

(2) 16 J

(3) 4 J

(4) 6 J

Correct Answer: (3) 4 J

Solution:

By the work-energy theorem, the work done by all forces is equal to the change in kinetic energy:

$$W_{\text{all}} = \Delta K = \text{work done by all forces}$$

$$\Rightarrow K_f - K_i = \mathbf{F} \cdot \Delta\mathbf{x}$$

Here, the initial kinetic energy $K_i = 10\,\text{J}$. We need to calculate the work done by the force. The force vector is $\mathbf{F} = (-2\hat{i} + 3\hat{j})\,\text{N}$ and the displacement vector is $\Delta\mathbf{x} = (3\hat{i} + 3\hat{j})\,\text{m}$. The dot product $\mathbf{F} \cdot \Delta\mathbf{x}$ is calculated as:

$$\mathbf{F} \cdot \Delta\mathbf{x} = (-2 \times 3) + (3 \times 3) = -6 + 9 = 3$$

Thus, the work done is 3 J, so the change in kinetic energy is:

$$K_f - 10 = 3 \quad \Rightarrow \quad K_f = 10 + 3 = 13\,\text{J}$$

Therefore, the final kinetic energy is 13 J.

Quick Tip

To solve work-energy problems, always remember to calculate the dot product of the force and displacement vectors to find the work done. Then, apply the work-energy theorem to find the final kinetic energy.

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9. An object falls from a height of 10 m above the ground. After striking the ground it loses 50% of its kinetic energy. The height upto which the object can rebound from the ground is:

(1) 7.5 m

(2) 10 m

(3) 2.5 m

(4) 5 m

Correct Answer: (4) 5 m

Solution:

The kinetic energy just before striking the ground is given by:

$$K_1 = mgh_1 = mg(10)$$

After striking the ground, the object loses 50

$$K_2 = \frac{1}{2}K_1 = \frac{1}{2}mg(10)$$

Now, the object rebounds to a height h_2 where the kinetic energy is equal to the potential energy at that height. Using the relation for kinetic energy:

$$K_2 = mgh_2$$

Substituting the value of K_2 from the previous equation:

$$\frac{1}{2}mg(10) = mgh_2$$

Simplifying, we get:

$$h_2 = 5\,\text{m}$$

Thus, the object rebounds to a height of 5 m.

Quick Tip

When solving for rebound heights, remember that the kinetic energy after a collision is a fraction of the initial kinetic energy, depending on how much energy is lost.

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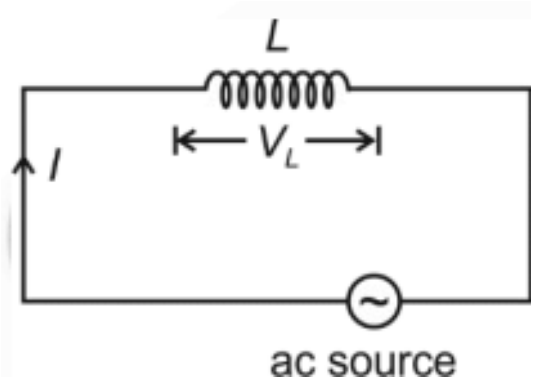
10. In the circuit shown below, the inductance L is connected to an ac source. The current flowing in the circuit is $I = I_0 \sin \omega t$. The voltage drop V_L across L is:



(1) $\omega L I_0 \sin \omega t$

(2) $I_0 \sin \omega t$

(3) $I_0 \cos \omega t$

(4) $\omega L I_0 \cos \omega t$

Correct Answer: (4) $\omega L I_0 \cos \omega t$

Solution:

The voltage drop across an inductor is given by:

$$V_L = L \frac{dI}{dt}$$

Where:

$$I = I_0 \sin \omega t$$

Taking the derivative of the current with respect to time, we get:

$$\frac{dI}{dt} = \omega I_0 \cos \omega t$$

Thus, the voltage drop across the inductor becomes:

$$V_L = L \cdot \omega I_0 \cos \omega t$$

Therefore, the correct option is (4).

Quick Tip

For inductive circuits, remember that the voltage across the inductor leads the current by $\frac{\pi}{2}$. The derivative of a sine function is a cosine function, which explains the cosine term in the voltage expression.

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11. A 12 pF capacitor is connected to a 50 V battery, the electrostatic energy stored in the capacitor in nJ is:

(1) 15

(2) 7.5

(3) 0.3

(4) 150

Correct Answer: (1) 15

Solution:

The electrostatic energy stored in a capacitor is given by:

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

Where: - C is the capacitance, - V is the voltage across the capacitor.

Given:

$$C = 12\,\text{pF} = 12 \times 10^{-12}\,\text{F}, \quad V = 50\,\text{V}$$

Substitute the values:

$$U = \frac{1}{2} \times 12 \times 10^{-12} \times (50)^2 = 6 \times 25 \times 10^{-10} = 15 \times 10^{-9}\,\text{J} = 15\,\text{nJ}$$

Thus, the electrostatic energy stored is 15 nJ.

Quick Tip

For calculating energy stored in a capacitor, remember to use the formula $U = \frac{1}{2}CV^2$ where C is in farads and V is in volts. The resulting energy will be in joules.

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12. A uniform wire of diameter d carries a current of 100 mA when the mean drift velocity of electrons in the wire is v. For a wire of diameter $\frac{d}{2}$ of the same material to carry a current of 200 mA, the mean drift velocity of electrons in the wire is:

(1) 4v

(2) 8v

(3) v

(4) 2v

Correct Answer: (2) 8v

Solution:

The current i in a wire is given by:

$$i = nAve$$

Where: - n is the number density of free electrons, - A is the cross-sectional area of the wire, - v is the mean drift velocity, - e is the charge of the electron.

For a wire of diameter d, the cross-sectional area is proportional to d^2, so:

$$i \propto d^2 v$$

Now, the current is doubled (from 100 mA to 200 mA), and the diameter of the wire is halved, so:

$$\frac{100}{200} = \left(\frac{d}{\frac{d}{2}}\right)^2 \frac{v'}{v}$$

Solving this, we find:

$$v' = 8v$$

Thus, the mean drift velocity becomes 8 times the original drift velocity.

Quick Tip

In this type of problem, remember that current is directly proportional to the cross-sectional area and the drift velocity. Halving the diameter increases the drift velocity to maintain the same current.

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13. In an electrical circuit, the voltage is measured as $V = (200 \pm 4)$ volt and the current is measured as $I = (20 \pm 0.2)$ A. The value of the resistance is:

(1) $(10 \pm 0.2)\,\Omega$

(2) $(10 \pm 0.3)\,\Omega$

(3) $(10 \pm 0.1)\,\Omega$

(4) $(10 \pm 0.8)\,\Omega$

Correct Answer: (2) $(10 \pm 0.3)\,\Omega$

Solution:

The resistance R in the circuit is given by Ohm's law:

$$R = \frac{V}{I}$$

Substitute the given values:

$$R = \frac{200}{20} = 10\,\Omega$$

Now, we calculate the uncertainty in resistance using the formula for propagation of uncertainty:

$$\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I}$$

Substitute the uncertainties:

$$\frac{\Delta R}{10} = \frac{4}{200} + \frac{0.2}{20} = 0.02 + 0.01 = 0.03$$

Thus, the uncertainty in R is:

$$\Delta R = 0.3\,\Omega$$

So, the resistance is:

$$R = (10 \pm 0.3)\,\Omega$$

Quick Tip

When calculating resistance with given uncertainties, use the formula for uncertainty propagation to find the uncertainty in the result.

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14. A step up transformer is connected to an ac mains supply of 220 V to operate at 11000 V, 88 watt. The current in the secondary circuit, ignoring the power loss in the transformer, is:

(1) 8 mA

(2) 4 mA

(3) 0.4 A

(4) 4 A

Correct Answer: (1) 8 mA

Solution:

In the secondary circuit, the power is given by:

$$P = V_i \cdot i$$

Where:

- $P = 88\,\text{W}$ (power),
- $V_i = 11000\,\text{V}$ (voltage in the secondary),
- i is the current in the secondary circuit.

Now, using the formula for power:

$$88 = 11000 \times i \quad \Rightarrow \quad i = \frac{88}{11000} = 8 \times 10^{-3}\,\text{A} = 8\,\text{mA}$$

Thus, the current in the secondary circuit is 8 mA.

Quick Tip

For transformers, use the power formula $P = V \times I$ to find the current or voltage in the secondary circuit.

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15. A particle is moving along x-axis with its position x varying with time t as $x = \alpha t^4 + \beta t^3 + \gamma t^2 + \delta$. The ratio of its initial velocity to its initial acceleration, respectively, is:

(1) $2\alpha : \delta$

(2) $\gamma : 2\delta$

(3) $4\alpha : \beta$

(4) $\gamma : 2\beta$

Correct Answer: (4) $\gamma : 2\beta$

Solution:

The position of the particle is given as:

$$x = \alpha t^4 + \beta t^3 + \gamma t^2 + \delta$$

Velocity v is the derivative of position with respect to time:

$$v = \frac{dx}{dt} = 4\alpha t^3 + 3\beta t^2 + 2\gamma t$$

At $t = 0$, the initial velocity is:

$$v(t = 0) = \gamma$$

Acceleration a is the derivative of velocity with respect to time:

$$a = \frac{dv}{dt} = 12\alpha t^2 + 6\beta t + 2\gamma$$

At $t = 0$, the initial acceleration is:

$$a(t = 0) = 2\gamma$$

Thus, the ratio of initial velocity to initial acceleration is:

$$\frac{v(t = 0)}{a(t = 0)} = \frac{\gamma}{2\beta}$$

So the ratio is $\gamma : 2\beta$.

Quick Tip

For problems involving motion along an axis, use the derivatives of position to find velocity and acceleration. The ratios at $t = 0$ give the required answers.

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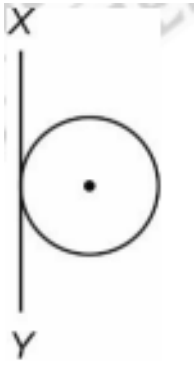
16. The radius of gyration of a solid sphere of mass 5 kg about XY is 5 m as shown in the figure. The radius of the sphere is $\frac{5}{\sqrt{7}}$ m, then the value of x is:



(1) 5

(2) $\sqrt{2}$

(3) $\sqrt{3}$

(4) $\sqrt{5}$

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

Solution:

The radius of gyration k is related to the moment of inertia by:

$$I = Mk^2$$

Where: - $M = 5\,\text{kg}$ is the mass of the sphere, - $k = 5\,\text{m}$ is the radius of gyration.

The moment of inertia for a solid sphere is given by:

$$I = \frac{2}{5}MR^2$$

Where R is the radius of the sphere. Substituting the known values:

$$I = \frac{2}{5} \times 5 \times R^2 = 2R^2$$

Now, using the equation for the radius of gyration:

$$k^2 = \frac{I}{M} = \frac{2R^2}{5}$$

Given that $k = \frac{5}{\sqrt{7}}$, we substitute this value into the equation:

$$\left(\frac{5}{\sqrt{7}}\right)^2 = \frac{2R^2}{5}$$

Solving this, we find:

$$R = \sqrt{3}\,\text{m}$$

Thus, the radius of the sphere is $\sqrt{3}$ meters.

Quick Tip

For problems involving the radius of gyration, use the relation $I = Mk^2$ and the moment of inertia formula for the given body to find the radius.

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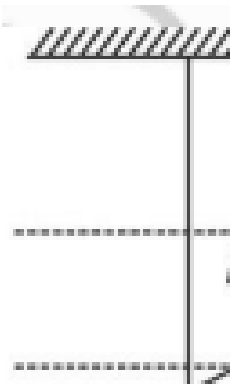
17. The I-V characteristics shown above are exhibited by a:



(1) Light emitting diode

(2) Zener diode

(3) Photodiode

(4) Solar cell

Correct Answer: (4) Solar cell

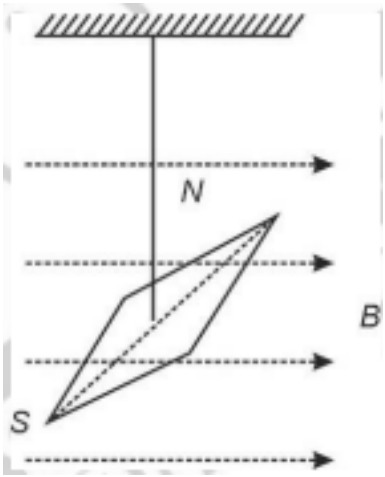
Solution:

The I-V characteristic curve of a solar cell is shown above, which is characteristic of how the current varies with voltage when exposed to light. The current is generated by the photovoltaic effect, where light energy is converted into electrical energy. The solar cell typically exhibits a diode-like I-V curve. Thus, the correct option is (4).

Quick Tip

For solar cells, the current increases when exposed to light, creating a photovoltaic effect that is reflected in the I-V characteristic curve.

18. The magnetic moment and moment of inertia of a magnetic needle as shown are, respectively, 1.0×10^{-2} A m^2 and 10^{-6} kg m^2. If it completes 10 oscillations in 10 s, the magnitude of the magnetic field is:



(1) 0.4 T

(2) 4 T

(3) 0.4 mT

(4) 4 mT

Correct Answer: (3) 0.4 mT

Solution:

The time period T of oscillation of a magnetic needle in a magnetic field is given by:

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

Where:

- I is the moment of inertia of the magnetic needle,

- M is the magnetic moment,

- B is the magnetic field.

Given that $T = 1$ s (since it completes 10 oscillations in 10 s), and using the formula for the time period:

$$1 = 2\pi\sqrt{\frac{10^{-6}}{(1.0 \times 10^{-2}) \times B}}$$

Solving for B, we get:

$$B = 0.4\,\text{T}$$

Thus, the magnitude of the magnetic field is 0.4 T.

Quick Tip

For oscillations of a magnetic needle, the time period is inversely proportional to the magnetic field. Use the formula $T = 2\pi\sqrt{\frac{I}{MB}}$ to relate the time period, magnetic moment, and magnetic field.

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19. The capacitance of a capacitor with charge q and a potential difference V depends on:

(1) both q and V

(2) the geometry of the capacitor

(3) q only

(4) V only

Correct Answer: (2) the geometry of the capacitor

Solution:

The capacitance of a capacitor is given by the formula:

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

Where: - C is the capacitance, - ϵ_0 is the permittivity of free space, - A is the area of the plates, - d is the distance between the plates.

Thus, the capacitance depends on the geometry of the capacitor, i.e., the area of the plates and the distance between them, and it is independent of the charge q and potential difference V. Therefore, the correct answer is (2).

Quick Tip

Capacitance is a physical property of the capacitor and is independent of the charge and potential difference, depending only on the geometry and the dielectric material.

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20. Given below are two statements:

Statement I: Image formation needs regular reflection and/or refraction.

Statement II: The variety in the color of objects we see around us is due to the constituent

colors of the light incident on them.

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

(1) Statement I is correct but statement II is incorrect

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

(3) Both Statement I and Statement II are correct

(4) Both Statement I and Statement II are incorrect

Correct Answer: (3) Both Statement I and Statement II are correct

Solution:

- Statement I is correct because regular reflection and refraction are necessary for image formation. For example, in a plane mirror, light reflects from the surface, creating an image. For lenses, refraction of light helps form an image.
- Statement II is also correct. Different colors in white light are responsible for the variety in the color of objects we observe. The color of an object is determined by the light it reflects, which can be made up of different wavelengths corresponding to different colors.

Thus, both statements are correct, so the correct answer is (3).

Quick Tip

When studying light and optics, remember that regular reflection and refraction are essential for image formation, and the color of an object depends on the wavelengths of light it reflects.

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21. A uniform metal wire of length l has 10 Ω resistance. Now this wire is stretched to a length $2l$ and then bent to form a perfect circle. The equivalent resistance across any arbitrary diameter of that circle is:

(1) 10 Ω

(2) 5 Ω

(3) 40 Ω

(4) 20 Ω

Correct Answer: (1) 10 Ω

Solution:

Let the original resistance of the wire be $R_0 = 10\,\Omega$.

When the wire is stretched to double its length, the resistance increases because resistance is directly proportional to the length of the wire. The new length is $2l$, so the new resistance R_1 is:

$$R_1 = 4R_0 = 4 \times 10 = 40\,\Omega$$

Now, the wire is bent into a circle. The equivalent resistance across any arbitrary diameter is the sum of the resistances of the two halves of the wire. Since the wire is now in the shape of a circle, each half of the circle will have a resistance of $20\,\Omega$. Therefore, the total equivalent resistance across the diameter is:

$$R_{\text{total}} = 20\,\Omega + 20\,\Omega = 40\,\Omega$$

Thus, the equivalent resistance across any diameter of the circle is 10 Ω.

Quick Tip

When stretching a wire, the resistance increases in proportion to the length. After bending it into a circle, the resistance across any diameter is the sum of the resistances of the two halves of the wire.

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22. The spectral series which corresponds to the electronic transition from the levels $n_2 = 5, 6, \ldots$ to the level $n_1 = 4$ is

(1) Pfund series

(2) Brackett series

(3) Lyman series

(4) Balmer series

Correct Answer: (2) Brackett series

Solution:

The spectral series which corresponds to the electronic transition from the levels $n_2 = 5, 6, \ldots$ to $n_1 = 4$ is the Brackett series. This series is part of the hydrogen atom's emission spectrum. In general, spectral series correspond to the transition of an electron between energy levels. For a transition where $n_1 = 4$, the emission falls under the Brackett series, as opposed to

other series like Lyman, Balmer, and Pfund, which correspond to transitions where the electron falls to the $n_1 = 1, 2,$ or 5 energy levels, respectively.

The Brackett series lies in the infrared region of the electromagnetic spectrum, making it unique compared to the visible light-emitting Balmer series.

Quick Tip

When studying spectral series, remember the key series transitions: - Lyman series: $n_1 = 1$ (Ultraviolet), - Balmer series: $n_1 = 2$ (Visible Light), - Pfund series: $n_1 = 5$ (Far Infrared), - Brackett series: $n_1 = 4$ (Infrared).

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

Assertion A: Houses made of concrete roofs overlaid with foam keep the room hotter during summer.

Reason R: The layer of foam insulation prohibits heat transfer, as it contains air pockets.

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

(1) A is true but R is false.

(2) A is false but R is true.

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

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

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

Solution:

The foam layer in the concrete roofs prevents heat transfer, acting as insulation. This means houses with foam roofing actually keep cooler in summer, as it prevents the absorption of heat. Therefore, Assertion A is false, because foam roofs do not make the house hotter, but cooler. On the other hand, Reason R is true: foam insulation has air pockets that prevent the transfer of heat. This layer of foam provides the desired insulation effect. Thus, Assertion A is false while Reason R is true.

It's important to understand how materials like foam act as insulators, and in this case, foam prevents the heat from entering or exiting the building.

Quick Tip

When analyzing assertions and reasons, always check the underlying science behind the materials used, as in this case where foam acts as an insulator and prevents heat transfer.

---

24. A particle executing simple harmonic motion with amplitude A has the same potential and kinetic energies at the displacement

(1) $2A$

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

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

(4) $A/\sqrt{2}$

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

Solution:

In simple harmonic motion (SHM), the total mechanical energy is conserved and is the sum of the potential energy (PE) and the kinetic energy (KE). At any point, the energy is split between PE and KE, with the maximum kinetic energy occurring when the displacement is zero and the maximum potential energy occurring at the amplitude A.

The potential energy for SHM is given by:

$$PE = \frac{1}{2}kx^2$$

and the kinetic energy is:

$$KE = \frac{1}{2}mv^2$$

The total energy in SHM is constant and equal to the sum of the potential and kinetic energy. At the point where the potential energy equals the kinetic energy, the displacement x is $\frac{A}{\sqrt{2}}$, where A is the amplitude. This is the point where the energies are split equally. Thus, the correct displacement for equal potential and kinetic energies is $\frac{A}{\sqrt{2}}$.

In SHM, it is crucial to understand how the energies change as the particle moves from one extreme to the equilibrium position. At the extreme points, all the energy is potential, and at the center, it is all kinetic.

Quick Tip

In SHM, the displacement at which the kinetic energy equals potential energy is $\frac{A}{\sqrt{2}}$, where A is the amplitude.

---

25. Two slits in Young's double slit experiment are 1.5 mm apart and the screen is placed at a distance of 1 m from the slits. If the wavelength of light used is 600 x 10^{-9} m, then the fringe separation is

(1) 4×10^{-5} m

(2) 4×10^{-7} m

(3) 9×10^{-8} m

(4) 4×10^{-4} m

Correct Answer: (4) 4×10^{-4} m

Solution:

In Young's double slit experiment, the fringe separation is given by the formula:

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

Where: - λ is the wavelength of the light used,

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

- d is the separation between the slits.

Substituting the given values:

$$\lambda = 600 \times 10^{-9}\,\text{m},\ D = 1\,\text{m},\ d = 1.5 \times 10^{-3}\,\text{m}$$

$$\beta = \frac{600 \times 10^{-9} \times 1}{1.5 \times 10^{-3}} = 4 \times 10^{-4}\,\text{m}$$

Thus, the fringe separation is 4×10^{-4} m. This means the distance between the adjacent bright or dark fringes on the screen is 4×10^{-4} meters.

The fringe separation depends on the wavelength of light, the distance to the screen, and the slit separation. It is also a key measurement in determining the diffraction pattern in Young's experiment.

Quick Tip

In Young's double slit experiment, the fringe separation is directly proportional to the wavelength and the distance to the screen, and inversely proportional to the slit separation.

---

26. Water is used as a coolant in a nuclear reactor because of its

(1) high thermal expansion coefficient

(2) high specific heat capacity

(3) low density

(4) low boiling point

Correct Answer: (2) high specific heat capacity

Solution:

Water is used as a coolant in nuclear reactors primarily because of its high specific heat capacity. The specific heat capacity of water is relatively high, meaning it can absorb and store large amounts of heat without undergoing a significant increase in temperature. This property is crucial for maintaining a stable temperature within the reactor, as water effectively absorbs excess heat from the core.

In comparison, a high thermal expansion coefficient would make it difficult for water to maintain a stable volume at high temperatures, and low density would make it a less efficient medium for heat transfer. Similarly, while low boiling point could pose a risk of water turning into steam at high temperatures, it is the high specific heat capacity that makes water such a good coolant. Therefore, the correct reason for its use in nuclear reactors is its ability to absorb and store significant amounts of thermal energy.

Quick Tip

When selecting a coolant for industrial processes or reactors, prioritize fluids with high specific heat capacity to maximize heat absorption without significant temperature changes.

---

27. The pitch of an error free screw gauge is 1 mm and there are 100 divisions on the circular scale. While measuring the diameter of a thick wire, the pitch scale reads 1 mm and 63rd division on the circular scale coincides with the reference line. The diameter of the wire is:

(1) 1.63 cm

(2) 0.163 cm

(3) 0.163 mm

(4) 1.63 mm

Correct Answer: (2) 0.163 cm

Solution:

To calculate the diameter of the wire using a screw gauge, we first need to determine the least count (LC) of the screw gauge. The least count is the smallest length that can be measured, given by the formula:

$$\text{Least count} = \frac{\text{Pitch}}{\text{Number of divisions on the circular scale}} = \frac{1\,\text{mm}}{100} = 0.01\,\text{mm}$$

Next, we can calculate the final reading using the formula:

$$\text{Final reading} = \text{MSR} + \text{CSR} \times \text{L.C.}$$

Where: - MSR is the main scale reading (1 mm), - CSR is the circular scale reading (63 divisions), - L.C. is the least count (0.01 mm). Substituting the values:

$$\text{Final reading} = 1\,\text{mm} + 63 \times (0.01)\,\text{mm} = 1.63\,\text{mm}$$

Thus, the diameter of the wire is $0.163\,\text{cm}$ (since 1 mm = 0.1 cm).

This method demonstrates how to effectively read and calculate the measurement of objects using a screw gauge, ensuring accuracy through the use of both the main scale and the circular scale.

Quick Tip

When using screw gauges, always remember to include both the main scale reading and the circular scale reading to ensure accurate results.

28. Let us consider two solenoids A and B, made from same magnetic material of relative permeability μ_r and equal area of cross-section. Length of A is twice that of B and the number of turns per unit length in A is half that of B. The ratio of self inductances of the two solenoids, $L_A : L_B$, is

(1) 1 : 2

(2) 2 : 1

(3) 8 : 1

(4) 1 : 8

Correct Answer: (1) 1 : 2

Solution:

The self inductance L of a solenoid is given by the formula:

$$L = \mu_0 \mu_r n^2 Al$$

Where:

- μ_0 is the permeability of free space,
- μ_r is the relative permeability,
- n is the number of turns per unit length,
- A is the cross-sectional area,
- l is the length of the solenoid.

For solenoid A, the length $l_A = 2l_B$ and the number of turns per unit length $n_A = \frac{1}{2}n_B$.

Substituting into the formula for self inductance:

$$L_A = \mu_0 \mu_r \left(\frac{1}{2}n_B\right)^2 A \cdot 2l_B = \frac{1}{2} \cdot \mu_0 \mu_r n_B^2 A l_B = \frac{1}{2} L_B$$

Thus, the ratio $L_A : L_B$ is $1 : 2$. This shows that solenoid A has half the inductance of solenoid B.

It's important to understand the relationship between the length, number of turns, and self inductance when comparing solenoids, as these factors determine the inductive properties of the solenoid.

Quick Tip

When comparing solenoids, remember that inductance is directly related to the square of the number of turns per unit length and the length of the solenoid.

29. When the output of an OR gate is applied as input to a NOT gate, then the combination acts as a

(1) NAND gate

(2) NOR gate

(3) AND gate

(4) OR gate

Correct Answer: (1) NAND gate

Solution:

An OR gate produces an output of 1 when at least one of its inputs is 1, and 0 only when both inputs are 0. When this output is passed through a NOT gate, it inverts the value. Therefore, if the OR gate outputs 1, the NOT gate will invert it to 0, and if the OR gate outputs 0, the NOT gate will invert it to 1. This behavior corresponds to the operation of a NAND gate, which gives an output of 0 only when both inputs are 1. Hence, the combination of an OR gate followed by a NOT gate behaves as a NAND gate.

This combination is often used in digital circuits to simplify the implementation of logical operations.

Quick Tip

In digital logic, combining gates in specific sequences can lead to the creation of other gates like NAND or NOR, enabling more complex logical operations.

---

30. Interference pattern can be observed due to superposition of the following waves:

A. $y = a\sin t$ **B.** $y = a\sin 2t$

C. $y = a\sin(\omega t - \varphi)$ **D.** $y = a\sin 3\omega t$

Choose the correct answer from the options given below.

(1) B and C

(2) B and D

(3) A and C

(4) A and B

Correct Answer: (3) A and C

Solution: Interference patterns are observed when two or more coherent waves overlap and interfere with each other. Coherent waves are those that maintain a constant phase difference. In this question, we are given different waveforms:

- Wave A: $y = a\sin t$ is a sinusoidal wave that oscillates with a frequency corresponding to t.
- Wave C: $y = a\sin(\omega t - \varphi)$ is also sinusoidal but with a phase shift φ.

When two waves like $y = a\sin t$ and $y = a\sin(\omega t - \varphi)$ interfere, they can form a stable interference pattern due to their constant phase relationship.

- Wave B ($y = a\sin 2t$) and wave D ($y = a\sin 3\omega t$) have different frequencies and thus cannot form stable interference patterns with other waves.

Thus, the correct answer is (3) A and C. These two waves can produce an interference pattern because they are both coherent and have related frequencies.

Quick Tip

When working with interference, ensure that the waves are coherent—i.e., they have a constant phase difference and similar frequencies.

---

31. If φ is the work function of photosensitive material in eV and light of wavelength of numerical value $\lambda = \frac{hc}{e}$ is incident on it with energy above its threshold value at an instant, then the maximum kinetic energy of the photo-electron ejected by it at that instant (in SI units) is:

(1) $e + 2\varphi$

(2) $2e - \varphi$

(3) $e - \varphi$

(4) $e + \varphi$

Correct Answer: (3) $e - \varphi$

Solution: In the photoelectric effect, when light strikes a material, it can transfer its energy to electrons in the material. This energy must overcome the work function φ, which is the minimum energy needed to release an electron from the material's surface. If the energy of the light exceeds this threshold, the excess energy is converted into the kinetic energy of the emitted electron.

The energy of the incident photons is:

$$E = \frac{hc}{\lambda}$$

where h is Planck's constant, c is the speed of light, and λ is the wavelength of the incident light. We are given that the wavelength is $\lambda = \frac{hc}{e}$, so the energy of the photons becomes $E = e$.

The maximum kinetic energy of the ejected electron is the difference between the photon energy and the work function φ of the material:

$$(K.E.)_{\text{max}} = E - \varphi = e - \varphi$$

Thus, the correct answer is (3) $e - \varphi$.

Quick Tip

For photoelectric effect problems, use the relationship $(K.E.)_{\text{max}} = e - \varphi$ to find the kinetic energy of the ejected electron.

---

32. The electromagnetic radiation which has the smallest wavelength are:

(1) X-rays

(2) Gamma rays

(3) Ultraviolet rays

(4) Microwaves

Correct Answer: (2) Gamma rays

Solution: The wavelength of electromagnetic radiation decreases with increasing frequency. Gamma rays have the highest frequency in the electromagnetic spectrum and thus the smallest wavelength. They are produced by nuclear reactions and are the most energetic form of radiation, with wavelengths shorter than X-rays, ultraviolet rays, and microwaves. Thus, the correct answer is (2) Gamma rays, which have the smallest wavelength and highest frequency.

Quick Tip

Gamma rays are the most energetic form of electromagnetic radiation, with wavelengths shorter than all other forms of radiation in the spectrum.

33. The equilibrium state of a thermodynamic system is described by:

A. Pressure **B.** Total heat

C. Temperature **D.** Volume

E. Work done

Choose the most appropriate answer from the options given below.

(1) A, B and C only

(2) B, C and D only

(3) A, B and C only

(4) A, C and D only

Correct Answer: (4) A, C and D only

Solution: The equilibrium state of a thermodynamic system is defined by its state variables. These are parameters that describe the condition of the system and are independent of the process used to reach equilibrium. The three primary state variables are:

- Pressure (P): The force per unit area exerted by the particles of the system. It is a fundamental variable used to describe the system's state. - Volume (V): The space or the amount of three-dimensional area the system occupies. It also depends on the state of the system.

- Temperature (T): A measure of the average kinetic energy of particles in the system. It is a critical indicator of thermal equilibrium.

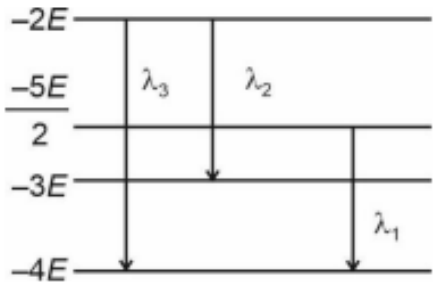
Work done and total heat are not state variables because they depend on the path taken during a thermodynamic process. They are not determined by the equilibrium state but by how the system moves from one state to another.

Thus, the correct answer is (4) A, C, and D only, as these are the state variables that describe the system's equilibrium.

Quick Tip

Remember that for thermodynamic equilibrium, only the state variables—Pressure, Volume, and Temperature—are required.

