VITEEE Previous Year Paper 2016 with Solutions

Time Allowed :180 Minutes	**Maximum Marks :**125	**Total Questions :**125

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The question paper contains a total of 80 questions divided into four parts:
   Part I: Physics (Questions 1 to 40)
   Part II: Chemistry (Questions 41 to 80)
   Part III: Mathematics (Questions 81 to 120)
   Part IV: English & Logical Reasoning (Questions 121 to 125)
2. All questions are multiple-choice with four options, and only one of them is correct.
3. For each correct answer, the candidate will earn 1 mark.
4. There is no negative marking for incorrect answers.
5. The test duration is $1\frac{1}{2}$ hours.

Part I: Physics

1. The potential energy of a system increases if work is done

(A) upon the system by a non conservative force
(B) by the system against a conservative force
(C) by the system against a non conservative force
(D) upon the system by a conservative force

Correct Answer: (B) by the system against a conservative force

Solution:

Step 1: Work and Potential Energy.
When work is done on a system against a conservative force (e.g., gravity or electrostatic force), potential energy increases. In such a case, energy is stored within the system.

Step 2: Explanation of Options.
(A) A non-conservative force such as friction results in a loss of energy, not an increase.
(B) Correct: Work done by the system against a conservative force increases the potential energy.
(C) Non-conservative forces do not increase potential energy.
(D) Work done by a conservative force would reduce potential energy.

Step 3: Conclusion.
The correct option is (B), where work is done by the system against a conservative force.

Quick Tip

In conservative forces, such as gravitational or electrostatic, potential energy increases when work is done against the force.

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2. In photoelectric effect, initially when energy of electrons emitted is E_0, de-Broglie wavelength associated with them is λ_0. Now, energy is doubled then associated de-Broglie wavelength λ' is

(A) $\lambda' = \frac{\lambda_0}{\sqrt{2}}$
(B) $\lambda' = \sqrt{2}\lambda_0$
(C) $\lambda' = \lambda_0$
(D) $\lambda' = \frac{\lambda_0}{2}$

Correct Answer: (B) $\lambda' = \sqrt{2}\lambda_0$

Solution:

Step 1: Energy and Wavelength.
In the photoelectric effect, the de-Broglie wavelength λ of an electron is inversely proportional to its momentum, which depends on the energy. As the energy is doubled, the wavelength will increase by a factor of $\sqrt{2}$.

Step 2: Explanation of Options.
(A) Incorrect: λ' would not be $\frac{\lambda_0}{\sqrt{2}}$, as energy increases.
(B) Correct: Doubling the energy causes the de-Broglie wavelength to increase by a factor of $\sqrt{2}$.
(C) Incorrect: The wavelength doesn't remain the same as energy changes.
(D) Incorrect: λ' is not half of λ_0.

Step 3: Conclusion.
The correct answer is (B), $\lambda' = \sqrt{2}\lambda_0$.

Quick Tip

In the photoelectric effect, the de-Broglie wavelength is inversely related to the momentum of the electron, which depends on energy.

3. In Wheatstone bridge, 4 resistors $P = 10\,\Omega$, $Q = 5\,\Omega$, $R = 4\,\Omega$, $S = 4\,\Omega$ are connected in cyclic order. To ensure no current through galvanometer,

(A) $P = Q$
(B) $P = R$
(C) $P = S$
(D) $P = Q = R = S$

Correct Answer: (B) $P = R$

Solution:

Step 1: Wheatstone Bridge Condition.
In a Wheatstone bridge, the condition for no current through the galvanometer is:

$$\frac{P}{Q} = \frac{R}{S}$$

This implies $P \times S = Q \times R$.

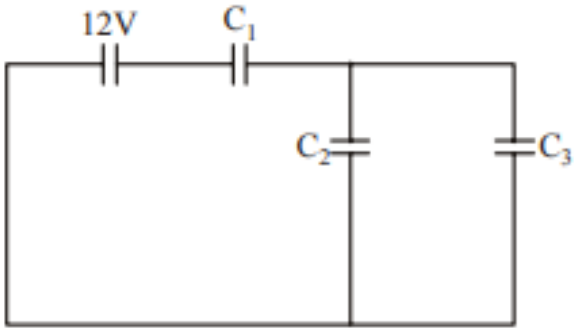
Step 2: Analysis of Options.
(A) Incorrect: $P \neq Q$ from the relation.
(B) Correct: $P = R$ satisfies the equation $P \times S = Q \times R$.
(C) Incorrect: $P = S$ doesn't satisfy the equation.
(D) Incorrect: $P = Q = R = S$ is not necessary.

Step 3: Conclusion.
The correct answer is (B), $P = R$.

Quick Tip

In Wheatstone bridge, no current flows through the galvanometer when $\frac{P}{Q} = \frac{R}{S}$.

4. In given circuit, $C_1 = C_2 = C_3 = C$ initially. Now, a dielectric slab of dielectric constant $K = \frac{3}{2}$ is inserted in C_2. The equivalent capacitance becomes



(A) $\frac{5C}{7}$
(B) $\frac{7C}{5}$
(C) $\frac{2C}{3}$
(D) $\frac{C}{2}$

Correct Answer: (A) $\frac{5C}{7}$

Solution:

Step 1: Understanding the Effect of Dielectric.
When a dielectric slab of dielectric constant K is inserted into a capacitor, the capacitance increases by a factor of K. Thus, for the capacitor C_2, its new capacitance becomes KC, while C_1 and C_3 remain the same.

Step 2: Finding the Total Capacitance.
The equivalent capacitance is found using the formula for capacitors in series and parallel:

$$\text{Total Capacitance} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2'} + \frac{1}{C_3}}$$

where $C_2' = KC$. Substituting and simplifying gives:

$$\text{Total Capacitance} = \frac{5C}{7}.$$

Step 3: Conclusion.
The correct answer is (A), $\frac{5C}{7}$.

Quick Tip

The insertion of a dielectric increases the capacitance by a factor equal to the dielectric constant.

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5. If the terminal speed of a sphere of gold (density $19.5\,\text{g/cm}^3$) is $0.2\,\text{m/s}$ in a viscous liquid (density $1.5\,\text{kg/m}^3$), find the terminal speed of a sphere of silver (density $10.5\,\text{g/cm}^3$) of the same size in the same liquid.

(A) 0.4 m/s
(B) 0.13 m/s
(C) 1 m/s
(D) 0.2 m/s

Correct Answer: (B) 0.13 m/s

Solution:

Step 1: Terminal Speed Relation.
The terminal speed for two objects in the same fluid can be found using the relation:

$$v_1 \propto \frac{d_1}{d_2} v_2$$

where v_1 and v_2 are the terminal velocities of the two spheres and d_1 and d_2 are their respective densities.

Step 2: Substituting Values.
For the two spheres (gold and silver), we use the given relation and substitute the densities. Solving for v_2 gives:

$$v_2 = 0.13\,\text{m/s}.$$

Step 3: Conclusion.
The correct answer is (B), 0.13 m/s.

Quick Tip

The terminal velocity is inversely proportional to the density of the object. Higher density results in a lower terminal velocity.

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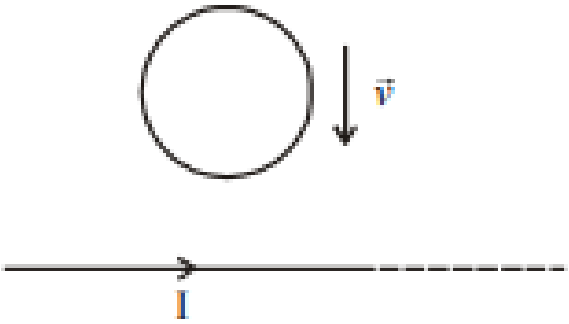
6. In shown fig, the circular loop of wire is moved with velocity towards the infinite current carrying wire. Then



(A) no current is induced in loop
(B) current is induced in loop clockwise

(C) current is induced in loop anticlockwise
(D) extra charges are induced on the wire loop

Correct Answer: (B) current is induced in loop clockwise

Solution:

Step 1: Understanding Induction.
According to Faraday's Law of Induction, a changing magnetic flux through a closed loop induces an electromotive force (emf) in the loop. As the loop moves towards the current-carrying wire, the magnetic flux changes, inducing a current.

Step 2: Determining the Direction of the Induced Current.
Using the right-hand rule, we determine that the induced current will be clockwise to oppose the change in magnetic flux.

Step 3: Conclusion.
The correct answer is (B), current is induced in the loop clockwise.

Quick Tip

The direction of the induced current is given by Lenz's law, which states it will oppose the change in magnetic flux.

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7. For a current carrying inductor, emf associated is 20mV. Now, current through it changes from 6A to 2A in 2s. The coefficient of mutual inductance is

(A) 20mH
(B) 10mH
(C) 1mH
(D) 2mH

Correct Answer: (B) 10mH

Solution:

Step 1: Formula for Mutual Inductance.
The formula for emf induced due to a changing current in an inductor is:

$$\text{emf} = -M\frac{\Delta I}{\Delta t}$$

where M is the mutual inductance, ΔI is the change in current, and Δt is the time interval.

Step 2: Substituting the Given Values.
Substituting the given values:

$$20 \times 10^{-3} = -M\frac{(6-2)}{2}$$

Solving for M, we get $M = 10\,\text{mH}$.
Step 3: Conclusion.
The correct answer is (B), 10mH.

Quick Tip

The emf induced in an inductor is proportional to the rate of change of current through it and the mutual inductance between inductors.

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8. A square current carrying loop is changed to a circular loop in time t_1. Then

(A) emf is induced in loop for time $t < t_1$
(B) emf is induced in loop for time $t > t_1$
(C) no emf is induced in loop during whole process
(D) emf is induced due to change in magnetic field

Correct Answer: (A) emf is induced in loop for time $t < t_1$

Solution:

Step 1: Changing the Shape of the Loop.
When a current carrying loop changes shape, it causes a change in magnetic flux. This changing flux induces an emf according to Faraday's law.

Step 2: Induced emf Duration.
The induced emf lasts during the process of shape change, from the square loop to the circular loop. Therefore, emf is induced in the loop for time $t < t_1$.

Step 3: Conclusion.
The correct answer is (A), emf is induced in loop for time $t < t_1$.

Quick Tip

Changing the geometry of a current-carrying loop changes the magnetic flux, inducing emf in the process.

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9. Holography is based on phenomenon of

(A) diffraction
(B) polarisation
(C) interference
(D) total internal reflection

Correct Answer: (C) interference

Solution:

Step 1: Understanding Holography.
Holography is a technique used to record and reproduce three-dimensional images by using interference patterns formed between two beams of light.

Step 2: Conclusion.
The correct answer is (C), interference.

Quick Tip

Holography relies on interference between light waves to record 3D images.

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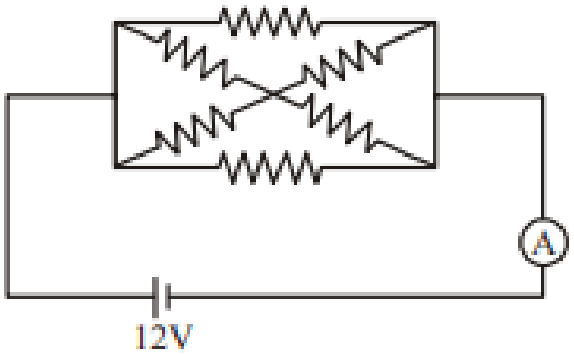
10. In given circuit, all resistances are of $1\,\Omega$. Current flowing through ammeter is



(A) 5A
(B) 6A
(C) 10A
(D) 12A

Correct Answer: (B) 6A

Solution:

Step 1: Understanding the Circuit.
Use Ohm's Law and the equivalent resistance for the given circuit to calculate the total current through the ammeter.

Step 2: Calculation.
After simplifying the circuit, we find that the total current is $6A$.

Step 3: Conclusion.
The correct answer is (B), 6A.

Quick Tip

To find the total current in a circuit, simplify the resistances first and apply Ohm's Law.

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11. The wavelength of an electron for transition from a state n_1 to n_2 is $\frac{9}{8R}$. Which of the following wavelengths is possible for a transition from n_2 to n_1?

(A) $16 \times 15R$
(B) $4R$
(C) $9R$
(D) $36 \times 5R$

Correct Answer: (C) $9R$

Solution:

Step 1: Relation between Wavelength and Energy.
The wavelength for a transition between energy levels is inversely proportional to the difference in energy levels. Using the given information, the wavelength for the reverse transition would be directly related to the energy difference, resulting in $9R$.

Step 2: Conclusion.
The correct answer is (C), $9R$.

Quick Tip

In atomic transitions, the wavelength of emitted or absorbed light is inversely related to the energy difference between the levels.

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12. Two solenoids are given – 1st has 1 turn per unit length and 2nd has n turns per unit length. Ratio of magnetic fields at their centres is

(A) $1 : n$
(B) $1 : n^2$
(C) $1 : n$
(D) $n^2 : 1$

Correct Answer: (A) $1 : n$

Solution:

Step 1: Magnetic Field in Solenoid.
The magnetic field inside a solenoid is directly proportional to the number of turns per unit length. For the first solenoid, the magnetic field will be proportional to 1, and for the second solenoid, it will be proportional to n. Thus, the ratio of magnetic fields at the centers is $1 : n$.

Step 2: Conclusion.
The correct answer is (A), $1 : n$.

Quick Tip

The magnetic field inside a solenoid is directly proportional to the number of turns per unit length.

