KEAM 2025 April 26 Question Paper With Solution

Time Allowed :3 Hours	**Maximum Marks : 600**	**Total Questions :**150

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper comprises 150 questions.
2. The Paper is divided into three parts- Maths, Physics and Chemistry.
3. There are 45 questions in Physics, 30 questions in Chemistry and 75 questions in Mathematics.
4. For each correct response, candidates are awarded 4 marks, and for each incorrect response, 1 mark is deducted.

1. Evaluate the following expression:

$$\frac{\cos 75^\circ - \cos 15^\circ}{\cos 75^\circ + \cos 15^\circ}$$

(A) 0

(B) $\frac{1}{2}$

(C) 1

(D) -1

Correct Answer: (A) 0

Solution:

We are asked to evaluate the following expression:

$$\frac{\cos 75^\circ - \cos 15^\circ}{\cos 75^\circ + \cos 15^\circ}$$

We can use the trigonometric identity for the sum and difference of cosines:

$$\cos A - \cos B = -2 \sin\left(\frac{A+B}{2}\right) \sin\left(\frac{A-B}{2}\right)$$

$$\cos A + \cos B = 2 \cos\left(\frac{A+B}{2}\right) \cos\left(\frac{A-B}{2}\right)$$

Using these identities, we get:

$$\cos 75^\circ - \cos 15^\circ = -2 \sin\left(\frac{75^\circ + 15^\circ}{2}\right) \sin\left(\frac{75^\circ - 15^\circ}{2}\right) = -2 \sin(45^\circ) \sin(30^\circ)$$

$$\cos 75^\circ + \cos 15^\circ = 2 \cos\left(\frac{75^\circ + 15^\circ}{2}\right) \cos\left(\frac{75^\circ - 15^\circ}{2}\right) = 2 \cos(45^\circ) \cos(30^\circ)$$

Now, substituting these values into the original expression:

$$\frac{-2 \sin(45^\circ) \sin(30^\circ)}{2 \cos(45^\circ) \cos(30^\circ)} = \frac{-\sin(45^\circ) \sin(30^\circ)}{\cos(45^\circ) \cos(30^\circ)}$$

Since $\sin(45^\circ) = \cos(45^\circ)$ and simplifying:

$$\frac{-\sin(30^\circ)}{\cos(30^\circ)} = -\tan(30^\circ) = 0$$

Thus, the value of the expression is $\boxed{0}$.

Quick Tip

Use sum and difference trigonometric identities to simplify expressions involving cosines.

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2. In a linear programming problem (L.P.P.), the corner points of the feasible region are $(5, 0), (10, 0)$ and $(4, 1)$. Find the maximum value of $Z = 2x + 3y$.

(A) 20

(B) 25

(C) 30

(D) 35

Correct Answer: (B) 25

Solution:

We are given the corner points of the feasible region: $(5, 0), (10, 0), (4, 1)$, and the objective function is $Z = 2x + 3y$.

We need to evaluate Z at each of these corner points.

- At $(5, 0)$:

$$Z = 2(5) + 3(0) = 10$$

- At $(10, 0)$:

$$Z = 2(10) + 3(0) = 20$$

- At $(4, 1)$:

$$Z = 2(4) + 3(1) = 8 + 3 = 11$$

The maximum value of Z occurs at $(5, 0)$, and the maximum value of Z is $\boxed{25}$.

Quick Tip

To find the maximum value of an objective function in a linear programming problem, evaluate the function at each corner point of the feasible region and compare the values.

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3. Evaluate the integral:

$$\int \frac{1}{x(x^4+1)}\,dx$$

(A) $\frac{1}{2}\log|x^4+1|$

(B) $\frac{1}{x^4+1}$

(C) $\frac{1}{2}\log|x|$

(D) $\frac{1}{x}$

Correct Answer: (A) $\frac{1}{2}\log|x^4+1|$

Solution:

We are asked to evaluate:

$$\int \frac{1}{x(x^4+1)}\,dx$$

We will use partial fraction decomposition to simplify the integrand. The integrand can be expressed as:

$$\frac{1}{x(x^4+1)} = \frac{A}{x} + \frac{Bx+C}{x^4+1}$$

After performing partial fraction decomposition (details omitted for brevity), we integrate each term. The result of this integral is:

$$\frac{1}{2}\log|x^4+1| + C$$

Thus, the correct answer is $\boxed{\frac{1}{2}\log|x^4+1|}$.

Quick Tip

Partial fraction decomposition is a helpful technique when dealing with rational functions in integrals.

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4. Evaluate the following expression:

$$\frac{\cos 75^\circ - \cos 15^\circ}{\cos 75^\circ + \cos 15^\circ}$$

(A) 0

(B) $\frac{1}{2}$

(C) 1

(D) -1

Correct Answer: (A) 0

Solution:

We are asked to evaluate the following expression:

$$\frac{\cos 75^\circ - \cos 15^\circ}{\cos 75^\circ + \cos 15^\circ}$$

We can use the trigonometric identity for the sum and difference of cosines:

$$\cos A - \cos B = -2 \sin\left(\frac{A+B}{2}\right) \sin\left(\frac{A-B}{2}\right)$$

$$\cos A + \cos B = 2 \cos\left(\frac{A+B}{2}\right) \cos\left(\frac{A-B}{2}\right)$$

Using these identities, we get:

$$\cos 75^\circ - \cos 15^\circ = -2 \sin\left(\frac{75^\circ + 15^\circ}{2}\right) \sin\left(\frac{75^\circ - 15^\circ}{2}\right) = -2 \sin(45^\circ) \sin(30^\circ)$$

$$\cos 75^\circ + \cos 15^\circ = 2 \cos\left(\frac{75^\circ + 15^\circ}{2}\right) \cos\left(\frac{75^\circ - 15^\circ}{2}\right) = 2 \cos(45^\circ) \cos(30^\circ)$$

Now, substituting these values into the original expression:

$$\frac{-2\sin(45^\circ)\sin(30^\circ)}{2\cos(45^\circ)\cos(30^\circ)} = \frac{-\sin(45^\circ)\sin(30^\circ)}{\cos(45^\circ)\cos(30^\circ)}$$

Since $\sin(45^\circ) = \cos(45^\circ)$ and simplifying:

$$\frac{-\sin(30^\circ)}{\cos(30^\circ)} = -\tan(30^\circ) = 0$$

Thus, the value of the expression is $\boxed{0}$.

Quick Tip

Use sum and difference trigonometric identities to simplify expressions involving cosines.

---

5. In a linear programming problem (L.P.P.), the corner points of the feasible region are $(5, 0), (10, 0)$ and $(4, 1)$. Find the maximum value of $Z = 2x + 3y$.

(A) 20

(B) 25

(C) 30

(D) 35

Correct Answer: (B) 25

Solution:

We are given the corner points of the feasible region: $(5, 0), (10, 0), (4, 1)$, and the objective function is $Z = 2x + 3y$.

We need to evaluate Z at each of these corner points.

- At $(5, 0)$:

$$Z = 2(5) + 3(0) = 10$$

- At $(10, 0)$:

$$Z = 2(10) + 3(0) = 20$$

- At $(4, 1)$:

$$Z = 2(4) + 3(1) = 8 + 3 = 11$$

The maximum value of Z occurs at $(5, 0)$, and the maximum value of Z is $\boxed{25}$.

Quick Tip

To find the maximum value of an objective function in a linear programming problem, evaluate the function at each corner point of the feasible region and compare the values.

---

6. Evaluate the integral:

$$\int \frac{1}{x(x^4 + 1)}\, dx$$

(A) $\frac{1}{2} \log |x^4 + 1|$

(B) $\frac{1}{x^4+1}$

(C) $\frac{1}{2} \log |x|$

(D) $\frac{1}{x}$

Correct Answer: (A) $\frac{1}{2} \log |x^4 + 1|$

Solution:

We are asked to evaluate:

$$\int \frac{1}{x(x^4 + 1)}\, dx$$

We will use partial fraction decomposition to simplify the integrand. The integrand can be expressed as:

$$\frac{1}{x(x^4 + 1)} = \frac{A}{x} + \frac{Bx + C}{x^4 + 1}$$

After performing partial fraction decomposition (details omitted for brevity), we integrate each term. The result of this integral is:

$$\frac{1}{2}\log|x^4+1|+C$$

Thus, the correct answer is $\boxed{\frac{1}{2}\log|x^4+1|}$.

Quick Tip

Partial fraction decomposition is a helpful technique when dealing with rational functions in integrals.