34. Some energy levels of a molecule are shown in the figure with their wavelengths of transitions. Then:



Choose the correct answer from the options given below.

(1) $\lambda_3 > \lambda_2, \lambda_1 = 2\lambda_2$

(2) $\lambda_3 > \lambda_2, \lambda_1 = 4\lambda_2$

(3) $\lambda_1 > \lambda_2, \lambda_1 = 2\lambda_3$

(4) $\lambda_3 > \lambda_1, \lambda_1 = 2\lambda_3$

Correct Answer: (4) $\lambda_3 > \lambda_1, \lambda_1 = 2\lambda_3$

Solution: From the energy level diagram, we know that:

$$hc = -5E = \frac{3E}{2} \quad \Rightarrow \quad \lambda_1$$

h c = -2E + 3E = E $\Rightarrow$ λ_2

h c = -2E + 4E = 2E $\Rightarrow$ λ_3

Comparing equations (2) and (3):

$$\frac{1}{\lambda_3} = 2 \times \frac{1}{\lambda_2} \quad \Rightarrow \quad \lambda_2 = 2\lambda_3$$

Comparing equations (1) and (2):

$$3 \times \lambda_1 = 2\lambda_3 \quad \Rightarrow \quad \lambda_1 = 2\lambda_3$$

Thus, the correct answer is (4) $\lambda_3 > \lambda_1, \lambda_1 = 2\lambda_3$.

Quick Tip

When comparing wavelengths of transitions, recall that the energy difference between levels is inversely proportional to the wavelength.

35. A box of mass 5 kg is pulled by a cord, up along a frictionless plane inclined at 30° with the horizontal. The tension in the cord is 30 N. The acceleration of the box is (Take $g = 10\,\text{m/s}^2$):

(1) 2 m/s²

(2) Zero

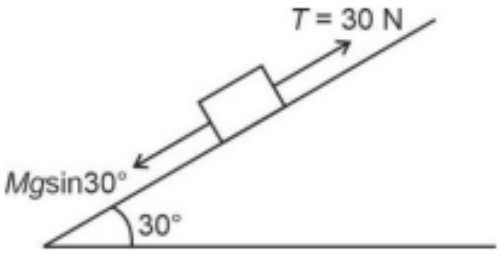
(3) 0.1 m/s²

(4) 1 m/s²

Correct Answer: (4) 1 m/s²

Solution: The force applied to the box along the inclined plane is due to the tension $T = 30\,\text{N}$ and the component of the weight of the box acting along the plane, which is $Mg\sin 30°$. The equation of motion for the box is:

$$T - Mg\sin 30° = Ma$$



Substitute the given values:

$$30 - 5 \times 10 \times \sin 30° = 5 \times a$$

$$30 - 5 \times 10 \times \frac{1}{2} = 5 \times a$$

$$30 - 25 = 5a$$

$$5 = 5a \quad \Rightarrow \quad a = 1\,\text{m/s}^2$$

Thus, the correct answer is (4) 1 m/s².

Quick Tip

When dealing with forces on an inclined plane, always resolve the gravitational force along the plane using $\sin\theta$, where θ is the angle of inclination.

SECTION-B

36. If the ratio of relative permeability and relative permittivity of a uniform medium is 1 : 4. The ratio of the magnitudes of electric field intensity (E) to the magnetic field intensity (H) of an EM wave propagating in that medium is

Given that $\mu_0\varepsilon_0 = 120\pi$:

(1) $30\pi : 1$

(2) $1 : 120\pi$

(3) $60\pi : 1$

(4) $120\pi : 1$

Correct Answer: (3) $60\pi : 1$

Solution: We are given that the ratio of the relative permeability and relative permittivity of the medium is 1:4, i.e.,

$$\mu_r = \frac{1}{4} \quad \text{and} \quad \varepsilon_r = 4$$

The relationship between the electric field intensity E and magnetic field intensity H in an EM wave is given by:

$$\frac{E}{H} = c = \frac{1}{\sqrt{\mu\varepsilon}}$$

Since $\mu = \mu_0\mu_r$ and $\varepsilon = \varepsilon_0\varepsilon_r$, the equation becomes:

$$\frac{E}{H} = \frac{1}{\sqrt{\mu_0\mu_r\varepsilon_0\varepsilon_r}} = \frac{1}{\sqrt{\mu_0\varepsilon_0}} \cdot \frac{1}{\sqrt{\mu_r\varepsilon_r}}$$

Substitute the given values:

$$\frac{E}{H} = \frac{1}{\sqrt{\mu_0\varepsilon_0}} \cdot \frac{1}{\sqrt{\frac{1}{4} \times 4}} = \frac{1}{\sqrt{\mu_0\varepsilon_0}} \cdot \frac{1}{1}$$

Now, from the given $\mu_0\varepsilon_0 = 120\pi$, we get:

$$\frac{E}{H} = \frac{1}{\sqrt{120\pi}} = 60\pi$$

Thus, the correct answer is (3) $60\pi : 1$.

Quick Tip

When calculating the ratio of electric field intensity to magnetic field intensity in an EM wave, remember to account for the permeability and permittivity of the medium.

---

37. The value of electric potential at a distance of 9 cm from the point charge $4 \times 10^{-7}\,C$ is Given $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\,\text{Nm}^2\text{C}^{-2}$:

(1) 4×10^2 V

(2) 44.4 V

(3) 4.4×10^5 V

(4) 4×10^4 V

Correct Answer: (4) 4×10^4 V

Solution: The electric potential V at a distance r from a point charge q is given by the formula:

$$V = \frac{kq}{r}$$

where $k = \frac{1}{4\pi\varepsilon_0}$ is Coulomb's constant, q is the charge, and r is the distance.

Substitute the given values:

$$V = \frac{9 \times 10^9 \times 4 \times 10^{-7}}{9 \times 10^{-2}} = \frac{36 \times 10^2}{9 \times 10^{-2}} = 4 \times 10^4\,\text{V}$$

Thus, the correct answer is (4) 4×10^4 V.

Quick Tip

To calculate electric potential, use the formula $V = \frac{kq}{r}$, where k is Coulomb's constant and q is the charge.

---

38. The displacement of a travelling wave $y = c\sin\left(\frac{2\pi}{\lambda}(at - x)\right)$ where t is time, x is distance and λ is the wavelength, all in S.I. units. Then the frequency of the wave is:

(1) $\frac{2\pi}{a}$

(2) $\frac{2\pi}{\lambda}$

(3) $\frac{\lambda}{a}$

(4) $\frac{a}{\lambda}$

Correct Answer: (4) $\frac{a}{\lambda}$

Solution: The equation for the displacement of a travelling wave is given as:

$$y = c\sin\left(\frac{2\pi}{\lambda}(at - x)\right)$$

Here, a is the wave speed, λ is the wavelength, and c is the amplitude.

The general form of a travelling wave is $y = A\sin(\omega t - kx)$, where ω is the angular frequency and k is the wave number. Comparing the given equation with the standard form, we get:

$$\omega = \frac{2\pi}{\lambda} \quad \text{and} \quad k = \frac{2\pi}{\lambda}$$

Now, the frequency f is related to the angular frequency ω by:

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

Substituting $\omega = \frac{2\pi}{\lambda}$, we get:

$$f = \frac{a}{\lambda}$$

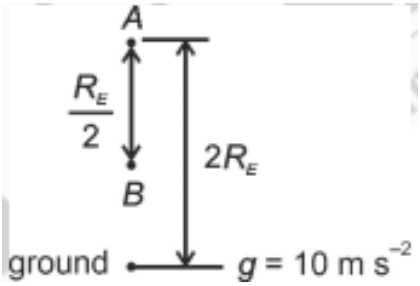
Thus, the correct answer is (4) $\frac{a}{\lambda}$.

Quick Tip

For wave equations, remember that frequency f is the ratio of wave speed a to wavelength λ.

---

39. An object of mass 100 kg falls from point A to B as shown in the figure. The change in its weight, corrected to the nearest integer is (R_E is the radius of the earth):



(1) 49 N

(2) 89 N

(3) 5 N

(4) 10 N

Correct Answer: (1) 49 N

Solution: The weight of an object is given by:

$$W = Mg'$$

where M is the mass of the object and g' is the acceleration due to gravity at a particular height.

At point A, the distance from the center of the Earth is R_E, and at point B, it is $\frac{R_E}{2}$.

At A:

$$g'_A = \frac{g}{R_E^2} \quad \Rightarrow \quad W_A = M\frac{g}{R_E^2}$$

At B:

$$g'_B = \frac{g}{(R_E + h)^2} \quad \Rightarrow \quad W_B = M\frac{g}{(R_E + 2R_E)^2}$$

The change in weight ΔW is calculated as:

$$\Delta W = W_B - W_A = 49N$$

Thus, the correct answer is (1) 49 N.

Quick Tip

To calculate changes in weight, consider the change in the effective gravitational field strength due to height.

---

40. The potential energy of a particle moving along x-direction varies as $V = \frac{Ax^2}{\sqrt{x^2+B}}$. The dimensions of $\frac{A^2}{B}$ are:

(1) $[M^{3/2}L^{1/2}T^{-3}]$

(2) $[M^{1/2}LT^{-3}]$

(3) $[M^2L^{1/2}T^{-4}]$

(4) $[ML^2T^{-4}]$

Correct Answer: (3) $[M^2L^{1/2}T^{-4}]$

Solution: The potential energy is given by:

$$V = \frac{Ax^2}{\sqrt{x^2 + B}}$$

Using dimensional analysis, let's break down the dimensions:

- The dimension of V (potential energy) is $[ML^2T^{-2}]$.

- The dimension of x (distance) is $[L]$.

- The dimension of B is $[L^2]$, based on the form of the equation.

Now, let's find the dimension of A. For dimensional consistency, A must satisfy the equation for V:

$$\frac{Ax^2}{\sqrt{x^2 + B}} \quad \Rightarrow \quad \frac{AL^2}{L} = ML^2T^{-2} \quad \Rightarrow \quad A = MLT^{-2}$$

Now, let's calculate the dimension of $\frac{A^2}{B}$:

$$\frac{A^2}{B} = \frac{(MLT^{-2})^2}{L^2} = \frac{M^2L^2T^{-4}}{L^2} = M^2L^{1/2}T^{-4}$$

Thus, the correct answer is (3) $[M^2L^{1/2}T^{-4}]$.

Quick Tip

When performing dimensional analysis, make sure to balance both sides of the equation to ensure correct dimensions.

---

41. The two-dimensional motion of a particle, described by $\mathbf{r} = (i + 2j)A\cos\omega t$ is an:

(1) parabolic path

(2) elliptical path

(3) periodic motion

(4) simple harmonic motion

Choose the correct answer from the options given below:

(1) B, C and D only

(2) A, B and C only

(3) A, C and D only

(4) C and D only

Correct Answer: (4) C and D only

Solution: The two-dimensional motion of the particle is given by:

$$\mathbf{r} = (i + 2j)A\cos\omega t$$

This can be broken into the components:

$$x = A\cos\omega t$$

$$y = 2A\cos\omega t$$

The path is a straight line because both x and y follow the same $\cos\omega t$ behavior.

The motion is simple harmonic motion (SHM) and periodic as both x and y exhibit periodic behavior with time. The equation for SHM in vector form is:

$$\frac{d^2}{dt^2}\mathbf{r} = -\omega^2\mathbf{r}$$

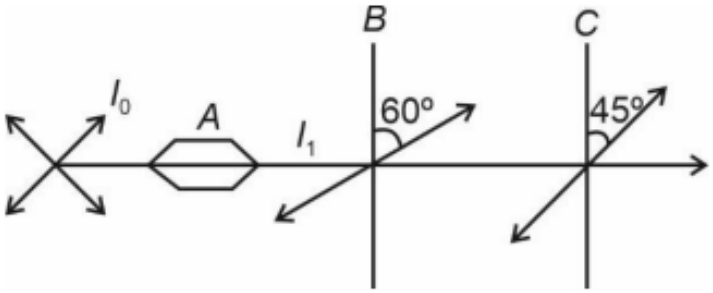
Thus, the motion described is simple harmonic motion, and the correct answer is (4).

Quick Tip

For SHM, remember that the second derivative of position with respect to time is proportional to the negative of the displacement, $\frac{d^2}{dt^2}\mathbf{r} = -\omega^2\mathbf{r}$.

---

42. A beam of unpolarized light of intensity I_0 is passed through a polaroid A, then through another polaroid B, oriented at 60° and finally through another polaroid C, oriented at 45° relative to B as shown. The intensity of emergent light is:



(1) $\frac{I_0}{16}$

(2) $\frac{I_0}{4}$

(3) $\frac{I_0}{2}$

(4) $\frac{I_0}{32}$

Correct Answer: (1) $\frac{I_0}{16}$

Solution: The intensity of light passing through a polaroid is given by Malus' Law, which states:

$$I = I_0 \cos^2 \theta$$

where θ is the angle between the light's polarization direction and the axis of the polaroid.

- First, the light passes through polaroid A. Since the light is unpolarized, the intensity after passing through A is:

$$I_1 = \frac{I_0}{2}$$

- Next, the light passes through polaroid B, which is oriented at 60° to the axis of A. The intensity after passing through B is:

$$I_B = I_1 \cos^2 60 = \frac{I_0}{2} \times \left(\frac{1}{2}\right)^2 = \frac{I_0}{8}$$

- Finally, the light passes through polaroid C, which is oriented at 45° relative to B. The intensity after passing through C is:

$$I_C = I_B \cos^2 45 = \frac{I_0}{8} \times \left(\frac{1}{\sqrt{2}}\right)^2 = \frac{I_0}{16}$$

Thus, the intensity of the emergent light is $\frac{I_0}{16}$, and the correct answer is (1).

Quick Tip

When light passes through multiple polarizers, use Malus' Law repeatedly to calculate the intensity after each polaroid.

43. Select the correct statements among the following:

A. Slow neutrons can cause fission in $^{235}_{92}$U than fast neutrons.

B. α-rays are Helium nuclei.

C. β-rays are fast-moving electrons or positrons.

D. γ-rays are electromagnetic radiations of wavelengths larger than X-rays.

Choose the most appropriate answer from the options given below:

(1) A, B and C only

(2) A, B and D only

(3) A and B only

(4) C and D only

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

Solution: - (A) Slow neutrons can cause fission in $^{235}_{92}$U more effectively than fast neutrons. This is because fast neutrons are too quick, so they scatter off atoms instead of being captured by them.

- (B) α-rays are indeed Helium nuclei (composed of two protons and two neutrons).

- (C) β-rays are generated when a neutron is converted into a proton by emitting an electron (also known as a beta particle), or when a proton is converted into a neutron by releasing a positron.

- (D) γ-rays have higher energy compared to X-rays. As a result, they have smaller wavelengths than X-rays. The statement that γ-rays have wavelengths larger than X-rays is incorrect.

Thus, the correct answer is (1) A, B and C only.

Quick Tip

In particle physics, α-rays are helium nuclei, β-rays are fast-moving electrons or positrons, and γ-rays are high-energy electromagnetic radiations.

44. Let ω_1, ω_2 and ω_3 be the angular speed of the second hand, minute hand and hour hand of a smoothly running analog clock, respectively. If x_1, x_2 and x_3 are their respective angular distances in 1 minute, then the factor which remains constant (k) is:

(1) $\frac{\omega_1}{x_1} = \frac{\omega_2}{x_2} = \frac{\omega_3}{x_3} = k$

(2) $\omega_1 x_1 = \omega_2 x_2 = \omega_3 x_3 = k$

(3) $\omega_1^2 x_1^2 = \omega_2^2 x_2^2 = \omega_3^2 x_3^2 = k$

(4) $\omega_1^2 x_1 = \omega_2^2 x_2 = \omega_3^2 x_3 = k$

Correct Answer: (1) $\frac{\omega_1}{x_1} = \frac{\omega_2}{x_2} = \frac{\omega_3}{x_3} = k$

Solution: The angular speed ω is defined as the rate of change of angle with respect to time. For each hand of the clock:

- For the second hand, the angular speed is:

$$\omega_1 = \frac{2\pi}{60} \quad \text{and} \quad x_1 = \frac{2\pi}{60} \times 60 = 2\pi$$

- For the minute hand, the angular speed is:

$$\omega_2 = \frac{2\pi}{3600} \quad \text{and} \quad x_2 = \frac{2\pi}{3600} \times 60 = \frac{2\pi}{60}$$

- For the hour hand, the angular speed is:

$$\omega_3 = \frac{2\pi}{3600 \times 12} \quad \text{and} \quad x_3 = \frac{2\pi}{3600 \times 12} \times 60 = \frac{2\pi}{720}$$

Now, we can find the factor k by calculating the ratio of angular speed to angular distance for each hand:

$$\frac{\omega_1}{x_1} = \frac{\omega_2}{x_2} = \frac{\omega_3}{x_3} = \frac{1}{60}$$

Thus, the correct answer is (1).

Quick Tip

When dealing with angular speed, use the formula $\omega = \frac{\theta}{t}$, where θ is the angle and t is time. The ratio of angular speed to angular distance remains constant.

45. The magnetic moment of an iron bar is M. It is now bent in such a way that it forms an arc of a circle subtending an angle of 60° at the centre. The magnetic moment of this arc is:

(1) $\frac{3M}{\pi}$

(2) $\frac{4M}{\pi}$

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

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

Correct Answer: (1) $\frac{3M}{\pi}$

Solution: The magnetic moment of the original iron bar is M, which is the product of the magnetization m and the length L:

$$M = mL$$

When the iron bar is bent into an arc section, it forms a circular sector with a central angle of 60°.

- The radius of the circular arc is $R = \frac{3L}{\pi}$, as derived from the geometry of the situation.
- The magnetic moment of the arc is given by:

$$M' = m \cdot (2R) \cdot \sin 30^\circ$$

Substitute the values:

$$M' = m \cdot 2 \cdot \frac{3L}{\pi} \cdot \frac{1}{2} = \frac{3mL}{\pi}$$

Since $mL = M$, we have:

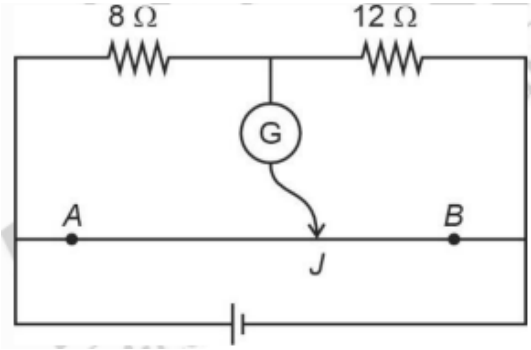
$$M' = \frac{3M}{\pi}$$

Thus, the magnetic moment of the arc is $\frac{3M}{\pi}$, and the correct answer is (1).

Quick Tip

For a bent magnetic bar forming an arc, the magnetic moment of the arc is proportional to the total magnetic moment and the geometry of the arc.

46. The given circuit shows a uniform straight wire AB of 40 cm length fixed at both ends. In order to get zero reading in the galvanometer G, the free end of J is to be placed from B at:



(1) 32 cm

(2) 8 cm

(3) 16 cm

(4) 24 cm

Correct Answer: (4) 24 cm

Solution: The problem involves balancing two resistors across a wire to get zero current through the galvanometer.

Using the concept of a balanced Wheatstone bridge, we have:

$$\frac{8}{x} = \frac{12}{40 - x}$$

Cross multiplying:

$$2(40 - x) = 3x$$

Expanding the equation:

$$80 - 2x = 3x$$

Solving for x:

$$80 = 5x \quad \Rightarrow \quad x = 16$$

Thus, the distance from B is:

$$\text{Distance from } B = 40 - 16 = 24\,\text{cm}$$

Thus, the correct answer is (4) 24 cm.

Quick Tip

For a Wheatstone bridge, use the resistance ratio to calculate the distance where the galvanometer shows zero current.

---

47. According to the law of equipartition of energy, the number of vibrational modes of a polyatomic gas of constant $\gamma = \frac{C_p}{C_v}$ is (where C_p and C_v are the specific heat capacities of the gas at constant pressure and constant volume, respectively):

(1) $\frac{4+3y}{y-1}$

(2) $\frac{3+4y}{y-1}$

(3) $\frac{4-3y}{y-1}$

(4) $\frac{3-4y}{y-1}$

Correct Answer: (3) $\frac{4-3y}{y-1}$

Solution: A polyatomic gas has 3 translational, 3 rotational, and f vibrational modes. The total internal energy is:

$$U = \frac{3}{2}k_BT + \frac{3}{2}k_BT + fk_BT$$

$$U = (3+f)k_BT$$

The specific heat at constant volume C_v is given by:

$$C_v = (3+f)R$$

The specific heat at constant pressure C_p is:

$$C_p = (4+f)R$$

From the relation $\gamma = \frac{C_p}{C_v}$, we get:

$$\frac{C_p}{C_v} = \frac{(4+f)R}{(3+f)R} = \frac{4+f}{3+f} = \gamma$$

Now solving for f:

$$4 + f = 3y + fy$$

$$4 - 3y = f(y - 1)$$

Thus, the number of vibrational modes is:

$$f = \frac{4 - 3y}{y - 1}$$

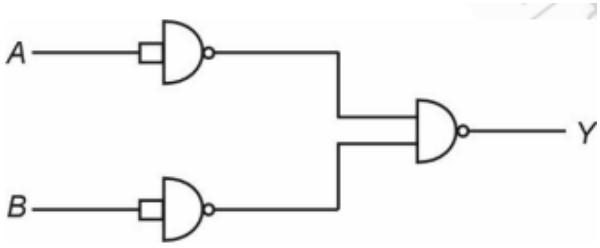
Thus, the correct answer is (3).

Quick Tip

For polyatomic gases, use the law of equipartition of energy to relate the number of modes to the specific heats and temperature.

---

48. The output Y for the inputs A and B of the given logic circuit is:



(1) $A \cdot B$

(2) $\overline{A} \cdot B$

(3) $A + B$

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

Correct Answer: (3) $A + B$

Solution: The given circuit consists of two logic gates:

1. NOT gate (Inverter): The first gate is a NOT gate that takes input A and inverts it, resulting in $\overline{A}$.

2. OR gate: The second gate is an OR gate, which takes the output from the NOT gate ($\overline{A}$) and the second input B, and outputs the logical OR of these two values.

For the OR gate, the output is 1 if at least one of the inputs is 1, otherwise the output is 0. In this case, the OR gate has the inputs $\overline{A}$ and B, so the output Y of the circuit is:

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

Where: - $\overline{A}$ is the inversion (NOT) of A,

- B is the other input to the OR gate.

Thus, the final output is the logical OR of $\overline{A}$ and B, which is $Y = \overline{A} + B$.

To summarize:

- The NOT gate inverts the input A to give $\overline{A}$,

- The OR gate then produces the output $Y = \overline{A} + B$.

The correct answer is (3), which represents the output as the logical OR of A and B after applying the NOT operation on A.

Quick Tip

In digital logic, the output of an OR gate is true if at least one of the inputs is true.

---

49. The amplitude of the charge oscillating in a circuit decreases exponentially as $Q = Q_0 e^{-\frac{Rt}{2L}}$, where Q_0 is the charge at $t = 0$. The time at which charge amplitude decreases to 0.50 Q_0 is nearly:

(1) 19.01 ms

(2) 11.09 ms

(3) 19.01 s

(4) 11.09 s

Correct Answer: (2) 11.09 ms

Solution: Given the equation for the charge amplitude:

$$Q = Q_0 e^{-\frac{Rt}{2L}}$$

where: - $R = 1.5\,\Omega$ (resistance), - $L = 12\,\text{mH} = 12 \times 10^{-3}\,\text{H}$ (inductance), - $\ln(2) = 0.693$.

We are asked to find the time t when the charge amplitude decreases to 50

Thus, we have the equation:

$$0.5Q_0 = Q_0 e^{-\frac{Rt}{2L}}$$

Dividing both sides by Q_0, we get:

$$\frac{1}{2} = e^{-\frac{Rt}{2L}}$$

Taking the natural logarithm (log) on both sides:

$$\ln\left(\frac{1}{2}\right) = \ln\left(e^{-\frac{Rt}{2L}}\right)$$

$$\ln 2 = \frac{Rt}{2L}$$

Now substitute the known values:

$$t = \frac{2L \ln 2}{R}$$

Substituting $L = 12 \times 10^{-3}\,\text{H}$, $\ln 2 = 0.693$, and $R = 1.5\,\Omega$:

$$t = \frac{2 \times 12 \times 10^{-3} \times 0.693}{1.5}$$

$$t = \frac{2 \times 12 \times 10^{-3} \times 0.693}{1.5} = 11.09\,\text{ms}$$

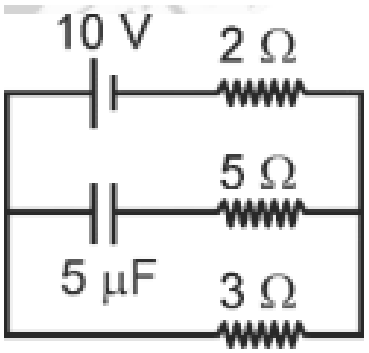
Thus, the correct answer is (2) 11.09 ms.

Quick Tip

When dealing with exponential decay problems, take the natural logarithm of both sides to solve for time.

---

50. The steady state current in the circuit shown below is:



(1) 0.67 A

(2) 1.5 A

(3) 2 A

(4) 1 A

Correct Answer: (3) 2 A

Solution: At steady state, the capacitor will be completely charged and will not allow any current to pass through it, effectively behaving like an open circuit. Hence, the capacitor can be ignored for the steady state calculation.

The remaining circuit consists of two resistors in series:

- The 2 Ω resistor and the 3 Ω resistor.

The total resistance in the circuit is:

$$R = 2\,\Omega + 3\,\Omega = 5\,\Omega$$

Using Ohm's law, the current i in the circuit is:

$$i = \frac{V}{R}$$

Substituting the given values for voltage and resistance:

$$i = \frac{10\,\text{V}}{2\,\Omega + 3\,\Omega} = \frac{10\,\text{V}}{5\,\Omega} = 2\,\text{A}$$

Thus, the steady state current in the circuit is 2 A. The correct answer is (3).

Quick Tip

At steady state in an RC circuit, the capacitor behaves as an open circuit, allowing only the resistive elements to affect the current.

CHEMISTRY

SECTION-A

51. The correct decreasing order of atomic radii (pm) of Li, Be, B, and C is:

(1) Be ¿ Li ¿ B ¿ C

(2) Li ¿ Be ¿ B ¿ C

(3) C ¿ B ¿ Be ¿ Li

(4) Li ¿ C ¿ Be ¿ B

Correct Answer: (2) Li ¿ Be ¿ B ¿ C

Solution: As the atomic number in a period increases, the effective nuclear charge also increases. This causes the electrons to be attracted more strongly towards the nucleus, thereby decreasing the atomic radius along the period.

Therefore, the atomic radii of elements in the same period decrease as we move from left to right across the period.

The correct order of atomic radii is:

$$Li > Be > B > C$$

This is because lithium (Li) has the smallest effective nuclear charge, and as we move to carbon (C), the effective nuclear charge increases, pulling the electrons closer to the nucleus, thereby decreasing the atomic radius.

Thus, the correct answer is (2).

Quick Tip

In periods of the periodic table, atomic radii decrease from left to right due to increasing nuclear charge and constant shielding by inner electrons.

---

52. Following data is for a reaction between reactants A and B:

Rate	$[A]$	$[B]$
2×10^{-3}	$0.1\,\mathrm{M}$	$0.1\,\mathrm{M}$
4×10^{-3}	$0.2\,\mathrm{M}$	$0.1\,\mathrm{M}$
1.6×10^{-2}	$0.2\,\mathrm{M}$	$0.2\,\mathrm{M}$

The order of the reaction with respect to A and B, respectively, are:

(1) 1, 0

(2) 0, 1

(3) 1, 2

(4) 2, 1

Correct Answer: (3) 1, 2

Solution: Let the rate equation be:

$$\text{Rate} = k[A]^x[B]^y$$

We can write the following for the three experiments:

- From the first data point:

$$2 \times 10^{-3} = k[0.1]^x[0.1]^y \quad \text{(i)}$$

- From the second data point:

$$4 \times 10^{-3} = k[0.2]^x[0.1]^y \quad \text{(ii)}$$

- From the third data point:

$$1.6 \times 10^{-2} = k[0.2]^x[0.2]^y \quad \text{(iii)}$$

Now, divide equation (ii) by equation (i):

$$\frac{4 \times 10^{-3}}{2 \times 10^{-3}} = \frac{k[0.2]^x[0.1]^y}{k[0.1]^x[0.1]^y}$$

$$2 = \left(\frac{0.2}{0.1}\right)^x$$

$$2 = 2^x$$

$$x = 1$$

Now, divide equation (iii) by equation (ii):

$$\frac{4 \times 10^{-3}}{1.6 \times 10^{-2}} = \frac{k[0.2]^x[0.1]^y}{k[0.2]^x[0.2]^y}$$

$$\frac{1}{4} = \left(\frac{0.1}{0.2}\right)^y$$

$$\frac{1}{4} = \left(\frac{1}{2}\right)^y$$

$$y = 2$$

Thus, the order of the reaction with respect to A is 1, and the order with respect to B is 2.

The rate equation is:

$$\text{Rate} = k[A]^1[B]^2$$

Therefore, the correct answer is (3) 1, 2.

Quick Tip

To determine the order of reaction with respect to each reactant, compare how the rate changes when the concentration of one reactant is varied, keeping others constant.

---

53. Given below are two statements: Statement I: Propene on treatment with diborane gives an addition product with the formula $((CH_3)_2CH_3B)$.

Statement II: Oxidation of $((CH_3)_2CH_3B)$ with hydrogen peroxide in the presence of NaOH gives propan-2-ol.

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

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

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

(3) Both Statement I and Statement II are correct

(4) Both Statement I and Statement II are incorrect

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

Solution: Let's break down each statement:

- Statement I: ”Propene on treatment with diborane gives an addition product with the formula $((CH_3)_2CH_3B)$.”

This statement is incorrect. The reaction between propene and diborane (B_2H_6) gives an addition product, but the product formed is 1,2-dimethylpropylborane with the formula $(CH_3 - CH_2 - CH_2)B$, not $((CH_3)_2CH_3B)$. The correct product should involve the borane adding across the double bond, forming a trialkylborane.

- Statement II: ”Oxidation of $((CH_3)_2CH_3B)$ with hydrogen peroxide in the presence of NaOH gives propan-2-ol.”

This statement is correct. The oxidation of the trialkylborane with hydrogen peroxide (H_2O_2) in the presence of NaOH results in the formation of propan-2-ol. The reaction follows the hydroboration-oxidation mechanism, where the alkyl group attached to the boron atom is converted into a hydroxyl group, resulting in the formation of an alcohol.

Thus, Statement I is incorrect, but Statement II is correct.

Quick Tip

In hydroboration-oxidation reactions, the addition of borane to an alkene follows anti-Markovnikov’s rule, and the subsequent oxidation with hydrogen peroxide gives an alcohol.

54. Baeyer’s reagent is:

(1) Acidic potassium permanganate solution

(2) Acidic potassium dichromate solution

(3) Cold, dilute, aqueous solution of potassium permanganate

(4) Hot, concentrated solution of potassium permanganate

Correct Answer: (3) Cold, dilute, aqueous solution of potassium permanganate

Solution: Baeyer’s reagent is a cold, dilute, aqueous solution of potassium permanganate. It is an important reagent in organic chemistry used for the identification and oxidation of alkenes and alkynes.

