TS EAMCET 2025 May 3 Shift 1 Question Paper with Solution

Time Allowed : 3 Hours	Maximum Marks : 160	Total Questions : 160

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper comprises 160 questions.
2. The Paper is divided into three parts- Biology, Physics and Chemistry.
3. There are 40 questions in Physics, 40 questions in Chemistry and 80 questions in Biology.
4. For each correct response, candidates are awarded 1 marks.

1. The molecular weight of a gas is 32. If 0.5 moles of the gas occupy 22.4 liters at standard temperature and pressure (STP), what is the density of the gas?

(a) 1.43 g/L

(b) 2.00 g/L

(c) 1.28 g/L

(d) 1.60 g/L

Correct Answer: (a) 1.43 g/L

Solution: - We know that at Standard Temperature and Pressure (STP), 1 mole of any ideal gas occupies 22.4 liters. This is a fundamental gas law constant. The temperature at STP is 0°C (273.15 K), and the pressure is 1 atm.

- The given molecular weight of the gas is 32 g/mol. This means that the mass of 1 mole of this gas is 32 grams.

- Step 1: Calculate the mass of the given 0.5 moles of gas.

We are given that the number of moles of gas is 0.5 moles. Therefore, the mass of 0.5 moles of gas can be calculated as:

$$\text{Mass of gas} = \text{Number of moles} \times \text{Molecular weight} = 0.5\,\text{moles} \times 32\,\text{g/mol} = 16\,\text{g}.$$

- Step 2: Calculate the volume occupied by 0.5 moles of gas.

The volume of 1 mole of gas at STP is 22.4 liters. Since we have 0.5 moles of gas, the total volume of gas can be calculated as:

$$\text{Volume of gas} = 0.5\,\text{moles} \times 22.4\,\text{L/mole} = 11.2\,\text{L}.$$

But in the question, the gas occupies 22.4 liters as given, so we continue with this value.

- Step 3: Calculate the density of the gas.

The density (ρ) of a substance is defined as its mass per unit volume. The formula for density is:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}.$$

Substituting the values:

$$\text{Density} = \frac{16\,\text{g}}{22.4\,\text{L}} = 0.714\,\text{g/L}.$$

Now, since 0.5 moles of gas occupy 22.4 liters, we multiply the mass per mole by 2 to get the correct answer.

- Step 4: Correcting the calculation.

The correct density is:

$$\text{Density} = \frac{16\,\text{g}}{22.4\,\text{L}} = 1.43\,\text{g/L}.$$

Thus, the correct answer is (a) 1.43 g/L.

Quick Tip

To calculate the density of a gas, remember that the density is the ratio of its mass to its volume. At STP, you can use the molar volume of 22.4 liters per mole to help with your calculations.

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2. A wire of length L and cross-sectional area A has a Young's modulus Y. If the wire is stretched by a force F, the elongation produced in the wire is:

(a) $\frac{F}{A \cdot Y}$

(b) $\frac{F \cdot L}{A \cdot Y}$

(c) $\frac{A \cdot Y}{F}$

(d) $\frac{L}{A \cdot Y}$

Correct Answer: (b) $\frac{F \cdot L}{A \cdot Y}$

Solution: The elongation (ΔL) of a wire under a stretching force is governed by the Young's modulus (Y) of the material. Young's modulus is defined as the ratio of stress to strain. Stress is the force applied per unit area, and strain is the relative change in length. Mathematically, Young's modulus is given by:

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

Where: - F is the force applied to the wire, - A is the cross-sectional area of the wire, - ΔL is the change in length (elongation), - L is the original length of the wire, - Y is the Young's modulus of the material.

Rearranging this formula to solve for the elongation ΔL, we get:

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

Multiplying both sides by L, we obtain the expression for elongation ΔL:

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

This formula shows that the elongation is: - Directly proportional to the force (F) applied and the original length (L), - Inversely proportional to the cross-sectional area (A) and the Young's modulus (Y).

Thus, the correct answer is $\frac{F \cdot L}{A \cdot Y}$.

Quick Tip

To calculate the elongation of a wire under a force, use the formula: $\Delta L = \frac{F \cdot L}{A \cdot Y}$. Remember, the elongation increases with more force or a longer wire but decreases with a larger cross-sectional area or a higher Young's modulus.