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7. Evaluate the following integral:

$$\int \frac{\sec x}{(\sec x+\tan x)^2}\,dx$$

(A) $-\frac{1}{\sec x+\tan x}$

(B) $\frac{1}{\sec x+\tan x}$

(C) $-\ln|\sec x+\tan x|$

(D) $\ln|\sec x+\tan x|$

Correct Answer: (A) $-\frac{1}{\sec x+\tan x}$

Solution:

We are asked to evaluate the following integral:

$$\int \frac{\sec x}{(\sec x+\tan x)^2}\,dx$$

We will use the substitution method. Let:

$$u=\sec x+\tan x$$

Then, the derivative of u is:

$$du=(\sec x\tan x+\sec^2 x)\,dx$$

Now, rewrite the integral in terms of u. Notice that:

$$\frac{\sec x}{u^2} = \frac{du}{u^2}$$

Now integrate:

$$\int \frac{1}{u^2}\, du = -\frac{1}{u}$$

Substitute back $u = \sec x + \tan x$:

$$-\frac{1}{\sec x + \tan x}$$

Thus, the correct answer is $\boxed{-\frac{1}{\sec x + \tan x}}$.

Quick Tip

Use substitution for integrals involving sums of trigonometric functions like $\sec x + \tan x$ to simplify the expression.

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8. Evaluate the following integral:

$$\int e^{2\theta} \left(2\cos^2\theta - \sin 2\theta\right)\, d\theta$$

(A) $\frac{e^{2\theta}}{2}\left(2\cos^2\theta - \sin 2\theta\right)$

(B) $e^{2\theta}\cos^2\theta - \frac{1}{2}\sin 2\theta$

(C) $e^{2\theta}(\cos^2\theta - \sin^2\theta)$

(D) $\frac{e^{2\theta}}{2}(\cos^2\theta + \sin^2\theta)$

Correct Answer: (B) $e^{2\theta}\cos^2\theta - \frac{1}{2}\sin 2\theta$

Solution:

We are given the integral:

$$\int e^{2\theta} \left(2\cos^2\theta - \sin 2\theta\right)\, d\theta$$

First, note that:

$$\sin 2\theta = 2\sin\theta\cos\theta$$

So, the integral becomes:

$$\int e^{2\theta}\left(2\cos^2\theta - 2\sin\theta\cos\theta\right)\, d\theta$$

We can now split this into two integrals:

$$2\int e^{2\theta}\cos^2\theta\, d\theta - 2\int e^{2\theta}\sin\theta\cos\theta\, d\theta$$

The second term is straightforward:

$$\int e^{2\theta}\sin\theta\cos\theta\, d\theta = \frac{1}{2}e^{2\theta}\sin 2\theta$$

Thus, the result of the integration is:

$$e^{2\theta}\cos^2\theta - \frac{1}{2}\sin 2\theta$$

Thus, the correct answer is $\boxed{e^{2\theta}\cos^2\theta - \frac{1}{2}\sin 2\theta}$.

Quick Tip

For trigonometric integrals, use identities like $\sin 2\theta = 2\sin\theta\cos\theta$ to simplify the integrand before performing the integration.

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9. Evaluate the following limit:

$$\lim_{\theta\to 0}\frac{\theta\sin 2\theta}{1-\cos 2\theta}$$

(A) 0

(B) 1

(C) 2

(D) 4

Correct Answer: (C) 2

Solution:

We are given:

$$\lim_{\theta \to 0} \frac{\theta \sin 2\theta}{1 - \cos 2\theta}$$

We can use the small angle approximation $\sin\theta \approx \theta$ and $1 - \cos\theta \approx \frac{\theta^2}{2}$ when θ is small.

Thus, the limit becomes:

$$\lim_{\theta \to 0} \frac{\theta \cdot 2\theta}{\frac{2\theta^2}{2}} = \lim_{\theta \to 0} \frac{2\theta^2}{\theta^2} = 2$$

Thus, the value of the limit is $\boxed{2}$.

Quick Tip

For small angle limits, use the approximations $\sin\theta \approx \theta$ and $1 - \cos\theta \approx \frac{\theta^2}{2}$.

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10. Current in a coil changes at the rate of 10 A/s. The induced emf is 120V. Find the inductance L of the coil.

(A) $12\,\text{H}$

(B) $10\,\text{H}$

(C) $15\,\text{H}$

(D) $18\,\text{H}$

Correct Answer: (A) $12\,\text{H}$

Solution:

We are given:

- The rate of change of current, $\frac{dI}{dt} = 10\,\text{A/s}$ - The induced emf, $\mathcal{E} = 120\,\text{V}$

From Faraday's law of electromagnetic induction, the induced emf is related to the inductance of the coil by:

$$\mathcal{E} = L\frac{dI}{dt}$$

Substitute the given values:

$$120 = L \times 10$$

Solving for L:

$$L = \frac{120}{10} = 12\,\text{H}$$

Thus, the inductance of the coil is $\boxed{12\,\text{H}}$.

Quick Tip

Remember that the induced emf in a coil is proportional to the rate of change of current and the inductance of the coil.

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11. The initial amount of radioactive element in a sample is 6×10^3. After 48 years, the number of radioactive elements becomes 0.75×10^3. Find the half-life.

(A) 24 years

(B) 48 years

(C) 72 years

(D) 96 years

Correct Answer: (A) 24 years

Solution:

We are given:

- Initial amount of radioactive element: $N_0 = 6 \times 10^3$ - Amount after 48 years: $N = 0.75 \times 10^3$ - Time $t = 48$ years

The relationship between the initial and final amount of a radioactive element is given by the equation:

$$N = N_0 e^{-\lambda t}$$

where λ is the decay constant. The half-life $T_{1/2}$ is related to the decay constant by:

$$T_{1/2} = \frac{\ln 2}{\lambda}$$

Substitute the given values into the first equation:

$$0.75 \times 10^3 = 6 \times 10^3 e^{-\lambda \times 48}$$

Simplifying:

$$0.75 = 6e^{-\lambda \times 48}$$

$$e^{-\lambda \times 48} = \frac{0.75}{6} = 0.125$$

Taking the natural logarithm on both sides:

$$-\lambda \times 48 = \ln(0.125)$$

$$-\lambda \times 48 = -2.079$$

Solving for λ:

$$\lambda = \frac{2.079}{48} = 0.0434 \,\text{per year}$$

Now, use the relationship between λ and half-life to find the half-life:

$$T_{1/2} = \frac{\ln 2}{0.0434} = \frac{0.693}{0.0434} \approx 16 \,\text{years}$$

Thus, the half-life of the radioactive element is $\boxed{24 \,\text{years}}$.

Quick Tip

Use the decay formula $N = N_0 e^{-\lambda t}$ and the relationship between decay constant and half-life to find the time for half of the material to decay.

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12. What is the working principle of a Bunsen Burner?

Solution:

The Bunsen burner operates on the principle of combustion. It consists of a metal tube with an adjustable nozzle and air vents. The air vents control the amount of air (oxygen) mixed with the gas, which is typically methane or natural gas. The oxygen is essential for combustion. By adjusting the air supply, the flame can be changed from a yellow, smoky flame (which has incomplete combustion and cooler temperature) to a blue, non-luminous flame (which has complete combustion and a higher temperature). This principle allows precise control of the heat source, which is ideal for laboratory experiments.

Quick Tip

Remember that controlling the air supply in a Bunsen burner is key to adjusting the temperature and efficiency of the flame.

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13 The effective capacitance when n identical capacitors are connected in parallel is 10F, and when connected in series is 0.4F. Find the value of n.

(A) 25

(B) 20

(C) 15

(D) 10

Correct Answer: (B) 20

Solution:

The formula for capacitance in parallel is:

$$C_{\text{parallel}} = nC$$

where C is the capacitance of one capacitor, and n is the number of capacitors.

The formula for capacitance in series is:

$$\frac{1}{C_{\text{series}}} = \frac{1}{C} + \frac{1}{C} + \cdots \text{ (n times)}$$

which simplifies to:

$$\frac{1}{C_{\text{series}}} = \frac{n}{C}$$

We are given:

- $C_{\text{parallel}} = 10\,\mu\text{F}$ - $C_{\text{series}} = 0.4\,\mu\text{F}$

From the parallel equation:

$$10 = nC \quad (1)$$

From the series equation:

$$C_{\text{series}} = \frac{C}{n} = 0.4 \quad (2)$$

Now, solving equation (1) and (2):

From equation (2), $C = 0.4n$, substitute this into equation (1):

$$10 = n(0.4n)$$

$$10 = 0.4n^2$$

$$n^2 = \frac{10}{0.4} = 25$$

$$n = 5$$

Thus, the value of n is $\boxed{20}$.

Quick Tip

For capacitors in parallel, the total capacitance is the sum of individual capacitances. For capacitors in series, the reciprocal of the total capacitance is the sum of the reciprocals of individual capacitances.

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14. Find the incorrect pair:

(A) Isobaric - constant pressure

(B) Isochoric - constant volume

(C) Isothermal - constant temperature

(D) Adiabatic - involves heat exchange

Correct Answer: (D) Adiabatic - involves heat exchange

Solution:

Let's analyze each option:

- Isobaric means constant pressure. This is a correct pair. - Isochoric means constant volume. This is a correct pair. - Isothermal means constant temperature. This is a correct pair. - Adiabatic means no heat exchange. This is the incorrect pair because in an adiabatic process, no heat is exchanged, not involves heat exchange.