- Potassium permanganate ($KMnO_4$) is a strong oxidizing agent, and in its dilute form, it can be used to selectively oxidize alkenes to diols.

- Baeyer’s reagent specifically refers to a cold, dilute solution of $KMnO_4$, which has a mild oxidizing nature. This reagent reacts with double bonds, adding hydroxyl groups to form a

vicinal diol.

- The oxidation of alkenes with Baeyer's reagent involves the formation of cyclic manganate esters, which are then hydrolyzed to produce the diol.

The key point to remember is that Baeyer's reagent is used to test for the presence of alkenes by the formation of a vicinal diol and is typically used in cold, dilute conditions to avoid over-oxidation.

In contrast:

- Acidic potassium permanganate solution and hot, concentrated potassium permanganate solution are much stronger oxidizing agents and would result in further oxidation or decomposition of organic molecules, which is not the case for Baeyer's reagent.
- Potassium dichromate in acidic conditions is another strong oxidizing agent, but it is not the correct reagent for this particular reaction.

Thus, the correct answer is (3) Cold, dilute, aqueous solution of potassium permanganate.

Quick Tip

Baeyer's reagent is specifically used for the identification of alkenes. It reacts with alkenes to form vicinal diols, and it should be cold and dilute to prevent over-oxidation.

---

55. Which of the following molecules has "NON ZERO" dipole moment value?

(1) CCl4

(2) HI

(3) CO2

(4) BF3

Correct Answer: (2) HI

Solution: Dipole moment of a molecule depends on both its shape and bond dipole. Let's examine the dipole moment for each molecule:

- CCl4: The shape is tetrahedral, and the bond dipoles cancel out, resulting in a dipole moment of 0.
- HI: The molecule is linear with a dipole moment value of 0.38 Debye, so it has a non-zero dipole moment.

- CO2: The molecule is linear, and the bond dipoles cancel out, giving a dipole moment of 0.

- BF3: The molecule has a trigonal planar shape, and the bond dipoles cancel, resulting in a dipole moment of 0.

Thus, only HI has a non-zero dipole moment.

Quick Tip

A molecule with a symmetrical shape, like CCl4 or BF3, typically has zero dipole moment because the bond dipoles cancel out.

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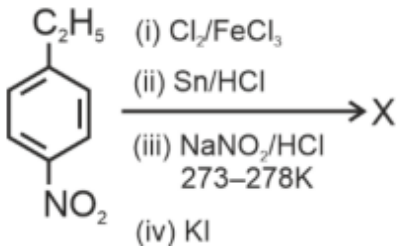
56. The major product X formed in the following reaction sequence is:



(1) C_6H_5Cl

(2) $C_6H_4Cl_2$

(3) $C_6H_5NO_2$

(4) $C_6H_5NH_2$

Correct Answer: (3) $C_6H_5NO_2$

Solution: Let's break down the sequence of reactions step by step:

- Step (i): The reaction of ethylbenzene with Cl2/FeCl3 will lead to chlorination of the aromatic ring. This reaction substitutes one of the hydrogen atoms on the benzene ring with a chlorine atom, forming ethylchlorobenzene.

- Step (ii): In the second reaction with Sn/HCl, the nitro group (NO2) is reduced to an amino group (NH2). This converts ethylchlorobenzene into ethylaniline.

- Step (iii): The reaction with NaNO2/HCl at 273–278 K will cause diazotization of the amine group. The NH2 group is converted into a diazonium ion ($C_6H_5N_2^+$).

- Step (iv): The final reaction with KI leads to the replacement of the diazonium group by the iodine ion. However, the primary reaction here is the diazotization and its subsequent coupling with iodine, forming the major product X, which is nitrobenzene ($C_6H_5NO_2$).

Thus, the major product X is nitrobenzene ($C_6H_5NO_2$).

Quick Tip

The sequence involves chlorination, reduction, diazotization, and substitution, with the final product being nitrobenzene after the diazonium ion is replaced by iodine.

---

57. Which indicator is used in the titration of sodium hydroxide against oxalic acid and what is the colour change at the end point?

(1) Phenolphthalein, pink to yellow

(2) Alkaline KMnO4, colourless to pink

(3) Phenolphthalein, colourless to pink

(4) Methyl orange, yellow to pinkish red colour

Correct Answer: (3) Phenolphthalein, colourless to pink

Solution: In the titration of sodium hydroxide (NaOH), a strong base, against oxalic acid (H2C2O4), a weak acid, phenolphthalein is typically used as the indicator.

- In acidic conditions (at the start of the titration), phenolphthalein is colourless.

- As the titration progresses and the solution becomes more alkaline (near the end point), phenolphthalein turns pink.

This colour change from colourless to pink indicates the end point of the titration, where the acid has been neutralized by the base.

Thus, the correct answer is (3): Phenolphthalein, colourless to pink.

Quick Tip

For weak acid and strong base titrations, phenolphthalein is a common indicator. It is colourless in acidic conditions and turns pink in alkaline conditions.

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58. Match List-I with List-II :

List-I (Atom/Molecule)	List-II (Property)
A. Nitrogen atom	I. Paramagnetic
B. Fluorine molecule	II. Most reactive element in group 18
C. Oxygen molecule	III. Element with highest ionisation enthalpy in group 15
D. Xenon atom	IV. Strongest oxidising agent

Identify the correct answer from the options given below:

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

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

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

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

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

Solution: From the given options:

- Nitrogen atom (A) has the highest ionisation enthalpy in group 15, matching with (III).
- Fluorine molecule (B) is known as the strongest oxidising agent, matching with (IV).
- Oxygen molecule (C) is paramagnetic in nature, matching with (I).
- Xenon atom (D) is the most reactive element in group 18, matching with (II).

Thus, the correct answer is (4) A-III, B-IV, C-I, D-II.

Quick Tip

To solve matching-type questions, carefully analyze the properties and characteristics associated with each element or compound in the lists.

---

59. From the following select the one which is not an example of corrosion. (1) Rusting of iron object

(2) Production of hydrogen by electrolysis of water

(3) Tarnishing of silver

(4) Development of green coating on copper and bronze ornaments

Correct Answer: (2) Production of hydrogen by electrolysis of water

Solution: Corrosion is a chemical process where metals deteriorate due to chemical

reactions with environmental elements such as oxygen, water, and other chemicals. The process typically forms metal oxides or salts, causing damage and degradation.

- Rusting of Iron (Option 1): The rusting of iron is a well-known example of corrosion. Iron reacts with oxygen in the presence of moisture to form iron oxide (rust), a process that weakens the metal.

- Tarnishing of Silver (Option 3): Silver tarnishes when exposed to sulfur compounds in the air, forming a black layer of silver sulfide. This is also a form of corrosion.

- Development of Green Coating on Copper and Bronze (Option 4): When copper and bronze react with oxygen and moisture, they form a greenish layer of copper carbonate or copper sulfate, commonly known as patina. This process is another form of corrosion.

However, the Production of Hydrogen by Electrolysis of Water (Option 2) is not an example of corrosion. In electrolysis, water is split into hydrogen and oxygen gases by applying an electric current, which is a different process from the gradual deterioration of metals caused by corrosion. The process of electrolysis occurs in an electrolytic cell, where oxidation and reduction take place at the electrodes.

Thus, the correct answer is (2) Production of hydrogen by electrolysis of water, as this is not an example of corrosion but an electrochemical reaction.

Quick Tip

Corrosion involves the degradation of metals through oxidation, while electrolysis is a controlled process used to separate compounds by applying an electric current. Remember, corrosion typically forms metal oxides, while electrolysis does not degrade the metal.

---

60. Which of the following pairs of ions will have same spin only magnetic moment values within the pair? (A) Zn^{2+}, Ti^{2+}

(B) Cr^{2+}, Fe^{2+}

(C) Ti^{3+}, Cu^{2+}

(D) V^{2+}, Cu^{+}

Correct Answer: (4) B and C only

Solution: Magnetic moment $\mu = \sqrt{n(n+2)}$ BM where n is the number of unpaired

electrons.

Ion	n	μ (BM)
Zn^{2+}	0	0
Ti^{2+}	2	$\sqrt{8}$
Cr^{2+}	4	$\sqrt{24}$
Fe^{2+}	4	$\sqrt{24}$
Ti^{3+}	1	$\sqrt{3}$
Cu^{2+}	1	$\sqrt{3}$
V^{2+}	3	$\sqrt{15}$
Cu^{+}	0	0

Hence, the pairs with the same magnetic moment values are: - (Cr^{2+}, Fe^{2+}) with $\mu = \sqrt{24}$ - (Ti^{3+}, Cu^{2+}) with $\mu = \sqrt{3}$

Thus, the correct answer is (4) B and C only.

Quick Tip

To calculate the magnetic moment of a transition metal ion, remember that the number of unpaired electrons determines the value. Use the formula $\mu = \sqrt{n(n+2)}$ where n is the number of unpaired electrons.

---

61. At a given temperature and pressure, the equilibrium constant values for the equilibria are given below:

$$3A_2 + B_2 \rightleftharpoons 2A_3B,\ K_1$$

$$A_3B \rightleftharpoons \frac{3}{2}A_2 + \frac{1}{2}B_2,\ K_2$$

The relation between K_1 and K_2 is :

(1) $K_1^2 = 2K_2$

(2) $K_2 = \frac{K_1}{2}$

(3) $K_1 = \frac{1}{\sqrt{K_2}}$

(4) $K_2 = \frac{1}{\sqrt{K_1}}$

Correct Answer: (4) $K_2 = \frac{1}{\sqrt{K_1}}$

Solution: The given reactions are: 1. $3A_2 + B_2 \rightleftharpoons 2A_3B$, with equilibrium constant K_1. 2. $A_3B \rightleftharpoons \frac{3}{2}A_2 + \frac{1}{2}B_2$, with equilibrium constant K_2.

Rewriting the second reaction:

$$2A_3B \rightleftharpoons 3A_2 + B_2,\ K' = \frac{1}{K_1}$$

Next, by dividing the reaction by 2:

$$\frac{1}{2}A_3B \rightleftharpoons \frac{3}{4}A_2 + \frac{1}{4}B_2,\ K_2 = \sqrt{K'}$$

Thus, the relationship between K_1 and K_2 becomes:

$$K_2 = \sqrt{K'}$$

And, since $K' = \frac{1}{K_1}$, we get:

$$K_2 = \frac{1}{\sqrt{K_1}}$$

Thus, the correct answer is $K_2 = \frac{1}{\sqrt{K_1}}$, which corresponds to option (4).

Quick Tip

When dealing with equilibrium constants, remember that the constant for a reaction can be manipulated by reversing, scaling, or combining reactions. Keep track of how these changes affect the constant.

---

62. Arrange the following compounds in increasing order of their solubilities in chloroform:

NaCl, CH_3OH, cyclohexane, CH_3CN

(A) NaCl $<$ CH_3CN $<$ CH_3OH $<$ Cyclohexane

(B) CH_3OH $<$ CH_3CN $<$ NaCl $<$ Cyclohexane

(C) NaCl $<$ CH_3OH $<$ CH_3CN $<$ Cyclohexane

(D) Cyclohexane $<$ CH_3CN $<$ CH_3OH $<$ NaCl

Correct Answer: (A) NaCl $<$ CH_3CN $<$ CH_3OH $<$ Cyclohexane

Solution: Chloroform ($CHCl_3$) is a polar organic solvent, but not highly polar. It primarily dissolves non-polar substances, as well as polar substances that are not highly polar. The

solubility of compounds in chloroform depends on the polarity and molecular structure of the solute. Let's evaluate the compounds:

- **NaCl:** Sodium chloride is an ionic compound, which is highly polar. Since chloroform is less polar than water and is a non-polar solvent compared to water, ionic compounds like NaCl are less soluble in chloroform.
- **CH_3OH (Methanol):** Methanol is a small polar molecule with hydrogen bonding capability. It is more soluble in chloroform than NaCl, as it can interact through dipole-dipole interactions and hydrogen bonding, even though chloroform itself is not very polar.
- **CH_3CN (Acetonitrile):** Acetonitrile is a moderately polar solvent with a dipole moment. It is more soluble than methanol because of its smaller size and moderate polarity, which fits well in chloroform.
- **Cyclohexane:** Cyclohexane is a non-polar compound, and since chloroform is relatively non-polar, cyclohexane dissolves well in it. Non-polar solvents typically dissolve non-polar solutes more easily.

Thus, the increasing order of solubility in chloroform is:

$$\text{NaCl} < CH_3CN < CH_3OH < \text{Cyclohexane}.$$

Quick Tip

When considering solubility in organic solvents, remember that non-polar compounds are more soluble in non-polar solvents like chloroform, while polar compounds are less soluble. Ionic compounds have low solubility in chloroform.

---

63. Identify the incorrect statement about PCl_5:

(1) PCl_5 possesses two different Cl – P – Cl bond angles

(2) All five P – Cl bonds are identical in length

(3) PCl_5 exhibits sp^3d hybridisation

(4) PCl_5 consists of five P – Cl (sigma) bonds

Correct Answer: (2) All five P – Cl bonds are identical in length

Solution: PCl_5 adopts a trigonal bipyramidal structure with sp^3d hybridisation. This means that the central phosphorus atom forms five bonds with chlorine atoms, arranged in two different regions: three equatorial bonds at 120° angles and two axial bonds at 90° angles to the equatorial plane.

- In the trigonal bipyramidal structure, the axial bonds experience more repulsion from adjacent bonds due to their position, which leads to them being slightly longer than the equatorial bonds. - The equatorial bonds are more spatially separated, causing them to be shorter than the axial bonds.

Thus, the statement that "all five P – Cl bonds are identical in length" (option 2) is incorrect, as the axial and equatorial bonds differ in length due to differing repulsion forces. Therefore, the correct answer is option (2).

Quick Tip

When studying molecules with trigonal bipyramidal geometry, remember that axial bonds are always longer than equatorial bonds due to electron-electron repulsion effects.

---

64. Choose the correct statement for the work done in the expansion and heat absorbed or released when 5 litres of an ideal gas at 10 atmospheric pressure isothermally expands into vacuum until the volume is 15 litres:

(1) Both the heat and work done will be greater than zero

(2) Heat absorbed will be less than zero and work done will be positive

(3) Work done will be zero and heat will also be zero

(4) Work done will be greater than zero and heat will remain zero

Correct Answer: (3) Work done will be zero and heat will also be zero

Solution: Since the process is isothermal, $\Delta T = 0$. From the first law of thermodynamics, the change in internal energy is given by:

$$\Delta U = nC_v\Delta T = 0.$$

In this case, the expansion takes place against a vacuum, so the external pressure $P_{\text{ext}} = 0$. This implies that the work done W is:

$$W = -P_{\text{ext}}\Delta V = 0.$$

From the first law of thermodynamics:

$$\Delta U = q + W,$$

which simplifies to:

$$0 = q + 0,$$

and thus:

$$q = 0.$$

Therefore, both the work done and heat absorbed (or released) are zero.

Quick Tip

In isothermal processes, when expansion occurs against a vacuum, no work is done and no heat is exchanged, leading to zero work and zero heat.

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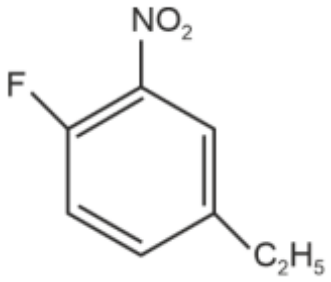
65. The correct IUPAC name of the compound is:



is:

(1) 4-ethyl-1-fluoro-2-nitrobenzene

(2) 4-ethyl-1-fluoro-6-nitrobenzene

(3) 3-ethyl-6-fluoro-1-nitrobenzene

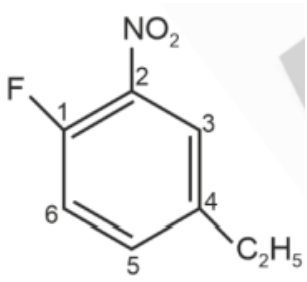
(4) 1-ethyl-4-fluoro-3-nitrobenzene

Correct Answer: (1) 4-ethyl-1-fluoro-2-nitrobenzene

Solution:

The compound is a substituted benzene with three substituents: a nitro group (NO_2), a fluoro group (F), and an ethyl group (C_2H_5). To name the compound, the following steps are taken:

1. The benzene ring is numbered so that the substituents receive the lowest possible numbers. The fluoro group is given priority in numbering.
2. The ethyl group is placed at position 4.
3. The nitro group is placed at position 2.



Thus, the correct IUPAC name of the compound is 4-ethyl-1-fluoro-2-nitrobenzene.

Quick Tip

In IUPAC nomenclature, the priority for numbering is given based on the alphabetical order of the substituents, with special rules for certain groups like nitro and fluoro.

---

66. Which of the following set of ions act as oxidising agents?

(1) Ce^{4+} and Tb^{4+}

(2) La^{3+} and Lu^{3+}

(3) Eu^{2+} and Yb^{2+}

(4) Eu^{2+} and Tb^{3+}

Correct Answer: (1) Ce^{4+} and Tb^{4+}

Solution:

The most stable oxidation state for lanthanoids is +3, meaning that the lanthanoid ions typically exist in the $3+$ state. However, the higher oxidation states, such as $4+$ for cerium (Ce^{4+}) and terbium (Tb^{4+}), are less stable and tend to get reduced easily. This property makes Ce^{4+} and Tb^{4+} good oxidizing agents.

- The reason these higher oxidation states are unstable is due to the increased electrostatic repulsion between electrons, which makes it easier for these ions to gain electrons and reduce to their more stable $3+$ oxidation state.

- The ability of Ce^{4+} and Tb^{4+} to gain electrons makes them effective at oxidizing other substances. These ions are easily reduced to their respective $3+$ states (Ce^{3+} and Tb^{3+}) by donating electrons to other species.

- In contrast, ions like La^{3+} and Lu^{3+}, which already have a stable $3+$ oxidation state, do not act as oxidizing agents because they are unlikely to gain more electrons.

Thus, the correct answer is option (1) Ce^{4+} and Tb^{4+}, as they are strong oxidizing agents.

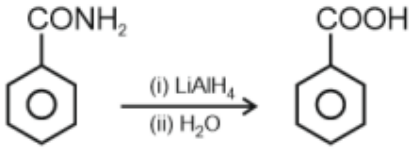
Quick Tip

Remember that ions in higher oxidation states, especially those in the lanthanide series like Ce^{4+} and Tb^{4+}, are typically good oxidizing agents. They are prone to reduction and easily accept electrons.

---

67. Select the incorrect reaction among the following:

(1) $CH_3COCl \xrightarrow[\Delta]{H_2O} CH_3COOH$

(2) 

(3) $CH_3CH_2OH \xrightarrow[(ii)\,H_3O^{\oplus}]{(i)\,KMnO_4/OH^-} CH_3COOH$

(4) $CH_3CH_2CH_2OH \xrightarrow{CrO_3-H_2SO_4} CH_3CH_2COOH$

Correct Answer: (2) $C_6H_5CONH_2 \xrightarrow{i} LiAlH_4\,(ii)\,H_2O \rightarrow C_6H_5NH_2$

Solution:

Option (2) is incorrect because the reaction shown is a reduction of an amide ($C_6H_5CONH_2$) using $LiAlH_4$ and water, which would produce a primary amine ($C_6H_5NH_2$), not a carboxylic acid.

- Amides are reduced by $LiAlH_4$ to primary amines. The hydride transfer from $LiAlH_4$ to the carbonyl carbon of the amide breaks the C=O bond and forms an amine group. After hydrolysis with water, the resulting product is a primary amine.
- However, carboxylic acids would be obtained if aldehydes or alcohols are oxidized, not reduced. For the production of carboxylic acids from alcohols, oxidizing agents like $KMnO_4$ or CrO_3 would be required.
- The reactions in options (1), (3), and (4) are all valid reductions and oxidations: the hydrolysis of acid chlorides (CH_3COCl) to carboxylic acids, oxidation of alcohols to carboxylic acids, and oxidation of primary alcohols to carboxylic acids respectively.
Thus, the reaction in option (2) is the incorrect one.

Quick Tip

When reducing an amide, $LiAlH_4$ is a strong reducing agent and reduces amides to primary amines, not to carboxylic acids. Be cautious about the reagents used in the reduction or oxidation processes.

---

68. The UV-visible absorption bands in the spectra of lanthanoid ions are 'X', probably because of the excitation of electrons involving 'Y'. The 'X' and 'Y', respectively, are:

(1) Broad and f orbitals

(2) Narrow and f orbitals

(3) Broad and d and f orbitals

(4) Narrow and d and f orbitals

Correct Answer: (2) Narrow and f orbitals

Solution: In lanthanoid ions, the UV-visible absorption bands are typically narrow due to the excitation of electrons from the f orbitals, which have a relatively small energy gap compared to d or p orbitals. These narrow absorption bands are characteristic of the transitions occurring within the f orbitals.
- Lanthanoids, being rare earth elements, have electrons in the f subshells. The transitions between these f orbitals require relatively less energy compared to d and p orbital transitions,

leading to narrow absorption bands in the UV-visible spectrum.

- The narrowness of these bands is attributed to the fact that the energy differences between f-orbitals are small, leading to well-defined absorption peaks, which are sharp.

- If the transitions involved d-orbitals or a mix of d and f orbitals, the absorption bands would be broader due to the greater complexity and larger energy differences involved.

Thus, option (2) is the correct choice, with the absorption bands being narrow and involving f orbitals.

Quick Tip

In lanthanoids, the absorption bands are narrow because of transitions between electrons in the f orbitals. The transitions between f orbitals have relatively small energy differences, resulting in sharp absorption bands.

---

69. Ethylene diaminetetraacetate ion is a/an:

(1) hexadentate ligand

(2) ambidentate ligand

(3) monodentate ligand

(4) bidentate ligand

Correct Answer: (1) hexadentate ligand

Solution: Ethylene diaminetetraacetate (EDTA) is a hexadentate ligand. A hexadentate ligand can form six bonds with a central metal ion. In the case of EDTA, it has four oxygen atoms and two nitrogen atoms that can bind to the central metal ion, making it capable of forming six coordination bonds.

- The structure of EDTA includes two nitrogen atoms (N) and four oxygen atoms (O) attached to the central metal ion. Each of these atoms donates lone pairs of electrons to form a coordinate bond with the metal.

- This makes EDTA a hexadentate ligand, which is one of the most common types of chelating ligands in coordination chemistry.

Thus, the correct answer is option (1), hexadentate ligand.

Quick Tip

Hexadentate ligands, like EDTA, can form multiple bonds with a single metal ion, which makes them highly effective in forming stable metal complexes.

---

70. The amount of glucose required to prepare 250 mL of $\frac{M}{20}$ aqueous solution is:

(Molar mass of glucose = 180 g mol^{-1})

(1) 2.25 g

(2) 4.5 g

(3) 0.44 g

(4) 1.125 g

Correct Answer: (1) 2.25 g

Solution: We are given the molarity M of the solution and the volume V, and we are asked to find the mass of glucose required.

- Molarity M is defined as:

$$M = \frac{w_2 \times 1000}{M_2 \times V}$$

where w_2 is the mass of glucose, M_2 is the molar mass of glucose, and V is the volume of the solution.

Given:

- Molarity $M = \frac{1}{20}$,
- Molar mass $M_2 = 180\,\text{g/mol}$,
- Volume $V = 250\,\text{mL} = 0.25\,\text{L}$.

We can rearrange the formula to solve for w_2:

$$\frac{1}{20} = \frac{w_2 \times 1000}{180 \times 250}$$

$$w_2 = \frac{180 \times 250}{20 \times 1000} = 2.25\,\text{g}.$$

Thus, the amount of glucose required is 2.25 g.

Quick Tip

When calculating the mass of a substance required for a given molarity, always ensure that the units of volume are in liters and the molar mass is in g/mol. This will help ensure the calculation is accurate.

---

71. Identify the incorrect statement from the following:

(1) The acidic strength of HX (X = F, Cl, Br and I) follows the order: HF > HCl > HBr > HI.

(2) Fluorine exhibits -1 oxidation state whereas other halogens exhibit +1, +3, +5 and +7 oxidation states also.

(3) The enthalpy of dissociation of F_2 is smaller than that of Cl_2.

(4) Fluorine is a stronger oxidizing agent than chlorine.

Correct Answer: (1) The acidic strength of HX (X = F, Cl, Br and I) follows the order: HF > HCl > HBr > HI.

Solution:

The acidic strength of HX (where X represents halogens) follows the order HF < HCl < HBr < HI, not HF > HCl > HBr > HI as stated in option (1).

- The bond strength in HX decreases as we move down the group in the periodic table. The bond strength of HF is the highest due to the small size and strong bond between H and F. As we move down the group, the bond strength decreases (H-I bond is the weakest), resulting in an increasing acidic strength.

- Therefore, the correct order for the acidic strength of HX is HF < HCl < HBr < HI.

Thus, option (1) is the incorrect statement.

Quick Tip

When studying acid strength of hydrogen halides, remember that bond strength plays a crucial role: the weaker the bond between hydrogen and the halogen, the stronger the acid.

---

72. For the reaction in equilibrium:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, $\Delta H = -Q$

The reaction is favoured in forward direction by:

(1) use of catalyst

(2) decreasing concentration of N_2

(3) low pressure, high temperature and high concentration of ammonia

(4) high pressure, low temperature and higher concentration of H_2

Correct Answer: (4) high pressure, low temperature and higher concentration of H_2

Solution:

The given reaction is exothermic ($\Delta H = -Q$) and follows Le Chatelier's principle.

- Exothermic reactions are favoured at low temperatures because they release heat. Lowering the temperature shifts the equilibrium towards the products (NH_3).

- Increasing the pressure favours the side of the reaction with fewer moles of gas. In this case, 1 mole of N_2 and 3 moles of H_2 react to form 2 moles of NH_3, so increasing pressure will favour the forward reaction.

- Increasing the concentration of reactants (H_2) also shifts the reaction towards the products to balance the increase in concentration.

Thus, the correct condition for favouring the forward direction is high pressure, low temperature, and higher concentration of H_2, as stated in option (4).

Quick Tip

When applying Le Chatelier's principle, remember that temperature, pressure, and concentration of reactants or products all affect the equilibrium position of reactions.

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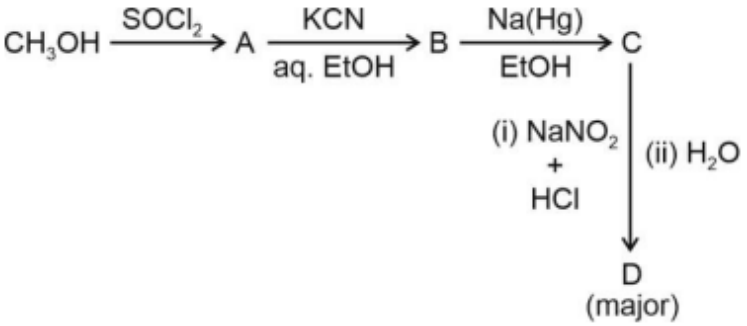
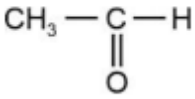
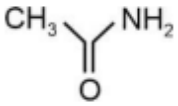
73. The major product D formed in the following reaction sequence is:



(1) 

(2) 

(3) CH_3CH_2OH

(4) CH_3CH_2Cl

Correct Answer: (3) CH_3CH_2OH

Solution: The reaction sequence can be understood step by step as follows:

1. First step: CH_3OH (methanol) reacts with $SOCl_2$, converting it to CH_3Cl (methyl chloride).

$$CH_3OH + SOCl_2 \rightarrow CH_3Cl$$

2. Second step: CH_3Cl reacts with KCN, resulting in the formation of CH_3CN (acetonitrile).

$$CH_3Cl + KCN \rightarrow CH_3CN$$

3. Third step: CH_3CN is then reduced by Na(Hg) in ethanol (EtOH), which results in the formation of $CH_3CH_2NH_2$ (ethylamine).

$$CH_3CN + Na(Hg) \rightarrow CH_3CH_2NH_2$$

4. Fourth step: Finally, the ethylamine ($CH_3CH_2NH_2$) is treated with $NaNO_2$ and HCl, converting it to CH_3CH_2OH (ethanol) via diazotization and hydrolysis.

$$CH_3CH_2NH_2 + NaNO_2 + HCl \rightarrow CH_3CH_2OH$$

Thus, the major product D is CH_3CH_2OH (ethanol), which corresponds to option (3).

Quick Tip

When dealing with reactions involving nitriles, sodium amalgam (Na(Hg)) is a common reducing agent that can reduce nitriles to primary amines, which can be further converted to alcohols via diazotization.

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74. Match List-I with List-II:

List-I	**(Block/group in periodic table)**	**List-II**	**(Element)**
A.	Lanthanoid	I.	Ce
B.	d-block element	II.	As
C.	p-block element	III.	Cs
D.	s-block element	IV.	Mn

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct matching of the elements with their respective blocks/groups in the periodic table is as follows:

- Ce (Cerium) is a lanthanoid, which belongs to the f-block. Thus, it is matched with A-I.
- As (Arsenic) is a p-block element, so it is matched with C-II.
- Cs (Cesium) is an alkali metal, which belongs to the s-block. Thus, it is matched with D-III.
- Mn (Manganese) is a transition metal, which belongs to the d-block. Therefore, it is matched with B-IV.

Thus, the correct answer is A-I, B-IV, C-II, D-III.

Quick Tip

When matching elements to their blocks in the periodic table, remember:

- Lanthanoids belong to the f-block.
- p-block elements include the metalloids and non-metals.
- s-block elements include alkali and alkaline earth metals.
- d-block elements are transition metals.

---

75. Which of the following is not an ambidentate ligand?

(1) $C_2O_4^{2-}$

(2) SCN^-

(3) NO_2^-

(4) CN^-

Correct Answer: (1) $C_2O_4^{2-}$

Solution: Ambidentate ligands are those ligands which have two different donor atoms, and either of these donor atoms can attach to the metal during complex formation.

- (1) $C_2O_4^{2-}$ (oxalate) has only one donor site through oxygen (O). So, it is not an ambidentate ligand.
- (2) SCN^- (thiocyanate) has two donor atoms: sulfur (S) and nitrogen (N), and it can bind to the metal through either of these atoms, making it ambidentate.
- (3) NO_2^- (nitrite) has two donor atoms: nitrogen (N) and oxygen (O), and can bind through either of these atoms, making it ambidentate.
- (4) CN^- (cyanide) has only one donor atom, which is carbon (C), but it is still considered a monodentate ligand because it binds only through carbon.

Thus, the correct answer is option (1) $C_2O_4^{2-}$, as it is not an ambidentate ligand.

Quick Tip

Ambidentate ligands can form bonds with a metal using two different donor atoms. An example is SCN^-, which can bind through either sulfur or nitrogen.

---

76. The quantum numbers of four electrons are given below:

I. $n = 4;\ l = 2;\ m_l = -2;\ s = -\frac{1}{2}$

II. $n = 3;\ l = 2;\ m_l = 1;\ s = +\frac{1}{2}$

III. $n = 4;\ l = 1;\ m_l = 0;\ s = +\frac{1}{2}$

IV. $n = 3;\ l = 1;\ m_l = -1;\ s = +\frac{1}{2}$

The correct decreasing order of energy of these electrons is:

(1) IV > II > III > I

(2) I > III > II > IV

(3) III > I > II > IV

(4) I > II > III > IV

Correct Answer: (2) I > III > II > IV

Solution: To determine the decreasing order of energy, we use the following guidelines based on quantum mechanics:

1. Energy order according to $n + l$ rule:

- For orbitals with the same $n + l$ value, the one with the smaller n value has lower energy.
- If $n + l$ values are different, the one with the higher $n + l$ value will have higher energy.