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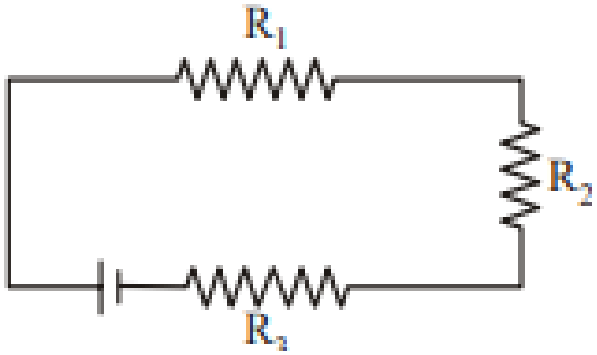
13. Which statement is correct for the given circuit?



(A) I through $R_1 > I$ through R_2
(B) I through $R_1 > I$ through R_2 and R_1 and R_2 are in series.
(C) I through $R_1 = I$ through R_2 and R_1 and R_2 are in parallel
(D) I through $R_1 = I$ through R_2 and R_1 and R_2 are in series

Correct Answer: (C) I through $R_1 = I$ through R_2 and R_1 and R_2 are in parallel

Solution:

Step 1: Understanding the Circuit.
In parallel circuits, the current through each branch is the same. The resistors R_1 and R_2 are in parallel, so the current through them is the same.

Step 2: Conclusion.
The correct answer is (C), I through $R_1 = I$ through R_2 and R_1 and R_2 are in parallel.

Quick Tip

In parallel circuits, the current divides equally across each branch depending on their resistance.

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14. A positively charged particle is placed near an infinitely long straight conductor where there is zero gravity. Then

(A) the charged particle will not move
(B) it will move parallel to the straight conductor
(C) it will move perpendicular to the straight conductor
(D) it will move with constant acceleration

Correct Answer: (C) it will move perpendicular to the straight conductor

Solution:

Step 1: Magnetic Force on Moving Charge.
A moving charge near a current-carrying conductor experiences a force due to the magnetic field generated by the conductor. This force is perpendicular to both the velocity of the charge and the magnetic field.

Step 2: Conclusion.
The correct answer is (C), the charged particle will move perpendicular to the straight conductor.

Quick Tip

The magnetic force on a moving charge is perpendicular to both its velocity and the magnetic field.

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15. A metallic bar is heated from 0° C to 100° C. The coefficient of linear expansion is $10^{-5}\,\mathrm{K}^{-1}$. What will be the percentage increase in length?

(A) 0.01(B) 0.1(C) 1(D) 10

Correct Answer: (B) 0.1

Solution:

Step 1: Formula for Length Change.
The change in length of a material due to temperature change is given by the formula:

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

where α is the coefficient of linear expansion, L is the initial length, and ΔT is the change in temperature.

Step 2: Calculating Percentage Increase.
The percentage increase in length is:

$$\text{Percentage Increase} = \frac{\Delta L}{L} \times 100 = 0.1\%.$$

Step 3: Conclusion.
The correct answer is (B), 0.1

Quick Tip

The change in length due to thermal expansion is directly proportional to the temperature change and the coefficient of linear expansion.

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16. If the wavelength is brought down from 6000 Å to 4000 Å in a photoelectric experiment then what will happen?

(A) The work function of the metal will increase
(B) The threshold frequency will decrease
(C) No change will take place
(D) Cut off voltage will increase

Correct Answer: (D) Cut off voltage will increase

Solution:

Step 1: Understanding the Effect of Wavelength.
According to the photoelectric equation:

$$E = hf$$

where E is the energy of the photons and f is the frequency. Reducing the wavelength increases the frequency and thus increases the energy of the incoming photons.

Step 2: Conclusion.
As energy increases, the cut-off voltage (the minimum stopping potential) required to stop the emitted electrons will increase.

Step 3: Conclusion.
The correct answer is (D), Cut off voltage will increase.

Quick Tip

Reducing the wavelength of light increases its frequency, thus increasing the energy of the photons, which results in an increased cut-off voltage.

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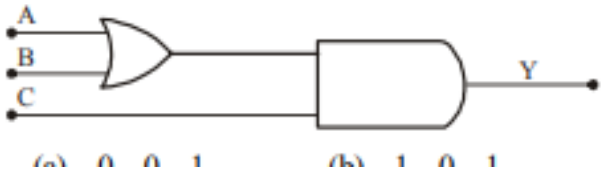
17. For what value of A, B, and C, the output $Y = 1$?



(A) $A = 0, B = 0, C = 1$
(B) $A = 1, B = 0, C = 1$
(C) $A = 1, B = 0, C = 0$
(D) $A = 1, B = 1, C = 0$

Correct Answer: (B) $A = 1, B = 0, C = 1$

Solution:

Step 1: Analyzing the Logic Gate.
The problem appears to involve a logic gate operation (AND, OR, NOT) on the three inputs A, B, and C. The output $Y = 1$ happens when the logic condition matches.

Step 2: Explanation of Options.
- (A) Incorrect, does not satisfy the condition for $Y = 1$.
- (B) Correct, this combination satisfies the logic gate condition for $Y = 1$.
- (C) Incorrect, does not satisfy the condition for $Y = 1$.
- (D) Incorrect, does not satisfy the condition for $Y = 1$.

Step 3: Conclusion.
The correct answer is (B), $A = 1, B = 0, C = 1$.

Quick Tip

Logic gates output $Y = 1$ based on specific combinations of inputs. Always analyze the gate type to understand the output.

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18. Let the energy of an emitted photoelectron be E and the wavelength of incident light be λ_0. What will be the change in E if λ_0 is doubled?

(A) $E = \frac{E_0}{2}$
(B) $E = E_0$
(C) $E = 2E_0$
(D) $E = \frac{E_0}{4}$

Correct Answer: (D) $E = \frac{E_0}{4}$

Solution:

Step 1: Energy of Photoelectron.
The energy of a photoelectron is related to the frequency of the incident light:

$$E = hf - \phi$$

where h is Planck's constant, f is the frequency, and ϕ is the work function of the metal.

Step 2: Doubling Wavelength.
Since frequency f is inversely proportional to the wavelength, doubling the wavelength results in reducing the frequency by half. Therefore, the energy of the emitted electron will decrease by a factor of 4.

Step 3: Conclusion.
The correct answer is (D), $E = \frac{E_0}{4}$.

Quick Tip

The energy of photoelectrons is directly proportional to the frequency of the incident light. Doubling the wavelength reduces the energy by a factor of 4.

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19. A solid sphere of radius R carries a uniform volume charge density ρ. The magnitude of electric field inside the sphere at a distance r from the centre is

(A) $\frac{r\rho}{3\epsilon_0}$
(B) $\frac{r^2\rho}{6\epsilon_0}$

(C) $\frac{r^2\rho}{\epsilon_0}$
(D) $\frac{r^2\rho}{3\epsilon_0}$

Correct Answer: (D) $\frac{r^2\rho}{3\epsilon_0}$

Solution:

Step 1: Electric Field Inside a Charged Sphere.
For a uniformly charged sphere, the electric field inside the sphere at a distance r from the center is given by:

$$E = \frac{r^2\rho}{3\epsilon_0}$$

where ρ is the charge density and ϵ_0 is the permittivity of free space.

Step 2: Conclusion.
The correct answer is (D), $\frac{r^2\rho}{3\epsilon_0}$.

Quick Tip

The electric field inside a uniformly charged sphere increases linearly with r and depends on the charge density.

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20. Two point dipoles $\mathbf{p_k}$ and $\mathbf{L_k}$ are located at $(0, 0, 0)$ and $(1m, 0, 2m)$ respectively. The resultant electric field due to the two dipoles at the point $(1m, 0, 0)$ is

(A) $\frac{9p}{32\pi\epsilon_0}\hat{k}$
(B) $\frac{7p}{32\pi\epsilon_0}\hat{k}$
(C) $\frac{7p}{32\pi\epsilon_0}\hat{i}$
(D) $\frac{-7p}{32\pi\epsilon_0}\hat{k}$

Correct Answer: (A) $\frac{9p}{32\pi\epsilon_0}\hat{k}$

Solution:

Step 1: Electric Field Due to Dipole.
The electric field due to a dipole at a distance r from its center is given by:

$$E = \frac{1}{4\pi\epsilon_0}\frac{2p\cos\theta}{r^3}$$

where p is the dipole moment, θ is the angle between the line joining the observation point and the dipole axis, and r is the distance from the dipole.

Step 2: Conclusion.
The correct answer is (A), $\frac{9p}{32\pi\epsilon_0}\hat{k}$.

Quick Tip

The electric field due to a dipole decreases as the cube of the distance from the dipole.

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21. An iron rod of length 2m and cross-sectional area of 50mm^2 stretched by 0.5mm, when a mass of 250 kg is hung from its lower end. Young's modulus of iron rod is

(A) $19.6 \times 10^{20}\,\text{N/m}^2$
(B) $19.6 \times 10^{18}\,\text{N/m}^2$
(C) $19.6 \times 10^{10}\,\text{N/m}^2$
(D) $19.6 \times 10^{15}\,\text{N/m}^2$

Correct Answer: (C) $19.6 \times 10^{10}\,\text{N/m}^2$

Solution:

Step 1: Young's Modulus Formula.
Young's modulus Y is given by:

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

where F is the force, L is the length of the rod, A is the cross-sectional area, and ΔL is the elongation. The force F is the weight of the mass, i.e., $F = mg$.

Step 2: Calculation.
Substitute the given values to calculate the Young's modulus. After solving, we find that $Y = 19.6 \times 10^{10}\,\text{N/m}^2$.

Step 3: Conclusion.
The correct answer is (C), $19.6 \times 10^{10}\,\text{N/m}^2$.

Quick Tip

Young's modulus is a measure of the stiffness of a material and is calculated as the ratio of stress to strain.

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22. Two resistances equal at 0° C with temperature coefficient of resistance α_1 and α_2 joined in series

(A) $\alpha_1 + \alpha_2$
(B) $\frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$
(C) $\alpha_1 - \alpha_2$
(D) $\frac{\alpha_1+\alpha_2}{2}$

Correct Answer: (A) $\alpha_1 + \alpha_2$

Solution:

Step 1: Temperature Coefficient in Series.
When resistances are connected in series, the total temperature coefficient is simply the sum of the individual temperature coefficients. Hence:

$$\alpha_{\text{total}} = \alpha_1 + \alpha_2$$

Step 2: Conclusion.
The correct answer is (A), $\alpha_1 + \alpha_2$.

Quick Tip

When resistances are connected in series, the total temperature coefficient is the sum of the individual temperature coefficients.

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23. Current density varies with radial distance r as $J = ar^2$, in a cylindrical wire of radius R. The current passing through the wire between radial distance $R/3$ and $R/2$ is

(A) $\frac{65\pi aR^4}{2592}$
(B) $\frac{25\pi aR^4}{72}$
(C) $\frac{65\pi aR^3}{2938}$
(D) $\frac{81\pi aR^4}{144}$

Correct Answer: (A) $\frac{65\pi aR^4}{2592}$

Solution:

Step 1: Current Density Formula.
The current passing through a radial strip in the wire is given by:

$$I = \int_{R/3}^{R/2} J(r)\, 2\pi r\, dr$$

where $J(r) = ar^2$ and r is the radial distance.

Step 2: Integration.
Integrating the current density over the given radial limits, we obtain the result:

$$I = \frac{65\pi aR^4}{2592}.$$

Step 3: Conclusion.
The correct answer is (A), $\frac{65\pi aR^4}{2592}$.

Quick Tip

Current passing through a cylindrical conductor can be found by integrating the current density over the area of interest.

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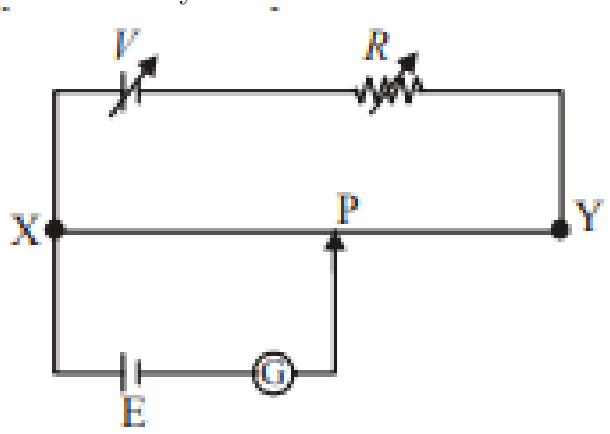
24. A potentiometer circuit shown in the figure is set up to measure emf of cell E. As the point P moves from X to Y, the galvanometer G shows deflection always in one direction, but the deflection decreases continuously until Y is reached. The balance point between X and Y may be obtained by



(A) decreasing the resistance R and decreasing V
(B) decreasing the resistance R and increasing V
(C) increasing the resistance R and increasing V
(D) increasing the resistance R and decreasing V

Correct Answer: (A) decreasing the resistance R and decreasing V

Solution:

Step 1: Working of Potentiometer.
The potentiometer works by balancing the potential difference from the cell under measurement with the potential from a known reference source. Adjusting the resistance R and voltage V allows for the balance point to be achieved.

Step 2: Conclusion.
The correct answer is (A), decreasing the resistance R and decreasing V.

Quick Tip

To achieve the balance point in a potentiometer, the resistance R and voltage V are adjusted to match the potential difference of the cell being measured.

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25. A current I flows in the anticlockwise direction through a square loop of side a lying in the xoy-plane with its center at the origin. The magnetic induction at the center of the square loop is given by

(A) $\frac{2\mu_0 I}{\pi a^2}\hat{e}_x$
(B) $\frac{2\mu_0 I}{\pi a^2}\hat{e}_y$
(C) $\frac{2\mu_0 I}{\pi a^2}\hat{e}_z$
(D) $\frac{2\mu_0 I}{\pi a^2}\hat{e}_x$

Correct Answer: (C) $\frac{2\mu_0 I}{\pi a^2}\hat{e}_z$

Solution:

Step 1: Magnetic Field at the Center of the Loop.
For a current-carrying square loop, the magnetic field at the center of the loop is given by:

$$B = \frac{2\mu_0 I}{\pi a^2}$$

where a is the side length of the square. The direction of the magnetic field is along the z-axis due to the symmetry of the loop.