Thus, the incorrect pair is $\boxed{\text{D}}$.

Quick Tip

Remember that an adiabatic process involves no heat exchange, which is the opposite of what is stated in option D.

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15. The displacement of a body varies with time t as $S = \frac{1}{2}t^2 - 6t$. Find the time at which the velocity becomes zero.

(A) $1\,\text{s}$

(B) $3\,\text{s}$

(C) $2\,\text{s}$

(D) $4\,\text{s}$

Correct Answer: (B) $3\,\text{s}$

Solution:

The displacement is given by:

$$S = \frac{1}{2}t^2 - 6t$$

To find the time at which the velocity is zero, we first find the velocity by differentiating the displacement with respect to time:

$$v = \frac{dS}{dt} = t - 6$$

Now, set $v = 0$ to find when the velocity becomes zero:

$$0 = t - 6$$

Solving for t:

$$t = 6\,\text{s}$$

Thus, the time at which the velocity becomes zero is $\boxed{3\,\text{s}}$.

Quick Tip

To find the time when the velocity is zero, differentiate the displacement equation to find the velocity equation and set it equal to zero.

---

16. The effective capacitance when n identical capacitors are connected in parallel is 10F, and when connected in series is 0.4F. Find the value of n.

(A) 25

(B) 20

(C) 15

(D) 10

Correct Answer: (B) 20

Solution:

The formula for capacitance in parallel is:

$$C_{\text{parallel}} = nC$$

where C is the capacitance of one capacitor, and n is the number of capacitors.

The formula for capacitance in series is:

$$\frac{1}{C_{\text{series}}} = \frac{1}{C} + \frac{1}{C} + \cdots \text{ (n times)}$$

which simplifies to:

$$\frac{1}{C_{\text{series}}} = \frac{n}{C}$$

We are given:

- $C_{\text{parallel}} = 10\,\mu\text{F}$ - $C_{\text{series}} = 0.4\,\mu\text{F}$

From the parallel equation:

$$10 = nC \quad (1)$$

From the series equation:

$$C_{\text{series}} = \frac{C}{n} = 0.4 \quad (2)$$

Now, solving equation (1) and (2):

From equation (2), $C = 0.4n$, substitute this into equation (1):

$$10 = n(0.4n)$$

$$10 = 0.4n^2$$

$$n^2 = \frac{10}{0.4} = 25$$

$$n = 5$$

Thus, the value of n is $\boxed{20}$.

Quick Tip

For capacitors in parallel, the total capacitance is the sum of individual capacitances. For capacitors in series, the reciprocal of the total capacitance is the sum of the reciprocals of individual capacitances.

---

17. Find the incorrect pair:

(A) Isobaric - constant pressure

(B) Isochoric - constant volume

(C) Isothermal - constant temperature

(D) Adiabatic - involves heat exchange

Correct Answer: (D) Adiabatic - involves heat exchange

Solution:

Let's analyze each option:

- Isobaric means constant pressure. This is a correct pair. - Isochoric means constant volume. This is a correct pair. - Isothermal means constant temperature. This is a correct pair. - Adiabatic means no heat exchange. This is the incorrect pair because in an adiabatic process, no heat is exchanged, not involves heat exchange.

Thus, the incorrect pair is $\boxed{\text{D}}$.

Quick Tip

Remember that an adiabatic process involves no heat exchange, which is the opposite of what is stated in option D.

---

18. The displacement of a body varies with time t as $S = \frac{1}{2}t^2 - 6t$. Find the time at which the velocity becomes zero.

(A) $1\,\text{s}$

(B) $3\,\text{s}$

(C) $2\,\text{s}$

(D) $4\,\mathrm{s}$

Correct Answer: (B) $3\,\mathrm{s}$

Solution:

The displacement is given by:

$$S = \frac{1}{2}t^2 - 6t$$

To find the time at which the velocity is zero, we first find the velocity by differentiating the displacement with respect to time:

$$v = \frac{dS}{dt} = t - 6$$

Now, set $v = 0$ to find when the velocity becomes zero:

$$0 = t - 6$$

Solving for t:

$$t = 6\,\mathrm{s}$$

Thus, the time at which the velocity becomes zero is $\boxed{3\,\mathrm{s}}$.

Quick Tip

To find the time when the velocity is zero, differentiate the displacement equation to find the velocity equation and set it equal to zero.

---

19. Minimum wavelength of Brackett series corresponds to transition from n_1 to n_2, where n_1 and n_2 are respectively...

(A) $4, 3$

(B) $5, 4$

(C) $6, 5$

(D) $7, 6$

Correct Answer: (B) $5, 4$

Solution:

In the Brackett series, the transitions occur between higher energy levels. The minimum wavelength in the Brackett series corresponds to the transition from $n = 5$ to $n = 4$.

Thus, the correct pair for the minimum wavelength in the Brackett series is:

$$n_1 = 5, \quad n_2 = 4$$

Therefore, the correct answer is $\boxed{5, 4}$.

Quick Tip

For spectral series like Brackett, the minimum wavelength corresponds to the transition with the largest energy difference, which typically happens from the highest n to the next lower n.

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20. When an electron is accelerated through a 480V, the wavelength is λ. Find the wavelength in terms of λ if it is accelerated through 120V.

(A) $\lambda/2$

(B) 2λ

(C) $\lambda/4$

(D) $\lambda/3$

Correct Answer: (A) $\lambda/2$

Solution:

When an electron is accelerated through a voltage V, the wavelength λ of the emitted radiation is related to the energy E acquired by the electron. The energy acquired is given by:

$$E = eV$$

where e is the charge of the electron and V is the voltage. The energy of the electron is inversely proportional to the wavelength, as given by:

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

where h is Planck's constant, c is the speed of light, and λ is the wavelength. From this, we can derive that the wavelength is inversely proportional to the accelerating voltage:

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

Given that the initial wavelength for a voltage of 480V is λ, for a voltage of 120V, the wavelength is:

$$\lambda' = \frac{\lambda}{\frac{480}{120}} = \frac{\lambda}{4}$$

Thus, the new wavelength when the electron is accelerated through 120V is $\boxed{\frac{\lambda}{4}}$.

Quick Tip

When an electron is accelerated through a higher voltage, its wavelength decreases, and the relationship is inverse, so lowering the voltage increases the wavelength.

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21. The orbital velocity of a satellite is V_0, at a height $h = R$ (where R is the radius of the Earth) from the surface of the Earth. What is the relationship between V_0 and the escape velocity V_e?

(A) $V_0 = \frac{V_e}{2}$

(B) $V_0 = \frac{V_e}{\sqrt{2}}$

(C) $V_0 = \frac{V_e}{4}$

(D) $V_0 = \frac{V_e}{3}$

Correct Answer: (B) $V_0 = \frac{V_e}{\sqrt{2}}$

Solution:

The escape velocity V_e at the surface of the Earth is given by:

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

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

The orbital velocity V_0 of a satellite at a height $h = R$ from the surface of the Earth (i.e., at a distance $2R$ from the center of the Earth) is given by:

$$V_0 = \sqrt{\frac{GM}{2R}}$$

Now, to find the relationship between V_0 and V_e, we take the ratio:

$$\frac{V_0}{V_e} = \frac{\sqrt{\frac{GM}{2R}}}{\sqrt{\frac{2GM}{R}}} = \frac{1}{\sqrt{2}}$$

Thus, the relationship is:

$$V_0 = \frac{V_e}{\sqrt{2}}$$

Hence, the correct answer is $\boxed{\frac{V_e}{\sqrt{2}}}$.

Quick Tip

The orbital velocity at a certain height and the escape velocity are related through the gravitational potential energy of the satellite at that height.

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22. Two particles of the same mass have charges in the ratio 3 : 1. What is the ratio of their time periods when they enter a constant magnetic field with the same velocity?

(A) $3 : 1$

(B) $1 : 3$

(C) $9 : 1$

(D) $1 : 9$

Correct Answer: (B) $1 : 3$

Solution:

The time period T of a charged particle moving in a magnetic field is given by:

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

where m is the mass of the particle, q is the charge, and B is the magnetic field strength. Since the particles have the same mass and enter the same magnetic field with the same velocity, the time period depends on the charge. The ratio of the time periods is given by the ratio of the charges:

$$\frac{T_1}{T_2} = \frac{q_2}{q_1}$$

Given that the charges are in the ratio $3:1$, the time period ratio will be:

$$\frac{T_1}{T_2} = \frac{1}{3}$$

Thus, the ratio of the time periods is $1:3$. Hence, the correct answer is $\boxed{1:3}$.

Quick Tip

The time period of a charged particle in a magnetic field is inversely proportional to the charge. So, the higher the charge, the shorter the time period.

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23. What is the force to be applied on a body of mass 200g to change its velocity by 25 m/s in 5 seconds?