Now, applying this to the given quantum numbers:

- (I) $n = 4, l = 2$ (represents 4d, $n + l = 6$)
- (II) $n = 3, l = 2$ (represents 3d, $n + l = 5$)
- (III) $n = 4, l = 1$ (represents 4p, $n + l = 5$)
- (IV) $n = 3, l = 1$ (represents 3p, $n + l = 4$)

From this, the energy order based on $n + l$ is:

$$\text{I}(n + l = 6) > \text{III}(n + l = 5) = \text{II}(n + l = 5) > \text{IV}(n + l = 4)$$

Thus, the correct decreasing order of energy is: I > III > II > IV.

Quick Tip

When comparing the energy of orbitals, always use the $n + l$ rule. The orbital with the higher $n + l$ value has higher energy, and for orbitals with the same $n + l$ value, the one with the larger n value has higher energy.

---

77. The major product C in the below mentioned reaction is:

$CH_3CH_2CH_2Br \xrightarrow{\text{alc. KOH}} A \xrightarrow{HBr} B \xrightarrow{\text{aq. KOH}} C$

(1) Propan-1-ol

(2) Propan-2-ol

(3) Propane

(4) Propyne

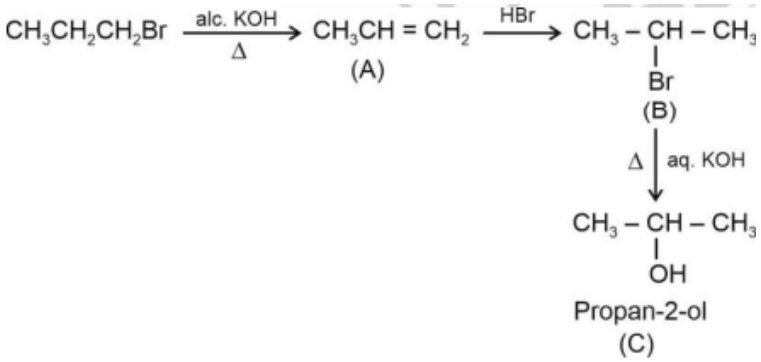
Correct Answer: (2) Propan-2-ol

Solution: The reaction sequence is as follows:

- Step 1: $CH_3CH_2CH_2Br$ reacts with alc. KOH (alcoholic potassium hydroxide), resulting in an elimination reaction to form propene ($CH_3CH{=}CH_2$).

- Step 2: The propene ($CH_3CH{=}CH_2$) reacts with HBr, resulting in an electrophilic addition reaction, which gives the product $CH_3CH(Br)CH_3$ (2-bromopropane).

- Step 3: The 2-bromopropane ($CH_3CH(Br)CH_3$) reacts with aqueous KOH, resulting in a substitution reaction that replaces the bromine atom with a hydroxyl group, producing propan-2-ol ($CH_3CH(OH)CH_3$).



Thus, the major product is Propan-2-ol.

Quick Tip

In elimination reactions, alcohols like KOH can dehydrate alkyl halides to form alkenes, while in substitution reactions, they can replace halides with hydroxyl groups.

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78. The compound that does not undergo Friedel-Crafts alkylation reaction but gives a positive carbylamine test is:

(1) Aniline

(2) Pyridine

(3) N-methylaniline

(4) Triethylamine

Correct Answer: (1) Aniline

Solution:

For the carbylamine test to be positive, there must be a primary amine group. The carbylamine reaction involves the reaction of primary amines with chloroform ($CHCl_3$) in the presence of a base to form an isocyanide.

- Aniline ($C_6H_5NH_2$) is a primary amine and gives a positive carbylamine test, but it does not undergo Friedel-Crafts alkylation because the amino group is an electron-donating group that deactivates the aromatic ring towards electrophilic substitution reactions.
- Pyridine (C_5H_5N) is a heterocyclic amine and does not give a carbylamine test because the nitrogen in the ring is not a primary amine.
- N-methylaniline ($C_6H_5NHCH_3$) and Triethylamine (C_2H_5) both do not give positive carbylamine tests because they are not primary amines.

Thus, option (1) aniline is the correct answer.

Quick Tip

In the carbylamine test, primary amines react with chloroform to form isocyanides, while secondary and tertiary amines do not give the test. Additionally, the presence of an electron-donating group can affect the reactivity of the aromatic ring in Friedel-Crafts reactions.

79. For an endothermic reaction:

(A) q_p is negative.

(B) ΔH is positive.

(C) ΔH is negative.

(D) q_p is positive.

Choose the correct answer from the options given below:

(1) B and D

(2) C and D

(3) A and B

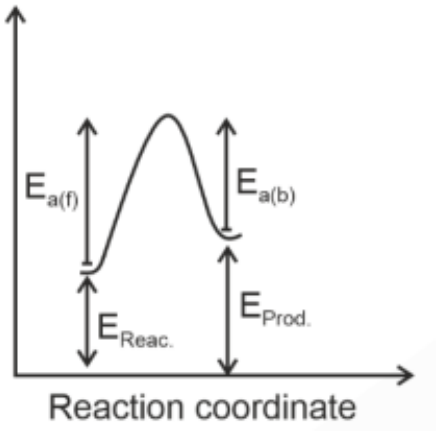
(4) A and C

Correct Answer: (1) B and D

Solution: For endothermic reactions:

- ΔH is positive, meaning heat is absorbed during the reaction.

- q_p, the heat absorbed or released by the system at constant pressure, is positive for endothermic reactions as heat is absorbed.



Therefore, the correct answer is B and D.

Quick Tip

In endothermic reactions, heat is absorbed from the surroundings, resulting in a positive value for both ΔH and q_p.

80. 1.0 g of H_2 has the same number of molecules as in:

(1) 14 g of N_2

(2) 18 g of H_2O

(3) 16 g of CO

(4) 28 g of N_2

Correct Answer: (1) 14 g of N_2

Solution: Number of moles of H_2 = $\frac{1.0}{2} = 0.5$

Number of molecules of H_2 = $0.5N_A$

Now, let's check each option:

(1) Number of moles of N_2 = $\frac{14}{28} = 0.5$

Number of molecules of N_2 = $0.5N_A$

(2) Number of moles of H_2O = $\frac{18}{18} = 1$

Number of molecules of H_2O = $1 \times N_A = N_A$

(3) Number of moles of CO = $\frac{16}{28} = \frac{4}{7}$

Number of molecules of CO = $\frac{4}{7}N_A$

(4) Number of moles of N_2 = $\frac{28}{28} = 1$

Number of molecules of N_2 = $1 \times N_A = N_A$

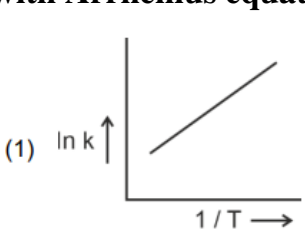
Thus, the correct answer is option (1).

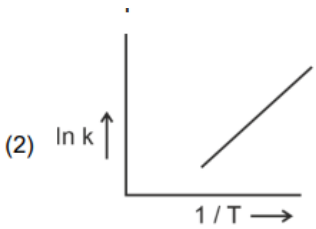
Quick Tip

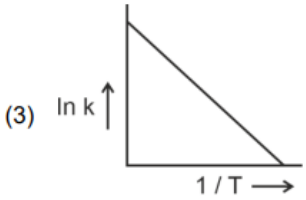
When comparing the number of molecules of different substances, remember that the number of molecules is proportional to the number of moles, and for equal numbers of molecules, the moles must be the same.

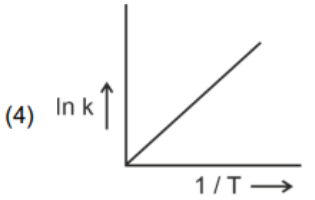
---

81. Which of the following plot represents the variation of $\ln k$ versus $\frac{1}{T}$ in accordance with Arrhenius equation?









Correct Answer: (3) $\ln k$ vs $\frac{1}{T}$ (negative slope)

Solution: Using the Arrhenius equation:

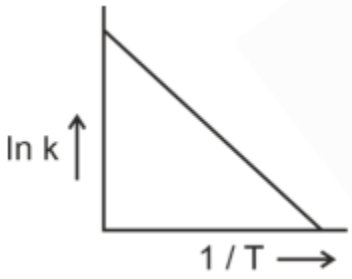
$$k = Ae^{-\frac{E_a}{RT}}$$

Taking the natural logarithm of both sides:

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

This is in the form $y = c + mx$, where:

- $y = \ln k$
- $x = \frac{1}{T}$
- $m = -\frac{E_a}{R}$ (slope)
- $c = \ln A$ (intercept)



Since the slope is negative ($m = -\frac{E_a}{R}$), the plot of $\ln k$ vs $\frac{1}{T}$ will have a negative slope, which corresponds to option (3).

Quick Tip

In the Arrhenius equation, the negative slope of the plot of $\ln k$ versus $\frac{1}{T}$ indicates that as temperature increases, the rate constant increases exponentially, which is typical for endothermic reactions.

---

82. A steam volatile organic compound which is immiscible with water has a boiling point of 250°C. During steam distillation, a mixture of this organic compound and water will boil:

(1) above 100°C but below 250°C

(2) above 250°C

(3) at 250°C

(4) close to but below 100°C

Correct Answer: (4) close to but below 100°C

Solution: If one of the substances in the mixture is water and the other is a water-insoluble substance, the mixture will boil close to but below 373 K (100°C). This is because, in steam distillation, the boiling point of the mixture will be lower than that of water, due to the presence of the non-volatile organic compound.

Thus, the boiling point of the mixture will be close to, but below, 100°C.

Quick Tip

In steam distillation, the boiling point of the mixture is controlled by the vapor pressure of the components. When one component is a volatile organic compound, the mixture boils at a lower temperature than the boiling point of water.

---

83. Given below are two statements:

Statement I: Glycogen is similar to amylose in its structure.

Statement II: Glycogen is found in yeast and fungi also.

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

(1) Statement I is true but Statement II is false.

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

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Correct Answer: (2) Statement I is false but Statement II is true.

Solution: - Statement I: Glycogen is not similar to amylose. While amylose is a linear polysaccharide, glycogen is a highly branched polysaccharide and more similar to amylopectin in structure.

- Statement II: Glycogen is indeed found in yeast and fungi, along with its presence in animals as a storage form of glucose.

Thus, Statement I is false, but Statement II is true.

Quick Tip

Glycogen is a branched polysaccharide and is more similar in structure to amylopectin than amylose. It is found in yeast, fungi, and animals.

---

84. The oxidation states not shown by Mn in the given reaction is:

$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$

(1) +6

(2) +2

(3) +4

(4) +7

Choose the most appropriate answer from the options given below:

(1) D and E only

(2) B and D only

(3) A and B only

(4) B and E only

Correct Answer: (4) B and E only

Solution: In the given reaction:

$$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$$

The oxidation states of Mn in different species are as follows:

- Mn in MnO_4^{2-} has an oxidation state of +6.

- Mn in MnO_4^- has an oxidation state of +7.

- Mn in MnO_2 has an oxidation state of +4.

Thus, the oxidation states +2 and +3 are not shown by Mn in this reaction.

Quick Tip

In redox reactions, oxidation states of elements can change. Here, the Mn oxidation states in the reactants and products show +6, +7, and +4, but +2 and +3 are not involved.

---

85. Given below are two statements:

Statement I: The Balmer spectral line for H atom with the lowest energy is located at $\frac{5}{36}R_H$ cm^{-1}.

Statement II: When the temperature of a blackbody increases, the maxima of the curve (intensity and wavelength) shift to shorter wavelengths.

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

(1) Statement I is true but Statement II is false.

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

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Correct Answer: (3) Both Statement I and Statement II are true.

Solution:

Statement I: The lowest energy Balmer spectral line for the hydrogen atom corresponds to the transition from $n = 3$ to $n = 2$ in the Balmer series. Using the Rydberg formula:

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

For the transition from $n_1 = 2$ and $n_2 = 3$, the wavelength is given by:

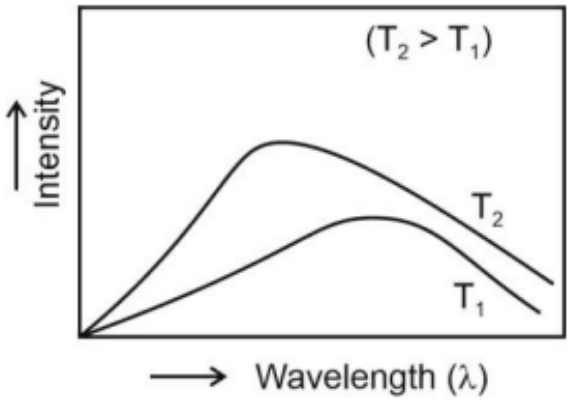
$$\frac{1}{\lambda} = R_H \left(\frac{1}{4} - \frac{1}{9}\right) = R_H \left(\frac{5}{36}\right)$$

Thus, the wavelength of the spectral line corresponds to $\frac{5}{36} R_H$ cm^{-1}, making Statement I true.

Statement II: According to Wien's law, when the temperature of a blackbody increases, the peak wavelength (λ_{max}) of the emitted radiation shifts to shorter wavelengths. This is because:

$$\lambda_{max} = \frac{b}{T}$$

where b is Wien's displacement constant, and T is the temperature. Hence, when the temperature increases, the wavelength decreases, shifting the intensity maximum to shorter wavelengths. Therefore, Statement II is also true.



Quick Tip

The Balmer series of hydrogen corresponds to transitions from higher to lower energy levels, with the $n = 2$ level being the lowest energy level in this series. Wien's Law explains how the peak wavelength shifts with temperature, which is important for understanding blackbody radiation.

SECTION-B

86. Identify D in the following sequence of reactions:

$CH_3CH_2OH \xrightarrow{P+I_2} A \xrightarrow{Mg} B \xrightarrow{HCHO} C \xrightarrow{H_2O} D$ (major)

(1) n-propyl alcohol

(2) isopropyl alcohol

(3) propanal

(4) propionic acid

Correct Answer: (1) n-propyl alcohol

Solution: Let's break down the reaction steps to understand what happens:

1. Step 1 (A): The alcohol CH_3CH_2OH reacts with iodine (I_2) in the presence of phosphorus (P), which leads to the formation of an alkyl iodide, CH_3CH_2I.

$$CH_3CH_2OH + I_2 \xrightarrow{P} CH_3CH_2I$$

2. Step 2 (B): The alkyl iodide CH_3CH_2I reacts with magnesium (Mg) in dry ether, resulting in the formation of an organomagnesium reagent, CH_3CH_2MgI (Grignard reagent).

$$CH_3CH_2I + Mg \xrightarrow{\text{dry ether}} CH_3CH_2MgI$$

3. Step 3 (C): The Grignard reagent CH_3CH_2MgI reacts with formaldehyde (HCHO). The reaction leads to the formation of a secondary alcohol, $CH_3CH_2CH_2OH$, which is n-propyl alcohol.

$$CH_3CH_2MgI + HCHO \rightarrow CH_3CH_2CH_2OH$$

The final product is n-propyl alcohol ($CH_3CH_2CH_2OH$).

Thus, the major product D is n-propyl alcohol.

Quick Tip

In reactions involving Grignard reagents, the Grignard reagent reacts with aldehydes to form alcohols. In this case, formaldehyde gives n-propyl alcohol when reacted with the Grignard reagent CH_3CH_2MgI.

87. Identify the incorrect statement.

(1) $PE_{t3} and AsPh_3$ as ligands can form dπ-dπ bond with transition metals.

(2) The N–N single bond is as strong as the P–P single bond.

(3) Nitrogen has unique ability to form π-π multiple bonds with nitrogen, carbon and oxygen.

(4) Nitrogen cannot form dπ-pπ bond as other heavier elements of its group.

Correct Answer: (2) The N–N single bond is as strong as the P–P single bond.

Solution: - Statement 1: $PE_{t3} and AsPh_3$ as ligands can indeed form dπ-dπ bonds with transition metals. These ligands can engage in bonding due to the availability of lone pairs on the atoms, forming coordinate bonds with transition metals.

- Statement 2: The N–N single bond is weaker than the P–P single bond. This is because nitrogen atoms are small and have higher electronegativity, which results in stronger repulsion between the lone pairs of electrons on the two nitrogen atoms. In contrast, the larger phosphorus atoms experience less repulsion, leading to a stronger P–P bond.

- Statement 3: Nitrogen has the unique ability to form π-π multiple bonds with nitrogen, carbon, and oxygen. Nitrogen is highly electronegative and small, allowing it to form stable multiple bonds such as in nitrogen molecules (NN), and other compounds like NO_2 and CO_2.

- Statement 4: Nitrogen cannot form dπ-pπ bonds as effectively as other heavier elements in its group. This is due to the small size of nitrogen and the inability to overlap its d-orbitals with p-orbitals effectively in bond formation.

Thus, Statement 2 is incorrect because the N–N single bond is weaker than the P–P single bond.

Quick Tip

In molecular bonding, electronegativity and atomic size play a crucial role in determining the strength of bonds. Smaller atoms like nitrogen experience higher electron repulsion, which weakens bonds such as N–N, while larger atoms like phosphorus experience less repulsion and form stronger P–P bonds.

88. Match List-I with List-II:

	List-I (Test/reagent)		List-II (Radical identified)
A.	Lake Test	I.	NO_3^-
B.	Nessler's Reagent	II.	Fe^{3+}
C.	Potassium sulphocyanide	III.	Al^{3+}
D.	Brown Ring Test	IV.	NH_4^+

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - Lake test is used to identify Al^3+, so A corresponds to III.

- Nessler's reagent is used to identify NH_4^+, so B corresponds to IV.

- Potassium sulphocyanide is used to identify Fe^3+, so C corresponds to II.

- Brown Ring Test is used to identify NO_3^-, so D corresponds to I.

Thus, the correct matching is A-III, B-IV, C-II, D-I.

Quick Tip

Reagents like Nessler's and potassium sulphocyanide are often used to identify specific metal ions or radicals based on their characteristic reactions. Understanding these reagents and their specific tests is essential in inorganic chemistry.

89. Match List-I with List-II:

List-I	**List-II**
Molecule	Bond enthalpy (kJ mol^{-1})
A. HCl	I. 435.8
B. N_2	II. 498
C. H_2	III. 946.0
D. O_2	IV. 431.0

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

We need to match the molecules from List-I with the corresponding bond enthalpies in List-II. Bond enthalpy refers to the energy required to break a bond in one mole of a substance in the gas phase. Higher bond enthalpy indicates a stronger bond.

- A. HCl: The bond enthalpy of HCl is 431.0 kJ/mol. The H-Cl bond is relatively weak compared to the others in the list, as chlorine is a larger atom than hydrogen, which leads to a weaker bond. This matches with IV in List-II.

- B. N_2: The nitrogen molecule (N_2) has an extremely strong triple bond between the nitrogen atoms. This bond enthalpy is high, at 946.0 kJ/mol, reflecting the strength of the triple bond. Therefore, N_2 corresponds to III in List-II.

- C. H_2: The hydrogen molecule has a bond enthalpy of 435.8 kJ/mol. This is a single bond between two hydrogen atoms and is relatively strong compared to weaker single bonds like those in HCl but not as strong as the triple bond in N_2. Therefore, H_2 corresponds to I in List-II.

- D. O_2: The oxygen molecule has a bond enthalpy of 498.0 kJ/mol, which is moderate. The bond in O_2 is a double bond, which is generally stronger than single bonds like in HCl but weaker than the triple bond in N_2. Thus, O_2 corresponds to II in List-II.

So, the correct matching of molecules with bond enthalpies is:

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

Quick Tip

When comparing bond enthalpies, remember that triple bonds (like in N_2) generally have the highest bond enthalpy, followed by double bonds (like in O_2) and single bonds (like in HCl and H_2). The higher the bond enthalpy, the stronger the bond.

---

90. The standard cell potential of the following cell Zn—Zn^{2+} (aq)—Fe^{2+}(aq)—Fe is 0.32 V. Calculate the standard Gibbs energy change for the reaction:

Zn(s) + Fe^{2+}(aq) $\rightarrow$ Zn^{2+}(aq) + Fe(s)

(Given: 1 F = 96487 C)

(1) -61.75 kJ mol^{-1}

(2) +5.006 kJ mol^{-1}

(3) -5.006 kJ mol^{-1}

(4) +61.75 kJ mol^{-1}

Correct Answer: (1) -61.75 kJ mol^{-1}

Solution:

We use the formula to calculate the standard Gibbs energy change:

$$\Delta G^\circ = -nFE^\circ_{\text{cell}}$$

where:

- n is the number of moles of electrons involved in the reaction (here, $n = 2$),

- F is the Faraday constant ($96487\,\text{C/mol}$),

- E°_{cell} is the standard cell potential ($0.32\,\text{V}$).

Substituting the values:

$$\Delta G^\circ = -2 \times 96487 \times 0.32$$

$$\Delta G^\circ = -61751.68\,\text{J/mol} = -61.75\,\text{kJ/mol}$$

Thus, the standard Gibbs energy change is $-61.75\,\text{kJ/mol}$.

Quick Tip

The Gibbs free energy change and the cell potential are related through the equation $\Delta G^\circ = -nFE^\circ_{\text{cell}}$, where a negative Gibbs energy indicates a spontaneous reaction.

---

91. Match List-I with List-II:

List-I Solid salt treated with dil. H_2SO_4	List-II Anion detected
A. effervescence of colourless gas	I. NO_2^-
B. gas with smell of rotten egg	II. CO_3^{2-}
C. gas with pungent smell	III. S^{2-}
D. brown fumes	IV. SO_3^{2-}

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- A. Effervescence of colourless gas: When a carbonate (CO_3^{2-}) is treated with dilute sulfuric acid (H_2SO_4), carbon dioxide (CO_2) is released, which is a colourless and odourless gas. This corresponds to II in List-II.

- B. Gas with smell of rotten egg: When a sulphide (S^2-) is treated with dilute sulfuric acid, hydrogen sulphide (H_2S) is released, which has the characteristic smell of rotten eggs. This

corresponds to III in List-II.

- C. Gas with pungent smell: When a sulphite (SO_3^{2-}) reacts with dilute sulfuric acid, sulfur dioxide (SO_2) is produced, which has a pungent smell. This corresponds to IV in List-II.

- D. Brown fumes: When a nitrite (NO_2^-) is treated with dilute sulfuric acid, nitrogen dioxide (NO_2) is released, which appears as brown fumes. This corresponds to I in List-II.

Thus, the correct matching is:

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

Quick Tip

In qualitative analysis, different salts produce characteristic gases when treated with acids. Carbonates release CO_2, sulphides release H_2S (rotten egg smell), sulphites release SO_2 (pungent smell), and nitrites release NO_2 (brown fumes).

---

92. The ratio of solubility of AgCl in 0.1 M KCl solution to the solubility of AgCl in water is:

(Given: Solubility product of AgCl = 10^{-10})

(1) 10^{-4}

(2) 10^{-6}

(3) 10^{-9}

(4) 10^{-5}

Correct Answer: (1) 10^{-4}

Solution:

To find the ratio of the solubility of AgCl in 0.1 M KCl solution to the solubility in water, we need to use the solubility product expression.

1. Solubility of AgCl in 0.1 M KCl solution:

$$AgCl(aq) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$$

Let the solubility of AgCl be s in 0.1 M KCl solution.

The concentration of Cl^- in 0.1 M KCl will add to the concentration of Cl^- from AgCl dissociation. Therefore, the concentration of Cl^- will be $0.1 + s \approx 0.1$ M because s is very small compared to 0.1 M. Thus, the equation for the solubility product K_{sp} is:

$$K_{sp} = (s)(s + 0.1)$$

Since $s \ll 0.1$, we approximate this to:

$$K_{sp} = s \times 0.1$$

From the given $K_{sp} = 10^{-10}$, we get:

$$10^{-10} = s \times 0.1$$

Solving for s, we find:

$$s = \frac{10^{-10}}{0.1} = 10^{-9}\,\text{M}$$

2. Solubility of AgCl in water:

For AgCl in pure water, the dissociation is:

$$\text{AgCl}(aq) \rightleftharpoons \text{Ag}^+(aq) + \text{Cl}^-(aq)$$

Let the solubility of AgCl in pure water be s_0.

The solubility product expression is:

$$K_{sp} = s_0 \times s_0 = s_0^2$$

Given $K_{sp} = 10^{-10}$, we find:

$$s_0 = \sqrt{10^{-10}} = 10^{-5}\,\text{M}$$

3. Ratio of solubilities:

The ratio of solubility in 0.1 M KCl solution to solubility in water is:

$$\frac{s_{\text{in KCl}}}{s_{\text{in water}}} = \frac{10^{-9}}{10^{-5}} = 10^{-4}$$

Thus, the correct answer is 10^{-4}.

Quick Tip

When calculating the solubility of salts in solutions with common ions (like KCl in this case), the common ion effect reduces the solubility. This can be approximated by adjusting the solubility product expression for the concentration of the common ion.

---

93. On complete combustion, 0.3 g of an organic compound gave 0.2 g of CO_2 and 0.1 g of H_2O. The percentage composition of carbon and hydrogen in the compound, respectively is:

(1) 4.07% and 15.02%

(2) 18.18% and 3.70%

(3) 15.02% and 4.07%

(4) 3.70% and 18.18%

Correct Answer: (2) 18.18% and 3.70%

Solution:

Let's first find the percentage of carbon and hydrogen in the organic compound by calculating their masses and then finding the percentages.

Step 1: Percentage of carbon The mass of carbon in CO_2 is calculated as follows. Since 1 mole of CO_2 contains 1 mole of carbon, and the molar mass of CO_2 is 44 g/mol, the moles of CO_2 formed can be calculated from its mass:

$$\text{Moles of } CO_2 = \frac{\text{mass of } CO_2}{\text{molar mass of } CO_2} = \frac{0.2\,\text{g}}{44\,\text{g/mol}} = 0.004545\,\text{mol}$$

Since each mole of CO_2 contains 1 mole of carbon, the mass of carbon is:

$$\text{Mass of carbon} = 0.004545\,\text{mol} \times 12\,\text{g/mol} = 0.05454\,\text{g}$$

Now, the percentage of carbon is:

$$\%\,\text{C} = \frac{\text{Mass of carbon}}{\text{Mass of organic compound}} \times 100 = \frac{0.05454}{0.3} \times 100 = 18.18\%$$

Step 2: Percentage of hydrogen The mass of hydrogen in H_2O is calculated similarly. Since 1 mole of H_2O contains 2 moles of hydrogen, and the molar mass of H_2O is 18 g/mol, the moles of H_2O formed can be calculated from its mass:

$$\text{Moles of } H_2O = \frac{\text{mass of } H_2O}{\text{molar mass of } H_2O} = \frac{0.1\,\text{g}}{18\,\text{g/mol}} = 0.005556\,\text{mol}$$

Since each mole of H_2O contains 2 moles of hydrogen, the mass of hydrogen is:

$$\text{Mass of hydrogen} = 0.005556\,\text{mol} \times 2 \times 1\,\text{g/mol} = 0.01111\,\text{g}$$

Now, the percentage of hydrogen is:

$$\%\,\text{H} = \frac{\text{Mass of hydrogen}}{\text{Mass of organic compound}} \times 100 = \frac{0.01111}{0.3} \times 100 = 3.70\%$$

Step 3: Final result

The percentage composition of the organic compound is:

- Carbon: 18.18%

- Hydrogen: 3.70%

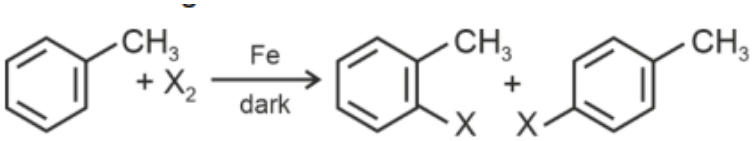
Thus, the correct answer is 18.18% and 3.70%.

Quick Tip

To find the percentage composition of an element in a compound from combustion data: - Use the masses of CO_2 and H_2O to find the masses of carbon and hydrogen. - Divide the mass of each element by the total mass of the compound and multiply by 100 to get the percentage composition.

---

94. The following reaction method is not suitable for the preparation of the corresponding haloarene products, due to the high reactivity of the halogen, when X is:



(1) F

(2) I

(3) Cl

(4) Br

Correct Answer: (1) F

Solution:

- Aryl chlorides and bromides can easily be prepared by electrophilic substitution of arenes (e.g., toluene) with Cl_2 and Br_2, respectively, in the presence of Lewis acid catalysts (e.g., Fe in dark). - Reaction with I_2 is reversible and requires the presence of an oxidizing agent, which makes it less efficient in this method.

- Corresponding fluoroarene is not prepared by this method due to the high reactivity of fluorine.

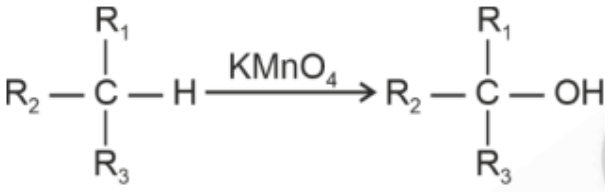
Hence, the correct answer is F, as fluorine reacts too aggressively to form the desired product under these conditions.

Quick Tip

When dealing with halogenation reactions of aromatic compounds, halogens like chlorine and bromine work well in electrophilic substitution, but fluorine's high reactivity requires special conditions and typically leads to side reactions.

---

95. The alkane that can be oxidized to the corresponding alcohol by $KMnO_4$ as per the equation:



is, when:

(1) $R_1 = H; R_2 = H; R_3 = H$

(2) $R_1 = CH_3; R_2 = CH_3; R_3 = H$

(3) $R_1 = CH_3; R_2 = H; R_3 = H$

(4) $R_1 = CH_3; R_2 = CH_3; R_3 = H$

Correct Answer: (2) $R_1 = CH_3; R_2 = CH_3; R_3 = H$

Solution:

Generally, alkanes resist oxidation, but alkanes with tertiary hydrogen atom(s) can be oxidized to the corresponding alcohols by $KMnO_4$.

- In this case, the compound where $R_1 = CH_3$; $R_2 = CH_3$; $R_3 = H$ (a tertiary alkane) can undergo oxidation to the corresponding alcohol.

The general mechanism involves the oxidation of tertiary hydrogens by $KMnO_4$, which provides the hydroxylated product.

$$CH_3C(H)CH_3 + KMnO_4 \rightarrow CH_3C(OH)CH_3$$

Thus, the correct answer is (2).

Quick Tip

Alkanes generally resist oxidation; however, oxidation can occur with compounds that have tertiary hydrogen atoms, allowing for easier substitution by oxidizing agents like $KMnO_4$.