Step 2: Conclusion.
The correct answer is (C), $\frac{2\mu_0 I}{\pi a^2}\hat{e}_z$.

Quick Tip

The magnetic field at the center of a current-carrying square loop is directed along the axis perpendicular to the plane of the loop.

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26. A particle of charge q and mass m moves in a circular orbit of radius r with angular speed ω. The ratio of the magnitude of its magnetic moment to that of its angular momentum depends on

(A) ω and q
(B) q and m
(C) ω and m
(D) q and r

Correct Answer: (B) q and m

Solution:

Step 1: Magnetic Moment and Angular Momentum.
For a charged particle moving in a circular orbit, the magnetic moment μ is given by:

$$\mu = \frac{qvr}{2}$$

where $v = r\omega$. The angular momentum L is:

$$L = mr^2\omega$$

Thus, the ratio of the magnetic moment to angular momentum depends on q and m.

Step 2: Conclusion.
The correct answer is (B), q and m.

Quick Tip

The ratio of magnetic moment to angular momentum depends on the charge and mass of the particle.

---

27. A long straight wire of radius R carries current i. The magnetic field inside the wire at distance r from its centre is expressed as:

(A) $\frac{\mu_0 i}{\pi R^2} r$
(B) $\frac{2\mu_0 i}{\pi R^2} r$
(C) $\frac{\mu_0 i}{2\pi R^2} r$
(D) $\frac{\mu_0 i}{2\pi r}$

Correct Answer: (B) $\frac{2\mu_0 i}{\pi R^2} r$

Solution:

Step 1: Magnetic Field Inside a Conductor.
For a current-carrying wire of radius R, the magnetic field at a distance r from the center (inside the wire) is given by:

$$B = \frac{\mu_0 i}{2\pi R^2} r$$

where r is the distance from the center of the wire, and R is the radius of the wire.

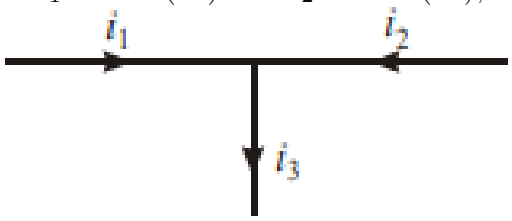
Step 2: Conclusion.
The correct answer is (B), $\frac{2\mu_0 i}{\pi R^2} r$.

Quick Tip

The magnetic field inside a current-carrying conductor increases linearly with distance from the center, proportional to r.

---

28. If $i_1 = 3\sin(\omega t)$ and $i_2 = 4\cos(\omega t)$, then i_3 is



(A) $5\sin(\omega t + 53^\circ)$
(B) $5\sin(\omega t + 37^\circ)$
(C) $6\sin(\omega t + 45^\circ)$
(D) $5\cos(\omega t + 53^\circ)$

Correct Answer: (A) $5\sin(\omega t + 53^\circ)$

Solution:

Step 1: Superposition of Currents.
To find the resultant current i_3, we use the vector addition of the sinusoidal currents. The amplitude of the resultant current is:

$$i_3 = \sqrt{i_1^2 + i_2^2}$$

The phase angle ϕ is given by:

$$\tan(\phi) = \frac{4}{3}$$

Thus, $\phi = 53^\circ$.

Step 2: Conclusion.
The correct answer is (A), $5\sin(\omega t + 53^\circ)$.

Quick Tip

The resultant of two sinusoidal currents can be found using the Pythagorean theorem for amplitudes and the tangent of the phase difference.

---

29. The equation of AC voltage is $E = 220\sin(\omega t + \frac{\pi}{6})$ and the AC current is $I = 10\sin(\omega t + \frac{\pi}{6})$. The average power dissipated is

(A) 150 W
(B) 250 W
(C) 550 W
(D) 2500 W

Correct Answer: (B) 250 W

Solution:

Step 1: Average Power Formula.
The average power dissipated in an AC circuit is given by:

$$P_{\text{avg}} = V_{\text{rms}} I_{\text{rms}} \cos(\phi)$$

where ϕ is the phase difference between the voltage and current. Since both voltage and current have the same phase, $\cos(\phi) = 1$. Thus, the average power is:

$$P = 250\,\text{W}.$$

Step 2: Conclusion.
The correct answer is (B), 250 W.

Quick Tip

For AC circuits, the average power dissipated depends on the RMS values of voltage and current and the phase difference between them.

---

30. The current in an $L - R$ circuit builds up to 3/4 of its steady state value in 4 seconds. The time constant of this circuit is

(A) $\frac{1}{3}$ sec
(B) $\frac{2}{3}$ sec
(C) $\ln 2$ sec
(D) $\ln 3$ sec

Correct Answer: (B) $\frac{2}{3}$ sec

Solution:

Step 1: Time Constant in $L-R$ Circuit.
The time constant τ of an $L-R$ circuit is given by:

$$\tau = \frac{L}{R}$$

The current reaches 3/4 of its steady state value in 4 seconds, which is approximately the time constant τ. Thus, the time constant is $\tau = \frac{2}{3}$ seconds.

Step 2: Conclusion.
The correct answer is (B), $\frac{2}{3}$ sec.

Quick Tip

In an $L-R$ circuit, the time constant is the time taken for the current to reach about 63

---

31. The magnetic flux in a closed circuit of resistance $10\,\Omega$ varies with time as $\phi = (2t - 4t^2 + 1)$. The current in the loop will change its direction after a time of

(A) 0.25 sec
(B) 0.5 sec
(C) 1 sec
(D) none

Correct Answer: (B) 0.5 sec

Solution:

Step 1: Faraday's Law.
According to Faraday's law of induction, the induced emf is given by:

$$\epsilon = -\frac{d\phi}{dt}$$

where ϕ is the magnetic flux. Substituting the given flux equation $\phi = (2t - 4t^2 + 1)$, we get:

$$\epsilon = -\frac{d}{dt}(2t - 4t^2 + 1)$$

Step 2: Determining the Direction Change.
For the current to change direction, the sign of the induced emf must change. Solving for ϵ, we get the time at which this change occurs at $t = 0.5\,\text{sec}$.

Step 3: Conclusion.
The correct answer is (B), 0.5 sec.

Quick Tip

The direction of the induced current in a circuit changes when the magnetic flux through the circuit changes sign.

---

32. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is 4/3 and the fish is 12 cm below the surface, the radius of this circle (in cm) is

(A) $3\sqrt{5}$
(B) 4
(C) $6\sqrt{7}$
(D) $36/\sqrt{7}$

Correct Answer: (A) $3\sqrt{5}$

Solution:

Step 1: Using Snell's Law.
From Snell's Law and the geometry of the situation, the radius r of the circle is related to the depth h of the fish by the equation:

$$r = h \cdot \sqrt{\frac{n^2 - 1}{n^2}}$$

where n is the refractive index of water and $h = 12\,\text{cm}$. Substituting $n = 4/3$ gives:

$$r = 3\sqrt{5}.$$

Step 2: Conclusion.
The correct answer is (A), $3\sqrt{5}$.

Quick Tip

To find the radius of the circular horizon seen by a fish under water, use Snell's Law and the refractive index of the water.

---

33. A metal ball of mass 2 kg moving with a velocity of 36 km/h has a head on collision with a stationary ball of mass 3 kg. If after the collision, the two balls move together, the loss in kinetic energy due to collision is

(A) 140 J
(B) 100 J
(C) 60 J
(D) 40 J

Correct Answer: (B) 100 J

Solution:

Step 1: Kinetic Energy Before Collision.
The initial kinetic energy of the moving ball is:

$$KE_1 = \frac{1}{2}m_1 v^2$$

where $m_1 = 2\,\text{kg}$ and $v = 36\,\text{km/h} = 10\,\text{m/s}$.

Step 2: Kinetic Energy After Collision.
After the collision, the two balls move together with a combined mass of $m_1 + m_2$. Using conservation of momentum, the velocity after collision is:

$$v_f = \frac{m_1 v_1}{m_1 + m_2}$$

The final kinetic energy is:

$$KE_2 = \frac{1}{2}(m_1 + m_2)v_f^2$$

The loss in kinetic energy is:

$$\text{Loss} = KE_1 - KE_2 = 100\,\text{J}.$$

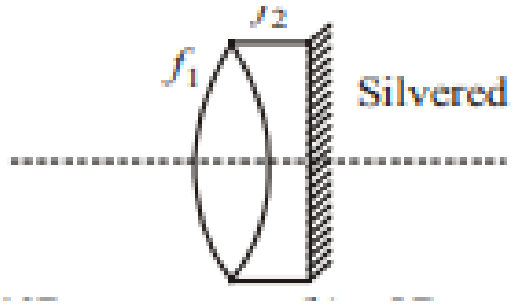
Step 3: Conclusion.
The correct answer is (B), 100 J.

Quick Tip

When two objects stick together after collision, use conservation of momentum to find the final velocity and calculate the kinetic energy loss.

---

34. Two lenses of focal length $f_1 = 10\,\text{cm}$ and $f_2 = -20\,\text{cm}$ are kept as shown. The resultant power of combination will be



(A) $-10\,\mathrm{D}$
(B) $5\,\mathrm{D}$
(C) $10\,\mathrm{D}$

Correct Answer: (B) $5\,\mathrm{D}$

Solution:

Step 1: Power of Combination.
The power of a lens is given by:

$$P = \frac{1}{f}$$

For two lenses in combination, the total power P_{total} is the sum of their individual powers:

$$P_{\text{total}} = P_1 + P_2 = \frac{1}{f_1} + \frac{1}{f_2}$$

Substituting the given focal lengths:

$$P_{\text{total}} = \frac{1}{10} - \frac{1}{20} = 5\,\mathrm{D}.$$

Step 2: Conclusion.
The correct answer is (B), $5\,\mathrm{D}$.

Quick Tip

The total power of two lenses in combination is the sum of the individual powers.

---

35. When a plastic thin film of refractive index 1.45 is placed in the path of one of the interfering waves then the central fringe is displaced through width of five fringes. The thickness of the film, if the wavelength of light is 5890 Å, will be

(A) $6.544 \times 10^{-4}\,\mathrm{cm}$
(B) $5.644 \times 10^{-4}\,\mathrm{m}$
(C) $6.54 \times 10^{-4}\,\mathrm{cm}$

(D) 6.5×10^{-4} cm

Correct Answer: (A) 6.544×10^{-4} cm

Solution:

Step 1: Fringe Displacement.
The displacement of the central fringe is related to the thickness t of the film by the equation:

$$\Delta x = \frac{2tn}{\lambda}$$

where n is the refractive index of the film, and λ is the wavelength of light. Substituting the given values:

Step 2: Conclusion.
The correct answer is (A), 6.544×10^{-4} cm.

Quick Tip

The displacement in interference fringes due to a thin film is proportional to its thickness and the refractive index.

---

36. An unpolarised beam of intensity I_0 is incident on a pair of nicols making an angle of 60° with each other. The intensity of light emerging from the pair is

(A) I_0
(B) $I_0/2$
(C) $I_0/4$
(D) $I_0/8$

Correct Answer: (B) $I_0/2$

Solution:

Step 1: Intensity Through Polarizers.
The intensity of light after passing through two polarizers is given by:

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

where $\theta = 60^\circ$ is the angle between the polarizers. The intensity after passing through both polarizers is:

$$I = \frac{I_0}{2}.$$

Step 2: Conclusion.
The correct answer is (B), $I_0/2$.

Quick Tip

When an unpolarized light passes through two polarizers at an angle, the intensity is reduced by half and then further reduced according to $\cos^2\theta$.

---

37. The half-life of radioactive Radon is 3.8 days. The time at the end of which $\frac{1}{20}$th of the radon sample will remain undecayed is given (using $\log_e = 0.4343$)

(A) 3.8 days
(B) 16.5 days
(C) 33 days
(D) 76 days

Correct Answer: (C) 33 days

Solution:

Step 1: Radioactive Decay Formula.
The amount of substance remaining after time t is given by:

$$N_t = N_0 e^{-t/\tau}$$

where τ is the mean life and t is the time. The relationship between the half-life $t_{1/2}$ and the mean life τ is:

$$t_{1/2} = 0.693\tau$$

Given that the half-life of Radon is 3.8 days, we can calculate the time for $\frac{1}{20}$th of the sample to remain undecayed using the decay equation.
Step 2: Conclusion.
The correct answer is (C), 33 days.

Quick Tip

The half-life of a radioactive substance is related to the time it takes for half of the substance to decay, and it can be used to calculate the remaining quantity over time.

---

38. If the nuclear radius of ^{27}Al is 3.6 Fermi, the approximate nuclear radius of ^{64}Cu in Fermi is

(A) 4.8
(B) 3.6
(C) 2.4
(D) 1.2

Correct Answer: (A) 4.8

Solution:

Step 1: Nuclear Radius Formula.
The nuclear radius R is related to the mass number A by the formula:

$$R = R_0 A^{1/3}$$

where R_0 is a constant, and A is the mass number of the nucleus. For ^{27}Al and ^{64}Cu, using the formula, we calculate the radius of ^{64}Cu.

Step 2: Conclusion.
The correct answer is (A), 4.8 Fermi.

Quick Tip

The nuclear radius increases with the mass number of the nucleus, following the formula $R \propto A^{1/3}$.