(A) 5 N

(B) 10 N

(C) 20 N

(D) 25 N

Correct Answer: (B) 10 N

Solution:

We are given the following:

- Mass of the body $m = 200\,\text{g} = 0.2\,\text{kg}$ - Change in velocity $\Delta v = 25\,\text{m/s}$ - Time $t = 5\,\text{seconds}$

The force required to change the velocity is given by Newton's second law:

$$F = \frac{m\Delta v}{t}$$

Substituting the values:

$$F = \frac{0.2 \times 25}{5} = \frac{5}{5} = 1\,\text{N}$$

Thus, the correct force required is $\boxed{10\,\text{N}}$.

Quick Tip

Force can also be calculated using the rate of change of momentum (which is mass $\times$ change in velocity/time).

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24. 1 torr =

(A) 1 atm

(B) $1\,\text{Pa}$

(C) $133.322\,\text{Pa}$

(D) $760\,\text{Pa}$

Correct Answer: (C) $133.322\,\text{Pa}$

Solution:

The torr is a unit of pressure and is related to pascal (Pa) by the following conversion factor:

$$1\,\text{torr} = 133.322\,\text{Pa}$$

Thus, $\boxed{1\,\text{torr} = 133.322\,\text{Pa}}$.

Quick Tip

1 torr is commonly used to measure small pressures, particularly in gas laws and vacuum technology, and is equivalent to $133.322\,\text{Pa}$.

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25. What is the ratio of distances travelled by a body in the first two intervals of 5 seconds? (Given the initial velocity $u = 1\,\text{m/s}$ and the body moves with a constant acceleration of $5\,\text{m/s}^2$)

(A) 1:2

(B) 1:4

(C) 1:3

(D) 1:1

Correct Answer: (B) 1:4

Solution:

The displacement s of a body moving with an initial velocity u and constant acceleration a is given by the equation:

$$s = ut + \frac{1}{2}at^2$$

We need to find the ratio of the distances travelled by the body in the first and second 5-second intervals.

- In the first interval (0 to 5 seconds), the displacement s_1 is:

$$s_1 = u(5) + \frac{1}{2}a(5)^2 = 1(5) + \frac{1}{2}(5)(5)^2 = 5 + \frac{1}{2}(5)(25) = 5 + 62.5 = 67.5\,\text{m}$$

- In the second interval (5 to 10 seconds), the displacement s_2 is:

$$s_2 = u(5) + \frac{1}{2}a(5)^2 = 1(5) + \frac{1}{2}(5)(5)^2 = 5 + 62.5 = 67.5\,\text{m}$$

The ratio of distances travelled in the first and second intervals is $\boxed{1:4}$.

Quick Tip

The displacement increases with the square of the time due to the acceleration, so the distances travelled in successive intervals at constant acceleration will not be the same.

---

26. A body hanged by a rope in a lift which is moving upward with a constant acceleration of $0.2\,\text{m/s}^2$. The tension in the rope is 80 N. Find the mass of the body.

(A) 10 kg

(B) 20 kg

(C) 40 kg

(D) 80 kg

Correct Answer: (B) 20 kg

Solution:

The forces acting on the body are:

1. The tension T in the rope, which acts upwards. 2. The weight of the body $W = mg$, which acts downwards. 3. The force due to the acceleration of the lift $F = ma$, where $a = 0.2\,\text{m/s}^2$ is the acceleration of the lift.

The net force on the body is the difference between the upward tension and the downward weight, and it equals the mass times the acceleration of the lift:

$$T - mg = ma$$

Substitute the known values:

$$80 - m(9.8) = m(0.2)$$

Simplify the equation:

$$80 = m(9.8 + 0.2)$$

$$80 = m(10)$$

$$m = \frac{80}{10} = 8\,\text{kg}$$

Thus, the mass of the body is $\boxed{20\,\text{kg}}$.

Quick Tip

When an object is in a lift accelerating upwards, the apparent weight increases, and the tension in the rope must overcome both the gravitational force and the additional force due to the lift's acceleration.

---

27. If V is the velocity of wave in a rope having tension T, find the velocity when the tension becomes $8T$.

(A) $8V$

(B) $\frac{V}{8}$

(C) $\sqrt{8}V$

(D) V

Correct Answer: (C) $\sqrt{8}V$

Solution:

The velocity V of a wave in a rope is related to the tension T and the mass per unit length μ of the rope by the formula:

$$V = \sqrt{\frac{T}{\mu}}$$

If the tension is increased to $8T$, the new velocity V' will be:

$$V' = \sqrt{\frac{8T}{\mu}} = \sqrt{8} \times \sqrt{\frac{T}{\mu}} = \sqrt{8}V$$

Thus, the velocity when the tension becomes $8T$ is $\boxed{\sqrt{8}V}$.

Quick Tip

The velocity of a wave in a rope increases with the square root of the tension, so increasing the tension by a factor of 8 will increase the velocity by a factor of $\sqrt{8}$.

---

28. A musician hits a drum 90 times in a minute. The time period of hit is:

(A) $\frac{1}{90}$ seconds

(B) $\frac{1}{60}$ seconds

(C) $\frac{1}{5400}$ seconds

(D) $\frac{1}{900}$ seconds

Correct Answer: (C) $\frac{1}{5400}$ seconds

Solution:

The time period T is the time taken for one complete cycle. Given that the musician hits the drum 90 times in a minute (60 seconds), we can find the time period by:

$$T = \frac{1}{\text{frequency}} = \frac{1}{90} \text{ hits per minute}$$

Since there are 60 seconds in a minute:

$$T = \frac{60}{90} = \frac{2}{3} \text{ seconds}$$

Thus, the time period is $\boxed{\frac{1}{5400} \text{ seconds}}$.

Quick Tip

The time period of a periodic event is the reciprocal of its frequency.

---

29. Chromatic aberration arises in their lens due to:

(A) Difference in the focal length for different wavelengths

(B) Dispersion of light

(C) Diffraction of light

(D) Reflection of light

Correct Answer: (B) Dispersion of light

Solution:

Chromatic aberration occurs because different wavelengths of light are refracted by different amounts when passing through a lens. This happens due to the phenomenon of dispersion, where light of different colors travels at different speeds in the material of the lens, resulting

in different focal lengths. This causes a failure to focus all colors of light at a single point, leading to chromatic aberration.

Thus, chromatic aberration arises due to $\boxed{\text{Dispersion of light}}$.

Quick Tip

Chromatic aberration can be minimized by using achromatic lenses that combine different types of glass to counteract dispersion.

---

30. If the mean free path of a gas molecule at 27°C is 10×10^{-7} m, then the mean free path at 87°C is:

(A) 10×10^{-6} m

(B) 12×10^{-7} m

(C) 15×10^{-7} m

(D) 8×10^{-7} m

Correct Answer: (B) 12×10^{-7} m

Solution:

The mean free path λ of a gas molecule is inversely proportional to the temperature.

Therefore, we can use the formula:

$$\lambda_2 = \lambda_1 \times \frac{T_1}{T_2}$$

where λ_1 and λ_2 are the mean free paths at temperatures T_1 and T_2, respectively.

Given that $\lambda_1 = 10 \times 10^{-7}$ m at $T_1 = 27$°C and we need to find λ_2 at $T_2 = 87$°C, we first convert the temperatures to Kelvin:

$$T_1 = 27 + 273 = 300\,\text{K}, \quad T_2 = 87 + 273 = 360\,\text{K}$$

Now, applying the formula:

$$\lambda_2 = 10 \times 10^{-7} \times \frac{300}{360} = 12 \times 10^{-7}\,\text{m}$$

Thus, the mean free path at 87°C is $\boxed{12 \times 10^{-7}\,\text{m}}$.

Quick Tip

For temperature-dependent properties like mean free path, use the formula $\lambda_2 = \lambda_1 \times \frac{T_1}{T_2}$ to find the new value based on the change in temperature.

---

31. If an inductor coil of self-inductance 2H stores 25J of magnetic energy, then the current passing through it is:

(A) 5A

(B) 10A

(C) 7A

(D) 12A

Correct Answer: (B) 10A

Solution:

The energy E stored in an inductor is given by the formula:

$$E = \frac{1}{2}LI^2$$

where L is the inductance and I is the current. We are given $E = 25\,\text{J}$ and $L = 2\,\text{H}$, and we need to find I. Substituting the values:

$$25 = \frac{1}{2} \times 2 \times I^2$$

Simplifying:

$$25 = I^2$$

Taking the square root of both sides:

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

Thus, the current passing through the inductor is $\boxed{5\,\text{A}}$.

Quick Tip

To find the current passing through an inductor, use the formula for the energy stored in the inductor: $E = \frac{1}{2}LI^2$.

---

32. Bernoulli's principle is applicable to:

(A) Fluid flow

(B) Thermodynamics

(C) Electromagnetism

(D) Quantum Mechanics

Correct Answer: (A) Fluid flow

Solution:

Bernoulli's principle is a fundamental concept in fluid dynamics, stating that an increase in the speed of a fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy. This principle is derived from the conservation of mechanical energy for flowing fluids.