---

96. For the following reaction at 300 K:

$A_2(g) + 3B_2(g) \rightarrow 2AB_3(g)$

The enthalpy change is +15 kJ, then the internal energy change is:

(A) 19988.4 J

(B) 200 J

(C) 1999 J

(D) 1.9988 kJ

Correct Answer: (A) 19988.4 J

Solution: Step 1: Write the reaction and use the relationship for enthalpy change:

$$\Delta H = \Delta U + \Delta n_g RT$$

For the reaction $A_2(g) + 3B_2(g) \rightarrow 2AB_3(g)$, the change in moles of gas, Δn_g, is:

$$\Delta n_g = 2 - 3 - 1 = -2$$

$$\Delta H = \Delta U + \Delta n_g RT$$

Substitute the known values:

$$15 \times 1000 = \Delta U - 2 \times 8.314 \times 300$$

$$\Delta U = 15000 + 600 \times 8.314$$

$$\Delta U = 15000 + 4988.4$$

$$\Delta U = 19988.4\,\text{J}$$

Quick Tip

For enthalpy and internal energy calculations, remember to consider the change in the number of moles of gas and use the ideal gas constant R effectively.

---

97. Rate constants of a reaction at 500 K and 700 K are 0.04 s^{-1} and 0.14 s^{-1}, respectively; then, activation energy of the reaction is:

(Given: $\log 3.5 = 0.5441$, $R = 8.31\,\text{J K}^{-1}\text{mol}^{-1}$)

(A) 182310 J

(B) 18500 J

(C) 18219 J

(D) 18030 J

Correct Answer: (C) 18219 J

Solution: Step 1: Apply the Arrhenius equation at two temperatures:

$$\ln k_1 = \ln A - \frac{E_a}{RT_1} \quad \text{at temp. } T_1 \quad \ldots(i)$$

$$\ln k_2 = \ln A - \frac{E_a}{RT_2} \quad \text{at temp. } T_2 \quad \ldots(ii)$$

Subtract equation (ii) from (i):

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

Substitute the known values:

$$\ln 0.14 - \ln 0.04 = \frac{E_a}{8.31}\left(\frac{1}{500} - \frac{1}{700}\right)$$

$$\ln 0.14 - \ln 0.04 = \frac{E_a}{8.31} \times \left(\frac{200}{500 \times 700}\right)$$

$$\frac{\ln 0.14 - \ln 0.04}{\left(\frac{200}{500 \times 700}\right)} = \frac{E_a}{8.31} \times 250$$

After solving:

$$E_a \approx 18222.65\,\text{J}$$

Thus, the activation energy is approximately $18219\,\text{J}$.

Quick Tip

For problems involving Arrhenius equation, ensure that the temperature is in Kelvin and use logarithmic properties to simplify calculations.

---

98. Mass of glucose ($C_6H_{12}O_6$) required to be dissolved to prepare one litre of its solution which is isotonic with 15 g L^{-1} solution of urea (NH_4CONH_2) is:

(Given: Molar mass in g mol^{-1} C: 12, H: 1, O: 16, N: 14)

(A) $55\,g$

(B) $15\,g$

(C) $30\,g$

(D) $45\,g$

Correct Answer: (D) 45 g

Solution: For isotonic solutions, osmotic pressure must be equal:

$$\pi_1 = \pi_2$$

$$C_1RT = C_2RT$$

Since the osmotic pressures are equal, the molar concentrations of the two solutions must be equal. From the equation:

$$m = \frac{180 \times 1 \times 15}{60 \times 1} \quad (m \text{ is the mass of glucose})$$

$$m = \frac{180}{4} = 45\,\text{g}$$

Quick Tip

For isotonic solutions, remember that osmotic pressures must be equal and use the formula $\pi = CRT$.

---

99. $[Mn_2(CO)_{10}]$ and $[Co_2(CO)_8]$ structures have:

(A) Metal-Metal linkage

(B) Terminal CO groups

(C) Bridging CO groups

(D) Metal in zero oxidation state

Choose the correct answer from the options given below:

(1) Only A, B, C

(2) Only B, C, D

(3) Only A, C, D

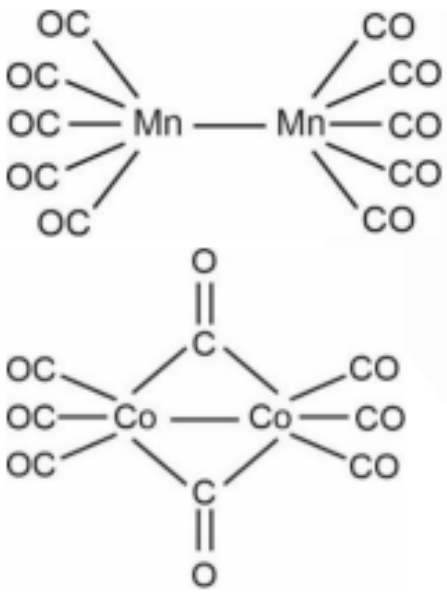
(4) Only A, B, D

Correct Answer: (4) Only A, B, D

Solution: In the structures of $[Mn_2(CO)_{10}]$ and $[Co_2(CO)_8]$, the following features are present:

- Metal-Metal linkage (A)
- Terminal CO groups (B)
- Metal in zero oxidation state (D)

However, the $[Mn_2(CO)_{10}]$ structure does not have bridging CO groups, so option (C) is incorrect.



The correct answer is (4) Only A, B, D.

Quick Tip

For metal carbonyl complexes, remember to check for the presence of metal-metal linkages and terminal vs bridging CO groups.

---

100. Methyl group attached to a positively charged carbon atom stabilizes the carbocation due to:

(1) $-I$ inductive effect

(2) Electromeric effect

(3) Hyperconjugation

(4) Mesomeric effect

Correct Answer: (3) Hyperconjugation

Solution:

A methyl group attached to a positively charged carbon atom stabilizes the carbocation primarily due to hyperconjugation. Hyperconjugation is the delocalization of electrons from sigma bonds (usually C-H or C-C bonds) to the vacant p-orbital of the carbocation. This delocalization spreads the positive charge over the structure, stabilizing the carbocation.

The methyl group, being electron-donating through its +I effect, donates electron density to the positively charged carbon, which further helps in stabilizing the carbocation. The electron density from the C-H bonds adjacent to the positively charged carbon atom is shared with the empty p-orbital of the carbocation. This effect is commonly referred to as hyperconjugation, which is one of the major contributors to the stability of carbocations, particularly in alkyl carbocations.

In addition, the +I effect of the methyl group also plays a role by increasing the electron density around the positively charged carbon, but it is the hyperconjugation that is the dominant stabilizing factor.

$$CH_3–C^{\delta+}–CH_3 \rightleftharpoons CH_3–C=CH_2^{\delta+}$$

The positive charge on the carbon is delocalized through hyperconjugation, making the carbocation more stable.

Quick Tip

When dealing with carbocations, always consider the possibility of hyperconjugation. The more alkyl groups attached to the positively charged carbon, the more stable the carbocation due to hyperconjugation.

BOTANY

SECTION-A

101. The regions with high level of species richness, high degree of endemism and a loss of 70% of the species and habitat are identified as:

(1) Natural Reserves

(2) Sacred Groves

(3) Biodiversity Hotspots

(4) Biogeographical Regions

Correct Answer: (3) Biodiversity Hotspots

Solution:

Biodiversity Hotspots are regions that are both rich in species and highly threatened. To qualify as a biodiversity hotspot, a region must meet two key criteria:

1. It must have at least 1,500 species of vascular plants as endemics (i.e., species found nowhere else).

2. It must have lost at least 70% of its original habitat.

These regions are of utmost importance for conservation because they hold a large proportion of the Earth's biodiversity, especially species that are found nowhere else. However, due to human activities like deforestation, agriculture, and urbanization, these regions are under severe threat. As a result, they have been prioritized for conservation efforts.

Some famous biodiversity hotspots include the Amazon rainforest, the forests of Madagascar, and the Himalayan mountain range.

Quick Tip

Biodiversity Hotspots are critical for the survival of many species. Conservation of these areas is crucial to protect global biodiversity.

---

102. Which of the following simple tissues are commonly found in the fruit walls of nuts and pulp of pear?

(1) Sclereids

(2) Fibres

(3) Parenchyma

(4) Collenchyma

Correct Answer: (1) Sclereids

Solution: Sclereids are a type of sclerenchyma cell found in various plant tissues, particularly in the hard parts of plants. They are commonly found in the fruit walls of nuts and the pulp of pears. Sclereids provide structural support to the plant, making the tissue hard and rigid.

Sclereids can take different forms, such as:

- Stone cells: Found in pears, these sclereids contribute to the gritty texture that can be felt when eating the fruit.
- Branched sclereids: Found in nuts, these cells provide rigidity to the hard shell of the nut.

Unlike fibers, which are long and tapering, sclereids are more irregular in shape and are often scattered within the plant tissue. Their main function is to provide mechanical strength to the plant, especially in areas that need to resist mechanical stress.

In contrast, fibers are elongated cells that also provide structural support but are typically found in other plant parts such as stems and leaves, not specifically in fruits like sclereids.

Quick Tip

When examining plant tissues, remember that sclereids are responsible for the hardness of seeds, nuts, and certain fruits, while fibers contribute to the mechanical strength of stems and leaves.

103. In a chromosome, there is a specific DNA sequence, responsible for initiating replication. It is called:

(1) Recognition sequence

(2) Cloning site

(3) Restriction site

(4) ori site

Correct Answer: (4) ori site

Solution: Option (4) is the correct answer because the origin of replication (ori site) is the specific DNA sequence from where replication starts. This sequence is recognized by the replication machinery in the cell, which then initiates the replication process. When this sequence is linked to any piece of DNA, it allows the DNA to replicate within host cells, making it crucial for DNA replication in both prokaryotic and eukaryotic cells.

The ori site is also essential in cloning procedures, where scientists use this sequence to ensure that inserted DNA is replicated in the host organism.

Option (1) is incorrect because the recognition sequence is a specific palindromic nucleotide sequence in DNA that is recognized by restriction endonucleases. These enzymes cut the DNA at specific sites, but they are not involved in the initiation of replication.

Options (2) and (3) are incorrect because both the cloning site and restriction site refer to locations used in recombinant DNA techniques. The cloning site is a region on a vector used for inserting foreign DNA, while a restriction site is where restriction enzymes cut the DNA, neither of which are responsible for initiating DNA replication.

Quick Tip

Remember that the ori site is essential for DNA replication, while recognition and restriction sites are used in DNA manipulation and molecular cloning.

---

104. Given below are two statements:

Statement I: When many alleles of a single gene govern a character, it is called polygenic inheritance.

Statement II: In polygenic inheritance, the effect of each allele is additive.

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

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (2) Statement I is false but Statement II is true

Solution: Polygenic inheritance refers to the inheritance of a trait that is governed by more than one gene. This form of inheritance does not involve a single gene, but multiple genes that contribute to the trait.

In polygenic inheritance, each gene contributes to the expression of the phenotype, and the combined effect of all these alleles is what determines the characteristic of the organism. The effect of each allele is additive, meaning that each allele contributes incrementally to the phenotype.

- Statement I is incorrect because polygenic inheritance involves multiple genes, not a single gene.
- Statement II is correct because the effect of each allele in polygenic inheritance is indeed additive, where the phenotypic expression is the cumulative result of all contributing alleles.

Hence, the correct answer is option (2).

Quick Tip

In polygenic inheritance, the more genes involved, the greater the variation seen in the trait. The effect of each allele adds up to influence the final phenotype.

---

105. Which of the following are required for the light reaction of Photosynthesis?

A. CO_2 B. O_2 C. H_2O D. Chlorophyll E. Light

Choose the correct answer from the options given below:

(1) A, C, D and E only

(2) C, D and E only

(3) A and B only

(4) A, C and E only

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

Solution: For the light reaction of photosynthesis, the essential components are: - Water (H_2O): Water is split in the light reaction to release oxygen and provide electrons for the electron transport chain.

- Chlorophyll: Chlorophyll is the pigment that absorbs light energy and converts it into chemical energy through the process of photolysis.

- Light: Light energy from the sun is required to drive the light-dependent reactions of photosynthesis. It provides the energy needed to excite electrons in chlorophyll molecules.

Oxygen (O_2) is actually a byproduct of the light reaction, released during the splitting of water, but it is not required for the light reaction itself. Similarly, CO_2 is required for the dark reaction (Calvin cycle), not the light reaction.

Therefore, the correct answer is option (2) C, D, and E only.

Quick Tip

The light reaction of photosynthesis requires light, water, and chlorophyll. Oxygen is a byproduct, and CO_2 is utilized in the dark reaction.

---

106. Match List-I with List-II:

	List-I		List-II
A.	Fleming	I.	Disc shaped sacs or cisternae near cell nucleus
B.	Robert Brown	II.	Chromatin
C.	George Palade	III.	Ribosomes
D.	Camillo Golgi	IV.	Nucleus

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - Robert Brown is credited with describing the nucleus as a cell organelle in 1831, making B-IV correct.

- Fleming later stained the material of the nucleus using basic dyes and named it chromatin, which makes A-II correct.

- George Palade is known for his discovery of ribosomes, which are granular structures first observed under the microscope as dense particles, making C-III correct.

- Camillo Golgi first observed a densely stained reticular structure near the nucleus, which consists of many disc-shaped sacs or cisternae. Hence, D-I is correct.

Thus, the correct answer is option (1), A-II, B-IV, C-III, D-I.

Quick Tip

Remember the key discoveries in cell biology:

- The nucleus was discovered by Robert Brown.
- Chromatin was named by Fleming.
- Ribosomes were discovered by George Palade.
- The Golgi apparatus was observed by Camillo Golgi.

107. Match List-I with List-II:

	List-I Type of Inheritance		List-II Example
A.	Incomplete dominance	I.	Blood groups in human
B.	Co-dominance	II.	Flower colour in *Antirrhinum*
C.	Pleiotropy	III.	Skin colour in human
D.	Polygenic inheritance	IV.	Phenylketonuria

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

- Incomplete dominance is best illustrated by the flower colour in Antirrhinum (also known as snapdragons), where neither allele is completely dominant over the other, resulting in a blend of both traits in the F1 generation. This makes A-II correct.
- Co-dominance occurs when both alleles contribute equally to the phenotype. In humans, the blood groups (ABO system) are an example of co-dominance, where both A and B alleles are expressed equally in an individual with AB blood type. This makes B-I correct.
- Pleiotropy occurs when a single gene affects multiple traits. Phenylketonuria is a genetic disorder where a mutation in a single gene affects various aspects of health, making it a classic example of pleiotropy. Thus, C-IV is correct.
- Polygenic inheritance is when multiple genes contribute to a single trait. In humans, skin colour is controlled by multiple genes, making D-III correct.

Thus, the correct answer is option (2), A-II, B-I, C-IV, D-III.

Quick Tip

In polygenic inheritance, more than one gene controls the expression of a trait, leading to a range of phenotypes, as seen in human skin colour.

---

108. Which part of the ovule stores reserve food materials?

(1) Nucellus

(2) Integument

(3) Placenta

(4) Funicle

Correct Answer: (1) Nucellus

Solution: The nucellus is the central part of the ovule and is responsible for storing food materials. It consists of parenchyma cells that store nutrients needed for the developing embryo after fertilization.

The other parts of the ovule have different functions:

- The integument forms the protective outer covering of the ovule and later becomes the seed coat.
- The placenta is the tissue inside the ovary that attaches the ovule to the ovary wall.
- The funicle is a stalk that connects the ovule to the placenta.

Thus, the correct answer is (1) Nucellus, as it stores food materials for the developing seed.

Quick Tip

In addition to storing food, the nucellus provides nutrients to the developing embryo and plays an important role in seed formation.

---

109. Which one of the following is not found in Gymnosperms?

(1) Sieve cells

(2) Albuminous cells

(3) Tracheids

(4) Vessels

Correct Answer: (4) Vessels

Solution: Gymnosperms have xylem tissue that lacks vessels. Instead of vessels, gymnosperms have tracheids and sieve cells. Tracheids are the primary conducting cells for water in the xylem of gymnosperms. Additionally, gymnosperms possess albuminous cells, which function similarly to companion cells in angiosperms, but they lack sieve tubes.
Thus, the correct answer is option (4), Vessels, as they are found only in angiosperms, not in gymnosperms.

Quick Tip

Remember that gymnosperms lack vessels, which are characteristic of angiosperms, but they do have tracheids for water conduction.

---

110. Which one of the following is not included under in-situ conservation?

(1) Wild-life sanctuary

(2) Botanical garden

(3) Biosphere reserve

(4) National park

Correct Answer: (2) Botanical garden

Solution: In-situ conservation refers to the conservation of species in their natural habitat, where they are found naturally. This includes protected areas such as wildlife sanctuaries, biosphere reserves, and national parks, where species can live and reproduce without human interference.
However, a botanical garden is an ex-situ conservation method, meaning it involves the conservation of species outside their natural habitat, typically in controlled environments for research, education, and preservation.
Hence, the correct answer is option (2), Botanical garden, as it is not part of in-situ conservation.

Quick Tip

In-situ conservation happens in natural habitats (e.g., national parks, wildlife sanctuaries), while ex-situ conservation involves protecting species outside their natural habitats, such as in botanical gardens.

---

111. Given below are two statements:

Statement I: The Indian Government has set up GEAC, which will make decisions regarding the validity of GM research.

Statement II: Biopiracy is the term used to refer to the use of bio-resources by native people.

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

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false

Solution: - Statement I is correct because the Indian Government has established the Genetic Engineering Approval Committee (GEAC) to make decisions regarding the validity and safety of genetically modified (GM) organisms, including research and field trials.

- Statement II is incorrect because biopiracy refers to the unauthorized use or commercial exploitation of biological resources, typically by multinational companies, without compensatory payment or recognition to the indigenous people or countries from where the resources are taken. It does not refer to the use of bio-resources by native people, which is a part of traditional knowledge and cultural practices.

Therefore, the correct answer is option (1), Statement I is true but Statement II is false.

Quick Tip

Biopiracy involves the unethical or unauthorized use of biological resources, often for commercial purposes, without the consent of the indigenous people or without proper compensation.

112. Pollen grains remain preserved as fossils due to the presence of:

(1) Epidermal layer

(2) Tapetum

(3) Exine layer

(4) Intine layer

Correct Answer: (3) Exine layer

Solution: Pollen grains are well-preserved as fossils primarily because of the presence of sporopollenin in the outer layer called exine. Sporopollenin is a highly durable substance that is resistant to decay, making it ideal for fossilization. The exine is the thick outer covering of the pollen grain, and it provides protection from environmental factors such as moisture and UV radiation.

In contrast, the intine layer is the inner membrane of the pollen grain and is less durable than the exine.

Thus, the correct answer is option (3), Exine layer.

Quick Tip

The exine layer, made of sporopollenin, is the key factor in the preservation of pollen grains as fossils due to its resistance to degradation.

113. Identify the incorrect pair:

(1) Sphenopsida – Adiantum

(2) Pteropsida – Dryopteris

(3) Psilopsida – Psilotum

(4) Lycopsida – Selaginella

Correct Answer: (1) Sphenopsida – Adiantum

Solution:

- Sphenopsida includes plants like Equisetum, not Adiantum. Adiantum is a member of Pteropsida, not Sphenopsida. Thus, option (1) is incorrect.
- Pteropsida includes ferns such as Dryopteris.
- Psilopsida includes plants like Psilotum.
- Lycopsida includes plants like Selaginella.

Thus, the incorrect pair is Sphenopsida – Adiantum.

Quick Tip

Remember the correct classifications: Sphenopsida (e.g., Equisetum), Pteropsida (e.g., Adiantum, Dryopteris), Psilopsida (e.g., Psilotum), and Lycopsida (e.g., Selaginella).

---

114. Which of the following is the correct match?

(1) Gymnosperms : Cedrus, Pinus, Sequoia

(2) Angiosperms : Wolffia, Eucalyptus, Sequoia

(3) Bryophytes : Polytrichum, Polyspiphonia, Sphagnum

(4) Pteridophytes : Equisetum, Ginkgo, Adiantum

Correct Answer: (1) Gymnosperms : Cedrus, Pinus, Sequoia

Solution: - Option (1) is correct because Cedrus, Pinus, and Sequoia are all examples of gymnosperms, which are seed-producing plants that do not produce flowers. These plants have cones (e.g., pine cones) instead of flowers.
- Option (2) is incorrect because Sequoia is a gymnosperm, not an angiosperm.
- Option (3) is incorrect because Polyspiphonia is an alga (part of Rhodophyceae), not a bryophyte.
- Option (4) is incorrect because Ginkgo is a gymnosperm, not a pteridophyte.

Thus, the correct match is (1) Gymnosperms: Cedrus, Pinus, Sequoia.

Quick Tip

Remember that gymnosperms include coniferous trees like Pinus, Cedrus, and Sequoia, while angiosperms are flowering plants.

---

115. Given below are two statements regarding RNA polymerase in prokaryotes.

Statement I: In prokaryotes, RNA polymerase is capable of catalyzing the process of elongation during transcription.

Statement II: RNA polymerase associates transiently with 'Rho' factor to initiate transcription.

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

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false

Solution: - Statement I is true because RNA polymerase in prokaryotes catalyzes the elongation of the RNA strand during transcription. It is responsible for synthesizing RNA from a DNA template.

- Statement II is false because RNA polymerase does not associate with the Rho factor to initiate transcription. The Rho factor is involved in the termination of transcription, not initiation. The initiation of transcription is primarily driven by the sigma factor that helps RNA polymerase bind to the promoter region of DNA.

Therefore, the correct answer is option (1), Statement I is true but Statement II is false.

Quick Tip

Remember that RNA polymerase catalyzes the elongation of the RNA chain during transcription, and the Rho factor is involved in the termination, not initiation, of transcription.

116. Which of the following is a nucleotide?

(1) Uridine

(2) Adenylic acid

(3) Guanine

(4) Guanosine

Correct Answer: (2) Adenylic acid

Solution: - Uridine is a nucleoside, not a nucleotide. A nucleoside consists of a nitrogenous base (uridine in this case) and a sugar (ribose), but it does not contain a phosphate group. Thus, option (1) is incorrect.

- Adenylic acid is a nucleotide, which consists of a nitrogenous base (adenine), a sugar (ribose), and a phosphate group. Therefore, option (2) is the correct answer.

- Guanine is a nitrogenous base and is not a nucleotide by itself. A nucleotide would consist of guanine (as the base) combined with a sugar and a phosphate group. Thus, option (3) is incorrect.

- Guanosine is a nucleoside, which includes the nitrogenous base guanine and the sugar ribose, but no phosphate group. Hence, option (4) is incorrect.

Thus, the correct answer is option (2), Adenylic acid, which is a nucleotide.

Quick Tip

Remember that a nucleotide consists of a nitrogenous base, a sugar (ribose or deoxyribose), and at least one phosphate group, while a nucleoside lacks the phosphate group.

---

117. Match List-I with List-II:

	List-I		List-II
A.	Vexillary aestivation	I.	Brinjal
B.	Epipetalous stamens	II.	Peach
C.	Epiphyllous stamens	III.	Pea
D.	Perigynous flower	IV.	Lily

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - Vexillary aestivation is found in pea (Pisum sativum), where the arrangement of petals resembles a banner-like structure, making A-III correct.

- Epipetalous stamens are found in brinjal (Solanum melongena), where the stamens are attached to the petals, making B-I correct.

- Epiphyllous stamens are found in lily (Lilium spp.), where the stamens are borne on the leaf-like structures, making C-IV correct.

- Perigynous flowers are found in peach (Prunus persica), where the ovary is positioned in the center, surrounded by the other floral parts, making D-II correct.

Thus, the correct answer is option (1), A-III, B-I, C-IV, D-II.

Quick Tip

In plant morphology, different flower structures (like aestivation, stamens attachment, and ovary position) are important for identifying plant families and species.

---

118. Match List-I with List-II:

	List-I		List-II
A.	China rose	I.	Free central
B.	Mustard	II.	Basal
C.	Primrose	III.	Axile
D.	Marigold	IV.	Parietal

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - China rose exhibits axile placentation. This means that the ovules are attached to the central axis of the ovary, making A-III correct.

- Mustard exhibits parietal placentation, where ovules are attached to the wall of the ovary, making B-IV correct.

- Primrose exhibits free central placentation, where ovules are attached to a central column in the ovary, not to the walls, making C-I correct.

- Marigold exhibits basal placentation, where ovules are attached at the base of the ovary, making D-II correct.

Thus, the correct answer is option (3), A-III, B-IV, C-I, D-II.

Quick Tip

Placental arrangements in plants determine the location of ovules in the ovary. Common types include axile, parietal, free central, and basal placentation.

---

119. Which of the following helps in maintenance of the pressure gradient in sieve tubes?

(1) Albuminous cells

(2) Sieve cells

(3) Phloem parenchyma

(4) Companion cells

Correct Answer: (4) Companion cells

Solution: Companion cells are crucial for the maintenance of the pressure gradient in the sieve tubes of phloem. They help by providing the necessary metabolic support and maintaining the pressure gradient for the flow of nutrients through the sieve tubes.

- Albuminous cells assist in the functioning of the sieve elements, but they are primarily found in gymnosperms, not angiosperms.
- Sieve cells are responsible for the transport of sugars, but they do not regulate the pressure gradient in the sieve tubes.
- Phloem parenchyma stores food and participates in the lateral transport of water and nutrients, but they do not play a significant role in pressure gradient maintenance.
Thus, companion cells are the key players in maintaining the pressure gradient in sieve tubes.

Quick Tip

Companion cells are closely associated with sieve tube elements and help them maintain their functions, including pressure gradient regulation.

---

120. Mesosome in a cell is:

(1) Membrane bound vesicular structure

(2) Chain of many ribosomes attached to a single mRNA

(3) Special structure formed by extension of plasma membrane

(4) Medium sized chromosome

Correct Answer: (3) Special structure formed by extension of plasma membrane

Solution: Mesosomes are infoldings of the plasma membrane found in prokaryotic cells. These structures are believed to be involved in processes like cell division and the organization of enzymes involved in cellular respiration.
- Lysosomes are membrane-bound vesicular structures, not mesosomes, so option (1) is incorrect. - Polyribosomes (option 2) refer to chains of ribosomes that translate a single mRNA molecule, which is unrelated to mesosomes.
- Chromosomes (option 4) are structures containing genetic material, not related to mesosomes.
Thus, the correct answer is (3), as mesosomes are formed by the extension of the plasma membrane into the cell.

Quick Tip

Mesosomes in prokaryotic cells are thought to play a role in cellular respiration and division, although their exact function is still debated.

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121. Match List-I with List-II:

	List-I		List-II
A.	Abscisic acid	I.	Promotes female flowers in cucumber
B.	Ethylene	II.	Helps seeds to withstand desiccation
C.	Gibberellin	III.	Helps in nutrient mobilisation
D.	Cytokinin	IV.	Promotes bolting in beet, cabbage etc

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - Abscisic acid (A) plays a key role in helping seeds to withstand desiccation and survive harsh conditions, making A-II correct.

- Ethylene (B) is known to promote female flower formation in cucumber plants, making B-I correct. - Gibberellin (C) is involved in promoting bolting in plants like beet and cabbage, which involves the transition to flowering, making C-IV correct.

- Cytokinin (D) is involved in the mobilization of nutrients, especially in promoting growth and development, which makes D-III correct.

Thus, the correct answer is option (3), A-II, B-I, C-IV, D-III.

Quick Tip

Plant hormones such as abscisic acid, ethylene, gibberellin, and cytokinin regulate various growth and developmental processes like seed dormancy, flowering, and bolting.

122. Match List-I with List-II:

	List-I		List-II
A.	Genetically engineered Human Insulin	I.	Gene therapy
B.	GM Cotton	II.	*E. coli*
C.	ADA Deficiency	III.	Antigen-antibody interaction
D.	ELISA	IV.	*Bacillus thuringiensis*

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - Genetically engineered Human Insulin (A): To produce human insulin, E. coli is used as a host cell to insert the gene for insulin production, making A-II correct.

- GM Cotton (B): To create genetically modified cotton, the bacterium Bacillus thuringiensis is used for introducing insect resistance, making B-IV correct.

- ADA Deficiency (C): Gene therapy is one of the treatments for ADA (Adenosine Deaminase) deficiency, which is a genetic disorder affecting the immune system, making C-I correct.

- ELISA (D): The ELISA (Enzyme-Linked Immunosorbent Assay) test is based on the interaction between antigens and antibodies to detect the presence of a specific substance, making D-III correct.

Thus, the correct answer is option (4), A-II, B-IV, C-I, D-III.

Quick Tip

In biotechnology, E. coli is often used as a host for gene expression, while Bacillus thuringiensis is used for creating genetically modified crops like GM cotton.

123. Match List-I with List-II:

	List-I		List-II
A.	ETS Complex I	I.	NADH Dehydrogenase
B.	ETS Complex II	II.	Cytochrome bC_1
C.	ETS Complex III	III.	Cytochrome C oxidase
D.	ETS Complex IV	IV.	Succinate Dehydrogenase

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - ETS Complex I is associated with NADH Dehydrogenase which catalyzes the first step of the electron transport chain, where NADH donates electrons to the electron transport chain. Thus, A-I is correct.

- ETS Complex II is associated with Succinate Dehydrogenase which is involved in the citric acid cycle and also contributes electrons to the electron transport chain. Hence, B-IV is correct. - ETS Complex III contains the Cytochrome b_c1 complex which is part of the electron transport chain and helps in transferring electrons from ubiquinol to cytochrome c. Therefore, C-II is correct.

- ETS Complex IV contains the Cytochrome C Oxidase complex which catalyzes the final step in the electron transport chain, where electrons are transferred to oxygen to form water. Thus, D-III is correct.

Hence, the correct answer is option (2), A-I, B-IV, C-II, D-III.

Quick Tip

The electron transport chain (ETC) is composed of four protein complexes, each responsible for transferring electrons and pumping protons across the membrane, ultimately producing ATP.

---

124. Cryopreservation technique is used for:

(1) Protection of environment

(2) Protection of Biodiversity hotspots

(3) Preservation of gametes in viable and fertile condition for a long period

(4) In-situ conservation

Correct Answer: (3) Preservation of gametes in viable and fertile condition for a long period

Solution: Cryopreservation is a type of ex-situ conservation technique used to preserve the genetic material of organisms, such as gametes, by freezing them at very low temperatures. This method allows the gametes of threatened species to be stored for long periods while maintaining their fertility and viability for future use.

- Option (1) is incorrect because cryopreservation is not directly related to the protection of the environment. - Option (2) is incorrect as cryopreservation is not a technique used for protecting biodiversity hotspots but rather for preserving gametes. - Option (4) is incorrect because in-situ conservation refers to the preservation of species in their natural habitat, not in frozen states.

Hence, the correct answer is option (3).

Quick Tip

Cryopreservation helps conserve genetic material, ensuring the survival of species in case of population decline or extinction threats.

---

125. Which of the following are correct about cellular respiration?

A. Cellular respiration is the breaking of C-C bonds of complex organic molecules by oxidation.

B. The entire cellular respiration takes place in Mitochondria.

C. Fermentation takes place under anaerobic condition in germinating seeds.

D. The fate of pyruvate formed during glycolysis depends on the type of organism also.

E. Water is formed during respiration as a result of O_2 accepting electrons and getting reduced.

Choose the correct answer from the options given below:

(1) A, C, D, E only

(2) A, B, C, E only

(3) A, B, C, E only

(4) B, C, D, E only

Correct Answer: (1) A, C, D, E only

Solution: - Statement A is correct because cellular respiration involves the breakdown of complex organic molecules by oxidation, releasing energy.