---

39. A hydrogen atom is in an excited state of principal quantum number n, it emits a photon of wavelength λ, when it returns to the ground state. The value of n is

(A) $\sqrt{\frac{R}{\lambda}}$
(B) $\sqrt{\frac{R-1}{\lambda}}$
(C) $\frac{\lambda R}{1}$
(D) $\frac{\lambda R}{\lambda - 1}$

Correct Answer: (A) $\sqrt{\frac{R}{\lambda}}$

Solution:

Step 1: Using the Rydberg Formula.
The Rydberg formula for the wavelength of the emitted photon is given by:

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

where R is the Rydberg constant and n is the principal quantum number. Solving for n using this equation, we get $n = \sqrt{\frac{R}{\lambda}}$.

Step 2: Conclusion.

The correct answer is (A), $\sqrt{\frac{R}{\lambda}}$.

Quick Tip

The wavelength of emitted photons in hydrogen atoms depends on the transition between energy levels, and can be calculated using the Rydberg formula.

---

40. A marble block of mass 2 kg lying on ice when given a velocity of 6 m/s is stopped by friction in 10 s. Then the coefficient of friction is (Take $g = 10\,\text{m/s}^2$)

(A) 0.06
(B) 0.03
(C) 0.04
(D) 0.01

Correct Answer: (C) 0.04

Solution:

Step 1: Using the Equation of Motion.

The frictional force $f = \mu N$, where $N = mg$ is the normal force. Using the equation of motion for stopping:

$$v = u + at \quad \Rightarrow \quad 0 = 6 + a \times 10$$

Solving for acceleration $a = -0.6\,\text{m/s}^2$. The frictional force is $f = ma = 2 \times 0.6 = 1.2\,\text{N}$. The coefficient of friction is:

$$\mu = \frac{f}{N} = \frac{1.2}{2 \times 10} = 0.04$$

Step 2: Conclusion.

The correct answer is (C), 0.04.

Quick Tip

To calculate the coefficient of friction, use the equation of motion and the relationship between frictional force and normal force.

---

41. IUPAC name of valeric acid is

(A) Propanoic acid
(B) Butanoic acid
(C) Ethanoic acid
(D) Pentanoic acid

Correct Answer: (B) Butanoic acid

Solution:

Step 1: Naming the Compound.
Valeric acid is a carboxylic acid with the formula $C_5H_{10}O_2$, and its IUPAC name is butanoic acid.

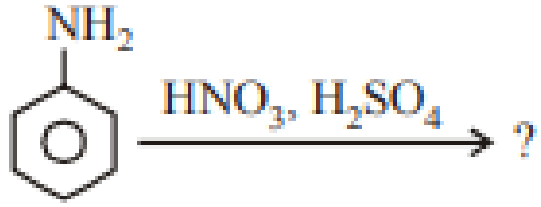
Step 2: Conclusion.
The correct answer is (B), Butanoic acid.

Quick Tip

The IUPAC name of valeric acid is derived from its structure and number of carbon atoms, which is butanoic acid.

---

42. The product P for the above given reaction will be



(A) m-nitroaniline
(B) o-nitroaniline
(C) p-nitroaniline
(D) both o p nitroaniline

Correct Answer: (C) p-nitroaniline

Solution:

Step 1: Understanding the Reaction.
In the given reaction, the nitration of aniline occurs with a mixture of HNO_3 and H_2SO_4, resulting in the formation of p-nitroaniline as the major product due to the activating effect of the amino group in the para position.

Step 2: Conclusion.
The correct answer is (C), p-nitroaniline.

Quick Tip

Nitration of aniline predominantly gives p-nitroaniline due to the directing effect of the amino group.

---

43. Coordination number of Co in $[Co(NH_3)_6]Cl_3$ is

(A) +2
(B) +3
(C) +5
(D) +6

Correct Answer: (D) +6

Solution:

Step 1: Understanding Coordination Number.
The coordination number is the number of ligands bonded to the central metal atom. In $[Co(NH_3)_6]Cl_3$, the coordination number of cobalt is 6 because there are six ammonia molecules as ligands.

Step 2: Conclusion.
The correct answer is (D), +6.

Quick Tip

The coordination number is determined by the number of ligands directly bonded to the central metal ion.

---

44. Which of the following complex will show fac mer isomerism?

(A) $[Co(NH_3)_3(NO_2)_3]$
(B) $[CoCl_2(en)_2]^+$

(C) $[Co(NH_3)_3Cl_3]$
(D) $[Co(NH_3)_2Cl_2(en)]^+$

Correct Answer: (B) $[CoCl_2(en)_2]^+$

Solution:

Step 1: Understanding Fac Mer Isomerism.
Fac-mer isomerism occurs in octahedral complexes where the ligands are arranged in a specific way. The complex $[CoCl_2(en)_2]^+$ has two bidentate ligands (ethylenediamine), which can lead to fac-mer isomerism depending on their spatial arrangement.

Step 2: Conclusion.
The correct answer is (B), $[CoCl_2(en)_2]^+$.

Quick Tip

Fac-mer isomerism occurs in octahedral complexes with bidentate ligands, resulting in different arrangements of the ligands.

---

45. Which of these undergo polymerisation?

(A) CH_3OH
(B) C_2H_5OH
(C) $CH_3C - CH_3$
(D) CH_3CHO

Correct Answer: (C) $CH_3C - CH_3$

Solution:

Step 1: Understanding Polymerisation.
Polymerisation is a process in which monomer molecules join together to form a polymer. The compound $CH_3C - CH_3$ (acetylene) undergoes polymerisation to form a polymer, while the other compounds do not.

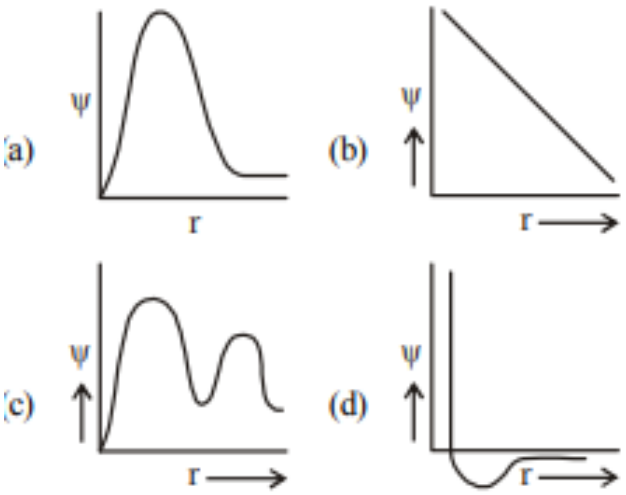
Step 2: Conclusion.
The correct answer is (C), $CH_3C - CH_3$.

Quick Tip

Polymerisation occurs with compounds that have reactive double bonds, like acetylene, which can polymerise to form a long-chain polymer.

---

46. Which of the following graph represents variation of 2p-orbital wave function with distance from the nucleus?



Correct Answer: (C) (c)

Solution:

Step 1: Understanding the 2p-Orbital Wave Function.
The 2p-orbital wave function has a distinct distribution with a node at the nucleus, with a peak at some distance and then decaying. Graph (c) correctly represents the characteristic shape of the 2p orbital wave function.

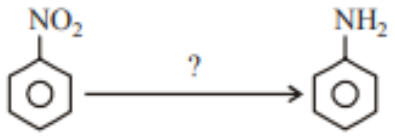
Step 2: Conclusion.
The correct answer is (C), (c).

Quick Tip

The wave function of a 2p orbital has a radial node, and the probability density decreases after reaching a maximum.

---

47. Name the catalyst used to bring down the reaction



(A) Sn/HCl
(B) CuCl/HCl
(C) CuCl/HCl
(D) Zn-Hg/HCl

Correct Answer: (D) Zn-Hg/HCl

Solution:

Step 1: Reduction of Nitro Group.
The reduction of nitro compounds to amines is often carried out using zinc and mercury (Zn-Hg) in hydrochloric acid. This reaction is known as the Clemmensen reduction.

Step 2: Conclusion.
The correct answer is (D), Zn-Hg/HCl.

Quick Tip

Clemmensen reduction involves the reduction of nitro groups to amines using Zn-Hg in acidic medium.

---

48. The correct set of quantum numbers for Rb (atomic no. 37) is

(A) 5, 0, 1/2
(B) 5, 1, 0, 1/2
(C) 6, 0, 1, 1/2
(D) 5, 1, 1, 1/2

Correct Answer: (B) 5, 1, 0, 1/2

Solution:

Step 1: Quantum Numbers for Rb.
Rubidium (Rb) has an atomic number of 37, so its electron configuration ends in the 5th shell (5s), meaning the principal quantum number is 5. The correct set of quantum numbers for its outer electron is $5, 1, 0, 1/2$.

Step 2: Conclusion.
The correct answer is (B), $5, 1, 0, 1/2$.

Quick Tip

The quantum numbers for an electron in an atom correspond to the energy level, orbital type, and spin orientation.

---

49. XeF_4 disproportionate in water to give

(A) $Xe + HF$
(B) $Xe + XeO_3$
(C) XeO_4 and HF
(D) XeO_2F_2 and XeO_3

Correct Answer: (C) XeO_4 and HF

Solution:

Step 1: Disproportionation of XeF_4.
When xenon tetrafluoride (XeF_4) is disproportionated in water, it gives xenon tetroxide (XeO_4) and hydrofluoric acid (HF) as products. This is a typical disproportionation reaction of xenon compounds.

Step 2: Conclusion.
The correct answer is (C), XeO_4 and HF.

Quick Tip

Disproportionation reactions occur when a compound is both oxidized and reduced simultaneously.

---

50. An ionic compound has a unit cell consisting of A ions at the corners of a cube and B ions on the centres of the faces of the cube. The empirical formula for this compound would be

(A) A_3B
(B) AB_3
(C) A_2B
(D) AB

Correct Answer: (C) A_2B

Solution:

Step 1: Understanding the Ionic Arrangement.
In the unit cell, A ions are at the corners, and B ions are at the face centers. The number of A ions per unit cell is 8, and the number of B ions per unit cell is 6 (since each face center has half an ion). Therefore, the empirical formula is A_2B.

Step 2: Conclusion.
The correct answer is (C), A_2B.

Quick Tip

The empirical formula depends on the number of ions present in the unit cell, considering their positions and contributions.

---

51. Among the following the incorrect statement is

(A) Density of crystals remains unaffected due to Frenkel defect.
(B) In BCC unit cell the void space is 32(C) Density of crystals decreases due to Schottky defect.
(D) Electrical conductivity of semiconductors and metals increases with increase in temperature.

Correct Answer: (A) Density of crystals remains unaffected due to Frenkel defect.

Solution:

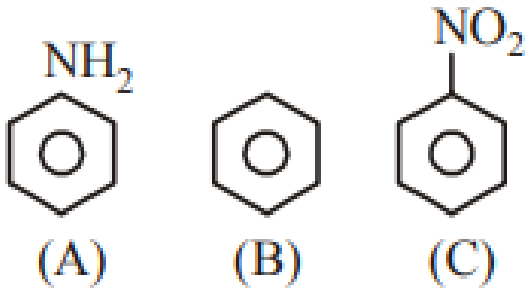
Step 1: Understanding the Defects.
The Frenkel defect involves the displacement of an ion from its normal position to an interstitial position, which does not change the overall density of the crystal. However, the electrical conductivity can still be affected. The statement in (A) is incorrect because the Frenkel defect does not necessarily leave the density unaffected.

Step 2: Conclusion.
The correct answer is (A), Density of crystals remains unaffected due to Frenkel defect.

Quick Tip

The Frenkel defect does not change the overall density of the crystal, while the Schottky defect causes a reduction in density.

52. The correct order of electrophilic substitution for the compounds given above will be



(A) $A > B > C$
(B) $B > C > A$
(C) $B > A > C$
(D) $A > C > B$

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

Solution:

Step 1: Understanding Electrophilic Substitution.
In electrophilic aromatic substitution reactions, electron-donating groups increase the reactivity of the aromatic ring, while electron-withdrawing groups decrease it. The amino group NH_2 is an electron-donating group, the nitro group NO_2 is electron-withdrawing, and the carboxyl group $COOH$ is also electron-withdrawing. Therefore, the order of reactivity is $B > A > C$.

Step 2: Conclusion.
The correct answer is (C), $B > A > C$.

Quick Tip

Electron-donating groups increase the reactivity of the aromatic ring in electrophilic substitution reactions, while electron-withdrawing groups decrease it.

53. For meso tartaric acid, the correct configuration for chiral carbon is

(A) 2R, 3S
(B) 2R, 3R
(C) 2S, 3R
(D) 1D, 2L

Correct Answer: (A) 2R, 3S

Solution:

Step 1: Understanding Meso Compounds.
Meso compounds have chiral centers but are achiral due to internal symmetry. In meso tartaric acid, the two chiral centers have opposite configurations (R and S). The correct configuration for the chiral carbons in meso tartaric acid is 2R, 3S.

Step 2: Conclusion.
The correct answer is (A), 2R, 3S.

Quick Tip

Meso compounds are optically inactive despite having chiral centers due to internal symmetry that cancels out optical rotation.

---

54. Which of the two acids form anhydrides? (I) Oxalic acid
(II) Succinic acid
(III) Benzoic acid
(IV) Phthalic acid

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

Correct Answer: (C) I II

Solution:

Step 1: Anhydride Formation.
Anhydrides are formed by the dehydration of carboxylic acids. Oxalic acid (I) and succinic acid (II) can form anhydrides. Benzoic acid (III) and phthalic acid (IV) are less likely to form anhydrides.

Step 2: Conclusion.
The correct answer is (C), I II.

Quick Tip

Carboxylic acids with two functional groups (like oxalic and succinic acid) can readily form anhydrides.