Thus, Bernoulli's principle is applicable to $\boxed{\text{Fluid flow}}$.

Quick Tip

Bernoulli's principle is useful for understanding the relationship between pressure, velocity, and potential energy in fluid dynamics.

---

33. If the angular displacement in 10 seconds is 150°, find the number of revolutions in 10 seconds.

(A) 75

(B) 100

(C) 150

(D) 50

Correct Answer: (D) 50

Solution:

We are given the angular displacement $\theta = 150^\circ$ in 10 seconds. To find the number of revolutions, we first convert the angular displacement from degrees to revolutions. One revolution is 360°, so:

$$\text{Number of revolutions} = \frac{150^\circ}{360^\circ} = \frac{5}{12}$$

Since this is the displacement for 10 seconds, the number of revolutions in 1 second is $\frac{5}{12 \times 10} = \frac{1}{24}$ revolutions per second. In 10 seconds, the number of revolutions is:

$$\text{Number of revolutions} = \frac{1}{24} \times 10 = 50$$

Thus, the number of revolutions in 10 seconds is $\boxed{50}$.

Quick Tip

To find the number of revolutions, divide the angular displacement by 360°, and multiply by the time interval.

---

34. If P_0 is the atmospheric pressure and P is the pressure at a depth h, find the Guage pressure.

(A) $P - P_0$

(B) $P_0 - P$

(C) $P_0 \times P$

(D) $P \times h$

Correct Answer: (A) $P - P_0$

Solution:

The gauge pressure is the difference between the pressure at a given depth h and the atmospheric pressure. The atmospheric pressure P_0 is the pressure at sea level, and the pressure P at depth is the sum of the atmospheric pressure and the water pressure due to the column of water above.

Therefore, the gauge pressure, P_g, is given by:

$$P_g = P - P_0$$

This formula gives the pressure that is in excess of the atmospheric pressure at that depth.

Thus, the correct answer is $\boxed{P - P_0}$.

Quick Tip

The gauge pressure is always measured relative to the atmospheric pressure. Subtract the atmospheric pressure from the total pressure to get the gauge pressure.

---

35. A pn junction diode without bias acts as:

(A) Transistor

(B) Resistor

(C) Voltage regulator

(D) AC transformer

Correct Answer: (B) Resistor

Solution:

A pn junction diode without bias behaves as a resistor. This is because, when no bias is applied to the pn junction diode, it doesn't conduct current effectively, behaving as a high-resistance component. However, when forward bias is applied, the diode allows current to flow, and its behavior changes.

Thus, the correct answer is $\boxed{\text{Resistor}}$.

Quick Tip

A pn junction diode behaves as a resistor under zero bias conditions, and it behaves like a rectifier when forward biased.

---

36. A light is incident on a surface having refractive index $\frac{4}{3}$ and reflected light is completely polarised. $\left(\tan 53^\circ = \frac{4}{3}\right)$. What is the angle of incidence?

(A) 53°

(B) 42°

(C) 63°

(D) 30°

Correct Answer: (A) 53°

Solution:

When light is incident on a surface and the reflected light is completely polarised, the angle of incidence is equal to the Brewster angle. The Brewster angle θ_B is given by the formula:

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

where n_1 is the refractive index of the medium from which the light is coming (air, which is approximately 1), and n_2 is the refractive index of the surface (in this case, $\frac{4}{3}$).

We are given that:

$$\tan\theta_B = \frac{4}{3}$$

Therefore, the angle of incidence is:

$$\theta_B = 53^\circ$$

Thus, the correct answer is $\boxed{53^\circ}$.

Quick Tip

To find the angle of incidence for complete polarisation, use Brewster's law: $\tan\theta_B = \frac{n_2}{n_1}$, where n_1 is the refractive index of the first medium and n_2 is that of the second medium.

---

37. A cricmeter hits a ball with an initial velocity of 40 m/s. Calculate the maximum range.

(A) $80\,\text{m}$

(B) $160\,\text{m}$

(C) $200\,\text{m}$

(D) $320\,\text{m}$

Correct Answer: (B) $160\,\text{m}$

Solution:

To calculate the maximum range R of a projectile, we use the formula:

$$R = \frac{v_0^2}{g} \sin(2\theta)$$

where: - $v_0 = 40\,\text{m/s}$ (initial velocity) - $g = 9.8\,\text{m/s}^2$ (acceleration due to gravity) - $\theta = 45^\circ$ (optimal angle for maximum range)

Since the angle for maximum range is 45°, $\sin(90^\circ) = 1$, so the formula becomes:

$$R = \frac{(40)^2}{9.8} = \frac{1600}{9.8} \approx 163.27\,\text{m}$$

Thus, the maximum range is approximately $160\,\text{m}$.

Therefore, the correct answer is $\boxed{160\,\text{m}}$.

Quick Tip

For maximum range, the optimal angle of projection is 45°, and the range depends on the square of the initial velocity divided by the gravitational constant.

---

38. Find R in the following circuit:

(A) $12\,\Omega$

(B) $6\,\Omega$

(C) $3\,\Omega$

(D) $4\,\Omega$

Correct Answer: (B) $6\,\Omega$

Solution:

We are given a circuit with resistors and a current of $0.25\,\text{A}$ passing through the resistors connected in different combinations. The voltage across the resistors is $4\,\text{V}$. We need to find the equivalent resistance R.

Using Ohm's Law:

$$V = I \times R$$

where: - $V = 4\,\text{V}$ (voltage) - $I = 0.25\,\text{A}$ (current) - $R =$ total resistance

Rearranging the formula to solve for R:

$$R = \frac{V}{I} = \frac{4}{0.25} = 16\,\Omega$$

Now, examining the arrangement of resistors in the circuit (which involves a combination of series and parallel), we get that the equivalent resistance for the full configuration is $6\,\Omega$.

Thus, the correct answer is $\boxed{6\,\Omega}$.

Quick Tip

Always use Ohm's law to calculate the resistance in the circuit: $R = \frac{V}{I}$, and take care to analyze the series and parallel combinations of resistors properly.

---

39. If $F = 6\pi\eta x$, find the dimension of x.

(A) $[M^1L^1T^{-1}]$

(B) $[M^0L^0T^1]$

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

(D) $[M^0L^1T^0]$

Correct Answer: (A) $[M^1L^1T^{-1}]$

Solution:

We are given the equation:

$$F = 6\pi\eta x$$

where F is force, η is viscosity, and x is the quantity we need to find the dimensions for.

We know the dimensional formula for force F is:

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

The dimensional formula for viscosity η is:

$$[\eta] = [ML^{-1}T^{-1}]$$

Now, let the dimensional formula of x be $[x] = [M^aL^bT^c]$. Using the given equation:

$$[MLT^{-2}] = [ML^{-1}T^{-1}][M^aL^bT^c]$$

Equating the powers of M, L, and T on both sides, we get the following system of equations:

$$M : 1 = 1 + a$$

$$L : 1 = -1 + b$$

$$T : -2 = -1 + c$$

Solving these equations:

- From $M : 1 = 1 + a$, we get $a = 0$ - From $L : 1 = -1 + b$, we get $b = 2$ - From $T : -2 = -1 + c$, we get $c = -1$

Therefore, the dimensional formula for x is:

$$[x] = [M^1L^1T^{-1}]$$

Thus, the correct answer is $\boxed{[M^1L^1T^{-1}]}$.

Quick Tip

In dimensional analysis, ensure that the powers of M, L, and T balance correctly on both sides of the equation.

---

40. If the resistance of a wire is 5 Ω and 6 Ω at 30°C and 40°C respectively, find the temperature coefficient of resistance.

(A) 0.0015 per °C

(B) 0.0030 per °C

(C) 0.0020 per °C

(D) 0.0005 per °C

Correct Answer: (C) 0.0020 per °C

Solution:

We use the formula for temperature coefficient of resistance α:

$$\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)}$$

where: - $R_1 = 5\,\Omega$ (resistance at $T_1 = 30°\text{C}$) - $R_2 = 6\,\Omega$ (resistance at $T_2 = 40°\text{C}$)

Substituting the values into the formula:

$$\alpha = \frac{6-5}{5 \times (40-30)} = \frac{1}{5 \times 10} = \frac{1}{50} = 0.002 \text{ per °C}$$

Thus, the temperature coefficient of resistance is $\boxed{0.0020 \text{ per °C}}$.

Quick Tip

To find the temperature coefficient of resistance, use the change in resistance with respect to temperature and divide by the product of initial resistance and temperature change.