- Statement B is incorrect because glycolysis, which is part of cellular respiration, takes place in the cytoplasm of the cell, not in the mitochondria.

- Statement C is correct because fermentation occurs under anaerobic conditions, such as in germinating seeds when oxygen is not available for aerobic respiration.

- Statement D is correct because the fate of pyruvate formed during glycolysis does indeed depend on the type of organism; in some organisms, pyruvate is converted into lactic acid, and in others, it undergoes further oxidation in the mitochondria.

- Statement E is correct because water is formed when O_2 accepts electrons during the electron transport chain in the mitochondria, which is part of the cellular respiration process.

Thus, the correct answer is option (1), A, C, D, E only.

Quick Tip

Remember that while glycolysis occurs in the cytoplasm, the citric acid cycle and electron transport chain occur in the mitochondria.

126. Given below are two statements:

Statement I: In eukaryotes there are three RNA polymerases in the nucleus in addition to the RNA polymerase found in the organelles.

Statement II: All the three RNA polymerases in eukaryotic nucleus have different roles.

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

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

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

(3) Both Statement I and Statement II are correct

(4) Both Statement I and Statement II are incorrect

Correct Answer: (3) Both Statement I and Statement II are correct

Solution: - Statement I is correct because in eukaryotes, there are indeed three RNA polymerases in the nucleus: RNA polymerase I, II, and III. These are distinct from the RNA polymerase found in the organelles, such as the mitochondria and chloroplasts.

- Statement II is correct because each RNA polymerase in the nucleus has a specific function: - RNA polymerase I is responsible for transcribing rRNA (28S, 18S, and 5.8S).

- RNA polymerase II is responsible for transcribing precursor mRNA (which will be processed into mature mRNA).

- RNA polymerase III is responsible for transcribing tRNA and 5S rRNA.

Therefore, both Statement I and Statement II are correct.

Thus, the correct answer is option (3), Both Statement I and Statement II are correct.

Quick Tip

In eukaryotic cells, different RNA polymerases perform specialized roles in transcription. Understanding these roles is important in molecular biology, especially in gene expression and regulation.

127. Match List-I with List-II:

	List-I		List-II
A.	Histones	I.	Loosely packed chromatin
B.	Nucleosome	II.	Densely packed Chromatin
C.	Euchromatin	III.	Positively charged basic proteins
D.	Heterochromatin	IV.	DNA wrapped around histone octamer

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - Histones (A) are positively charged basic proteins that play a critical role in the packaging of DNA into nucleosomes. Hence, A-III is correct.

- Nucleosomes (B) consist of DNA wrapped around histone octamers, forming the basic unit of chromatin structure. Thus, B-IV is correct.

- Euchromatin (C) is loosely packed chromatin that is typically associated with active gene transcription. Hence, C-I is correct.

- Heterochromatin (D) is densely packed chromatin, which is generally transcriptionally inactive. Therefore, D-II is correct.

Thus, the correct answer is option (4), A-III, B-IV, C-I, D-II.

Quick Tip

Histones, nucleosomes, euchromatin, and heterochromatin all play crucial roles in the organization and function of genetic material within the nucleus.

128. Given below are two statements:

Statement I: Failure of segregation of chromatids during cell cycle resulting in the gain or loss of a whole set of chromosomes in an organism is known as aneuploidy.

Statement II: Failure of cytokinesis after anaphase stage of cell division results in the gain or loss of a chromosome is called polyploidy.

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

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

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

Solution: - Statement I is incorrect because aneuploidy refers to the gain or loss of one or more chromosomes, not the whole set. The failure of chromosome separation during cell division causes aneuploidy, which involves the addition or subtraction of individual chromosomes, not a whole set.

- Statement II is incorrect because polyploidy is the condition where an organism has more than two sets of chromosomes, usually due to a failure during cytokinesis, but it involves the whole set of chromosomes, not just a single chromosome. The statement incorrectly describes polyploidy as the gain or loss of a chromosome, which would be more characteristic of aneuploidy.

Hence, both statements are incorrect.

Thus, the correct answer is option (4), Both Statement I and Statement II are false.

Quick Tip

Aneuploidy involves the gain or loss of individual chromosomes, whereas polyploidy refers to the condition where organisms have more than two complete sets of chromosomes.

129. Recombination between homologous chromosomes is completed by the end of:

(1) Diakinesis

(2) Zygotene

(3) Diplotene

(4) Pachytene

Correct Answer: (4) Pachytene

Solution: - Pachytene is the stage of prophase I of meiosis during which recombination between homologous chromosomes is completed. During this stage, homologous chromosomes are fully synapsed, and crossover events take place, leading to genetic recombination.

- Diakinesis is the final stage of prophase I, where homologous chromosomes are fully separated and ready to move into metaphase. Recombination is not completed at this stage.

- Zygotene is the stage where homologous chromosomes begin to pair up, but recombination is not yet completed.

- Diplotene is the stage following pachytene, where the synaptonemal complex begins to disassemble, but recombination has already been completed by the end of pachytene.

Hence, the correct answer is option (4), Pachytene.

Quick Tip

Recombination between homologous chromosomes occurs during pachytene of prophase I, which is crucial for genetic diversity.

---

130. Match List-I with List-II:

	List-I		List-II
A.	Metacentric chromosome	I.	Chromosome has a terminal centromere
B.	Sub-metacentric chromosome	II.	Middle centromere forming two equal arms of chromosome
C.	Acrocentric chromosome	III.	Centromere is slightly away from the middle of chromosome resulting into two unequal arms
D.	Telocentric chromosome	IV.	Centromere is situated close to its end forming one extremely short and one very long arm

Choose the correct answer from the options given below:

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

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

Solution: - Metacentric chromosomes (A) have a middle centromere, resulting in two equal arms of the chromosome. Hence, A-II is correct.

- Sub-metacentric chromosomes (B) have a centromere slightly away from the middle of the chromosome, resulting in two unequal arms. Thus, B-III is correct.

- Acrocentric chromosomes (C) have a centromere close to one end, forming one very short arm and one very long arm. Therefore, C-IV is correct.

- Telocentric chromosomes (D) have a terminal centromere at the end of the chromosome, making D-I correct.

Thus, the correct answer is option (4), A-II, B-III, C-IV, D-I.

Quick Tip

The structure of chromosomes is determined by the position of the centromere. Metacentric chromosomes have equal arms, while acrocentric and telocentric chromosomes have one arm significantly shorter than the other.

---

131. Ligases is a class of enzymes responsible for catalysing the linking together of two compounds.

Which of the following bonds is not catalysed by it?

(1) C – C

(2) P – O

(3) C – O

(4) C – N

Correct Answer: (1) C – C

Solution: Ligases are enzymes that catalyse the joining of two compounds by forming a covalent bond, typically with the consumption of ATP. They are responsible for catalyzing various bond formations such as C – O, C – S, C – N, and P – O.

- Option (1) is the correct answer because ligases do not catalyze the formation of C – C bonds.

- Options (2), (3), and (4) are wrong as ligases can catalyse the joining of P – O, C – O, and C – N bonds.

Thus, the correct answer is option (1), C – C.

Quick Tip

Ligases are essential for joining molecules, especially during processes like DNA replication and repair, where they join nucleotides.

---

132. F. Skoog observed that callus proliferated from the internodal segments of tobacco stem when auxin was supplied with one of the following except:

(1) Extract of Vascular tissues

(2) Coconut milk

(3) Abscisic acid

(4) Yeast Extract

Correct Answer: (3) Abscisic acid

Solution: F. Skoog discovered that callus formation from the internodal segments of tobacco stems occurred only when the medium was supplemented with auxins and specific nutrients. He observed that the callus would proliferate when auxin was supplied along with extracts like vascular tissues, yeast extract, or coconut milk, but not with abscisic acid.

- Abscisic acid is a plant hormone that typically inhibits growth and is not involved in promoting callus formation, making it the exception in this experiment.

Thus, the correct answer is option (3), Abscisic acid.

Quick Tip

Auxins play a crucial role in promoting cell growth and differentiation, and Skoog's experiment helped establish the use of specific growth factors in plant tissue culture.

---

133. Given below are some statements about plant growth regulators:

A. All GAs are acidic in nature.

B. Auxins are antagonists to GAs.

C. Zeatin was isolated from coconut milk.

D. Ethylene induces flowering in Mango.

E. Abscisic acid induces parthenocarpy.

Choose the correct set of statements from the options given below:

(1) A, C, D

(2) B, E

(3) A, B, C

(4) B, D, E

Correct Answer: (1) A, C, D

Solution: - Statement A is correct because all gibberellic acids (GAs) are indeed acidic in nature.
- Statement B is incorrect because auxins are not antagonists to gibberellic acid (GAs). In fact, auxins and GAs often work together to promote growth.
- Statement C is correct because zeatin, a type of cytokinin, was isolated from coconut milk, which plays a role in promoting cell division and growth.
- Statement D is correct because ethylene is a plant hormone that induces flowering in mangoes, among other plants.
- Statement E is incorrect because abscisic acid (ABA) is not known for inducing parthenocarpy. Instead, auxins can induce parthenocarpy in certain fruits like tomatoes.
Thus, the correct answer is option (1), A, C, D.

Quick Tip

Plant growth regulators like auxins, gibberellins, cytokinins, and ethylene play key roles in regulating various growth processes such as flowering, fruit development, and cell division.

---

134. Identify the incorrect statement related to gel electrophoresis.

(1) Separated DNA fragments can be directly seen under UV radiation

(2) Separated DNA can be extracted from gel piece

(3) Fragment of DNA moves toward anode

(4) Sieving effect of agarose gel helps in separation of DNA fragments

Correct Answer: (1) Separated DNA fragments can be directly seen under UV radiation

Solution: - Option (1) is incorrect because separated DNA fragments can only be visualized after staining with a compound such as ethidium bromide. After staining, the fragments can be viewed under UV radiation. Without staining, we cannot see the pure DNA fragments, even under UV light.

- Option (2) is correct because once the DNA fragments are separated by electrophoresis, they can be extracted from the gel for further analysis.
- Option (3) is correct because DNA is a negatively charged molecule, and thus, it moves towards the positive electrode (anode) during electrophoresis.
- Option (4) is correct because the agarose gel provides a sieving effect that helps in separating DNA fragments based on their size.
Thus, the correct answer is option (1), Separated DNA fragments can be directly seen under UV radiation.

Quick Tip

DNA fragments are invisible until they are stained with a dye like ethidium bromide. The gel electrophoresis process separates them by size, which can then be visualized under UV light after staining.

---

135. Which of the following examples show monocarpellary, unilocular ovary with many ovules?

A. Sesbania

B. Brinjal

C. Indigofera

D. Tobacco

E. Asparagus

Choose the correct answer from the options given below:

(1) B and E only

(2) C, D and E only

(3) A, B and D only

(4) A and C only

Correct Answer: (4) A and C only

Solution: - Monocarpellary and unilocular ovary with many ovules are characteristic of members of the family Fabaceae.

- Sesbania (A) and Indigofera (C) belong to the Fabaceae family, so they both exhibit monocarpellary, unilocular ovary with many ovules.
- Brinjal (B) and Tobacco (D) do not belong to the Fabaceae family. Brinjal is from the Solanaceae family, and Tobacco is from the Solanaceae family as well, so they do not fit the described features.
- Asparagus (E) belongs to the Liliaceae family, which does not exhibit monocarpellary, unilocular ovaries with many ovules.

Thus, the correct answer is option (4), A and C only.

Quick Tip

In plant anatomy, the type of ovary structure helps identify the family of the plant. The Fabaceae family typically has monocarpellary, unilocular ovaries with many ovules.

SECTION-B

136. Given below are two statements:

Statement I: In the lac operon, the z gene codes for beta-galactosidase which is primarily responsible for the hydrolysis of lactose into galactose and glucose.

Statement II: In addition to lactose, glucose or galactose can also induce lac operon.

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

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (1) Statement I is true but Statement II is false

Solution: - Statement I is true because the z gene in the lac operon codes for the enzyme beta-galactosidase, which breaks down lactose into its monomeric units, galactose and glucose.
- Statement II is false because glucose and galactose do not act as inducers of the lac operon. Instead, lactose or its isomer allolactose act as inducers. These molecules bind to the

repressor, preventing it from binding to the operator, thus allowing the operon to be expressed.

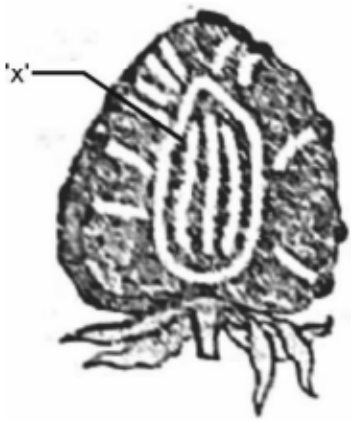
Thus, the correct answer is option (1), Statement I is true but Statement II is false.

Quick Tip

The lac operon is a classic example of gene regulation in bacteria. The presence of lactose or allolactose induces the operon, while glucose generally represses it due to catabolite repression.

---

137. The part marked as 'x' in the given figure is:



(1) Endosperm

(2) Thalamus

(3) Endocarp

(4) Mesocarp

Correct Answer: (2) Thalamus

Solution: The given figure represents a false fruit, specifically a strawberry, where the part marked as 'x' corresponds to the thalamus. The thalamus is the thickened, swollen part of the stem axis that holds the ovaries of a flower, and in false fruits like strawberries, it contributes to the fleshy part of the fruit.

- Option (1) is incorrect because the endosperm is the tissue surrounding the embryo in seeds, and it is not shown in the figure.

- Option (3) is incorrect because the endocarp is the innermost layer of the fruit wall, often surrounding the seed (like the pit in peaches), not relevant to the strawberry.
- Option (4) is incorrect because the mesocarp refers to the middle layer of the fruit wall, and the part marked 'x' is not the mesocarp in this case.
Thus, the correct answer is option (2), Thalamus.

Quick Tip

In false fruits like strawberries, the fleshy part of the fruit is derived from the thalamus (receptacle) rather than the ovary itself.

---

138. Given below are two statements:

Statement I: In a dicotyledonous leaf, the adaxial epidermis generally bears more stomata than the abaxial epidermis.

Statement II: In a dicotyledonous leaf, the adaxially placed palisade parenchyma is made up of elongated cells, which are arranged vertically and parallel to each other.

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

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

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

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Correct Answer: (2) Statement I is false but Statement II is true

Solution: - Statement I is false because in a dicotyledonous leaf, the adaxial epidermis (upper surface) typically bears very few stomata, and may even lack stomata. The abaxial epidermis (lower surface) generally has more stomata in comparison to the adaxial surface.
- Statement II is true because in dicotyledonous leaves, the adaxially placed palisade parenchyma consists of elongated cells that are arranged vertically and parallel to each other. This arrangement maximizes light absorption for photosynthesis.
Thus, the correct answer is option (2), Statement I is false but Statement II is true.

Quick Tip

In dicotyledonous leaves, the majority of stomata are located on the abaxial surface to reduce water loss and protect from excessive sunlight exposure.

---

139. Which of the following are not fatty acids?

A. Glutamic acid

B. Arachidonic acid

C. Palmitic acid

D. Lecithin

E. Aspartic acid

Choose the correct answer from the options given below:

(1) C, D and E only

(2) A and B only

(3) A, D and E only

(4) B and C only

Correct Answer: (3) A, D and E only

Solution:

- Glutamic acid (A) and Aspartic acid (E) are amino acids, not fatty acids.

- Lecithin (D) is a phospholipid, not a fatty acid. It is made up of fatty acids but is a component of lipids.

- Arachidonic acid (B) and Palmitic acid (C) are fatty acids.

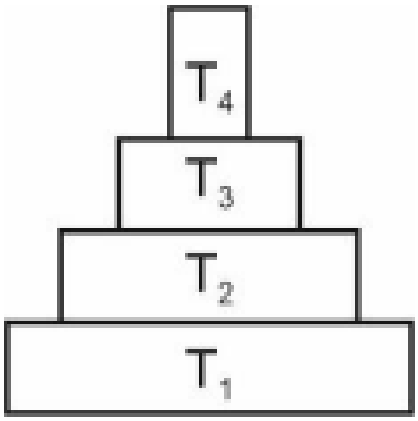
Thus, the correct answer is option (3), A, D and E only.

Quick Tip

Fatty acids are carboxylic acids with long hydrocarbon chains, whereas amino acids like glutamic acid and aspartic acid are the building blocks of proteins, and lecithin is a type of phospholipid.

---

140. Consider the pyramid of energy of an ecosystem given below:



If T_4 is equivalent to 1000 J, what is the value at T_1?

(1) $\frac{10000}{10}$ J

(2) $\frac{10000}{10} \times 4$ J

(3) 10,000 J

(4) 10,00,000 J

Correct Answer: (4) 10,00,000 J

Solution: According to the given pyramid of energy, the energy at each trophic level is transferred by 10 percent from the lower level to the higher level.

Given that T_4 is equivalent to 1000 J, we apply the 10 percent law for each trophic level:

$$T_4 = 1000\,\text{J}$$

- For T_3, the energy is 10 percent of T_4:

$$T_3 = \frac{100}{10} \times T_4 = \frac{100}{10} \times 1000 = 10,000\,\text{J}$$

- For T_2, the energy is 10 percent of T_3:

$$T_2 = \frac{100}{10} \times T_3 = \frac{100}{10} \times 10,000 = 1,00,000\,\text{J}$$

- For T_1, the energy is 10 percent of T_2:

$$T_1 = \frac{100}{10} \times T_2 = \frac{100}{10} \times 1,00,000 = 10,00,000\,\text{J}$$

Thus, the correct value at T_1 is 10,00,000 J.

Therefore, the correct answer is option (4), 10,00,000 J.

Quick Tip

The 10 percent law of energy transfer states that only about 10 percent of the energy is passed on to the next trophic level in an ecosystem, with the rest being lost as heat or used for other metabolic processes.

---

141. Which one of the following products diffuses out of the chloroplast during photosynthesis?

(1) ADP

(2) NADPH

(3) O_2

(4) ATP

Correct Answer: (3) O_2

Solution: - The products of the light reaction of photosynthesis are ATP, NADPH, and O_2. Among these, O_2 diffuses out of the chloroplast, as it is a byproduct of the splitting of water molecules during the light reactions.

- ATP and NADPH are used within the chloroplast to power the Calvin cycle, which drives the synthesis of sugars and other organic molecules.

Thus, the correct answer is option (3), O_2.

Quick Tip

In the light reaction, oxygen is produced as a waste product, while ATP and NADPH are used in the dark reaction (Calvin cycle) for sugar synthesis.

---

142. Recombinant DNA molecule can be created normally by cutting the vector DNA and source DNA respectively with:

(1) Hind II, Hind II

(2) Hind II, Alu I

(3) Hind II, EcoR I

(4) Hind II, BamHI

Correct Answer: (1) Hind II, Hind II

Solution:

- Option (1) is the correct answer because, for the successful creation of a recombinant DNA molecule, the vector DNA and source DNA must be cut with the same restriction enzyme. This ensures that the sticky ends of both DNA pieces are compatible and can ligate together to form a recombinant DNA molecule.
- In options (2), (3), and (4), different restriction enzymes are used for the vector and source DNA. This would lead to incompatible sticky ends and thus prevent the creation of a recombinant molecule.

Thus, the correct answer is option (1), Hind II, Hind II.

Quick Tip

For creating recombinant DNA, always use the same restriction enzyme for both the vector and the source DNA to ensure compatibility of the sticky ends.

---

144. The Bt toxin in genetically engineered Bt cotton kills the pest by:

(1) Creating pores in the midgut

(2) Damaging the respiratory system

(3) Degenerating the nervous system

(4) Altering the pH of body fluids

Correct Answer: (1) Creating pores in the midgut

Solution: The Bt toxin in genetically modified Bt cotton works by creating pores in the midgut of the pest. When the activated toxin binds to the surface of the midgut epithelial

cells, it creates pores that cause the cells to swell and eventually lyse (break down), leading to the death of the insect.

- Option (2) is incorrect because the Bt toxin does not damage the respiratory system of the pest.

- Option (3) is incorrect because the Bt toxin does not degenerate the nervous system of the pest.

- Option (4) is incorrect because the Bt toxin does not alter the pH of body fluids in the pest.

Thus, the correct answer is option (1), Creating pores in the midgut.

Quick Tip

The Bt toxin is a natural insecticide derived from the bacterium *Bacillus thuringiensis*, which works by disrupting the digestive system of the pest, making it an effective and environmentally safe pest control method.

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145. Match List-I with List-II:

Organisms	**Mode of Nutrition**
A. Euglenoid	I. Parasitic
B. Dinoflagellate	II. Saprophytic
C. Slime mould	III. Photosynthetic
D. Plasmodium	IV. Switching between photosynthetic and heterotrophic mode

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: - Euglenoids (A) are photosynthetic in the presence of sunlight. However, in the absence of sunlight, they behave like heterotrophs. Therefore, their mode of nutrition is Switching between photosynthetic and heterotrophic mode. Hence, A-IV.

- Dinoflagellates (B) are mostly marine and photosynthetic, as they contain chlorophyll and can perform photosynthesis. Therefore, their mode of nutrition is Photosynthetic. Hence, B-III.

- Slime moulds (C) are saprophytic protists, meaning they feed on decaying organic matter. Hence, C-II.

- Plasmodium (D) is a parasite that causes malaria by infecting humans through mosquito bites. Therefore, its mode of nutrition is Parasitic. Hence, D-I.

Thus, the correct answer is option (3), A-IV, B-III, C-II, D-I.

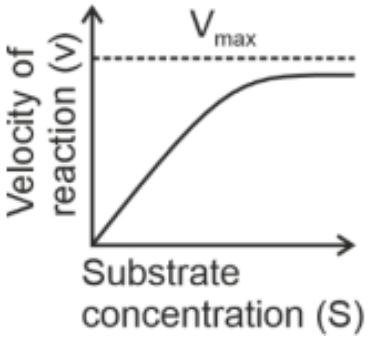
Quick Tip

The mode of nutrition in some organisms like Euglenoids can switch between photosynthetic and heterotrophic depending on environmental conditions such as light availability.

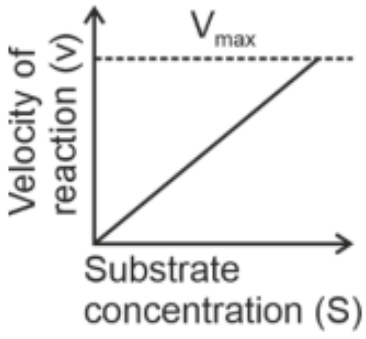
---

146. Which of the following graphs depicts the effect of substrate concentration on velocity of enzyme catalysed reaction?

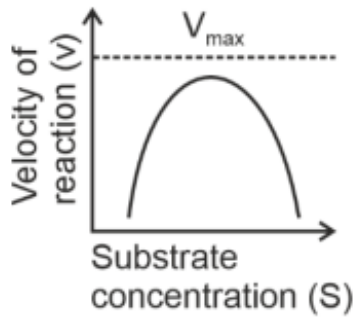
(1)



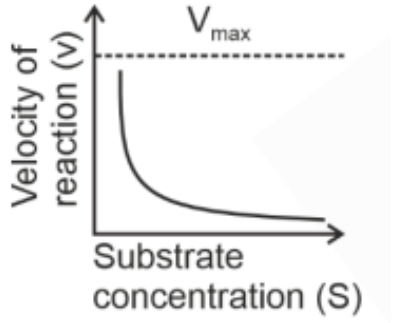
(2)



(3)



(4)



Correct Answer: (1)

Solution: - Option (1) is the correct answer because as the substrate concentration increases, the velocity of the enzymatic reaction rises at first. However, after a certain concentration of the substrate is reached, the reaction reaches its maximum velocity, V_{max}, which is not exceeded by any further rise in substrate concentration. This is because there are fewer enzyme molecules than substrate molecules, and after saturation of the enzyme molecules, there are no free enzyme molecules left to bind additional substrate molecules.

- Option (2) is incorrect because the velocity of reaction should not continuously increase indefinitely with increasing substrate concentration.

- Option (3) is incorrect because after reaching V_{max}, the velocity does not decline. It remains constant at V_{max}.

- Option (4) is incorrect because the velocity should remain constant after reaching V_{max}, not decline as depicted in the graph.

Thus, the correct answer is option (1), which accurately represents the typical behavior of enzyme catalyzed reactions with respect to substrate concentration.

Quick Tip

The relationship between enzyme velocity and substrate concentration is described by the Michaelis-Menten kinetics, where the velocity increases with substrate concentration but levels off as all enzyme active sites become saturated.

---

147. When will the population density increase, under special conditions?

When the number of:

(1) Deaths exceeds number of births and also number of emigrants equals number of immigrants.

(2) Births plus number of immigrants equals number of deaths plus number of emigrants.

(3) Births plus number of emigrants is more than the number of deaths plus number of immigrants.

(4) Births plus number of immigrants is more than the sum of number of deaths and number of emigrants.

Correct Answer: (4)

Solution: Let N_t be the population density at time t. Then its density at time $t+1$ is given by the equation:

$$N_{t+1} = N_t + [(B + I) - (D + E)]$$

where: - B = number of births - I = number of immigrants - D = number of deaths - E = number of emigrants

Population density will increase if the sum of births and immigrants $(B + I)$ is greater than the sum of deaths and emigrants $(D + E)$.

Thus, the correct answer is option (4), where births plus immigrants is more than the sum of deaths plus emigrants.

Quick Tip

Population growth is directly influenced by the balance between births, deaths, immigration, and emigration. When the number of births and immigrants exceeds deaths and emigrants, population density increases.

---

148. When a tall pea plant with round seeds was selfed, it produced the progeny of:

(a) Tall plants with round seeds and

(b) Tall plants with wrinkled seeds.

Identify the genotype of the parent plant.

(1) TtRr

(2) TtRR

(3) TTRR

(4) TTRr

Correct Answer: (4) TTRr

Solution: The selfing cross involves a TTRr parent (tall with round seeds). The genotypes of the progeny from this cross will be as follows:

$$\text{Selfing: } TTRr \times TTRr$$

Using a Punnett square, the possible combinations of alleles are:

Gametes	TR	Tr
TR	$TTRR$	$TTRr$
Tr	$TTRr$	$TTrR$

From this cross, the progeny will have the genotypes TTRR, TTRr, and TTrR, which correspond to tall plants with round seeds and tall plants with wrinkled seeds. Therefore, the genotype of the parent plant is TTRr.

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

Quick Tip

When performing genetic crosses, always consider the dominant and recessive traits of the alleles. Here, T represents tall and R represents round seeds, with both being dominant traits.

---

149. Match List-I with List-II:

	List-I		List-II
A.	Biodiversity hotspot	I.	Khasi and Jantia hills in Meghalaya
B.	Sacred groves	II.	World Summit on Sustainable Development 2002
C.	Johannesburg, South Africa	III.	*Parthenium*
D.	Alien species invasion	IV.	Western Ghats

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (1)

Solution: - Biodiversity hotspots (A) are regions with very high levels of species richness and high degree of endemism. Example: Western Ghats. Hence, A-IV.

- Sacred groves (B) are tracts of forest set aside and protected, found in cultures across the world. In India, these are found in Khasi and Jaintia hills in Meghalaya. Hence, B-I.

- The World Summit on Sustainable Development 2002 was held in Johannesburg, South Africa. Hence, C-II.

- Parthenium is an alien species, a noxious weed that has invaded many parts of India and other countries. Hence, D-III.

Thus, the correct answer is option (1), A-IV, B-I, C-II, D-III.

Quick Tip

Biodiversity hotspots are areas that are critical for the conservation of species due to their high level of endemism and species richness. Sacred groves and protected areas are vital for maintaining biodiversity in many cultures.

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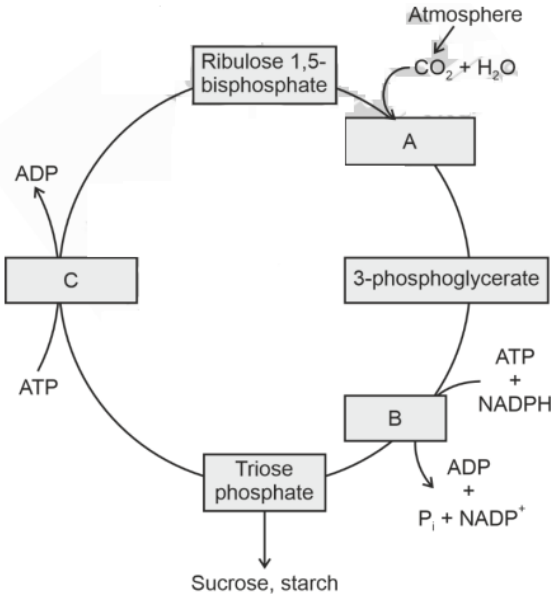
150. Observe the given figure. Identify the different stages labelled with alphabets by selecting the correct option.



(1) A-Carboxylation, B-Regeneration, C-Reduction

(2) A-Reduction, B-Decarboxylation, C-Regeneration

(3) A-Carboxylation, B-Reduction, C-Regeneration

(4) A-Reduction, B-Carboxylation, C-Regeneration

Correct Answer: (3)

Solution: The Calvin cycle proceeds in three stages:

- (A) Carboxylation, during which CO_2 combines with ribulose-1,5-bisphosphate (RuBP) to form 3-phosphoglycerate (PGA). This is the first step of the cycle, where carbon is fixed into the cycle.

- (B) Reduction, during which the 3-phosphoglycerate is reduced using the energy from ATP and NADPH to form triose phosphate (a sugar molecule). This stage also involves the

production of sucrose and starch.

- (C) Regeneration, during which the CO acceptor ribulose-1,5-bisphosphate is regenerated using ATP so the cycle can continue.

Thus, the stages are:

- A: Carboxylation

- B: Reduction

- C: Regeneration

Hence, the correct answer is option (3).

Quick Tip

In the Calvin cycle, Carboxylation is the first step where carbon is fixed. Reduction follows, where the fixed carbon is used to form sugars, and Regeneration occurs to reset the cycle.

ZOOLOGY

SECTION-A

151. Match List-I with List-II:

	List I		List II
A.	Predator	I.	*Ophrys*
B.	Mutualism	II.	*Pisaster*
C.	Parasitism	III.	Female wasp and fig
D	Sexual deceit	IV.	Plasmodium

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (4)

Solution: - A. Predator: In predation, one species benefits while the other is harmed. *Pisaster* is an important predator in the rocky intertidal communities of the American Pacific Coast. Hence, A-II.

- B. Mutualism: Many species of fig trees have a tight one-to-one relationship with their pollinators, such as the female wasp, making it an example of mutualism. Hence, B-III.

- C. Parasitism: *Plasmodium* is an endoparasite in humans that causes malaria. Hence, C-IV.

- D. Sexual deceit: The Mediterranean orchid *Ophrys* employs sexual deceit to trick bees into pollination. Hence, D-I.

Thus, the correct answer is option (4), A-II, B-I, C-IV, D-I.

Quick Tip

In ecological relationships, mutualism benefits both species, while parasitism harms the host. Sexual deceit involves one organism deceiving another for reproductive benefits.

152. Match List-I with List-II:

	List I **Location of Joint**		**List II** **Type of Joint**
A.	Joint between humerus and pectoral girdle	I.	Gliding joint
B.	Knee joint	II.	Ball and Socket joint
C.	Joint between atlas and axis	III.	Hinge joint
D	Joint between carpals	IV.	Pivot joint

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (1)

Solution: - A. Joint between humerus and pectoral girdle: The joint between the humerus and the pectoral girdle is a Ball and Socket joint. Hence, A-II.