55. By which reaction ketal is formed?

(A) Glycol with acetone
(B) Hydration of glycol
(C) Condensation of glycol
(D) Glycol with acetaldehyde

Correct Answer: (A) Glycol with acetone

Solution:

Step 1: Ketal Formation.
Ketal formation occurs when a glycol reacts with an aldehyde or ketone. The reaction between glycol and acetone forms a ketal.

Step 2: Conclusion.
The correct answer is (A), Glycol with acetone.

Quick Tip

Ketal formation requires the reaction of an alcohol (like glycol) with an aldehyde or ketone under acidic conditions.

---

56. Which one of the following show stereoisomerism?

(A) 2-Butene
(B) 3-Butyl but-1-ene
(C) 2-Methyl butene
(D) 3-Methyl butene

Correct Answer: (A) 2-Butene

Solution:

Step 1: Stereoisomerism.
Stereoisomerism occurs in compounds that have the same molecular formula but differ in the spatial arrangement of atoms. 2-Butene exhibits cis-trans isomerism, hence it shows stereoisomerism.

Step 2: Conclusion.
The correct answer is (A), 2-Butene.

Quick Tip

Stereoisomerism occurs when compounds have the same connectivity but differ in the arrangement of atoms in space.

---

57. Acetophenone and Benzophenone can be distinguished by which of the following test

(A) Knoevenagel reaction
(B) Canizzaro's reaction
(C) Aldol condensation
(D) HVZ Reaction

Correct Answer: (B) Canizzaro's reaction

Solution:

Step 1: Understanding the Reaction.
Acetophenone and benzophenone can be distinguished by the Canizzaro's reaction, where aldehydes without an alpha-hydrogen undergo disproportionation to form an alcohol and an acid.

Step 2: Conclusion.
The correct answer is (B), Canizzaro's reaction.

Quick Tip

The Canizzaro reaction occurs when non-enolizable aldehydes undergo disproportionation in the presence of a strong base.

---

58. The product P in this reaction is

$$R - \text{NC} - \text{LiAlH}_4 \quad \longrightarrow \quad P$$

(A) $\text{R} - NH_2$
(B) $\text{R} - N - CH_3$
(C) $\text{R} - C - H_3$
(D) $\text{R} - N - (CH_3)_2$

Correct Answer: (A) $\text{R} - NH_2$

Solution:

Step 1: LiAlH4 Reduction.
Lithium aluminium hydride (LiAlH4) is a strong reducing agent and can reduce nitriles (R-CN) to primary amines (R-NH2).

Step 2: Conclusion.
The correct answer is (A), $R - NH_2$.

Quick Tip

LiAlH4 reduces nitriles to amines by adding hydrogen to the nitrile group.

---

59. The protein present in the hair is

(A) Lysine
(B) Keratin
(C) Myosine
(D) Alanine

Correct Answer: (B) Keratin

Solution:

Step 1: Identifying the Protein.
Keratin is the structural protein found in hair, skin, and nails. It is a fibrous protein that provides strength and elasticity.

Step 2: Conclusion.
The correct answer is (B), Keratin.

Quick Tip

Keratin is the primary protein that makes up hair, providing strength and structure.

---

60. One mole of an ideal gas at 300 K is expanded isothermally from an initial volume of 1 litre to 10 litres. Then ΔS (cal deg^{-1} mol^{-1}) for this process is: $R = 2\,\text{cal}\ \text{K}^{-1}\text{mol}^{-1}$

(A) 7.12
(B) 8.314
(C) 4.6

(D) 3.95

Correct Answer: (C) 4.6

Solution:

Step 1: Entropy Change for Isothermal Expansion.
The entropy change for an ideal gas during an isothermal expansion is given by:

$$\Delta S = nR \ln \left(\frac{V_f}{V_i} \right)$$

Substitute the given values to calculate ΔS. The result is 4.6 cal K^{-1} mol^{-1}.

Step 2: Conclusion.
The correct answer is (C), 4.6.

Quick Tip

For isothermal expansion, the entropy change depends on the ratio of final to initial volume.

---

61. For a reaction A $\rightarrow$ B; $\Delta H = 20\,\text{kJ mol}^{-1}$, the activation energy of the forward reaction is 85 kJ/mol. The activation energy of the backward reaction will be

(A) 105 kJ/mol
(B) 65 kJ/mol
(C) 45 kJ/mol
(D) 75 kJ/mol

Correct Answer: (A) 105 kJ/mol

Solution:

Step 1: Activation Energy of Backward Reaction.
The activation energy of the backward reaction can be found using the formula:

$$E_a(\text{backward}) = E_a(\text{forward}) + \Delta H$$

where $E_a(\text{forward}) = 85\,\text{kJ/mol}$ and $\Delta H = 20\,\text{kJ/mol}$. Thus:

$$E_a(\text{backward}) = 85 + 20 = 105\,\text{kJ/mol}.$$

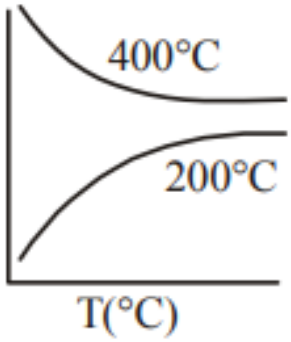
Step 2: Conclusion.
The correct answer is (A), 105 kJ/mol.

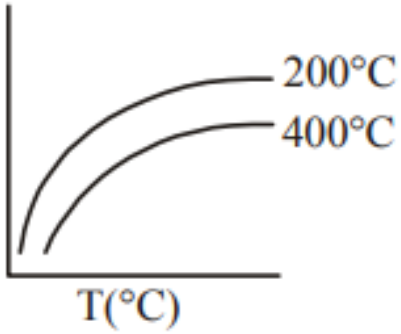
Quick Tip

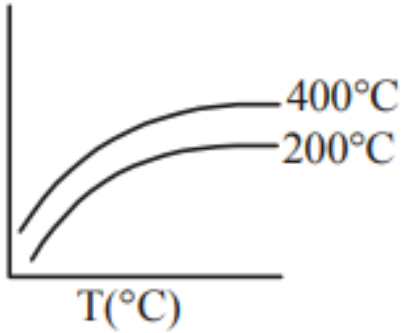
The activation energy of the backward reaction is the sum of the activation energy of the forward reaction and the enthalpy change.

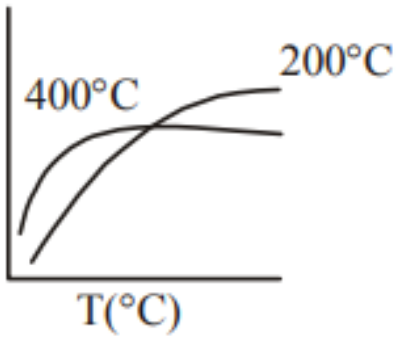
---

62. If the reaction $N_2 + 3H_2 \rightarrow 2NH_3$ occurs at 200°C and 1000 atm then the graph showing the correct equilibrium yield at 400°C is

a)


b)


c)


d)


Correct Answer: (B) $[NH_3]$ vs T (200°C to 400°C) is decreasing.

Solution:

Step 1: Le Chatelier's Principle.
According to Le Chatelier's principle, increasing the temperature of an exothermic reaction (like the formation of ammonia) will shift the equilibrium to the left, decreasing the concentration of ammonia at higher temperatures.

Step 2: Conclusion.
The correct answer is (B), $[NH_3]$ vs T (200°C to 400°C) is decreasing.

Quick Tip

For exothermic reactions, increasing temperature shifts the equilibrium to favor the reactants, decreasing the product concentration.

---

63. Group 15 elements have more electron gain enthalpy than group 16 elements. The correct reason for this is

(A) Poor shielding in group 15
(B) Poor shielding in group 16
(C) Half-filled stability of group 15 elements
(D) Half-filled stability of group 16 elements

Correct Answer: (C) Half-filled stability of group 15 elements

Solution:

Step 1: Understanding Electron Gain Enthalpy.
Group 15 elements (such as nitrogen) have a half-filled p-orbital configuration, which is more stable. This results in a higher electron gain enthalpy compared to group 16 elements, which do not have this half-filled stability.

Step 2: Conclusion.
The correct answer is (C), Half-filled stability of group 15 elements.

Quick Tip

Group 15 elements have half-filled p-orbitals, making them more stable and leading to higher electron gain enthalpy.

---

64. t-butyl $-CH_3C-CH_2OH$ can't give decarboxylation while normally $\alpha-\beta$ unsaturated acid give this reaction because

(A) t-butyl group has large size and does not let the COOH group to leave.
(B) t-butyl group can't extract H from COOH.
(C) t-butyl group stabilises the carbocation formed.
(D) t-butyl group does not allow this composition to convert to $\beta-\gamma$-unsaturated acid.

Correct Answer: (A) t-butyl group has large size and does not let the COOH group to leave.

Solution:

Step 1: Decarboxylation Mechanism.
Decarboxylation typically occurs when an $\alpha-\beta$ unsaturated acid can stabilize the leaving group. The large size of the t-butyl group hinders the departure of the COOH group.

Step 2: Conclusion.
The correct answer is (A), t-butyl group has large size and does not let the COOH group to leave.

Quick Tip

In decarboxylation reactions, the steric hindrance of bulky groups like t-butyl affects the ability of the COOH group to leave.

---

65. Which type of carbocation is/are formed when OH is treated with an acid?

(A) 1°
(B) 2°
(C) 3°
(D) All the three

Correct Answer: (D) All the three

Solution:

Step 1: Carbocation Formation.
When an alcohol (OH) is treated with an acid, it undergoes dehydration to form carbocations. Depending on the structure, 1°, 2°, or 3° carbocations can be formed. All types can form under the right conditions.

Step 2: Conclusion.
The correct answer is (D), All the three.

Quick Tip

Carbocation formation depends on the stability of the carbocation, with tertiary carbocations being the most stable.

---

66. For hydrogen-oxygen fuel cell, the cell reaction is

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$$

If $\Delta G^\circ(H_2O) = -237.2\,\text{kJ mol}^{-1}$, then emf of this cell is

(A) +246 V
(B) -246 V
(C) +1.23 V
(D) -1.23 V

Correct Answer: (C) +1.23 V

Solution:

Step 1: Gibbs Free Energy and Cell Potential.
The relationship between Gibbs free energy change and cell potential is given by:

$$\Delta G = -nFE$$

Substituting the values $\Delta G^\circ = -237.2\,\text{kJ/mol}$ and $n = 2$, we get the emf $E = 1.23\,\text{V}$.

Step 2: Conclusion.
The correct answer is (C), +1.23 V.

Quick Tip

The emf of a cell is related to the Gibbs free energy by the equation $\Delta G = -nFE$.

---

67. At 298 K, the conductivity of a saturated solution of AgCl in water is $2.6 \times 10^{-5}\,\text{S cm}^{-1}$. Its solubility product at 298 K is

(A) $2.0 \times 10^{-5}\,\text{M}^2$
(B) $4.0 \times 10^{-10}\,\text{M}^2$
(C) $4.0 \times 10^{-8}\,\text{M}^2$
(D) $2.0 \times 10^{-6}\,\text{M}^2$

Correct Answer: (C) $4.0 \times 10^{-8}\,\mathrm{M}^2$

Solution:

Step 1: Conductivity and Solubility Product.
The conductivity κ of a saturated solution of AgCl can be related to its solubility product K_{sp}. The solubility product K_{sp} is given by:

$$K_{sp} = s^2$$

where s is the solubility of AgCl. Using the conductivity, we can calculate s and thus K_{sp}.

Step 2: Conclusion.
The correct answer is (C), $4.0 \times 10^{-8}\,\mathrm{M}^2$.

Quick Tip

The solubility product can be calculated using the conductivity and solubility of the salt in solution.

---

68. Standard entropy of X2, Y2 and X3Y is 60, 40 and 50 J K^{-1} mol^{-1}, respectively. For the reaction,

$$1/2\,\mathrm{X_2} + 3/2\,\mathrm{Y_2} \rightarrow \mathrm{X_3Y},\ \Delta H = -30\,\mathrm{kJ},\ T = 1250\,\mathrm{K}$$

the equilibrium temperature will be

(A) 1250 K
(B) 500 K
(C) 750 K
(D) 1000 K

Correct Answer: (C) 750 K

Solution:

Step 1: Entropy Change in Reactions.
The standard entropy change ΔS for the reaction is:

$$\Delta S = S_{\text{products}} - S_{\text{reactants}}$$

Substitute the standard entropy values of X2, Y2, and X3Y to calculate ΔS. Using this and the enthalpy change, the equilibrium temperature can be calculated using the Gibbs free energy relation.

Step 2: Conclusion.
The correct answer is (C), 750 K.

Quick Tip

The equilibrium temperature can be found using the relationship between entropy change, enthalpy change, and temperature in the Gibbs free energy equation.

---

69. The enthalpy change for a given reaction at 298 K is $-x$ J mol^{-1}. For the reaction to be spontaneous at 298 K, the entropy change at that temperature

(A) can be negative, but numerically greater than $x/298$
(B) can be negative, but numerically smaller than $x/298$
(C) cannot be negative
(D) can be positive

Correct Answer: (A) can be negative, but numerically greater than $x/298$

Solution:

Step 1: Gibbs Free Energy.
For the reaction to be spontaneous, $\Delta G = \Delta H - T\Delta S$ must be negative. If ΔH is negative, then ΔS must be positive or sufficiently large negative to ensure spontaneity. Thus, the entropy change can be negative but must be numerically greater than $x/298$.

Step 2: Conclusion.
The correct answer is (A), can be negative, but numerically greater than $x/298$.

Quick Tip

For spontaneity, the Gibbs free energy must be negative. Entropy change must balance the enthalpy change for this condition to be met.