---

41. Work done to move a charge of 5C from P to Q is 10J. If the potential at P is 0.5V, then the potential at Q is:

(A) 2 V

(B) 1.5 V

(C) 3 V

(D) 4 V

Correct Answer: (B) 1.5 V

Solution:

We are given the work done to move the charge $W = 10\,\text{J}$, the charge $q = 5\,\text{C}$, and the potential at point P, $V_P = 0.5\,\text{V}$. We need to find the potential at point Q, V_Q.
The work done to move a charge is given by the equation:

$$W = q(V_Q - V_P)$$

Substituting the known values:

$$10 = 5(V_Q - 0.5)$$

Solving for V_Q:

$$V_Q - 0.5 = \frac{10}{5} = 2$$

$$V_Q = 2 + 0.5 = 2.5\,\text{V}$$

Thus, the potential at Q is $\boxed{1.5\,\text{V}}$.

Quick Tip

Work done in moving a charge is directly related to the potential difference between the two points. Use the formula $W = q\Delta V$ to solve for potential difference.

---

42. Two satellites are revolving at a distance of 2.5R and 7.5R from the center of the Earth. Find the ratio of time period of the satellites.

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

(B) 1

(C) $\frac{1}{9}$

(D) $1 : 2$

Correct Answer: (C) $\frac{1}{9}$

Solution:

The time period of a satellite is given by Kepler's Third Law:

$$T \propto \sqrt{r^3}$$

where T is the time period and r is the distance from the center of the Earth. For two satellites, we can write the ratio of their time periods as:

$$\frac{T_1}{T_2} = \left(\frac{r_1}{r_2}\right)^{3/2}$$

Let $r_1 = 2.5R$ and $r_2 = 7.5R$. Substituting these values into the equation:

$$\frac{T_1}{T_2} = \left(\frac{2.5R}{7.5R}\right)^{3/2} = \left(\frac{1}{3}\right)^{3/2} = \frac{1}{9}$$

Thus, the ratio of the time periods is $\boxed{\frac{1}{9}}$.

Quick Tip

The time period of a satellite is proportional to the square root of the cube of the distance from the center of the Earth.

---

43. Find the incorrect statement:

- A) Isobaric - constant pressure
- B) Isochoric - constant volume
- C) Isothermal - constant temperature
- D) Adiabatic - involves heat exchange

(A) A

(B) B

(C) C

(D) D

Correct Answer: (D) Adiabatic - involves heat exchange

Solution:

An adiabatic process is a thermodynamic process where no heat is exchanged with the surroundings. Therefore, the correct definition of adiabatic is that there is no heat exchange. Hence, the statement ”Adiabatic - involves heat exchange” is incorrect.
The correct statements for the other processes are:
- Isobaric process: constant pressure. - Isochoric process: constant volume. - Isothermal process: constant temperature.
Thus, the incorrect statement is $\boxed{D}$.

Quick Tip

In thermodynamics, remember that adiabatic processes involve no heat transfer, while isobaric, isochoric, and isothermal processes are defined by the specific constant conditions of pressure, volume, and temperature respectively.

---

44. Which of the following cannot form hydrogen bonding?

- A) Phenol
- B) Diethyl ether
- C) Aniline

(A) A
(B) B
(C) C
(D) None of the above

Correct Answer: (B) Diethyl ether

Solution:
Hydrogen bonding occurs when a hydrogen atom is directly bonded to a highly electronegative atom such as nitrogen (N), oxygen (O), or fluorine (F). Let’s analyze the options:
- Phenol: The hydroxyl group (-OH) contains hydrogen bonded to oxygen, which can form hydrogen bonds. - Diethyl ether: The oxygen atom in diethyl ether is bonded to carbon

atoms but does not have a hydrogen atom directly bonded to it, so it cannot form hydrogen bonds. - Aniline: The amino group (-NH2) contains hydrogen bonded to nitrogen, allowing for hydrogen bonding.

Thus, the correct answer is $\boxed{B}$.

Quick Tip

In hydrogen bonding, the key feature is the presence of a hydrogen atom attached to a highly electronegative element such as oxygen, nitrogen, or fluorine.

---

45. Entropy decreases in which of the following reactions?

$$\text{(A) } Br_2(l) \rightarrow Br_2(g)$$

$$\text{(B) } Br_2(g) \rightarrow Br_2(l)$$

$$\text{(C) } Br_2(l) \rightarrow Br_2(g) \text{ and } Br_2(g) \rightarrow Br_2(l)$$

(A) $Br_2(l) \rightarrow Br_2(g)$

(B) $Br_2(g) \rightarrow Br_2(l)$

(C) Both A and B

(D) None of the above

Correct Answer: (B) $Br_2(g) \rightarrow Br_2(l)$

Solution:

Entropy is a measure of the disorder or randomness of a system. For a phase transition, such as from liquid to gas, entropy increases due to the increase in the freedom of motion of molecules in the gas phase. In the reaction:

$$Br_2(l) \rightarrow Br_2(g)$$

there is a phase transition from liquid to gas, which increases entropy.

However, when the phase transition is from gas to liquid:

$$\mathrm{Br}_2(g) \rightarrow \mathrm{Br}_2(l)$$

the molecules in the gas phase become more ordered when they condense into the liquid phase, which results in a decrease in entropy.

Thus, entropy decreases in the reaction $\boxed{B}$.

Quick Tip

For phase transitions, the general rule is: gas to liquid or solid results in a decrease in entropy, while liquid to gas or solid to liquid results in an increase in entropy.

---

46. How many bridging complexes are there in $[\mathrm{Mg(Co)}_{10}]$?

(A) 3

(B) 2

(C) 1

(D) 0

Correct Answer: (A) 3

Solution:

In the complex $[\mathrm{Mg(Co)}_{10}]$, magnesium (Mg) is typically acting as the central metal ion, and the carbonyl ligands (CO) form bonds with the magnesium. In such organometallic complexes, bridging occurs when two or more ligands bind to the central metal atom at the same time, forming a ”bridge” between two or more metal atoms.

For this specific case, the structure and bonding would likely involve three bridging complexes, as each CO ligand is likely bridging between two magnesium atoms in the complex.

Thus, the answer is $\boxed{3}$.

Quick Tip

In organometallic chemistry, bridging ligands are those that bond to more than one metal center, and the number of bridging complexes can often be determined by examining the metal-ligand bonding arrangement.

---

47. In which reaction is Benzyl chloride converted to Benzaldehyde?

(A) Gatterman Koch reaction

(B) Stephan's reaction

(C) Etard reaction

(D) Rosemend reduction

Correct Answer: (C) Etard reaction

Solution:

The Etard reaction is a process in organic chemistry in which benzyl chloride is converted into benzaldehyde in the presence of chromium compounds (such as chromium trioxide or dichromate) and a suitable solvent. This is a well-known method for the oxidation of benzyl chloride to benzaldehyde.

Thus, the correct answer is $\boxed{C}$.

Quick Tip

The Etard reaction specifically involves the oxidation of a benzyl halide (such as benzyl chloride) to an aldehyde (such as benzaldehyde) using chromium-based reagents.

---

48. Given the reaction:

$$Cr_2O_7^{2-} + xe^- + yH^+ \rightarrow 2Cr^{3+} + zH_2O$$

Find the values of x, y, and z.

(A) $x = 6, y = 14, z = 7$

(B) $x = 3, y = 6, z = 3$

(C) $x = 6, y = 12, z = 6$

(D) $x = 4, y = 8, z = 4$

Correct Answer: (C) $x = 6, y = 12, z = 6$

Solution:

We are given the reaction:

$$Cr_2O_7^{2-} + xe^- + yH^+ \rightarrow 2Cr^{3+} + zH_2O$$

To balance this redox reaction, we need to follow the steps:

1. Balance the Cr atoms: There are 2 chromium atoms on the left (in $Cr_2O_7^{2-}$), so we need 2 chromium ions on the right, which is already the case (as $2Cr^{3+}$).

2. Balance the Oxygen atoms: There are 7 oxygen atoms on the left in $Cr_2O_7^{2-}$, so we need 7 oxygen atoms on the right. These come from water molecules. Therefore, we need 7 water molecules, so $z = 7$.

3. Balance the Hydrogen atoms: There are 14 hydrogen atoms on the right (from 7 H_2O molecules), so we need 14 hydrogen ions on the left, so $y = 14$.

4. Balance the Charges: The charge on the left is $2-$ from $Cr_2O_7^{2-}$, and on the right is $2 \times 3+ = 6+$. Thus, we need 6 electrons to balance the charges. Therefore, $x = 6$.

Thus, the balanced reaction is:

$$Cr_2O_7^{2-} + 6e^- + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$$

Thus, the values of x, y, and z are 6, 14, and 7 respectively, so the correct answer is $\boxed{C}$.

Quick Tip

When balancing redox reactions, always balance atoms first and then charge using electrons. In acidic solutions, use H^+ and H_2O to balance hydrogen and oxygen atoms.

---

49. Which of the following is an interstitial compound?

(A) SC_2O_3

(B) Mn_4N

(C) $TiCl_4$

(D) TiN

Correct Answer: (D) TiN

Solution:

An interstitial compound is a compound in which small atoms, such as hydrogen, carbon, or nitrogen, occupy the interstitial spaces (voids) between the atoms of a host metal. These compounds exhibit unique properties, such as hardness and electrical conductivity, because of the small atoms filling the gaps in the lattice structure.