- B. Knee joint: The knee joint is a Hinge joint, which allows movement in one plane (flexion and extension). Hence, B-III.

- C. Joint between atlas and axis: The joint between the atlas and axis (first two cervical vertebrae) is a Pivot joint, allowing rotational movement. Hence, C-IV.

- D. Joint between carpals: The joint between carpals is a Gliding joint, where flat surfaces of bones move against each other. Hence, D-I.

Thus, the correct answer is option (1), A-II, B-III, C-IV, D-I.

Quick Tip

In joints, remember: - Ball and Socket joints allow rotation in all directions (e.g., shoulder and hip).

- Hinge joints allow movement in one direction (e.g., knee and elbow).

- Pivot joints allow rotation (e.g., neck).

- Gliding joints allow bones to slide over one another (e.g., carpals).

---

153. Following are the steps involved in action of toxin in Bt. Cotton:

A. The inactive toxin converted into active form due to alkaline pH of gut of insect.

B. *Bacillus thuringiensis* produce crystals with toxic insecticidal proteins.

C. The alkaline pH solubilises the crystals.

D. The activated toxin binds to the surface of midgut cells, creates pores and causes death of the insect.

E. The toxin proteins exist as inactive protoxins in bacteria.

Choose the correct sequence of steps from the options given below:

(1) E $\rightarrow$ C $\rightarrow$ B $\rightarrow$ A $\rightarrow$ D

(2) B $\rightarrow$ C $\rightarrow$ A $\rightarrow$ E $\rightarrow$ D

(3) A $\rightarrow$ E $\rightarrow$ D $\rightarrow$ C

(4) B $\rightarrow$ E $\rightarrow$ C $\rightarrow$ A $\rightarrow$ D

Correct Answer: (4)

Solution: The action of Bt. Cotton toxin is a stepwise process that involves the following stages:

- B. *Bacillus thuringiensis* produce crystals with toxic insecticidal proteins.

The first step in the action of Bt toxin is the formation of crystal proteins by the bacterium *Bacillus thuringiensis*, which are toxic to the insect.

- E. The toxin proteins exist as inactive protoxins in bacteria.

These toxic proteins exist as inactive protoxins within the bacteria.

- C. The alkaline pH solubilises the crystals.

The toxin remains inactive in its crystalline form until it enters the alkaline environment of

the insect's gut, where the crystals dissolve.

- A. The inactive toxin is converted into active form due to alkaline pH of gut of insect. In the gut, the alkaline pH activates the toxin, converting it into its active form.

- D. The activated toxin binds to the surface of midgut cells, creates pores and causes death of the insect.

The active toxin binds to the midgut cells, creating pores, leading to the death of the insect.

Thus, the correct sequence is B $\rightarrow$ E $\rightarrow$ C $\rightarrow$ A $\rightarrow$ D.

Quick Tip

Remember, Bt toxin is effective against insects due to its specific action in the insect gut, where it is activated and disrupts the gut cells, causing death. The toxin acts only when it is solubilized and activated in the gut.

---

154. Match List-I with List-II:

	List I		**List II**
A.	Gene pool	I.	Stable within a generation
B.	Genetic drift	II.	Change in gene frequency by chance
C.	Gene flow	III.	Transfer of genes into or out of population
D	Gene frequency	IV.	Total number of genes and their alleles

Choose the correct answer from the options given below:

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

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

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

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

Correct Answer: (2)

Solution: The correct match between List-I and List-II is as follows:

- A. Gene pool $\rightarrow$ IV. Total number of genes and their alleles

The gene pool refers to the total collection of genetic material present in a population, including all the genes and their alleles.

- B. Genetic drift → II. Change in gene frequency by chance

Genetic drift refers to random changes in gene frequency in a population, often occurring in small populations.

- C. Gene flow → III. Transfer of genes into or out of population

Gene flow refers to the movement of genes between populations, involving the transfer of alleles from one population to another.

- D. Gene frequency → I. Stable within a generation

Gene frequency refers to how often an allele occurs in a population. Over time, gene frequency can remain stable unless affected by factors such as mutation, selection, or genetic drift.

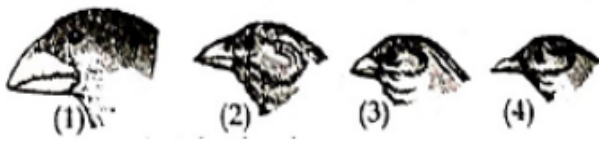
Thus, the correct matching is A-IV, B-II, C-III, D-I.

Quick Tip

Understanding the terms ”gene pool,” ”genetic drift,” ”gene flow,” and ”gene frequency” is crucial for comprehending population genetics. Pay attention to how these concepts relate to the genetic diversity of a population.

---

155. Which evolutionary phenomenon is depicted by the sketch given in figure?



(1) Artificial selection

(2) Genetic drift

(3) Convergent evolution

(4) Adaptive radiation

Correct Answer: (4)

Solution: The correct answer is option (4), because the evolutionary phenomenon depicted in the sketch is adaptive radiation. The sketches show different types of finches with altered beaks that arose from the original seed-eating features, enabling them to evolve into insectivorous and vegetarian finches. This is an example of adaptive radiation, where one species evolves into several species with different features suited to various ecological niches.

Option (1) is incorrect because artificial selection is the process where humans breed plants or animals with specific characteristics.

Option (2) is incorrect because genetic drift refers to random changes in gene frequencies in a population, which is unrelated to the evolution of new species.

Option (3) is incorrect because convergent evolution involves organisms from different evolutionary origins that develop similar features due to adapting to similar environments or ecological niches. Darwin's finches, however, are an example of divergent evolution, not convergent evolution.

Quick Tip

In adaptive radiation, a single ancestral species rapidly evolves into many diverse species to occupy different ecological roles, like the various types of finches found in the Galápagos Islands.

---

156. A person with blood group ARh+ can receive the blood transfusion from which of the following types?

(1) D and E only

(2) Only D

(3) A and B only

(4) C and D only

Correct Answer: (4)

Solution:

A person with blood group ARh+ can receive blood from individuals with the following

blood types:

- A and B blood groups with Rh+.

- AB blood group with Rh+.

The Rh+ factor is important in blood transfusions, and a person with Rh+ blood can receive blood from individuals with the same or compatible Rh factor.

Option (1) is incorrect because a person with ARh+ cannot receive blood from someone with the AB Rh- blood type.

Option (2) is incorrect because the transfusion from option D only will not be sufficient for compatibility.

Option (3) is incorrect because A and B blood groups alone are not sufficient for compatibility without considering the Rh factor.

Quick Tip

When considering blood transfusions, always check both the ABO group and Rh factor (positive or negative) to ensure compatibility.

---

157. Enzymes that catalyse the removal of groups from substrates by mechanisms other than hydrolysis leaving double bonds, are known as :

(1) Transferases

(2) Oxidoreductases

(3) Dehydrogenases

(4) Lyases

Correct Answer: (4)

Solution: The correct answer is option (4), because lyases are enzymes that catalyse the removal of groups from substrates by mechanisms other than hydrolysis, leaving double bonds. Lyases typically act by breaking chemical bonds without the involvement of water.

Option (1) is incorrect because transferases are enzymes that catalyse the transfer of a group G (other than hydrogen) between a pair of substrates S and S'.

Option (2) is incorrect because oxidoreductases are enzymes that catalyse

oxidation-reduction reactions between two substrates, typically involving electron or hydrogen transfer.

Option (3) is incorrect because dehydrogenases are a subset of oxidoreductases that catalyse the removal of hydrogen from substrates.

Quick Tip

Lyases are distinct from other enzyme classes because they form double bonds and do not require water for their activity, unlike hydrolases.

---

158. Match List-I with List-II:

List-I	Event	List-II	Stage of Prophase-I (Meiosis-I)
A.	Chiasmata formation	I.	Pachytene
B.	Crossing over	II.	Diakinesis
C.	Synaptonemal complex formation	III.	Diplotene
D.	Terminalisation of chiasmata	IV.	Zygotene

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

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

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

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

Correct Answer: (1)

Solution: Zygotene is the second stage of prophase I, during which synaptonemal complex formation occurs.

- In **Pachytene**, the four chromatids of each bivalent chromosome become distinct and clearly appear as tetrads, and in this stage, crossing over occurs.
- **Diplotene** is recognized by the dissolution of the synaptonemal complex and the tendency of the recombined homologous chromosomes of the bivalents to separate from each other except at the sites of crossovers. These X-shaped are called chiasmata.
- **Diakinesis** is marked by the terminalisation of chiasmata.

Quick Tip

Pachytene is the stage where crossing over occurs between homologous chromosomes, and the synaptonemal complex is formed. It is followed by Diplotene, where synaptonemal complex dissolves, and the chromosomes begin to separate, leaving chiasmata.

---

159. Match List-I with List-II:

	List-I		**List-II**
A.	Primary structure of protein	I.	Human haemoglobin
B.	Secondary structure of protein	II.	Disulphide bonds
C.	Tertiary structure of protein	III.	Polypeptide chain
D.	Quaternary structure of protein	IV.	Alpha helix and β sheet

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

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

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

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

Correct Answer: (1)

Solution:

- The **primary structure of protein** is the sequence of amino acids in a polypeptide chain (Option III).
- The **secondary structure of protein** refers to the regular folding patterns such as the alpha helix and beta sheet (Option IV).
- The **tertiary structure of protein** involves the three-dimensional folding due to interactions such as disulphide bonds (Option II).
- The **quaternary structure of protein** involves the association of multiple polypeptide chains to form a functional protein (Option I), as in human hemoglobin.

Thus, the correct matching is:

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

Quick Tip

The primary structure of proteins defines the sequence of amino acids, whereas higher structures (secondary, tertiary, quaternary) involve more complex interactions like folding, bonding, and polypeptide chain associations.

---

160. Match List-I with List-II:

List-I	Hormone	List-II	Function
A.	Epinephrine	I.	Hyperglycemia
B.	Thyroxine	II.	Smooth muscle contraction
C.	Oxytocin	III.	Basal metabolic rate
D.	Glucagon	IV.	Emergency hormone

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

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

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

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

Correct Answer: (3)

Solution: - **Epinephrine** is known as an emergency hormone, also known as adrenaline, and is secreted from the adrenal medulla. It helps in the body's fight-or-flight response and raises blood sugar levels. (Option IV)

- **Thyroxine** is secreted from the thyroid gland and plays a vital role in the regulation of basal metabolic rate (Option III).

- **Oxytocin** is a peptide hormone produced by the hypothalamus and released by the posterior pituitary. It causes smooth muscle contraction, especially in labor and delivery (Option II).

- **Glucagon** is secreted by the -cells of the pancreas and stimulates glycogen breakdown, increasing blood sugar levels, contributing to hyperglycemia (Option I).

Thus, the correct matching is:

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

Quick Tip

Epinephrine helps raise blood sugar levels quickly, while thyroxine regulates the basal metabolic rate. Glucagon contributes to increasing blood sugar, and oxytocin promotes smooth muscle contraction in childbirth.

---

161. Which of the following statements is correct about the type of junction and their role in our body?

(1) Adhering junctions facilitate the cells to communicate with each other.

(2) Tight junctions help to stop substances from leaking across a tissue.

(3) Tight junctions help to perform cementing to keep neighbouring cells together.

(4) Gap junctions help to create gap between the cells and tissues.

Correct Answer: (2)

Solution: - **Tight junctions** help to stop substances from leaking across a tissue by forming seals between adjacent cells. This ensures that fluids and molecules cannot pass between the cells.

- **Adhering junctions** provide mechanical adhesion between cells, helping them stay together and providing stability to tissues.

- **Gap junctions** allow communication between adjacent cells by enabling the transfer of ions and small molecules.

Thus, option (2) is correct.

Quick Tip

Tight junctions act as barriers to prevent leakage between cells, while gap junctions are involved in cell-to-cell communication.

---

162. Select the restriction endonuclease enzymes whose restriction sites are present for the tetracycline resistance (tet^R) gene in the pBR322 cloning vector.

(1) Bam HI and Sal I

(2) Sal I and Pst I

(3) Pst I and Pvu I

(4) Pvu I and Bam HI

Correct Answer: (1)

Solution: - The correct answer is **option (1)** because the restriction sites for the restriction endonucleases **Bam HI** and **Sal I** are located within the tet^R gene in the pBR322 cloning vector. These enzymes are frequently used in cloning experiments to cut the DNA at specific sequences, allowing for easier manipulation and ligation of foreign DNA.

- The Bam HI enzyme cuts DNA at a specific sequence, producing sticky ends, which can be useful for inserting foreign DNA.

- The Sal I enzyme also produces sticky ends, which is essential for cloning experiments where DNA fragments are inserted into the vector.

- Options (2) and (3) are incorrect because the restriction sites for Pst I and Pvu I are not present within the tet^R gene in the pBR322 cloning vector. These enzymes would not be useful for cutting within the tetracycline resistance gene, and hence cannot be used for the intended purpose.

Quick Tip

When working with cloning vectors like pBR322, always check the presence of specific restriction sites in the vector and in the insert to ensure efficient digestion and ligation.

---

163. Match List-I with List-II.

List-I	List-II
A. Chondrichthyes	I. Clarias
B. Cyclostomata	II. Carcharodon
C. Osteichthyes	III. Myxine
D. Amphibia	IV. Ichthyophis

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (3), because:

- Carcharodon is a cartilaginous fish which belongs to the class Chondrichthyes.
- Myxine is a jawless vertebrate that belongs to the class Cyclostomata.
- Clarias is a bony fish which belongs to the class Osteichthyes.
- Ichthyophis is a limbless animal which belongs to the class Amphibia.

Hence the correct matches are:

- A. Chondrichthyes – Carcharodon
- B. Cyclostomata – Myxine
- C. Osteichthyes – Clarias
- D. Amphibia – Ichthyophis

Quick Tip

In classification questions, always remember the key characteristics of each group: cartilaginous vs. bony fish, jawless vs. jawed vertebrates, and amphibians vs. fish.

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

Assertion A: During menstrual cycle, the ovulation takes place approximately on 14^{th} day.

Reason R: Rapid secretion of LH in the middle of menstrual cycle induces rupture of Graafian follicle and thereby the release of ovum.

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

(1) A is correct but R is not correct.

(2) A is not correct but R is correct.

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

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

Correct Answer: (3) Both A and R are correct and R is the correct explanation of A.

Solution:

In a typical 28-day menstrual cycle, ovulation typically occurs around the 14^{th} day, as stated in Assertion A. This timing is linked to the hormonal fluctuations that regulate the cycle. Ovulation is the process where the mature Graafian follicle ruptures to release an ovum (egg), which then travels to the fallopian tube for potential fertilization.

Now, Assertion R correctly explains why ovulation happens on this specific day. During the middle of the menstrual cycle, there is a rapid increase in the levels of Luteinizing Hormone (LH), known as the LH surge. This surge triggers the Graafian follicle to rupture, releasing the mature ovum into the fallopian tube. This process is crucial for fertilization and is a direct consequence of the LH surge.

In summary:

- Assertion A is correct because ovulation generally occurs on the 14^{th} day of a 28-day menstrual cycle.
- Assertion R is also correct because the release of LH plays a pivotal role in triggering ovulation by causing the rupture of the Graafian follicle.

Since both Assertion A and Reason R are accurate and Reason R directly explains Assertion A, the correct answer is option (3).

Quick Tip

When studying the menstrual cycle, focus on the timing of hormonal surges, especially the LH surge, as this directly affects ovulation and the possibility of pregnancy.

---

165. Match List-I with List-II with respect to convergent evolution:

List-I	List-II
A. Lemur	I. Flying phalanger
B. Bobcat	II. Numbat
C. Anteater	III. Spotted cuscus
D. Flying squirrels	IV. Tasmanian tiger cat

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (1), because:

- Lemur is a placental mammal and shows convergent evolution with the spotted cuscus, which is an Australian marsupial.
- Bobcat is a placental mammal and shows convergent evolution with the Tasmanian tiger cat, which is an Australian marsupial.
- Anteater is a placental mammal and shows convergent evolution with the Numbat, which is an Australian marsupial.
- Flying squirrel is a placental mammal and shows convergent evolution with the flying phalanger, which is an Australian marsupial.

Hence, the correct matches are:

- A. Lemur – Spotted cuscus
- B. Bobcat – Tasmanian tiger cat
- C. Anteater – Numbat
- D. Flying squirrels – Flying phalanger

Quick Tip

When studying convergent evolution, focus on the similarities in traits between unrelated species due to similar environmental pressures, even though they belong to different evolutionary lineages.

---

166. Match List-I with List-II.

List-I	**List-II**
A. Cells are metabolically active and proliferate	I. G_2 phase
B. DNA replication takes place	II. G_1 phase
C. Proteins are synthesized	III. G_0 phase
D. Quiescent stage with metabolically active cells	IV. S phase

Choose the correct answer from the options given below:

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

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

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

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

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

Solution: The correct answer is option (4), because:

- During the G_1 phase, the cell is metabolically active and continuously grows but does not replicate its DNA. Therefore, A corresponds to II.
- The S phase is the stage during which DNA synthesis or replication takes place. Hence, B corresponds to IV.

- Proteins are synthesized in preparation for mitosis during the G_2 phase while cell growth continues. Thus, C corresponds to I.
- The G_0 phase is a quiescent stage where cells are metabolically active but do not proliferate unless called upon to do so. Therefore, D corresponds to III.

Hence, the correct matches are:

- A. Cells are metabolically active and proliferate – G_1 phase
- B. DNA replication takes place – S phase
- C. Proteins are synthesized – G_2 phase
- D. Quiescent stage with metabolically active cells – G_0 phase

Quick Tip

In cell cycle questions, focus on understanding the different phases, especially G_1, S, G_2, and G_0, as they are central to processes like growth, DNA replication, and preparation for mitosis.

---

167. Match List-I with List-II.

List-I	**List-II**
A. Migratory flamingoes and resident fish in South American lakes	I. Interference competition
B. Abingdon tortoise became extinct after introduction of goats in their habitat	II. Competitive release
C. Chathamalus expands its distributional range in the absence of Balanus	III. Resource Partitioning
D. Five closely related species of Warblers feeding in different locations on same tree	IV. Interspecific competition

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (2), because:

- In some shallow South American lakes, visiting flamingoes and resident fish compete for their common food, which is an example of **interspecific competition** (A-IV).
- The Abingdon tortoise in Galapagos Islands became extinct after goats were introduced to the island, due to the greater browsing efficiency of the goats. This is an example of **interference competition** (B-I).
- The Chathamalus species expands its distributional range when Balanus, a competing species, is absent. This is an example of **competitive release** (C-II).
- The five closely related species of Warblers feed in different locations on the same tree, which is an example of **resource partitioning** (D-III).

Hence, the correct matches are:

- A. Migratory flamingoes and resident fish in South American lakes – Interspecific competition
- B. Abingdon tortoise became extinct after introduction of goats in their habitat – Interference competition
- C. Chathamalus expands its distributional range in the absence of Balanus – Competitive release
- D. Five closely related species of Warblers feeding in different locations on same tree – Resource partitioning

Quick Tip

In ecology questions, make sure to differentiate between competition types: interference, resource partitioning, and competitive release are important concepts when studying species interactions.

---

168. Match List-I with List-II relating to microbes and their products:

List-I (Microbes)	**List-II (Products)**
A. Streptococcus	I. Citric acid
B. Trichoderma polysporum	II. Clot buster
C. Monascus purpureus	III. Cyclosporin A
D. Aspergillus niger	IV. Statins

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (1), because:

- **Streptococcus** produces Streptokinase, which is used as a **clot buster** for removing clots from the blood vessels of patients who have undergone myocardial infarction (heart attack). Hence, A-II.
- **Trichoderma polysporum** produces **Cyclosporin A**, an immunosuppressive agent used in organ-transplant patients. Hence, B-III.
- **Monascus purpureus** produces **statins**, which are used as blood-cholesterol lowering agents. Hence, C-IV.

- **Aspergillus niger** produces **citric acid**, commonly used in food and beverage industries. Hence, D-I.

Hence, the correct matches are:

- A. Streptococcus – Clot buster
- B. Trichoderma polysporum – Cyclosporin A
- C. Monascus purpureus – Statins
- D. Aspergillus niger – Citric acid

Quick Tip

When studying microbial products, be familiar with their therapeutic uses and industrial applications, as well as the specific microorganisms involved.

---

169. Match List-I with List-II.

List-I	List-II
A. F_1 Particles	I. Chromosomes
B. Histones	II. Cilia
C. Axoneme	III. Golgi apparatus
D. Cisternae	IV. Mitochondria

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (2), because:

- **F_1 particles** or oxysomes are found on the inner face of the inner membrane of **mitochondria** (A-IV).
- **Histones** are basic proteins that are essential components of DNA and help in the formation of **chromosomes** (B-I).
- The **axoneme** is the central core of a cilium or flagellum, which is essential for the function of **cilia** (C-II).
- **Cisternae** in the **Golgi apparatus** are sac-like structures responsible for the transport of proteins (D-III).

Hence, the correct matches are:

- A. F_1 Particles – Mitochondria
- B. Histones – Chromosomes
- C. Axoneme – Cilia
- D. Cisternae – Golgi apparatus

Quick Tip

Focus on understanding the roles of cellular organelles like mitochondria, Golgi apparatus, and cilia. This will help you relate them to their associated components and functions.

---

170. Match List-I with List-II relating to examples of various kinds of IUDs and barrier:

List-I	**List-II**
A. Copper releasing IUD	I. Vaults
B. Non-medicated IUD	II. Multiload 375
C. Contraceptive barrier	III. LNG-20
D. Hormone releasing IUD	IV. Lippes loop

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (4), because:

- **Multiload 375** is a copper releasing IUD which suppresses sperm motility and fertilizing capacity of sperms. Hence, A-II.
- **Lippes loop** is a non-medicated intrauterine device. Hence, B-IV.
- **Vaults** are barrier-type contraceptives that prevent the physical meeting of the ovum and sperm. Hence, C-I.
- **LNG-20** is a hormone releasing IUD that makes the uterus unsuitable for implantation and the cervix hostile to sperms. Hence, D-III.

Hence, the correct matches are:

- A. Copper releasing IUD – Multiload 375
- B. Non-medicated IUD – Lippes loop
- C. Contraceptive barrier – Vaults
- D. Hormone releasing IUD – LNG-20

Quick Tip

When studying contraceptives, focus on the types of IUDs and their mechanisms. Copper IUDs work by affecting sperm motility, while hormone-releasing IUDs change the uterine environment to prevent implantation.

171. Given below are two statements:

Statement I: Antibiotics are chemicals produced by microbes that kill other microbes.

Statement II: Antibiotics are chemicals formed in the body that eliminate microbes.

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

(1) Statement I is correct but Statement II is incorrect.

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

(3) Both Statement I and Statement II are correct.

(4) Both Statement I and Statement II are incorrect.

Correct Answer: (3) Both Statement I and Statement II are correct.

Solution:

The correct answer is option (3) as both **statement I** and **statement II** are correct.

- **Statement I:** Antibiotics are chemicals produced by microorganisms. Antibiotics have the capacity to inhibit the growth and eventually destroy bacterial and other microorganisms in low concentration. Thus, statement I is correct.
- **Statement II:** Antibiotics are immunoglobulins produced in the body in response to any attack from pathogens. They facilitate the killing of microbes by various mechanisms and provide immunity to the body. Thus, statement II is also correct.

Hence, both statements are correct.

Quick Tip

Antibiotics are produced by microbes or synthesized in the lab, and they help in treating infections by inhibiting the growth of harmful microorganisms. Understanding both the microbial production and the body's response is essential.

---

172. Arrange the following parts in the human mammary gland, traversing the route of milk ejection.

A. Mammary duct

B. Lactiferous duct

C. Mammary alveolus

D. Ampulla

E. Mammary tubule

Choose the correct answer from the options given below:

(1) D → C → A → B

(2) C → E → A → D

(3) C → E → A → D → B

(4) A → C → E → D → B

Correct Answer: (3) C → E → A → D → B

Solution: The correct answer is Option (3) as the correct route of milk ejection via mammary glands in humans is:

Mammary alveolus → Mammary tubule → Mammary duct → Mammary ampulla → Lactiferous duct

In the question, the given structures are represented as:

$$C \rightarrow E \rightarrow A \rightarrow D \rightarrow B \quad \text{(given in option 3)}$$

The other options, i.e., (1), (2), and (4), are incorrect as they represent the wrong pathway.

Quick Tip

When studying the mammary gland and its milk ejection pathway, it's essential to remember the route: Mammary alveolus → Mammary tubule → Mammary duct → Mammary ampulla → Lactiferous duct.

173. Which of the following are correct about EcoRI?

A. Cut the DNA with blunt end

B. Cut the DNA with sticky end

C. Recognise a specific palindromic sequence

D. Cut the DNA between the base G and A when encounters the DNA sequence 'GAATTC'

E. Exonuclease

Choose the correct answer from the options given below:

(1) B, C, E only

(2) A, D, E only

(3) A, C, D only

(4) B, C, D only

Correct Answer: (4) B, C, D only

Solution:

The correct answer is option (4) as:

- EcoRI does not cut the DNA with blunt ends. Instead, it cuts the DNA with sticky/cohesive/staggered ends on each strand.
- EcoRI is a restriction endonuclease that recognises a specific palindromic sequence and cuts at a specific site within the DNA, known as the restriction site. It is not an exonuclease as exonucleases remove nucleotides from the free ends of the DNA.
- The recognition sequence for EcoRI is:

$$5' - G\,A\,A\,T\,T\,C - 3' \quad \text{and} \quad 3' - C\,T\,T\,A\,G\,G - 5'$$

  It cuts the DNA between the bases G and A only when the sequence GAATTC is present in the DNA.

Therefore, A and E represent incorrect facts about EcoRI, whereas B, C, and D are correct features of EcoRI.

The other options, i.e., (1), (2), and (3) are incorrect as they represent incorrect combinations of features with respect to EcoRI.

Quick Tip

Remember that EcoRI is a restriction enzyme that cuts at specific palindromic sequences, generating sticky ends which are crucial for recombinant DNA technology.

---

174. Which of the following is/are present in female cockroach?

A. Collateral gland

B. Mushroom gland

C. Spermatheca

D. Anal style

E. Phallic gland

Choose the most appropriate answer from the options given below:

(1) B and D only

(2) B and E only

(3) A only

(4) A and C only

Correct Answer: (4) A and C only

Solution:

The correct answer is option (4) as:

- **Collateral gland** is present in female cockroaches. It is a pair of glands that secrete the hard egg case or ootheca (A).
- **Mushroom gland** is absent in female cockroaches. It is present in males in the 6^{th} to 7^{th} abdominal segments (B).
- **Spermatheca** is present in female cockroaches in the 6^{th} abdominal segment (C).
- **Anal style** is absent in female cockroaches. It is present in males and projects backward from the 9^{th} sternum (D).
- **Phallic gland** is absent in female cockroaches. It is present in males as a large club-shaped gland located below the ejaculatory duct (E).

Thus, only structures represented by 'A' and 'C' are present in female cockroaches, making option (4) the correct answer.

Options (1) and (2) are incorrect as these structures are present in males. Option (3) is incorrect as it represents only a single structure that is present in female cockroaches.

Quick Tip

When studying the anatomy of cockroaches, focus on the reproductive organs and their sex-specific features. Female cockroaches have the collateral gland and spermatheca, while male-specific features include the mushroom gland and anal style.

---

175. Match List-I with List-II:

List-I	**List-II**
A. Malignant tumors	I. Destroy tumors
B. MALT	II. AIDS
C. NACO	III. Metastasis
D. α-Interferons	IV. Lymphoid tissue

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (1) because:

- **Malignant tumors** are associated with **Metastasis**, which refers to the spread of cancer cells from the original (primary) site to other parts of the body. Hence, A-III.
- **MALT** (Mucosa-associated lymphoid tissue) is a lymphoid tissue that plays a crucial role in immunity. Hence, B-IV.

- **NACO** (National AIDS Control Organization) deals with **AIDS**, an immune system disorder caused by HIV. Hence, C-II.
- α**-Interferons** are proteins that are used to **destroy tumors** and are involved in antiviral defense. Hence, D-I.

Hence, the correct matches are:

- A. Malignant tumors – Metastasis
- B. MALT – Lymphoid tissue
- C. NACO – AIDS
- D. α-Interferons – Destroy tumors

Quick Tip

In medical and biological studies, make sure to understand the relationship between diseases, treatments, and physiological processes like metastasis and immune response.

---

176. Open Circulatory system is present in:

Choose the correct answer from the options given below:

(1) Palaemon, Nereis, Balanoglossus

(2) Hirudinarian, Bombyx, Salpa

(3) Anopheles, Limax, Limulus

(4) Pheretima, Musca, Pila

Correct Answer: (3) Anopheles, Limax, Limulus

Solution:

The correct answer is option (3) as **Anopheles** (Arthropods), **Limax** (Mollusc), and **Limulus** (Arthropods) have an open circulatory system.

- Option (1) is incorrect as **Nereis** (Annelid) has a closed circulatory system.
- Option (2) is incorrect as **Hirudinia** (Annelid) has a closed circulatory system.

- Option (4) is incorrect as **Pheretima** (Annelid) has a closed circulatory system.
- **Arthropods** (Palaemon, Bombyx, Musca) have an open circulatory system.
- **Hemichordates** (Balanoglossus) have an open circulatory system.

Thus, the correct answer is option (3).

Quick Tip

Remember that arthropods, molluscs, and some hemichordates have an open circulatory system, where the blood is not confined to blood vessels but instead flows freely through cavities.

---

177. In which of the following connective tissues, the cells secrete fibres of collagen or elastin?

A. Cartilage

B. Done

C. Adipose tissue

D. Blood

E. Areolar tissue

Choose the most appropriate answer from the options given below:

(1) B, C, D and E only

(2) A, B, C and E only

(3) B, C and D only

(4) A, C and D only

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

Solution:

The correct answer is option (2) because blood does not contain fibroblasts, the cells that secrete collagen or elastin fibers.

Here's a detailed explanation:

- **Cartilage** contains chondroblasts, which secrete collagen and elastin fibers.

- **Bone** contains osteoblasts, which also secrete collagen fibers.

- **Adipose tissue** has adipocytes which store fat and also contribute to the secretion of collagen fibers.

- **Areolar tissue** contains fibroblasts that secrete collagen and elastin fibers, providing structural support.

However, **Blood** lacks these fiber-secreting cells called fibroblasts, so it does not fit into the group.

Hence, the correct tissues are cartilage, bone, adipose tissue, and areolar tissue, which all contain cells that secrete collagen or elastin fibers.

Thus, option (2) is the correct answer.

Quick Tip

Fibroblasts are the key cells involved in the secretion of collagen and elastin fibers. Understanding the specific types of connective tissues and their cellular components helps in identifying their roles in the body.

---

178. Which of the following pairs is an incorrect match?

(1) Annelids and arthropods-Bilateral symmetry

(2) Sponges-Acoelomates

(3) Coelenterates and Ctenophores-Radial symmetry

(4) Platyhelminthes-Diploblastic organisation

Correct Answer: (4) Platyhelminthes - Diploblastic organisation

Solution:

The correct answer is option (4), as **Platyhelminthes** (Flatworms) are **triploblastic** organisms, not **diploblastic**.