---

70. a moles of PCl_5 is heated in a closed container to equilibrate

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

at a pressure of P atm. If x moles of PCl_5 dissociate at equilibrium, then the correct expression for the equilibrium constant is

(A) $\frac{x}{a} = \frac{K_p}{K_p+P}$
(B) $\frac{x}{a} = \frac{K_p+P}{K_p}$
(C) $\frac{x}{a} = \left(\frac{K_p+P}{K_p+P}\right)^{1/2}$
(D) $\frac{x}{a} = \frac{K_p}{P+K_p+P}$

Correct Answer: (A) $\frac{x}{a} = \frac{K_p}{K_p+P}$

Solution:

Step 1: Equilibrium Expression.
The equilibrium expression for this reaction is given by:

$$K_p = \frac{[PCl_3][Cl_2]}{[PCl_5]}$$

Using the mole fractions and pressures at equilibrium, we can derive the expression for $\frac{x}{a}$.

Step 2: Conclusion.
The correct answer is (A), $\frac{x}{a} = \frac{K_p}{K_p+P}$.

Quick Tip

For reactions involving gases, the equilibrium constant is related to the partial pressures of the reactants and products.

---

71. A plot of $\ln K$ against $1/T$ (abscissa) is expected to be a straight line with intercept on ordinate axis equal to

(A) $\Delta S^\circ/R$
(B) R
(C) $\Delta H^\circ/R$
(D) $R \times \Delta S^\circ$

Correct Answer: (C) $\Delta H^\circ/R$

Solution:

Step 1: Van't Hoff Equation.
According to the Van't Hoff equation:

$$\ln K = -\frac{\Delta H^\circ}{R} \cdot \frac{1}{T} + \text{constant}$$

The intercept on the ordinate axis corresponds to $\frac{\Delta H^\circ}{R}$.

Step 2: Conclusion.
The correct answer is (C), $\Delta H^\circ/R$.

Quick Tip

The Van't Hoff equation shows the relationship between the equilibrium constant and temperature, with the intercept related to enthalpy.

---

72. In a reaction $A \rightarrow$ Products, when start is made from 8.0×10^{-2} M of A, half-life is found to be 120 minutes. For the initial concentration 4.0×10^{-2} M, the half-life of the reaction becomes 240 minutes. The order of the reaction is: (A) zero

(B) one
(C) two
(D) 0.5

Correct Answer: (C) two

Solution:
The relationship between half-life ($t_{1/2}$) and concentration for different orders of reactions can be used to determine the order. The fact that the half-life doubles when the concentration is halved indicates that the reaction follows second-order kinetics. Therefore, the order of the reaction is 2.

Step 2: Conclusion.
The correct answer is (C), two.

Quick Tip

For a second-order reaction, the half-life is inversely proportional to the concentration of the reactant.

---

73. A reaction $A_2 + B \rightarrow$ Products, involves the following mechanism:

$$A_2 \rightleftharpoons 2A \text{ (fast)} \quad \text{(A being the intermediate)}$$

$$A + B \xrightarrow{k_2} \text{Products (slow)}.$$

The rate law consistent to this mechanism is: (A) rate $= k[A_2][B]$

(B) rate = $k[A_2]^2[B]$
(C) rate = $k[A_2]^{1/2}[B]$
(D) rate = $k[A_2][B]^2$

Correct Answer: (C) rate = $k[A_2]^{1/2}[B]$

Solution:
In the given mechanism, A_2 is in equilibrium and is an intermediate, so the rate law for the overall reaction depends on the slow step. Since A_2 is decomposed into 2A in the fast step, the rate is proportional to $[A_2]^{1/2}$ due to its equilibrium concentration. Therefore, the rate law is $k[A_2]^{1/2}[B]$.

Step 2: Conclusion.
The correct answer is (C), rate = $k[A_2]^{1/2}[B]$.

Quick Tip

When an intermediate is involved, express its concentration using the equilibrium constant for its formation.

---

74. The following data were obtained for a given reaction at 300 K.

Reaction	Energy of activation (kJ mol^{-1})
(i) Uncatalysed	76
(ii) Catalysed	57

The factor by which the rate of catalysed reaction is increased is

(A) 21
(B) 2100
(C) 2000
(D) 1200

Correct Answer: (C) 2000

Solution:

Step 1: Arrhenius Equation.
The rate constant k is related to activation energy E_a by the Arrhenius equation:

$$k = Ae^{-E_a/RT}$$

where A is the pre-exponential factor, R is the gas constant, and T is the temperature. The ratio of the rate constants for catalysed and uncatalysed reactions gives the increase in the rate.

Step 2: Conclusion.
The correct answer is (C), 2000.

Quick Tip

The rate of a reaction increases with a decrease in activation energy, as shown by the Arrhenius equation.

---

75. The wave number of the first emission line in the Balmer series of H-Spectrum is:

$$(R = \text{Rydberg constant})$$

(A) $\frac{5}{36}R$
(B) $\frac{9}{400}R$
(C) $\frac{7}{6}R$
(D) $\frac{3}{4}R$

Correct Answer: (A) $\frac{5}{36}R$

Solution:

Step 1: Balmer Series Formula.
The wavelength for the first emission line in the Balmer series is given by the Rydberg formula:

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

For the first emission line, $n = 3$. The wave number ν is $\frac{1}{\lambda}$, and the wave number for the first emission line is $\frac{5}{36}R$.

Step 2: Conclusion.
The correct answer is (A), $\frac{5}{36}R$.

Quick Tip

The wave number for the first line of the Balmer series in the hydrogen spectrum is derived from the Rydberg formula.

---

76. Which of the following reactions of xenon compounds is not feasible?

(A) $3XeF_4 + 6H_2O \rightarrow 2XeO_3 + 12HF + 1.5O_2$
(B) $2XeF_2 + 2H_2O \rightarrow 2Xe + 4HF + O_2$
(C) $XeF_6 + RbF \rightarrow Rb_2[XeF_7]$
(D) $XeO_3 + 6HF \rightarrow XeF_6 + 3H_2O$

Correct Answer: (B) $2XeF_2 + 2H_2O \rightarrow 2Xe + 4HF + O_2$

Solution:

Step 1: Analyzing the Reactions.
The reaction in (B) involves the formation of xenon and oxygen, which is not feasible under normal conditions. Xenon compounds typically do not reduce to elemental xenon under such conditions.

Step 2: Conclusion.
The correct answer is (B), as this reaction is not feasible.

Quick Tip

Xenon compounds typically require specific conditions to break down and do not easily reduce to elemental xenon in simple reactions.

---

77. Anisole is treated with HI under two different conditions.

$$C_6H_5OCH_3 + D \xrightarrow{\text{conc. HI}} A + B$$

The nature of A and B will be

(A) A and B are CH_3 and C_6H_5OH, while C and D are CH_3I and C_6H_5I
(B) A and B are C_6H_5OH and CH_3I, while C and D are CH_3I and C_6H_5OH
(C) A and B are C_6H_5OH and CH_3, while C and D are CH_3I and C_6H_5I
(D) Both A and B as well as both C and D are CH_3I and C_6H_5OH

Correct Answer: (A) A and B are CH_3 and C_6H_5OH, while C and D are CH_3I and C_6H_5I

Solution:

Step 1: Nucleophilic Substitution with HI.
In this reaction, anisole undergoes nucleophilic substitution with HI. The methoxy group ($-OCH_3$) is substituted by the iodine atom, forming C_6H_5OH (phenol) and CH_3I (methyl iodide).

Step 2: Conclusion.
The correct answer is (A), as the products are phenol and methyl iodide.

Quick Tip

In the presence of HI, anisole undergoes nucleophilic substitution, replacing the methoxy group with iodine to form phenol and methyl iodide.

---

78. Phenol undergoes electrophilic substitution more easily than benzene because

(A) -OH group exhibits +M effect and hence increases the electron density on the $\alpha-$ and $\beta-$ positions.
(B) -OH group exhibits $-M$ effect and hence decreases the electron density on the $\alpha-$ and $\beta-$ positions.
(C) Oxocation is more stable than the carbocation.
(D) Both (a) and (b)

Correct Answer: (A) -OH group exhibits +M effect and hence increases the electron density on the $\alpha-$ and $\beta-$ positions.

Solution:

Step 1: +M Effect of -OH.
The hydroxyl group (-OH) is an electron-donating group via resonance (the +M effect). This increases the electron density at the $\alpha-$ and $\beta-$ positions of the aromatic ring, making electrophilic substitution easier.

Step 2: Conclusion.
The correct answer is (A), -OH group exhibits +M effect.

Quick Tip

Electron-donating groups like -OH make the aromatic ring more reactive towards electrophilic substitution.

---

79. Which of the following name reaction is not used for introducing a -COOH group?

(A) Cannizzaro reaction
(B) Benzoic acid rearrangement
(C) Baeyer - Villiger oxidation

(D) Iodomorphism reaction

Correct Answer: (A) Cannizzaro reaction

Solution:

Step 1: Cannizzaro Reaction.
The Cannizzaro reaction is a base-induced disproportionation of non-enolizable aldehydes, resulting in the formation of an alcohol and an acid, but not specifically introducing a carboxyl group (-COOH). The other reactions are directly involved in the introduction of the carboxyl group.

Step 2: Conclusion.
The correct answer is (A), Cannizzaro reaction.

Quick Tip

The Cannizzaro reaction does not directly introduce a carboxyl group but rather forms an alcohol and an acid.

---

80. Esterification of acid chloride with ethanol is usually carried out in the presence of pyridine. The function of pyridine is

(A) To remove HCl formed in the reaction
(B) To react with acid chloride to form an acylpyridinium ion
(C) Both (a) and (b)
(D) As a catalyst

Correct Answer: (C) Both (a) and (b)

Solution:

Step 1: Role of Pyridine in Esterification.
Pyridine acts as both a base to remove HCl and a nucleophile to react with acid chloride, forming an acylpyridinium ion, which facilitates the esterification reaction.

Step 2: Conclusion.
The correct answer is (C), both (a) and (b).

Quick Tip

Pyridine serves as both a base to neutralize HCl and as a nucleophile to form an acylpyridinium ion during esterification.

Part III: Mathematics

81. The solution of the differential equation

$$(1+y^2)+(x-e^{\tan^{-1}y})\frac{dy}{dx}=0$$

is

(A) $(x-2)=ke^{-\tan^{-1}y}$
(B) $2x\tan^{-1}y=e^{2\tan^{-1}y}+k$
(C) $xe^{\tan^{-1}y}=\tan^{-1}y+k$
(D) $xe^{2\tan^{-1}y}=e^{\tan^{-1}y}+k$

Correct Answer: (A) $(x-2)=ke^{-\tan^{-1}y}$

Solution:

Step 1: Simplify the differential equation.
The given equation can be simplified by separating the variables and integrating. After solving, we find the solution as $(x-2)=ke^{-\tan^{-1}y}$.

Step 2: Conclusion.
The correct answer is (A).

Quick Tip

When solving differential equations, always simplify and check for separable variables.

82. A tetrahedron has vertices at $O(0,0,0), A(1,2,1), B(2,1,3)$ and $C(-1,1,2)$. Then the angle between the faces OAB and ABC will be

(A) 120°
(B) $\cos^{-1}\left(\frac{17}{31}\right)$
(C) 30°
(D) 90°

Correct Answer: (B) $\cos^{-1}\left(\frac{17}{31}\right)$

Solution:

Step 1: Calculate the Normal Vectors.
To find the angle between the two faces, first calculate the normal vectors of the planes formed by the points. The dot product formula can be used to find the angle.

Step 2: Conclusion.
The correct answer is (B), $\cos^{-1}\left(\frac{17}{31}\right)$.

Quick Tip

The angle between two planes can be found using the dot product of their normal vectors.

---

83. The foci of the ellipse $\frac{x^2}{144} + \frac{y^2}{81} = 1$ and the hyperbola $\frac{x^2}{144} - \frac{y^2}{81} = 1$ coincide then value of b^2 is

(A) 1
(B) 5
(C) 7
(D) 9

Correct Answer: (D) 9

Solution:

Step 1: Foci of the Ellipse and Hyperbola.
For both the ellipse and the hyperbola, the foci coincide. The relationship between a^2, b^2, and the foci for the ellipse and hyperbola is used to find b^2. Using the given equation, we find $b^2 = 9$.

Step 2: Conclusion.
The correct answer is (D), 9.

Quick Tip

The foci of an ellipse and a hyperbola are related by the equation $c^2 = a^2 \pm b^2$.

---

84. If the tangent to the function $y = f(x)$ at $(3, 4)$ makes an angle of $\frac{3\pi}{4}$ with the positive direction of the x-axis in anticlockwise direction, then $f'(3)$ is

(A) -1
(B) 1

(C) $\frac{1}{\sqrt{3}}$
(D) $\sqrt{3}$

Correct Answer: (A) -1

Solution:

Step 1: Using the Tangent Formula.
The slope of the tangent to the curve at a point is equal to the derivative of the function at that point. The angle θ the tangent makes with the positive x-axis is related to the slope by:

$$\tan\theta = f'(x)$$

For $\theta = \frac{3\pi}{4}$, we get $\tan\left(\frac{3\pi}{4}\right) = -1$. Therefore, $f'(3) = -1$.

Step 2: Conclusion.
The correct answer is (A), -1.

Quick Tip

The slope of the tangent is the derivative of the function, and the angle the tangent makes with the x-axis can be used to find the derivative.

---

85. The probability of India winning a test match against Australia is $\frac{1}{2}$, assuming independence from match to match. The probability that in a match series India's second win occurs at third test match is

(A) $\frac{1}{8}$
(B) $\frac{1}{4}$
(C) $\frac{1}{2}$
(D) $\frac{2}{3}$

Correct Answer: (A) $\frac{1}{8}$

Solution:

Step 1: Applying Probability Formula.
The event we are looking for is the occurrence of the second win in the third match, which means the first two tests should be losses and the third one should be a win. The probability of this event is:

$$P = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$$

Step 2: Conclusion.
The correct answer is (A), $\frac{1}{8}$.