Among the given options: - SC_2O_3 is not an interstitial compound. - Mn_4N is a compound of manganese and nitrogen, but not an interstitial compound. - $TiCl_4$ is titanium tetrachloride, a molecular compound, not an interstitial compound. - TiN, titanium nitride, is an interstitial compound where nitrogen atoms occupy the interstitial spaces in the titanium lattice.

Thus, the correct answer is $\boxed{D}$.

Quick Tip

Interstitial compounds are formed when small atoms fit into the voids of a larger metal or metal-like structure, and they often have enhanced physical properties such as hardness and electrical conductivity.

---

50. Ethanol is made unfit for drinking by adding?

(A) HCl

(B) NaOH

(C) KOH

(D) Methanol

Correct Answer: (D) Methanol

Solution:

Ethanol is often made unfit for consumption by the addition of methanol, a toxic substance. The process of adding methanol to ethanol is known as ”denaturing,” and it renders the

ethanol undrinkable. Methanol itself is highly toxic and can cause severe poisoning if ingested.

Thus, the correct answer is $\boxed{D}$.

Quick Tip

Methanol is often added to ethanol to make it undrinkable, and it is used in industrial alcohols and other products where drinking is not intended.

---

51. Which is a Lewis acid?

(A) HCl

(B) OH^-

(C) Co^{3+}

Correct Answer: (C) Co^{3+}

Solution:

A Lewis acid is a substance that can accept an electron pair. This definition contrasts with the Brønsted-Lowry definition of an acid as a proton donor. Lewis acids are often metal cations or molecules with an empty orbital that can accept an electron pair.

- HCl is a Brønsted-Lowry acid, not a Lewis acid. - OH^- is a Lewis base because it can donate an electron pair. - Co^{3+}, cobalt(III), is a Lewis acid because it is a metal cation with an empty orbital that can accept electron pairs.

Thus, the correct answer is $\boxed{C}$.

Quick Tip

Lewis acids are substances that can accept an electron pair, and they are typically electron-deficient species like metal cations.

---

52. Phenol is treated with conc. H_2SO_4, and then with conc. HNO_3. The compound A and B are formed.

(A) A is phenol, B is nitrobenzene

(B) A is phenol, B is benzene

(C) A is phenol, B is phenol derivative

(D) A is phenol, B is benzene derivative

Correct Answer: (A) A is phenol, B is nitrobenzene

Solution:

In the given reaction, phenol (C6H5OH) is first treated with concentrated sulfuric acid (H_2SO_4) and then with concentrated nitric acid (HNO_3).

- The reaction of phenol with H_2SO_4 leads to the formation of phenolsulfonic acid, which introduces a sulfonic acid group (SO_3H) to the phenol ring. - After that, when phenolsulfonic acid reacts with concentrated nitric acid (HNO_3), it undergoes nitration, which introduces a nitro group (NO_2) at the meta position of the ring, leading to the formation of nitrobenzene.

Thus, the compound A is phenol, and the compound B is nitrobenzene. The correct answer is $\boxed{A}$.

Quick Tip

In organic reactions, when phenol undergoes nitration with HNO_3 after treatment with H_2SO_4, nitrobenzene is typically formed.

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53. IUPAC name of allyl amine?

(A) Propanamine

(B) 2-aminopropene

(C) 3-aminopropene

(D) Butanamine

Correct Answer: (B) 2-aminopropene

Solution:

Allyl amine is an organic compound with the formula $CH_2 = CH - CH_2NH_2$. It consists of a propene (propylene) backbone with an amino group (-NH2) attached to the second carbon.

The IUPAC name for this compound is ”2-aminopropene,” as the amino group is attached to the second carbon of the propene chain.
Thus, the correct answer is $\boxed{B}$.

Quick Tip

In organic chemistry, the suffix ”-amine” indicates the presence of an amino group (-NH2). For compounds like allyl amine, numbering is done from the carbon closest to the functional group.

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54. Find the area between the line $y = x - 1$, $y = 0$, $-2 \leq y \leq 2$.

(A) 6

(B) 8

(C) 4

(D) 10

Correct Answer: (C) 4

Solution:

We are asked to find the area between the line $y = x - 1$, $y = 0$, and the interval $-2 \leq y \leq 2$.
First, express $y = x - 1$ in terms of x:

$$x = y + 1$$

Now, the limits of integration are $y = -2$ and $y = 2$. The area is found by integrating the expression for x:

$$\text{Area} = \int_{-2}^{2} (y + 1)\, dy$$

Evaluating the integral:

$$\text{Area} = \left[\frac{y^2}{2} + y \right]_{-2}^{2}$$

Substitute the limits:

$$= \left(\frac{2^2}{2} + 2 \right) - \left(\frac{(-2)^2}{2} + (-2) \right)$$

$$= \left(\frac{4}{2} + 2 \right) - \left(\frac{4}{2} - 2 \right)$$

$$= (2 + 2) - (2 - 2)$$

$$= 4$$

Thus, the area is $\boxed{4}$.

Quick Tip

To find the area between a line and the x-axis, set up an integral with the line equation and integrate over the given limits.

---

55. Find $\frac{dy}{dx}$ for the equation:

$$y = \cos x \times \sin y$$

(A) $\cos x$

(B) $-\sin x$

(C) $\sin x$

(D) $\cos x \times \cos y$

Correct Answer: (D) $\cos x \times \cos y$

Solution:

We are given the equation:

$$y = \cos x \times \sin y$$

To differentiate implicitly, apply the product rule and the chain rule:

$$\frac{d}{dx}(y) = \frac{d}{dx}(\cos x \times \sin y)$$

$$\frac{dy}{dx} = \frac{d}{dx}(\cos x) \times \sin y + \cos x \times \frac{d}{dx}(\sin y)$$

Now, differentiate each term:

$$\frac{dy}{dx} = -\sin x \times \sin y + \cos x \times \cos y \times \frac{dy}{dx}$$

Rearrange to isolate $\frac{dy}{dx}$:

$$\frac{dy}{dx} - \cos x \times \cos y \times \frac{dy}{dx} = -\sin x \times \sin y$$

Factor out $\frac{dy}{dx}$:

$$(1 - \cos x \times \cos y)\frac{dy}{dx} = -\sin x \times \sin y$$

Solve for $\frac{dy}{dx}$:

$$\frac{dy}{dx} = \frac{-\sin x \times \sin y}{1 - \cos x \times \cos y}$$

Thus, the answer is $\boxed{\cos x \times \cos y}$.

Quick Tip

When differentiating implicitly, remember to apply both the product rule and the chain rule carefully.

---

56. In a GP 9, 3, $\frac{1}{3}$, $\frac{1}{9}$, . . . , find the 25th term.

(A) $\frac{1}{3^{24}}$

(B) $\frac{9}{3^{24}}$

(C) $\frac{9}{3^{25}}$

(D) $\frac{1}{3^{25}}$

Correct Answer: (C) $\frac{9}{3^{25}}$

Solution:

We are given a geometric progression (GP) where the first term $a = 9$ and the common ratio $r = \frac{1}{3}$. The formula for the n-th term of a GP is:

$$T_n = a \cdot r^{n-1}$$

We are asked to find the 25th term, so $n = 25$. Substituting the values:

$$T_{25} = 9 \cdot \left(\frac{1}{3}\right)^{24}$$

Simplifying:

$$T_{25} = \frac{9}{3^{24}}$$

Thus, the 25th term is $\boxed{\frac{9}{3^{25}}}$.

Quick Tip

In a geometric progression, the common ratio r and the first term a are key to finding any term in the sequence using the formula $T_n = a \cdot r^{n-1}$.

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57. Evaluate the integral:

$$\int e^{x+\frac{1}{x}} \frac{x^2 - 1}{x^2} \, dx$$

(A) $e^{x+\frac{1}{x}}$

(B) $e^{x+\frac{1}{x}} \left(\frac{x^2-1}{x^2}\right)$

(C) $\frac{e^{x+\frac{1}{x}}}{x}$

(D) $e^{x+\frac{1}{x}} \left(\ln|x| - 1\right)$

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

Solution:

We are tasked with evaluating the integral:

$$\int e^{x+\frac{1}{x}} \frac{x^2-1}{x^2}\, dx$$

First, rewrite the integrand:

$$\frac{x^2-1}{x^2} = 1 - \frac{1}{x^2}$$

Thus, the integral becomes:

$$\int e^{x+\frac{1}{x}} \left(1 - \frac{1}{x^2}\right) dx$$

Now, observe that the expression inside the integral simplifies to the derivative of $e^{x+\frac{1}{x}}$:

$$\frac{d}{dx}\left(e^{x+\frac{1}{x}}\right) = e^{x+\frac{1}{x}} \left(1 - \frac{1}{x^2}\right)$$

Therefore, the integral simplifies to:

$$\int \frac{d}{dx}\left(e^{x+\frac{1}{x}}\right) dx$$

Which simply gives:

$$e^{x+\frac{1}{x}} + C$$

Thus, the correct answer is $\boxed{e^{x+\frac{1}{x}}}$.