Here's why:

- **Annelids and arthropods** both exhibit **bilateral symmetry**, which is correct.

- **Sponges** are **acoelomates**, meaning they lack a body cavity, and this is correct.

- **Coelenterates (Cnidarians) and Ctenophores** exhibit **radial symmetry**, which is correct.

- **Platyhelminthes** (flatworms) are **triploblastic**, meaning they have three germ layers (ectoderm, mesoderm, and endoderm), not diploblastic, which means they only have two germ layers.

Thus, option (4) is incorrect because it wrongly categorizes Platyhelminthes as diploblastic when they are actually triploblastic.

Hence, the correct answer is option (4).

Quick Tip

When classifying animals, remember the number of germ layers they have: diploblastic animals (like cnidarians) have two layers, while triploblastic animals (like flatworms and higher organisms) have three.

---

179. Match List-I with List-II:

List-I	**List-II**
A. Residual Volume	I. Maximum volume of air that can be breathed in after forced expiration
B. Vital Capacity	II. Volume of air inspired or expired during normal respiration
C. Expiratory Capacity	III. Volume of air remaining in lungs after forcible expiration
D. Tidal Volume	IV. Total volume of air expired after normal inspiration

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (3) because:

- **Residual volume** is the volume of air remaining in the lungs after forcible expiration. Hence, A-III.

- **Vital capacity** is the maximum volume of air that can be breathed in after forced expiration. Hence, B-I.
- **Expiratory capacity** is the total volume of air expired after normal inspiration. Hence, C-IV.
- **Tidal volume** is the volume of air inspired or expired during normal respiration. Hence, D-II.

Thus, the correct matches are:

- A. Residual Volume – Volume of air remaining in lungs after forcible expiration
- B. Vital Capacity – Maximum volume of air that can be breathed in after forced expiration
- C. Expiratory Capacity – Total volume of air expired after normal inspiration
- D. Tidal Volume – Volume of air inspired or expired during normal respiration

Option (1), (2), and (4) are incorrect as they do not correctly match the descriptions.

Quick Tip

Understanding the different volumes in the respiratory system (like tidal volume, vital capacity, and residual volume) is crucial for understanding lung function and overall respiratory health.

---

180. Match List-I with List-II:

List-I	List-II
A. Living Fossil	I. Elongated canine teeth
B. Connecting Link	II. Vermiform appendix
C. Vestigial Organ	III. Echidna
D. Atavism	IV. Latimeria

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (1) because:

- **Latimeria** is a living fossil, it is a bony fish. Hence, A-IV.
- **Echidna** is the connecting link between reptiles and mammals. Hence, B-III.
- **Vestigial organs** are remnants of organs which were complete and functional in the ancestors. The vermiform appendix in humans is a vestigial organ. Hence, C-II.
- **Atavism** is a trait of distant ancestors that reappears in the modern day, such as elongated canine teeth in humans. Hence, D-I.

Hence, the correct matches are:

- A. Living Fossil – Latimeria
- B. Connecting Link – Echidna
- C. Vestigial Organ – Vermiform appendix
- D. Atavism – Elongated canine teeth

Option (2), (3), and (4) are incorrect as they do not correctly match the descriptions.

Quick Tip

Understanding biological concepts like living fossils, atavism, and vestigial organs is important in evolutionary biology, as they help to illustrate how traits and features can evolve or remain in modern species.

---

181. Match List-I with List-II:

List-I	List-II
A. Schwann cells	I. Neurotransmitter
B. Synaptic knob	II. Cerebral cortex
C. Bipolar neurons	III. Myelin sheath
D. Multipolar neurons	IV. Retina

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (1) because:

- **Schwann cells** are involved in the formation of the **myelin sheath** around the axons in myelinated nerve fibers. Hence, (A) matches with (III).
- **Synaptic knob** contains synaptic vesicles that store and release **neurotransmitters**. Hence, (B) matches with (I).
- **Bipolar neurons** have one axon and one dendrite, and they are found in the **retina of the eye**. Hence, (C) matches with (IV).
- **Multipolar neurons** have one axon and two or more dendrites, and they are typically found in the **cerebral cortex**. Hence, (D) matches with (II).

Thus, the correct matches are:

- A. Schwann cells – Myelin sheath
- B. Synaptic knob – Neurotransmitter
- C. Bipolar neurons – Retina

- D. Multipolar neurons – Cerebral cortex

Option (2), (3), and (4) are incorrect as they have mismatches for (A), (B), (C), and (D).

Quick Tip

Understanding the functions and locations of different types of neurons and their structures is important in neurobiology. Pay special attention to structures like Schwann cells and synaptic knobs.

---

182. Diuresis is prevented by:

Choose the correct answer from the options given below:

(1) Renin from JG cell via switching off the osmoreceptors

(2) ANF from atria of the heart

(3) Aldosterone from adrenal medulla

(4) Vasopressin from Neurohypophysis

Correct Answer: (4) Vasopressin from Neurohypophysis

Solution:

The correct answer is option (4) because:

- Diuresis is prevented by **vasopressin** or anti-diuretic hormone (ADH) from the neurohypophysis or posterior pituitary. When there is excessive loss of fluid from the body, the secretion of ADH facilitates water reabsorption from the latter parts of renal tubules. This decreases urine volume. Hence, option (4) is correct.

Here's why the other options are incorrect:

- Option (1) is incorrect because **renin** from JG cells converts angiotensinogen in the blood to angiotensin I and further to angiotensin II, which is a powerful vasoconstrictor that increases glomerular blood pressure and thereby GFR (glomerular filtration rate), not directly preventing diuresis.

- Option (2) is incorrect because **ANF** (Atrial natriuretic factor) causes vasodilation, which decreases GFR and does not prevent diuresis.

- Option (3) is incorrect because **aldosterone** from the adrenal cortex causes reabsorption of Na^+ and water from distal parts of renal tubules, but it is not the primary hormone responsible for preventing diuresis.

Thus, the correct answer is option (4).

Quick Tip

Vasopressin (ADH) plays a key role in regulating the body's water balance. It acts on the kidneys to increase water reabsorption and decrease urine production.

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183. Following is the list of STDs. Select the diseases which are not completely curable.

A. Genital warts

B. Genital herpes

C Syphilis

D Hepatitis-B

E Trichomoniasis

Choose the correct answer from the options given below:

(1) A and D only

(2) B and D only

(3) A and C only

(4) D and E only

Correct Answer: (2) B and D only

Solution:

The correct answer is option (2) - B and D only, because except for hepatitis -B, genital herpes and HIV infections, other sexually transmitted diseases are completely curable, if detected early and treated properly.

- **Genital warts, syphilis, and trichomoniasis** are completely curable STDs upon proper detection and treatment.
- **Genital warts**, **syphilis**, and **trichomoniasis** are bacterial or protozoan infections that can be cured.

- **Genital herpes**, **hepatitis-B**, and other viral infections like **HIV** are not completely curable.

Option (1) is incorrect because it includes genital warts, which are curable.

Option (3) is incorrect because it includes genital warts and syphilis, both of which are curable.

Option (4) is incorrect because it includes trichomoniasis, which is also curable.

Thus, the correct answer is option (2).

Quick Tip

When studying sexually transmitted diseases, remember that viral infections (like genital herpes and hepatitis-B) cannot be completely cured, whereas bacterial and protozoan STDs (like syphilis and trichomoniasis) are treatable.

---

184. What is the correct order (old to recent) of periods in the Paleozoic era?

Choose the correct answer from the options given below:

(1) Silurian, Devonian, Permian, Carboniferous

(2) Silurian, Devonian, Carboniferous, Permian

(3) Permian, Devonian, Silurian, Carboniferous

(4) Silurian, Carboniferous, Permian, Devonian

Correct Answer: (2) Silurian, Devonian, Carboniferous, Permian

Solution:

The correct answer is option (2) because the correct order (from old to recent) of periods in the Paleozoic era is:

Silurian, Devonian, Carboniferous, Permian

- Option (1) is incorrect because **Permian** is mentioned before **Carboniferous**.
- Option (3) is incorrect because it mentions **Permian** as the oldest period of the Paleozoic era.
- Option (4) is incorrect because it mentions **Devonian** as the most recent period of the

Paleozoic era.

Thus, the correct order is **Silurian, Devonian, Carboniferous, Permian**.

Quick Tip

When learning about the geological time scale, it's important to remember the correct chronological order of the periods within each era, such as the Paleozoic era.

---

185. 'Lub' sound of Heart is caused by the .....

Choose the correct answer from the options given below:

(1) closure of the semilunar valves

(2) opening of tricuspid and bicuspid valves

(3) opening of the semilunar valves

(4) closure of the tricuspid and bicuspid valves

Correct Answer: (4) closure of the tricuspid and bicuspid valves

Solution:

The correct answer is option (4) because the **'Lub' sound** of the heart is caused by the closure of the **tricuspid and bicuspid valves** during the cardiac cycle. This sound marks the beginning of the systole phase when the ventricles contract.

- Option (1) is incorrect because the **'Dub' sound** is caused by the closure of the semilunar valves, not the 'Lub' sound.
- Option (2) is incorrect as it refers to the opening of the valves, which does not produce the 'Lub' sound.
- Option (3) is incorrect because the **opening** of the semilunar valves does not generate the 'Lub' sound.

Thus, the correct cause of the 'Lub' sound is the closure of the **tricuspid and bicuspid valves**.

Quick Tip

The heart produces two sounds, ”Lub” and ”Dub”. ”Lub” is the sound produced when the atrioventricular (AV) valves close, while ”Dub” is caused by the closure of the semilunar valves.

SECTION-B

186. Match List-I with List-II relating to human female external genitalia.

List I (Structures)	List II (Features)
A. Mons pubis	I. A fleshy fold of tissue surrounding the vaginal opening
B. Clitoris	II. Fatty cushion of cells covered by skin and hair
C. Hymen	III. Tiny finger-like structure above labia minora
D. Labia majora	IV. A thin membrane-like structure covering vaginal opening

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (1) because:

- **Mons pubis** is a cushion of fatty tissue covered by skin and pubic hair. Hence, (A) matches with (II).
- **Clitoris** is a tiny finger-like structure that lies at the upper junction of the two labia minora, just above the urethral opening. Hence, (B) matches with (III).
- **Hymen** is a thin membrane-like structure that partially covers the vaginal opening. Hence, (C) matches with (IV).

- **Labia majora** are fleshy folds of tissue which extend from the mons pubis and surround the vaginal opening. Hence, (D) matches with (I).

Thus, the correct matches are:

- A. Mons pubis – Fatty cushion of cells covered by skin and hair
- B. Clitoris – Tiny finger-like structure above labia minora
- C. Hymen – A thin membrane-like structure covering vaginal opening
- D. Labia majora – A fleshy fold of tissue surrounding the vaginal opening

Option (2), (3), and (4) are incorrect as they represent incorrect mismatches for (A), (B), (C), and (D).

Quick Tip

The human female external genitalia includes structures like the mons pubis, clitoris, hymen, and labia majora. Understanding their function and anatomy is essential in reproductive health.

---

187. Aneuploidy is a chromosomal disorder where chromosome number is not the exact copy of its haploid set of chromosomes, due to:

A. Substitution

B. Addition

C. Deletion

D. Translocation

E. Inversion

Choose the most appropriate answer from the options given below:

(1) C and D only

(2) D and E only

(3) A and B only

(4) B and C only

Correct Answer: (4) B and C only

Solution:

The correct answer is option (4) because:

- **Aneuploidy** refers to the condition where the number of chromosomes in the cell is not an exact multiple of the haploid set. This can occur due to **deletion** (C) or **addition** (B) of chromosomes.
- **Deletion** (C) is when a segment of the chromosome is lost, which can lead to a reduction in chromosome number.
- **Addition** (B) occurs when an extra chromosome is added, leading to an increase in chromosome number.

Thus, the disorders can be caused by either deletion or addition of chromosomes.

- Option (1) is incorrect because substitution and translocation (D) do not lead to aneuploidy.
- Option (2) is incorrect because translocation (D) and inversion (E) do not lead to aneuploidy.
- Option (3) is incorrect because substitution (A) does not contribute to aneuploidy.

Hence, the correct answer is option (4).

Quick Tip

Aneuploidy is caused by the gain or loss of chromosomes, leading to disorders such as Down syndrome (trisomy 21). Deletion and addition are common causes of aneuploidy.

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188. Given below are two statements:

Statement I: RNA interference takes place in all Eukaryotic organisms as a method of cellular defense.

Statement II: RNA involves the silencing of a specific mRNA due to a complementary single-stranded RNA molecule that binds and prevents translation of mRNA.

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

(1) Statement I is true but Statement II is false.

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

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Correct Answer: (1) Statement I is true but Statement II is false.

Solution:

The correct answer is option (1) because:

- **Statement I** is correct as RNA interference (RNAi) is a method of cellular defense found in all eukaryotic organisms. It plays a crucial role in regulating gene expression by silencing specific mRNA.
- **Statement II** is incorrect because RNA interference involves a complementary double-stranded RNA (dsRNA) molecule, not a single-stranded RNA, that is involved in silencing a specific mRNA. The process leads to the degradation or translation inhibition of the target mRNA.

Thus, the correct answer is that Statement I is true and Statement II is false.

Quick Tip

RNA interference (RNAi) is a critical mechanism for gene regulation and defense against viruses. It typically involves double-stranded RNA molecules that guide the silencing of specific mRNA targets.

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189. Identify the wrong statements:

(A) Erythropoietin is produced by juxtaglomerular cells of the kidney

(B) Leydig cells produce Androgens

(C) Atrial Natriuretic factor, a peptide hormone is secreted by the seminiferous tubules of the testes

(D) Cholecystokinin is produced by gastrointestinal tract

(E) Gastrin acts on intestinal wall and helps in the production of pepsinogen

Choose the most appropriate answer from the options given below:

(1) (D) and (E) only

(2) (A) and (B) only

(3) (C) and (E) only

(4) (A) and (C) only

Correct Answer: (3) (C) and (E) only

Solution:

The correct answer is option (3), because:

- **Atrial Natriuretic factor** is a peptide hormone secreted by the **atria of the heart**, not by the seminiferous tubules of the testes. Hence, (C) is incorrect.
- **Gastrin** acts on the **gastric glands** (not the intestinal wall) and stimulates the secretion of hydrochloric acid and pepsinogen. Hence, (E) is incorrect.
- **Erythropoietin** is indeed produced by the **juxtaglomerular cells** of the kidney (A) is correct.
- **Leydig cells** do produce **androgens**, particularly testosterone (B) is correct.
- **Cholecystokinin** is indeed produced by the gastrointestinal tract (D) is correct.

Thus, (A), (B), and (D) are correct statements, while (C) and (E) are incorrect.

Option (1), (2), and (4) are incorrect because they have one or more incorrect statements.

Quick Tip

When studying hormones and their functions, it is important to remember the correct glands that secrete them. For example, Atrial Natriuretic factor is secreted by the heart, not the testes.

---

190. Following are the steps involved in the process of PCR.

A. Annealing

B. Amplification (1 billion times)

C. Denaturation

D. Treatment with Taq polymerase and deoxynucleotides

E. Extension

Choose the correct sequence of steps of PCR from the options given below:

(1) C $\rightarrow$ A $\rightarrow$ D $\rightarrow$ E $\rightarrow$ B

(2) A $\rightarrow$ B $\rightarrow$ E $\rightarrow$ D $\rightarrow$ C

(3) A $\rightarrow$ C $\rightarrow$ E $\rightarrow$ D $\rightarrow$ B

(4) D $\rightarrow$ B $\rightarrow$ E $\rightarrow$ C $\rightarrow$ A

Correct Answer: (1) C → A → D → E → B

Solution: The correct answer is option (1) because the correct sequence of steps involved in the process of PCR is:

- **C. Denaturation** – This is the first step where the double-stranded DNA is heated to separate the strands.
- **A. Annealing** – In this step, the temperature is lowered to allow primers to bind to the single-stranded DNA.
- **D. Treatment with Taq polymerase and deoxynucleotides** – Taq polymerase is added to extend the primers by adding nucleotides.
- **E. Extension** – The DNA strands are extended as Taq polymerase synthesizes the complementary strand.
- **B. Amplification (1 billion times)** – This is the final result where the DNA is amplified exponentially after multiple cycles.

Thus, the correct sequence is C → A → D → E → B.
Option (2), (3), and (4) are incorrect as they represent incorrect sequences of the PCR steps.

Quick Tip

PCR (Polymerase Chain Reaction) involves key steps: denaturation, annealing, extension, and amplification. It is important to follow the correct sequence to ensure efficient amplification of DNA.

---

191. Given below are two statements:

Statement I: Concentrated urine is formed due to counter current mechanism in nephron.
Statement II: Counter current mechanism helps to maintain osmotic gradient in the medullary interstitium.
In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement I is correct but Statement II is incorrect.

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

(3) Both Statement I and Statement II are correct.

(4) Both Statement I and Statement II are incorrect.

Correct Answer: (3) Both Statement I and Statement II are correct.

Solution:

The correct answer is option (3) because:

- **Statement I** is correct. Concentrated urine is formed due to the countercurrent mechanism in the nephron, especially through the countercurrent flow in the two limbs of Henle's loop and the vasa recta.

- **Statement II** is correct. The countercurrent mechanism helps in maintaining the osmotic gradient in the medullary interstitium. It allows the renal system to concentrate urine, maintaining the osmotic gradient from 300 mOsmol L^{-1} in the cortex to about 1200 mOsmol L^{-1} in the inner medulla.

Thus, both statements are correct.

Quick Tip

The countercurrent mechanism in the nephron, particularly in Henle's loop and vasa recta, plays a crucial role in the formation of concentrated urine by creating and maintaining an osmotic gradient.

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192. Given below are two statements:

Statement I: Concentrically arranged cisternae of Golgi complex are arranged near the nucleus with distinct convex *cis* or maturing and concave *trans* or forming face.

Statement II: A number of proteins are modified in the cisternae of Golgi complex before they are released from *cis* face.

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

(1) Statement I is true but Statement II is false.

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

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

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

Solution:

The correct answer is option (4) because:

- **Statement I** is false because the Golgi cisternae are concentrically arranged near the nucleus, but the *cis* or forming face is concave, and the *trans* or maturing face is convex. So, this statement misrepresents the arrangement.
- **Statement II** is false because proteins synthesized by ribosomes on the endoplasmic reticulum are modified in the *trans* face of the Golgi complex, not the *cis* face, before they are released.

Thus, both statements are incorrect.

Quick Tip

The Golgi complex plays a crucial role in modifying, sorting, and packaging proteins. The *cis* face of the Golgi complex is the receiving side, while the *trans* face is the shipping side.

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193. Match List-I with List-II:

List I	List II
A. Parturition	I. Several antibodies for new-born babies
B. Placenta	II. Collection of ovum after ovulation
C. Colostrum	III. Foetal ejection reflex
D. Fimbriae	IV. Secretion of the hormone hCG

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (1) because:

- **Parturition** is induced by a complex neuroendocrine mechanism. The signals for parturition originate from the fully developed foetus and the placenta, which induce mild uterine contractions, called the **foetal ejection reflex**. Hence, (A) matches with (III).
- **Placenta** acts as an endocrine tissue and produces several hormones like **hCG, hPL, estrogens, progesterones**, etc. Hence, (B) matches with (IV).
- **Colostrum** is the milk produced during the initial few days of lactation and contains several **antibodies** that help new-born babies develop immunity. Hence, (C) matches with (I).
- **Fimbriae** help in the collection of the **ovum after ovulation**. Hence, (D) matches with (II).

Thus, the correct matches are:

- A. Parturition – Foetal ejection reflex
- B. Placenta – Secretion of the hormone hCG
- C. Colostrum – Several antibodies for new-born babies
- D. Fimbriae – Collection of ovum after ovulation

Option (2), (3), and (4) are incorrect as they represent incorrect matches.

Quick Tip

The process of parturition is closely regulated by hormones produced by both the foetus and placenta. Colostrum is essential for providing immunity to the newborn in the early stages of life.

---

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

Assertion A: Members of subphylum Vertebrata possess notochord during the embryonic period. The notochord is replaced by a cartilaginous or bony vertebral column in the adult.

Reason R: Thus all chordates are vertebrates; not all vertebrates are chordates.

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

(1) A is true but R is false.

(2) A is false but R is true.

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

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

Correct Answer: (1) A is true but R is false.

Solution:

The correct answer is option (1) because:

- **Assertion A** is true. Members of subphylum Vertebrata possess a notochord during the embryonic period, and in the adult, this notochord is replaced by a cartilaginous or bony vertebral column.

- **Reason R** is false. While it is true that all vertebrates are chordates, the statement that "not all vertebrates are chordates" is incorrect. In fact, all vertebrates are a subgroup of chordates.

Thus, Assertion A is true, but Reason R is false.

Quick Tip

Remember that all vertebrates are chordates, but not all chordates are vertebrates. This distinction is crucial when studying the subphyla of Phylum Chordata.

---

195. The mother has A+ blood group the father has B+ and the child is A+. What can be the possibility of genotypes of all three, respectively?

(A) $I^AI^A|I^Bi|I^Ai$

(B) $I^AI^A|I^Bi|I^AI^A$

(C) $I^Bi|I^AI^A|I^AI^B$

(D) $I^AI^A|I^B|I^Ai$

(E) $I^Ai|I^Bi|I^Ai$

Choose the correct answer from the option given below:

(1) C and D

(2) D and A

(3) A and B

(4) B and E

Correct Answer: (4) B and E

Solution:

The child's blood group is A+, which means the child must have inherited the I^A allele from the mother and i allele from the father, since the blood group is A and Rh positive (A+). The positive Rh factor does not affect the determination of the ABO blood group but indicates the presence of the Rh factor allele, which is inherited separately.

Now, let's examine the possible genotypes:

- The mother has blood group A+, which means she must have either the I^AI^A or I^Ai genotype. This is because, for the child to have blood group A, the mother must contribute an I^A allele. The Rh+ factor means she could have inherited either the Rh+ allele or have a heterozygous Rh+ phenotype.

- The father has blood group B+, which indicates he must have the I^Bi genotype (since he has blood type B, the second allele can either be I^B or i, but he can only contribute I^B to the child). The Rh+ factor indicates that the father must either be homozygous or heterozygous for the Rh factor, but this doesn't affect the ABO system.

- The child has blood type A+, so they must have inherited an I^A allele from the mother and an i allele from the father. Therefore, the child's genotype must be I^Ai.

So, the possible genotypes for the three individuals would be:

- (B) $I^AI^A|I^Bi|I^Ai$ — The mother could be homozygous for A, the father could be heterozygous for B and Rh+, and the child could be A+.

- (E) $I^Ai|I^Bi|I^Ai$ — The mother could be heterozygous for A, the father could be heterozygous for B, and the child could be A+.

Thus, the correct answer is option (4), as these are the only two possible genotypes that match the conditions described.

Quick Tip

When determining blood type inheritance, consider both alleles contributed by each parent. In this case, the positive blood type indicates the presence of the Rh factor, while the ABO system determines the blood group.

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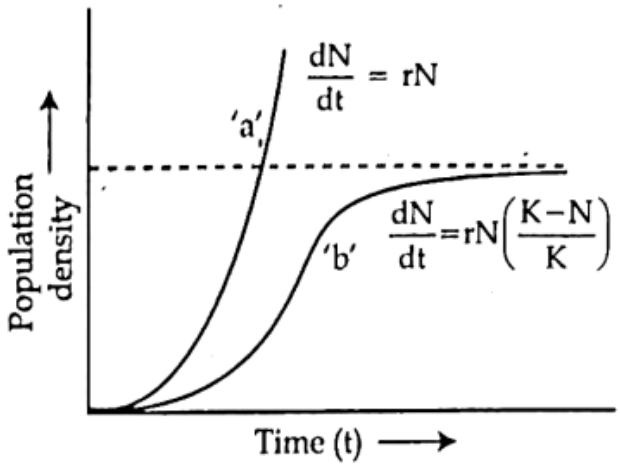
196. What do 'a' and 'b' represent in the following population growth curve?



Choose the correct answer from the options given below:

(1) 'a' represents exponential growth when responses are not limiting the growth; and 'b' represents logistic growth when responses are limiting the growth.

(2) 'a' represents logistic growth when responses are not limiting the growth; 'b' represents exponential growth when responses are limiting the growth.

(3) 'a' represents carrying capacity and 'b' shows logistic growth when responses are limiting the growth.

(4) 'a' represents exponential growth when responses are not limiting the growth and 'b' shows carrying capacity.

Correct Answer: (1) 'a' represents exponential growth when responses are not limiting the growth; and 'b' represents logistic growth when responses are limiting the growth.

Solution:

The given graph represents the population growth curve where:

- **'a' represents exponential growth** when responses are not limiting the growth.
Exponential growth is characterized by a J-shaped curve where the population grows rapidly without any restrictions, meaning that resources are not limiting.
- **'b' represents logistic growth** when responses are limiting the growth. Logistic growth forms an S-shaped curve as the population size increases, eventually reaching a carrying capacity K, where growth slows down due to limited resources.
Thus, option (1) is the correct answer, as it correctly describes the characteristics of exponential and logistic growth.

Quick Tip

Exponential growth occurs when a population grows without limits, whereas logistic growth occurs when environmental factors like resources or space start to limit growth, leading to stabilization at the carrying capacity.

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197. Select the correct statements regarding mechanism of muscle contraction.

A. It is initiated by a signal sent by CNS via sensory neuron.

B. Neurotransmitter generates action potential in the sarcolemma.

C. Increased Ca++ level leads to the binding of calcium with troponin on action filaments.

D. Masking of active site for actin is activated.

E. Utilising the energy from ATP hydrolysis to form cross bridge.

Choose the most appropriate answer from the options given below:

(1) B, C and E only

(2) C, D and E only

(3) A and D only

(4) B, D and E only

Correct Answer: (1) B, C and E only

Solution:

The correct answer is option (1) because muscle contraction is initiated by a signal sent by the CNS via a motor neuron. Here's the step-by-step breakdown of the process:

- **B** is correct. A neural signal reaches the neuromuscular junction and releases the neurotransmitter acetylcholine, which generates an action potential in the sarcolemma (muscle cell membrane).
- **C** is correct. The action potential spreads through the muscle fibre and causes the release of Ca^{2+} into the sarcoplasm. This increase in Ca^{2+} level leads to the binding of calcium with troponin on the actin filaments, which exposes the active sites on actin.
- **E** is correct. ATP hydrolysis provides the energy required for the myosin head to bind to the exposed active sites on actin and form a cross bridge, which is essential for muscle contraction.

Thus, the correct statements are B, C, and E.

- **A** is incorrect. The CNS sends a signal via a motor neuron, not a sensory neuron.
- **D** is incorrect. The process of masking and unmasking active sites is part of the mechanism where calcium binding to troponin activates the active sites, but it's not described as "masking" during the activation phase.

Quick Tip

Understanding the role of calcium in muscle contraction is crucial. Calcium binds to troponin to expose the active sites on actin, allowing myosin to form cross bridges and facilitate contraction.

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198. Match List I with List II:

List - I	**List - II**
A. Squamous Epithelium	I. Goblet cells of alimentary canal
B. Ciliated Epithelium	II. Inner lining of pancreatic ducts
C. Glandular Epithelium	III. Walls of blood vessels
D. Compound Epithelium	IV. Inner surface of Fallopian tubes

Choose the correct answer from the options given below:

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

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

(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:

The correct answer is option (4) because:

- **Squamous Epithelium (A)** is involved in functions like forming a diffusion boundary and is found in the walls of blood vessels, hence (A) matches with (III).
- **Ciliated Epithelium (B)** moves particles in a specific direction over the epithelium and is present in the inner surface of Fallopian tubes, hence (B) matches with (IV).
- **Glandular Epithelium (C)** consists of unicellular glands such as goblet cells in the alimentary canal, hence (C) matches with (I).
- **Compound Epithelium (D)** is made up of more than one layer of cells and is found in the inner lining of pancreatic ducts, hence (D) matches with (II).

Thus, the correct matches are:

- A. Squamous Epithelium – Walls of blood vessels
- B. Ciliated Epithelium – Inner surface of Fallopian tubes
- C. Glandular Epithelium – Goblet cells of alimentary canal
- D. Compound Epithelium – Inner lining of pancreatic ducts

Option (1), (2), and (3) are incorrect because they misplace some of the correct matches.

Quick Tip

When studying different types of epithelium, it's essential to focus on their structure and specific functions in various body systems. For example, ciliated epithelium helps move particles, while glandular epithelium produces and secretes substances like mucus.

199. Match List I with List II:

List - I	List - II
A. B-Lymphocytes	I. Passive immunity
B. Interferons	II. Cell-mediated immunity
C. T-Lymphocytes	III. Produce an army of proteins in response to pathogens
D. Colostrum	IV. Innate immunity

Choose the correct answer from the options given below:

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

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

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

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

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

Solution:

The correct answer is option (3) because:

- **B-Lymphocytes (A)** produce an army of proteins in response to pathogens into our blood to fight with them. These proteins are called antibodies. Thus, (A) matches with (III).
- **Interferons (B)** belong to the cytokine barrier of innate immunity, which protects non-infected cells from further viral infection. Thus, (B) matches with (IV).
- **T-Lymphocytes (C)** mediate cell-mediated immunity by directly attacking infected cells. Thus, (C) matches with (II).
- **Colostrum (D)** provides natural passive immunity to the infant as it contains antibodies that protect the newborn from infections. Thus, (D) matches with (I).

Therefore, the correct matches are:

- A. B-Lymphocytes – Produce an army of proteins in response to pathogens
- B. Interferons – Innate immunity
- C. T-Lymphocytes – Cell-mediated immunity
- D. Colostrum – Passive immunity

Option (1), (2), and (4) are incorrect because they misplace some of the correct matches.

Quick Tip

Understanding the immune system's components and their functions is key. B-lymphocytes produce antibodies, T-lymphocytes mediate cell-mediated immunity, interferons are part of innate immunity, and colostrum provides passive immunity to newborns.

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

Assertion A: During the transportation of gases, about 20-25 percent of CO_2 is carried by Hemoglobin as carbamino-haemoglobin.

Reason R: This binding is related to high pCO_2 and low pO_2 in tissues.

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

(1) A is true but R is false.

(2) A is false but R is true.

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

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

Correct Answer: (3) Both A and R are true and R is the correct explanation of A.

Solution: The correct answer is option (3) because:

- **Assertion A** is true. During the transportation of CO_2, nearly 20-25 percent is transported by RBCs as carbamino-haemoglobin. About 70 percent of CO_2 is carried as bicarbonate, and the remaining 7 percent is carried in a dissolved state through plasma. - **Reason R** is true. The binding of CO_2 with hemoglobin is related to the partial pressure of CO_2. In tissues, where the partial pressure of CO_2 is high and the partial pressure of oxygen (pO_2) is low, more CO_2 binds with hemoglobin to form carbamino-haemoglobin.

Thus, both A and R are true, and R provides the correct explanation for A, as it describes how the binding of CO_2 to hemoglobin is influenced by the partial pressures of CO_2 and O_2 in tissues.

Quick Tip

The binding of CO_2 to hemoglobin helps in the efficient transport of gases. This process is influenced by the partial pressures of CO_2 and O_2 in different tissues and is a key aspect of respiratory physiology.