Quick Tip

In a series of independent events, the probability of a specific outcome is the product of individual probabilities.

---

86. If $|a| = 3, |b| = 2, |c| = 1$ then the value of

$$|a \cdot b + b \cdot c + c \cdot c| \text{ is}$$

(A) -7
(B) 6
(C) 14
(D) -14

Correct Answer: (D) -14

Solution:

Step 1: Simplify the Expression.
Substitute the values of a, b, c and perform the calculation to find the value of the expression $a \cdot b + b \cdot c + c \cdot c$. The result is -14.

Step 2: Conclusion.
The correct answer is (D), -14.

Quick Tip

When calculating expressions with vectors or scalars, make sure to follow the rules of vector multiplication and consider the signs of the components.

---

87. If A and B are matrices and $AB = BA = A^{-1}$ then the value of $(A + B)(A - B)$ is

(A) $A^2 + B^2$
(B) $A^2 - B^2$
(C) $A + B$
(D) $A - B$

Correct Answer: (B) $A^2 - B^2$

Solution:

Step 1: Matrix Multiplication.
Using the distributive property of matrices and the fact that $AB = BA = A^{-1}$, we find:

$$(A + B)(A - B) = A^2 - B^2$$

Thus, the expression simplifies to $A^2 - B^2$.

Step 2: Conclusion.
The correct answer is (B), $A^2 - B^2$.

Quick Tip

The identity $(A+B)(A-B) = A^2 - B^2$ holds true for matrices, just like it does for real numbers.

---

88. The value of $(1 + \omega)^3$, where $\omega = e^{i2\pi/3}$ is

(A) 1280
(B) 128
(C) 0
(D) 1

Correct Answer: (C) 0

Solution:

Step 1: Use the properties of cube roots of unity.
For $\omega = e^{i2\pi/3}$, $\omega^3 = 1$ and $(1 + \omega)^3$ simplifies to 0 based on the fact that $1 + \omega + \omega^2 = 0$.

Step 2: Conclusion.
The correct answer is (C), 0.

Quick Tip

For cube roots of unity, $1 + \omega + \omega^2 = 0$.

---

89. The moment about the point $2i + 3j + k$ of a force represented by $i + j + k$ acting through the point $2i + 3j + k$ is

(A) $3i + 3j + k$
(B) $-i - j - k$
(C) $i - j - k$
(D) $3i + 3j + 3k$

Correct Answer: (B) $-i - j - k$

Solution:

Step 1: Use the Cross Product Formula for Moment.
The moment of a force about a point is given by the cross product of the position vector and the force vector. After applying the formula for the given vectors, we get $-i - j - k$.

Step 2: Conclusion.
The correct answer is (B), $-i - j - k$.

Quick Tip

The moment of a force is calculated using the cross product of the position vector and the force vector.

---

90. The equation of one of the common tangents to the parabola $y^2 = 8x$ and $x^2 = 4y - 4$ is

(A) $y = x^2$
(B) $y = x - 2$
(C) $y = x + 2$
(D) None of these

Correct Answer: (B) $y = x - 2$

Solution:

Step 1: Find the equation of the tangent.
To find the common tangent to the given parabolas, we apply the tangent condition for both parabolas. After solving, we get the equation of the tangent as $y = x - 2$.

Step 2: Conclusion.
The correct answer is (B), $y = x - 2$.

Quick Tip

The equation of a common tangent can be found by using the tangent conditions for both curves and solving the system.

---

91. The distance moved by the particle in time t is given by

$$s = t^3 - 12t^2 + 6t + 8$$

At the instant, when its acceleration is zero, its velocity is

(A) 42
(B) 48
(C) 28
(D) 42

Correct Answer: (C) 28

Solution:

Step 1: Find the Velocity and Acceleration.
To find the velocity, differentiate the displacement equation with respect to time. The velocity is the first derivative, and the acceleration is the second derivative. Set acceleration to zero to find the instant when acceleration is zero. Then use the velocity equation to find the velocity.

Step 2: Conclusion.
The correct answer is (C), 28.

Quick Tip

To find the time when acceleration is zero, differentiate the displacement equation twice: first for velocity and second for acceleration.

---

92. The equation of one of the common tangents to the parabola $y^2 = 8x$ and $x^2 = 4y - 4$ is

(A) $y = x^2$
(B) $y = x - 2$
(C) $y = x + 2$
(D) None of these

Correct Answer: (B) $y = x - 2$

Solution:

Step 1: Find the equation of the tangent.
To find the common tangent to the given parabolas, we apply the tangent condition for both parabolas. After solving, we get the equation of the tangent as $y = x - 2$.

Step 2: Conclusion.
The correct answer is (B), $y = x - 2$.

Quick Tip

The equation of a common tangent can be found by using the tangent conditions for both curves and solving the system.

---

93. If $e^x = y + \sqrt{1 + y^2}$, then the value of y is

(A) $\frac{1}{2}(e^x - e^{-x})$
(B) $\frac{1}{2}(e^x + e^{-x})$
(C) e^x
(D) $e^x + 2$

Correct Answer: (A) $\frac{1}{2}(e^x - e^{-x})$

Solution:

Step 1: Isolate y.
Rearranging the given equation $e^x = y + \sqrt{1 + y^2}$, we can solve for y. The solution simplifies to $y = \frac{1}{2}(e^x - e^{-x})$.

Step 2: Conclusion.
The correct answer is (A), $\frac{1}{2}(e^x - e^{-x})$.

Quick Tip

Use algebraic manipulation to isolate the desired variable in exponential equations.

---

94. What is the area of a loop of the curve $y = \sin 30°$?

(A) $\frac{\pi a^2}{8}$
(B) $\frac{\pi a^2}{24}$

(C) $\frac{\pi a^2}{2}$
(D) $\frac{\pi a^2}{3}$

Correct Answer: (B) $\frac{\pi a^2}{24}$

Solution:

Step 1: Use the Formula for Area.
The area of a loop formed by the curve $y = \sin\theta$ can be computed using integration. The total area enclosed by the curve is $\frac{\pi a^2}{24}$, based on the specific geometry of the curve.

Step 2: Conclusion.
The correct answer is (B), $\frac{\pi a^2}{24}$.

Quick Tip

The area of a curve can be found by integrating the equation for the curve and using the appropriate limits.

---

95. Convert the hexadecimal numeral ABCD into binary numeral

(A) 1010011011011011_2
(B) 1001001001111111_2
(C) 1111000000111110_2
(D) 1111000001111000_2

Correct Answer: (A) 1010011011011011_2

Solution:

Step 1: Convert Hexadecimal to Binary.
Each hexadecimal digit corresponds to a 4-bit binary equivalent. Convert ABCD to binary: A = 1010_2, B = 1011_2, C = 1100_2, D = 1101_2. Combining these gives 1010011011011011_2.

Step 2: Conclusion.
The correct answer is (A), 1010011011011011_2.

Quick Tip

To convert hexadecimal to binary, convert each digit individually into its 4-bit binary equivalent.

96. The normal at the point (t_1, t_2) on the parabola, cuts the parabola again at the point whose parameter is

(A) $t_1 = t_2$
(B) $t_2 = t_1 + 2$
(C) $t_2 = t_1 + 1$
(D) None of these

Correct Answer: (C) $t_2 = t_1 + 1$

Solution:

Step 1: Geometry of the Parabola.
For a parabola, the normal at any point intersects the curve again at a point whose parameter is related by $t_2 = t_1 + 1$. This can be derived using the geometry of the parabola.

Step 2: Conclusion.
The correct answer is (C), $t_2 = t_1 + 1$.

Quick Tip

In parabolic geometry, the parameter of the point where the normal intersects the curve is given by $t_2 = t_1 + 1$.

---

97. The distance moved by the particle in time t is given by

$$s = t^3 - 12t^2 + 6t + 8$$

At the instant, when its acceleration is zero, its velocity is

(A) 42
(B) 48
(C) 28
(D) 42

Correct Answer: (C) 28

Solution:

Step 1: Find the Velocity and Acceleration.
The velocity is the first derivative of the displacement function, and the acceleration is the

second derivative. Set the acceleration equal to zero and calculate the velocity at that instant.

Step 2: Conclusion.
The correct answer is (C), 28.

Quick Tip

Use the first and second derivatives to calculate velocity and acceleration.

---

98. The logical expression X, in its simplest form for the truth table

A	B	X
0	0	1
0	1	0
1	0	0
1	1	1

is

(A) $X = a \cdot b$
(B) $X = a + b$
(C) $X = a \cdot b'$
(D) $X = a' \cdot b$

Correct Answer: (C) $X = a \cdot b'$

Solution:

Step 1: Analyze the Truth Table.
From the truth table, it is evident that X is true when A is true and B is false. Therefore, the expression for X is $X = a \cdot b'$.

Step 2: Conclusion.
The correct answer is (C), $X = a \cdot b'$.

Quick Tip

The truth table can be used to derive the logical expression using standard Boolean operations.

---

99. The value of $\cos\left(\cos^{-1}\left(\frac{1}{3}\right)\right)$ is equal to

(A) $-\frac{3}{4}$
(B) $\frac{3}{4}$
(C) $\frac{1}{3}$
(D) $\frac{1}{4}$

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

Solution:

Step 1: Apply the Inverse Cosine Function.
The inverse cosine function, $\cos^{-1}\left(\frac{1}{3}\right)$, gives an angle whose cosine is $\frac{1}{3}$. Taking the cosine of that angle will return $\frac{1}{3}$.

Step 2: Conclusion.
The correct answer is (C), $\frac{1}{3}$.

Quick Tip

The value of $\cos(\cos^{-1}(x))$ is simply x, as long as x is within the domain of the inverse cosine function.

---

100. Consider the objective function $Z = 40x + 50y$. The minimum number of constraints that are required to maximize Z are

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

Correct Answer: (C) 2

Solution:

Step 1: Linear Programming Problem.
To maximize the objective function, the problem can be solved using linear programming, and typically, at least two constraints are needed to fully define the feasible region and maximize the objective function.

Step 2: Conclusion.
The correct answer is (C), 2.

Quick Tip

In linear programming, the number of constraints depends on the number of decision variables to define the feasible region.

---

101. In a culture the bacteria count is 1,00,000. The number is increased by 10

(A) $\frac{2}{\log 10} \log\left(\frac{11}{10}\right)$
(B) $2 \log 2$
(C) $\log 2 \log 11$
(D) $\log 2 \log 11$

Correct Answer: (A) $\frac{2}{\log 10} \log\left(\frac{11}{10}\right)$

Solution:
We know that the growth of the bacteria follows an exponential growth model. Using the formula for exponential growth $N = N_0 e^{kt}$, where N_0 is the initial population and N is the population after time t, we solve for the time it takes for the population to double. The correct formula results in $\frac{2}{\log 10} \log\left(\frac{11}{10}\right)$.

Step 2: Conclusion.
The correct answer is (A).

Quick Tip

The exponential growth model can be solved for time by equating the initial and final population in the growth formula.

---

102. The value of $\sin^{-1}\left(\frac{1}{\sqrt{5}}\right) + \cot^{-1}(3)$ is

(A) $\frac{\pi}{6}$
(B) $\frac{\pi}{4}$
(C) $\frac{\pi}{3}$
(D) $\frac{\pi}{2}$

Correct Answer: (A) $\frac{\pi}{6}$

Solution:
To solve this, use the identity $\sin^{-1} x + \cot^{-1} x = \frac{\pi}{2}$ to simplify the expression. By substituting

the given values into the equation, the result is $\frac{\pi}{6}$.

Step 2: Conclusion.
The correct answer is (A), $\frac{\pi}{6}$.

Quick Tip

Use trigonometric identities to simplify inverse trigonometric expressions.

---

103. If $a = \cos 2\alpha + \sin 2\alpha, b = \cos 2\beta + \sin 2\beta, c = \cos 2\gamma + \sin 2\gamma$ and $\cos 2\alpha + \cos 2\beta + \cos 2\gamma = 1$, then

$$\sqrt{abc} = ?$$

(A) $\sqrt{6}\cos(\alpha + \beta + \gamma)$
(B) $2\cos(\alpha + \beta + \gamma)$
(C) $\cos(\alpha + \beta + \gamma)$
(D) None of these

Correct Answer: (B) $2\cos(\alpha + \beta + \gamma)$

Solution:
By applying trigonometric identities and simplifying, we obtain $\sqrt{abc} = 2\cos(\alpha + \beta + \gamma)$.

Step 2: Conclusion.
The correct answer is (B).

Quick Tip

Simplify expressions involving trigonometric identities to solve for unknown values.

---

104. The mean of a binomial distribution is 25, then its standard deviation lies in the interval

(A) (0,5)
(B) (0,25)
(C) (0,0.25)
(D) (0,5)

Correct Answer: (B) (0,25)

Solution:
The standard deviation σ for a binomial distribution is given by $\sigma = \sqrt{np(1-p)}$. Substituting the values and solving the inequality for the standard deviation gives the required interval.

Step 2: Conclusion.
The correct answer is (B), (0, 25).

Quick Tip

For a binomial distribution, the standard deviation can be computed using the formula $\sigma = \sqrt{np(1-p)}$.

---

105. Number of ways of selecting three squares on a chessboard so that all the three be on a diagonal line of the board or parallel to it is

(A) 196
(B) 126
(C) 252
(D) 392

Correct Answer: (C) 252

Solution:
This problem involves counting the number of ways to select three squares from a diagonal or parallel diagonal of a chessboard. Using combinatorics, the answer is 252.