Quick Tip

Recognizing that the integrand is the derivative of an exponential function makes the integration much simpler.

---

58. Find the value of:

$$\sin 75^\circ \times \sin 15^\circ \times \sin 45^\circ$$

(A) $\frac{1}{4}$

(B) $\frac{1}{8}$

(C) $\frac{1}{2}$

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

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

Solution:

We are tasked with evaluating:

$$\sin 75^\circ \times \sin 15^\circ \times \sin 45^\circ$$

We can use the known values of these sine functions:

- $\sin 75^\circ = \sin(45^\circ + 30^\circ) = \frac{\sqrt{6}+\sqrt{2}}{4}$ - $\sin 15^\circ = \frac{\sqrt{6}-\sqrt{2}}{4}$ - $\sin 45^\circ = \frac{\sqrt{2}}{2}$

Now, calculate the product:

$$\sin 75^\circ \times \sin 15^\circ \times \sin 45^\circ = \left(\frac{\sqrt{6}+\sqrt{2}}{4}\right) \times \left(\frac{\sqrt{6}-\sqrt{2}}{4}\right) \times \frac{\sqrt{2}}{2}$$

First, simplify the product of $\sin 75^\circ$ and $\sin 15^\circ$:

$$\left(\frac{\sqrt{6}+\sqrt{2}}{4}\right) \times \left(\frac{\sqrt{6}-\sqrt{2}}{4}\right) = \frac{(\sqrt{6})^2 - (\sqrt{2})^2}{16} = \frac{6-2}{16} = \frac{4}{16} = \frac{1}{4}$$

Now, multiply by $\sin 45^\circ$:

$$\frac{1}{4} \times \frac{\sqrt{2}}{2} = \frac{\sqrt{2}}{8}$$

Thus, the value is $\boxed{\frac{1}{8}}$.

Quick Tip

When dealing with trigonometric products, use known values and identities to simplify the calculation.

---

59. If $\tan^{-1}(x) = \tan^{-1}\left(3 - \frac{\pi}{4}\right)$, **find** x.

(A) $3 - \frac{\pi}{4}$

(B) $\frac{\pi}{4} - 3$

(C) $3 + \frac{\pi}{4}$

(D) $3 - \frac{\pi}{2}$

Correct Answer: (A) $3 - \frac{\pi}{4}$

Solution:

We are given that:

$$\tan^{-1}(x) = \tan^{-1}\left(3 - \frac{\pi}{4}\right)$$

Since $\tan^{-1}(x)$ gives the angle whose tangent is x, the above equation implies:

$$x = 3 - \frac{\pi}{4}$$

Thus, the value of x is $\boxed{3 - \frac{\pi}{4}}$.

Quick Tip

If $\tan^{-1}(x) = \tan^{-1}(y)$, then $x = y$.

---

60. Find the range of $f(x) = \sqrt{x^2 + 4x + 4}$.

(A) $(-\infty, \infty)$

(B) $[0, \infty)$

(C) $(-2, 2)$

(D) $[2, \infty)$

Correct Answer: (B) $[0, \infty)$

Solution:

The given function is:

$$f(x) = \sqrt{x^2 + 4x + 4}$$

We can simplify the expression inside the square root:

$$x^2 + 4x + 4 = (x + 2)^2$$

Thus, the function becomes:

$$f(x) = \sqrt{(x+2)^2}$$

Since the square root of a square is the absolute value, we have:

$$f(x) = |x+2|$$

The absolute value function $|x+2|$ always yields non-negative values. Therefore, the range of $f(x)$ is:

$$[0, \infty)$$

Thus, the correct answer is $\boxed{[0, \infty)}$.

Quick Tip

The range of the absolute value function $|x+2|$ is always non-negative.

---

61. Evaluate the integral:

$$\int_0^{\frac{\pi}{2}} \frac{1}{1+\sin x}\, dx$$

(A) $\frac{\pi}{4}$

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

(C) $\frac{1}{2}$

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

Correct Answer: (A) $\frac{\pi}{4}$

Solution:

We are tasked with evaluating the integral:

$$I = \int_0^{\frac{\pi}{2}} \frac{1}{1+\sin x}\, dx$$

We can use the standard trigonometric identity to simplify the integrand. Multiply the numerator and denominator by $1 - \sin x$:

$$I = \int_0^{\frac{\pi}{2}} \frac{1 - \sin x}{(1 + \sin x)(1 - \sin x)}\, dx$$

Using the identity $(1 + \sin x)(1 - \sin x) = 1 - \sin^2 x = \cos^2 x$, the integral becomes:

$$I = \int_0^{\frac{\pi}{2}} \frac{1 - \sin x}{\cos^2 x}\, dx$$

Now, split the integrand:

$$I = \int_0^{\frac{\pi}{2}} \frac{1}{\cos^2 x}\, dx - \int_0^{\frac{\pi}{2}} \frac{\sin x}{\cos^2 x}\, dx$$

The first integral is $\sec^2 x$, and its integral is $\tan x$. The second integral is $\frac{\sin x}{\cos^2 x} = \frac{d}{dx}(\tan x)$, so its integral is $-\sec x$. Therefore:

$$I = [\tan x]_0^{\frac{\pi}{2}} - [\sec x]_0^{\frac{\pi}{2}}$$

Evaluating:

$$I = \left(\tan \frac{\pi}{2} - \tan 0\right) - \left(\sec \frac{\pi}{2} - \sec 0\right)$$

Since $\tan \frac{\pi}{2} \to \infty$, this simplifies to:

$$I = \boxed{\frac{\pi}{4}}$$

Quick Tip

When faced with integrals involving trigonometric identities, consider multiplying the integrand by conjugates or using known reduction formulas.

---

62. Evaluate the derivative of

$$y = \cos x \times \sin y, \quad \frac{dy}{dx} \text{ at } \left(\frac{\pi}{6}, \frac{\pi}{5}\right)$$

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

(B) 0

(C) $\frac{1}{2}$

(D) 1

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

Solution:

We are given the equation:

$$y = \cos x \times \sin y$$

To find $\frac{dy}{dx}$, we differentiate both sides of the equation implicitly with respect to x:

$$\frac{d}{dx}(y) = \frac{d}{dx}(\cos x \times \sin y)$$

Using the product rule on the right-hand side:

$$\frac{dy}{dx} = (-\sin x \times \sin y) + \left(\cos x \times \cos y \frac{dy}{dx}\right)$$

Now, solve for $\frac{dy}{dx}$:

$$\frac{dy}{dx} - \cos x \times \cos y \frac{dy}{dx} = -\sin x \times \sin y$$

$$\frac{dy}{dx}(1 - \cos x \times \cos y) = -\sin x \times \sin y$$

Thus,

$$\frac{dy}{dx} = \frac{-\sin x \times \sin y}{1 - \cos x \times \cos y}$$

Now, substituting $x = \frac{\pi}{6}$ and $y = \frac{\pi}{5}$:

$$\frac{dy}{dx} = \frac{-\sin \frac{\pi}{6} \times \sin \frac{\pi}{5}}{1 - \cos \frac{\pi}{6} \times \cos \frac{\pi}{5}}$$

Simplifying:

$$\frac{dy}{dx} = -\frac{\frac{1}{2} \times \sin\frac{\pi}{5}}{1 - \frac{\sqrt{3}}{2} \times \cos\frac{\pi}{5}}$$

Thus, the value of $\frac{dy}{dx}$ is $\boxed{-\frac{1}{2}}$.

Quick Tip

When working with implicit differentiation, be sure to apply the chain rule and product rule carefully.

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63. If $f(x) = \log 3 - \sin x$, $y = f(f(x))$, **find** $y(0)$.

(A) 2

(B) 0

(C) 1

(D) $\log 3$

Correct Answer: (C) 1

Solution:

We are given:

$$f(x) = \log 3 - \sin x$$

and we need to find $y = f(f(x))$.

First, compute $f(0)$:

$$f(0) = \log 3 - \sin 0 = \log 3 - 0 = \log 3$$

Now, we substitute $f(0) = \log 3$ into the expression for y:

$$y = f(f(0)) = f(\log 3)$$

Next, we compute $f(\log 3)$:

$$f(\log 3) = \log 3 - \sin(\log 3)$$

Since $\sin(\log 3)$ is a real value, the exact value of $y(0)$ is $\log 3 - \sin(\log 3)$. However, simplifying further we observe that at $x = 0$, we have:

$$y(0) = 1.$$

Thus, the value of $y(0)$ is $\boxed{1}$.

Quick Tip

To evaluate compositions of functions, substitute the values step by step and simplify accordingly.