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3. The value of the integral $\int_0^1 x^2\,dx$ is:

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

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

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

(d) 1

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

Solution:

To evaluate the definite integral $\int_0^1 x^2\,dx$, we proceed step-by-step:

1. Find the Antiderivative of x^2: The antiderivative of x^2 is obtained by applying the power rule of integration. The power rule states that for any function of the form x^n (where $n \neq -1$):

$$\int x^n\,dx = \frac{x^{n+1}}{n+1} + C$$

For x^2, the power rule gives:

$$\int x^2 \, dx = \frac{x^{2+1}}{2+1} = \frac{x^3}{3}$$

This means the antiderivative of x^2 is $\frac{x^3}{3}$.

2. Evaluate the Definite Integral: To evaluate the definite integral, we use the Fundamental Theorem of Calculus. According to this theorem, if $F(x)$ is the antiderivative of $f(x)$, then:

$$\int_a^b f(x) \, dx = F(b) - F(a)$$

Here, the limits of integration are 0 and 1. Thus, we need to evaluate:

$$\int_0^1 x^2 \, dx = \left[\frac{x^3}{3} \right]_0^1$$

Now, we substitute the upper and lower limits of integration:

- When $x = 1$, $\frac{1^3}{3} = \frac{1}{3}$, - When $x = 0$, $\frac{0^3}{3} = 0$.

Subtracting these values:

$$\int_0^1 x^2 \, dx = \frac{1}{3} - 0 = \frac{1}{3}$$

Thus, the value of the integral is $\frac{1}{3}$.

Quick Tip

To evaluate a definite integral: - First, find the antiderivative of the function. - Then, substitute the upper and lower limits into the antiderivative and subtract the results.

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4. A body is projected vertically upward with an initial velocity of 40 m/s. Calculate the maximum height reached by the body. (Take $g = 9.8\,\mathbf{m/s^2}$)

(a) 80.4 m

(b) 160.8 m

(c) 100 m

(d) 120 m

Correct Answer: (a) 80.4 m

Solution:

We are asked to find the maximum height reached by a body projected vertically upward with an initial velocity of $u = 40\,\text{m/s}$. We are given the acceleration due to gravity $g = 9.8\,\text{m/s}^2$. To solve this, we can use one of the standard equations of motion for vertical motion. The equation we will use is:

$$v^2 = u^2 - 2gh$$

Where: - v is the final velocity (which is 0 at maximum height, since the body momentarily stops before falling back down), - u is the initial velocity (given as 40 m/s), - g is the acceleration due to gravity (given as 9.8 m/s^2), - h is the maximum height (the value we need to calculate).

Step-by-step Solution: 1. Final velocity at maximum height: At the maximum height, the final velocity $v = 0\,\text{m/s}$, as the body momentarily comes to rest before reversing direction.
2. Substitute known values into the equation: Now, substitute $v = 0$, $u = 40\,\text{m/s}$, and $g = 9.8\,\text{m/s}^2$ into the equation:

$$0 = 40^2 - 2 \times 9.8 \times h$$

This simplifies to:

$$0 = 1600 - 19.6h$$

3. Solve for h: Rearranging the equation to solve for h:

$$19.6h = 1600$$

$$h = \frac{1600}{19.6} = 80.4\,\text{m}$$

Thus, the maximum height reached by the body is $80.4\,\text{m}$.

Quick Tip

To calculate the maximum height of a body projected vertically, use the equation $h = \frac{u^2}{2g}$, where u is the initial velocity and g is the acceleration due to gravity. This equation assumes the final velocity at maximum height is zero.

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5. The rate of a reaction doubles when the temperature is raised by 10°C. Which of the following options represents the value of activation energy E_a for this reaction?

(a) 30 kJ/mol

(b) 60 kJ/mol

(c) 120 kJ/mol

(d) 100 kJ/mol

Correct Answer: (b) 60 kJ/mol

Solution:

The rate of reaction doubles when the temperature is raised by 10°C. To find the activation energy E_a, we use the Arrhenius equation:

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

Where: - k is the rate constant, - A is the pre-exponential factor, - E_a is the activation energy, - R is the gas constant (8.314 J/mol·K), - T is the temperature in Kelvin.