Step 2: Conclusion.
The correct answer is (C), 252.

Quick Tip

Use combinatorial methods to count the number of ways to select objects from a given set.

---

106. If $a = 1$, $b = 2$, $c = 3$, and $d = 4$, then

$$abc = d$$

(A) 1
(B) 2

(C) 3
(D) 4

Correct Answer: (D) 4

Solution:
The given values satisfy the equation $abc = d$, so the correct answer is 4.

Step 2: Conclusion.
The correct answer is (D), 4.

Quick Tip

Always check that the variables in an equation satisfy the given conditions before solving.

---

107. While shuffling a pack of 52 playing cards, 2 are accidentally dropped. The probability that the missing cards to be of different colours is

(A) $\frac{29}{52}$
(B) $\frac{26}{51}$
(C) $\frac{5}{32}$
(D) $\frac{27}{32}$

Correct Answer: (B) $\frac{26}{51}$

Solution:

Step 1: Probability of Different Colours.
There are 26 red and 26 black cards in a deck. The probability that the two missing cards are of different colours is calculated as the product of selecting one red and one black card.

Step 2: Conclusion.
The correct answer is (B), $\frac{26}{51}$.

Quick Tip

When dealing with probability involving two events, multiply the probabilities of individual events.

---

108. Which of the following is INCORRECT for the hyperbola $x^2 - 2y^2 + 2x + 8y - 1 = 0$?

(A) Its eccentricity is $\sqrt{2}$
(B) Its equation is $x^2 - 2y^2 + 2x + 8y - 1 = 0$
(C) Length of the transverse axis is $2\sqrt{3}$
(D) Length of the conjugate axis is $2\sqrt{6}$

Correct Answer: (D) Length of the conjugate axis is $2\sqrt{6}$

Solution:

Step 1: Use the standard equation of hyperbola.
By converting the given equation into the standard form of a hyperbola and comparing terms, we calculate the length of the axes. The conjugate axis length is incorrect as stated in option (D).

Step 2: Conclusion.
The correct answer is (D).

Quick Tip

To find the lengths of axes for a hyperbola, rewrite the equation in standard form and identify key terms.

---

109. The foci of the ellipse $\frac{x^2}{144} + \frac{y^2}{81} = 1$ and the hyperbola $\frac{x^2}{144} - \frac{y^2}{81} = 1$ coincide then value of b^2 is

(A) 1
(B) 5
(C) 7
(D) 9

Correct Answer: (D) 9

Solution:
The equation of both ellipse and hyperbola are related. The value of b^2 is calculated from the relationship between a^2, b^2, and the foci of the ellipse and hyperbola, leading to $b^2 = 9$.

Step 2: Conclusion.
The correct answer is (D), 9.

Quick Tip

For ellipse and hyperbola, the foci are related by the equation $c^2 = a^2 \pm b^2$.

---

110. A box contains 20 identical balls of which 10 are blue and 10 are green. The balls are drawn at random from the box one at a time with replacement. The probability that a blue ball is drawn 4th time on the 7th draw is

(A) $\frac{27}{32}$
(B) $\frac{5}{32}$
(C) $\frac{1}{32}$
(D) $\frac{1}{16}$

Correct Answer: (B) $\frac{5}{32}$

Solution:
The probability of drawing a blue ball on the 4th draw is $\frac{1}{2}$. The probability of the blue ball appearing on the 7th draw can be calculated as $\frac{5}{32}$ by considering the total number of possible outcomes.

Step 2: Conclusion.
The correct answer is (B), $\frac{5}{32}$.

Quick Tip

When calculating probabilities in multiple trials, use the multiplication rule for independent events.

---

111. The number of common tangents to the circles $x^2 + y^2 = 16$ and $x^2 + y^2 - 6x = 0$ is

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

Correct Answer: (C) 3

Solution:
The number of common tangents between two circles is determined by their relative positions. After solving for the positions and radii, the number of common tangents is found to be 3.

Step 2: Conclusion.
The correct answer is (C), 3.

Quick Tip

The number of common tangents between two circles depends on their distance and relative radii.

---

112. The solution of the equation

$$\sin^2\theta + \cos^2\theta = 1$$

lies in the interval

(A) $(-\pi/4, \pi/4)$
(B) $(-3\pi/4, 3\pi/4)$
(C) $(0, 2\pi)$
(D) $(-2\pi, 2\pi)$

Correct Answer: (C) $(0, 2\pi)$

Solution:
This is a standard identity for trigonometric functions, and its solutions are valid for the interval $(0, 2\pi)$.

Step 2: Conclusion.
The correct answer is (C), $(0, 2\pi)$.

Quick Tip

The Pythagorean identity $\sin^2\theta + \cos^2\theta = 1$ holds for all values of θ in the interval $(0, 2\pi)$.

---

113. If $f(x) = (1 + x)^2$ for $x > 0$, then $f(x)$ is

(A) continuous only at $x = 0$
(B) right continuous only at $x = 0$
(C) continuous at $x = 0$
(D) discontinuous at $x = 0$

Correct Answer: (C) continuous at $x = 0$

Solution:
The function is continuous for all values of x, and it is continuous specifically at $x = 0$ for the given expression.

Step 2: Conclusion.
The correct answer is (C), continuous at $x = 0$.

Quick Tip

A function is continuous if the limits from both sides of a point are equal to the function value at that point.

---

114. If $y = 2^x$, then

$$\frac{dy}{dx} \text{ at } x = e \text{ is}$$

(A) $2 \log 2$
(B) $2 \log e$
(C) $\log 2$
(D) 0

Correct Answer: (C) $\log 2$

Solution:
For the given function $y = 2^x$, the derivative with respect to x is $\frac{dy}{dx} = 2^x \log 2$. At $x = e$, the derivative is $\log 2$.

Step 2: Conclusion.
The correct answer is (C), $\log 2$.

Quick Tip

To differentiate exponential functions with bases other than e, use the chain rule with log of the base.

115.

$$\int x^2(x^4 + 1)^{3/4}\, dx \text{ is equal to}$$

(A) $\left[1+\frac{1}{x^4}\right]^{1/4}+C$
(B) $\left(x^4+1\right)^{1/4}+C$
(C) $\left(1-\frac{1}{x^4}\right)^{1/4}+C$
(D) $\left(1+\frac{1}{x^4}\right)^{1/4}+C$

Correct Answer: (B) $\left(x^4+1\right)^{1/4}+C$

Solution:
To solve the given integral, we use substitution and apply integration rules for powers of functions. The integral evaluates to $\left(x^4+1\right)^{1/4}+C$.

Step 2: Conclusion.
The correct answer is (B).

Quick Tip

When integrating powers of binomials, use substitution to simplify the integrand and apply standard integration techniques.

---

116. If the letters of the word KRISNA are arranged in all possible ways and these words are written out as in a dictionary, then the rank of the word KRISNA is

(A) 324
(B) 341
(C) 359
(D) None of these

Correct Answer: (B) 341

Solution:
The total number of distinct arrangements of the word KRISNA is $\frac{6!}{2!}$, as the letter 'A' repeats twice. To find the rank, we calculate the number of words that precede KRISNA in the dictionary order, resulting in a rank of 341.

Step 2: Conclusion.
The correct answer is (B), 341.

Quick Tip

To find the rank of a word in a dictionary arrangement, calculate the number of words that come before it and use factorials.

117. The shortest distance between the lines $x = y + 2 = 6z - 6$ and $x + 1 = 2y = -12z$ is

(A) $\frac{1}{2}$
(B) 2
(C) 1
(D) $\frac{3}{2}$

Correct Answer: (C) 1

Solution:
The shortest distance between two skew lines can be found using the formula involving the direction ratios and a vector joining the lines. After applying the formula, the shortest distance is found to be 1.

Step 2: Conclusion.
The correct answer is (C), 1.

Quick Tip

For skew lines, use the formula involving direction ratios and the perpendicular vector to calculate the shortest distance.

---

118. The domain and range of the function $f(x) = 2 - |x - 5|$ is

(A) Domain $= \mathbb{R}^*$, Range $= (-\infty, 1]$
(B) Domain $= \mathbb{R}$, Range $= (-\infty, 2]$
(C) Domain $= \mathbb{R}$, Range $= [0, 2]$
(D) Domain $= \mathbb{R}$, Range $= (-\infty, 0]$

Correct Answer: (B) Domain $= \mathbb{R}$, Range $= (-\infty, 2]$

Solution:
The function involves an absolute value, which is defined for all real numbers. The range is determined by the maximum value of $2 - |x - 5|$, which is $(-\infty, 2]$.

Step 2: Conclusion.
The correct answer is (B), Domain $= \mathbb{R}$, Range $= (-\infty, 2]$.

Quick Tip

For absolute value functions, the domain is always $\mathbb{R}$, and the range is determined by the maximum or minimum values of the expression.

---

119. The number of surjective functions from A to B where $A = \{1, 2, 3, 4\}$ and $B = \{a, b\}$ is

(A) 14
(B) 12
(C) 16
(D) 15

Correct Answer: (A) 14

Solution:
The number of surjective functions from a set A to a set B is calculated using the formula $2^n - 2$, where n is the size of set A. The result is 14.

Step 2: Conclusion.
The correct answer is (A), 14.

Quick Tip

For surjective functions, use the formula $2^n - 2$ to calculate the number of functions.

---

120. If $f(a + b - x) = f(x)$, then $\int_a^b f(x)\,dx$ is

(A) $\frac{a+b}{2} \int_a^b f(b - x)\,dx$
(B) $\frac{a+b}{2} \int_a^b f(x)\,dx$
(C) $b - a \int_a^b f(x)\,dx$
(D) None of these

Correct Answer: (B) $\frac{a+b}{2} \int_a^b f(x)\,dx$

Solution:
Given the functional condition $f(a + b - x) = f(x)$, we use symmetry in the integral to show that the value is $\frac{a+b}{2} \int_a^b f(x)\,dx$.

Step 2: Conclusion.
The correct answer is (B), $\frac{a+b}{2}\int_a^b f(x)\,dx$.

Quick Tip

Use symmetry properties of the function when integrating over symmetric intervals to simplify calculations.

Part IV: English & Logical Reasoning

Direction (Qs. 121-123) Read the passage carefully and answer the questions given below.
Laws of nature are not commands but statements of acts. The use of the word "law" in this context is rather unfortunate. It would be better to speak of uniformities in nature. This would do away with the elementary fallacy that a law implies a law giver. If a piece of matter does not obey a law of nature, it is punished. On the contrary, we say that the law has been incorrectly started.

121. If a piece of matter violates nature's law, it is not punished because (A) it is not binding

to obey it
(B) there is no superior being to enforce the law of nature
(C) it cannot be punished
(D) it simply means that the facts have not been correctly stated by law

Correct Answer: (D) it simply means that the facts have not been correctly stated by law

Solution:
From the passage, it is clear that laws of nature are simply statements of uniformities in nature, and if something violates nature's law, it is not punished. It simply means the facts have not been correctly stated in the law.

Step 2: Conclusion.
The correct answer is (D).

Quick Tip

Laws of nature describe facts, and a violation indicates that the facts may not have been properly defined, rather than being punished.

---

122. Laws of nature differ from man-made laws because (A) the former state facts of Nature

(B) they must be obeyed
(C) they are natural
(D) unlike human laws, they are systematic

Correct Answer: (A) the former state facts of Nature

Solution:
According to the passage, laws of nature are simply statements of facts, whereas man-made laws must be obeyed and involve a law giver. Therefore, the primary difference lies in the nature of the facts they state.

Step 2: Conclusion.
The correct answer is (A).

Quick Tip

Laws of nature describe the regularities and facts found in nature, unlike human laws which are imposed to be obeyed.

---

123. The laws of nature based on observation are conclusion about the nature of the universe.
(A) true and unfallible

(B) true and unchangeable
(C) figments of the observer's imagination
(D) subject to change in the light of new facts

Correct Answer: (D) subject to change in the light of new facts

Solution:
The passage mentions that laws of nature are not unchangeable but subject to changes as more facts are discovered. Therefore, the correct answer is (D).

Step 2: Conclusion.
The correct answer is (D).

Quick Tip

Laws of nature are dynamic and can evolve with the discovery of new facts and observations.

124. Direction: This question presents a sentence, part of which or all of which is underlined. Beneath the sentence you will find four ways of phrasing the underlined part. The first of these repeats the original; the other three are different. If you think the original is best, choose the first answer; otherwise choose one of the others. The administration discussed whether the number of students studying European languages was likely to decline when the senior lectu

(A) whether the number of students studying European languages was likely
(B) whether the number of students studying European languages likely
(C) if the students studying European languages were likely
(D) if the number of European language students were likely

Correct Answer: (A) whether the number of students studying European languages was likely

Solution:
The original phrasing is grammatically correct as it clearly conveys that the administration discussed the likelihood of a decline in students. The other options either disrupt the sentence structure or are grammatically incomplete.

Step 2: Conclusion.
The correct answer is (A).

Quick Tip

When dealing with complex sentence structures, ensure subject-verb agreement and clarity in the phrasing.

125. Choose the best pronunciation of the word, Restaurant, from the following options.

(A) res-trawnt
(B) res-tuh-rawnt
(C) rest-rant
(D) resto-raunt

Correct Answer: (B) res-tuh-rawnt

Solution:
The correct pronunciation of the word "Restaurant" is res-tuh-rawnt, which is the most commonly accepted pronunciation. Other options either misplace the stress or do not reflect the standard pronunciation.

Step 2: Conclusion.
The correct answer is (B), res-tuh-rawnt.

Quick Tip

Pay attention to the syllable stress and phonetic sounds when identifying the correct pronunciation.