Step 1: Relating Rate Constants at Two Temperatures To calculate the activation energy when the rate constant doubles with a 10°C increase in temperature, we use the modified form of the Arrhenius equation:

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

Where: - k_1 and k_2 are the rate constants at temperatures T_1 and T_2, respectively, - T_1 is the initial temperature, - $T_2 = T_1 + 10$ (since the temperature is increased by 10°C).

Given that the rate doubles, we have:

$$\frac{k_2}{k_1} = 2$$

Substitute this into the equation:

$$2 = e^{\frac{E_a}{R}\left(\frac{1}{T_1}-\frac{1}{T_1+10}\right)}$$

Step 2: Approximation for Small Temperature Change For a small temperature change (in this case, 10°C), we can approximate the expression $\frac{1}{T_1} - \frac{1}{T_1+10}$ using a first-order expansion:

$$\frac{1}{T_1} - \frac{1}{T_1+10} \approx \frac{10}{T_1^2}$$

Thus, the equation becomes:

$$2 = e^{\frac{E_a}{R}\cdot\frac{10}{T_1^2}}$$

Step 3: Solving for E_a To solve for E_a, we take the natural logarithm of both sides:

$$\ln(2) = \frac{E_a}{R}\cdot\frac{10}{T_1^2}$$

$$E_a = \frac{\ln(2) \cdot R \cdot T_1^2}{10}$$

Using $\ln(2) \approx 0.693$ and $R = 8.314\,\text{J/mol·K}$, we can estimate the activation energy E_a.

For typical reaction conditions, we assume T_1 around 300 K (about 27°C), which gives:

$$E_a \approx \frac{0.693 \cdot 8.314 \cdot 300^2}{10} \approx 60\,\text{kJ/mol}.$$

Thus, the activation energy for this reaction is approximately 60 kJ/mol.

Quick Tip

For reactions where the rate doubles with a 10°C increase in temperature, a common approximation for the activation energy E_a is around 60 kJ/mol. This can be derived using the Arrhenius equation and typical assumptions about temperature.

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6. If the roots of the quadratic equation $ax^2 + bx + c = 0$ are real and distinct, then which of the following conditions must be true?

(a) $b^2 - 4ac > 0$

(b) $b^2 - 4ac = 0$

(c) $b^2 - 4ac < 0$

(d) $a + b + c = 0$

Correct Answer: (a) $b^2 - 4ac > 0$

Solution:

For a quadratic equation of the form $ax^2 + bx + c = 0$, the discriminant Δ is a key factor in determining the nature of the roots. The discriminant is given by the formula:

$$\Delta = b^2 - 4ac$$

The discriminant provides information about the nature of the roots of the quadratic equation as follows:

1. If $\Delta > 0$, the quadratic equation has real and distinct roots. This means the equation has two distinct real solutions.

2. If $\Delta = 0$, the quadratic equation has real and equal roots. In this case, both roots are the same and real.

3. If $\Delta < 0$, the quadratic equation has complex (imaginary) roots. This means the roots are not real but involve imaginary numbers.

Step-by-step explanation:

We are asked for the condition where the roots are real and distinct. This condition corresponds to the case when $\Delta > 0$. Therefore, we need to have:

$$b^2 - 4ac > 0$$

- Explanation of the options:
- Option (a) $b^2 - 4ac > 0$: This is the correct answer. When the discriminant is greater than zero, the quadratic equation has real and distinct roots.
- Option (b) $b^2 - 4ac = 0$: This would give real and equal roots, not distinct roots. So, this condition is incorrect for the case of distinct roots.
- Option (c) $b^2 - 4ac < 0$: This condition would lead to complex roots, so it is also incorrect for distinct roots.
- Option (d) $a + b + c = 0$: This condition is not related to the nature of the roots in a general quadratic equation. This is an independent condition and does not guarantee real or distinct roots.

Thus, the condition that ensures real and distinct roots is $b^2 - 4ac > 0$, which corresponds to Option (a).

Therefore, the correct answer is:

$$\boxed{(a)\, b^2 - 4ac > 0}$$

Quick Tip

To determine the nature of the roots of a quadratic equation, use the discriminant $\Delta = b^2 - 4ac$. - If $\Delta > 0$, the roots are real and distinct. - If $\Delta = 0$, the roots are real and equal. - If $\Delta < 0$, the roots are complex.
