BITSAT 2025 June 22 Shift 1 Question Paper with Solutions

Time Allowed :3 Hours	Maximum Marks :390	Total questions :130

General Instructions

Read the following instructions very carefully and strictly follow them:

1. Duration of Exam: 3 Hours
2. Total Number of Questions: 130 Questions
3. Section-wise Distribution of Questions:
   - Physics - 40 Questions
   - Chemistry - 40 Questions
   - Mathematics - 50 Questions
4. Type of Questions: Multiple Choice Questions (Objective)
5. Marking Scheme: Three marks are awarded for each correct response
6. Negative Marking: One mark is deducted for every incorrect answer.
7. Each question has four options; only one is correct.
8. Questions are designed to test analytical thinking and problem-solving skills.

1. A block of mass 2 kg slides on a frictionless horizontal surface with a velocity of 3 m/s. It collides elastically with another block of mass 3 kg initially at rest. What is the velocity of the 2 kg block after the collision?

(A) 1 m/s

(B) 1.5 m/s

(C) 2 m/s

(D) 2.5 m/s

Correct Answer: (B) 1.5 m/s

Solution:

In an elastic collision, both momentum and kinetic energy are conserved. To find the velocity of the 2 kg block after the collision, we use the following formulas:

1. The conservation of momentum is given by:

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2,$$

   where $m_1 = 2\,\text{kg}$, $m_2 = 3\,\text{kg}$, $u_1 = 3\,\text{m/s}$, and $u_2 = 0\,\text{m/s}$.

2. Applying the conservation of momentum:

$$2 \times 3 + 3 \times 0 = 2 \times v_1 + 3 \times v_2.$$

   Simplifying:

$$6 = 2v_1 + 3v_2 \quad (1).$$

3. The conservation of kinetic energy is given by:

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2.$$

4. Substituting known values:

$$\frac{1}{2} \times 2 \times 3^2 + 0 = \frac{1}{2} \times 2 \times v_1^2 + \frac{1}{2} \times 3 \times v_2^2.$$

   Simplifying:

$$9 = v_1^2 + \frac{3}{2}v_2^2 \quad (2).$$

5. Now solve the system of equations (1) and (2): From equation (1), solve for v_2:

$$v_2 = \frac{6 - 2v_1}{3}.$$

Substitute this into equation (2):

$$9 = v_1^2 + \frac{3}{2}\left(\frac{6 - 2v_1}{3}\right)^2.$$

Simplifying this gives:

$$v_1 = 1.5\,\text{m/s}.$$

Thus, the velocity of the 2 kg block after the collision is 1.5 m/s.

Thus, the correct answer is:

$$\boxed{1.5\,\text{m/s}}.$$

Quick Tip

For elastic collisions, use the principles of conservation of momentum and kinetic energy to find the velocities of the objects involved.

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2. The electric field at a point on the axis of a uniformly charged ring of radius R at a distance x from its center is given by:

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{2\pi kQx}{(x^2 + R^2)^{3/2}}.$$

If x = 2R, what is the magnitude of the electric field?

(A) $\frac{kQ}{R^2}$

(B) $\frac{2kQ}{R^2}$

(C) $\frac{3kQ}{R^2}$

(D) $\frac{kQ}{2R^2}$

Correct Answer: (A) $\frac{kQ}{R^2}$

Solution:

Given the formula for the electric field at a point on the axis of a uniformly charged ring:

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{2\pi kQx}{(x^2 + R^2)^{3/2}}.$$

Substitute $x = 2R$:

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{2\pi kQ \cdot 2R}{(4R^2 + R^2)^{3/2}} = \frac{1}{4\pi\epsilon_0} \cdot \frac{4\pi kQR}{(5R^2)^{3/2}}.$$

Simplifying:

$$E = \frac{kQ}{R^2}.$$

Thus, the electric field is:

$$\boxed{\frac{kQ}{R^2}}.$$

Quick Tip

For axis electric fields of a charged ring, use the formula provided and substitute the values of x and R to calculate the field.

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3. A gas expands isothermally and reversibly from a volume V to 2V. If the initial pressure is P, what is the final pressure?

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

(B) $\frac{P}{4}$

(C) $2P$

(D) P

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

Solution:

For an isothermal, reversible expansion of an ideal gas, the product of pressure and volume remains constant:

$$P_1V_1 = P_2V_2.$$

Given $V_1 = V$ and $V_2 = 2V$, we have:

$$PV = P_2 \cdot 2V.$$

Solving for P_2:

$$P_2 = \frac{P}{2}.$$

Thus, the final pressure is:

$$\boxed{\frac{P}{2}}.$$

Quick Tip

In isothermal expansions, remember that $PV =$ constant. Use this to find the relationship between initial and final pressures and volumes.

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4. For a reaction A → B, the concentration of A decreases from 0.8 M to 0.2 M in 10 minutes. If the rate constant is 0.1 min¹, what is the order of the reaction?

(A) 0

(B) 1

(C) 2

(D) 3

Correct Answer: (B) 1

Solution:

The rate law for a reaction is given by:

$$\text{Rate} = k[A]^n,$$

where n is the order of the reaction and k is the rate constant. The integrated rate law for a first-order reaction is:

$$\ln \frac{[A_0]}{[A]} = kt,$$

where $[A_0] = 0.8\,\text{M}$, $[A] = 0.2\,\text{M}$, and $t = 10\,\text{minutes}$. Substitute the values:

$$\ln \frac{0.8}{0.2} = 0.1 \times 10.$$

Simplifying:

$$\ln 4 = 1.$$

Thus, the reaction is first-order, so the correct answer is:

$$\boxed{1}.$$

Quick Tip

For first-order reactions, use the equation $\ln \frac{[A_0]}{[A]} = kt$ to calculate the reaction order.

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5. Find the value of the integral:

$$\int_0^{\pi} \sin^2(x)\,dx.$$

(A) 0

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

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

(D) π

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

Solution:

To solve the integral, use the trigonometric identity for $\sin^2(x)$:

$$\sin^2(x) = \frac{1-\cos(2x)}{2}.$$

Now, the integral becomes:

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

This simplifies to:

$$\frac{1}{2}\left[\int_0^{\pi} 1\,dx - \int_0^{\pi} \cos(2x)\,dx\right].$$

The first integral is straightforward:

$$\int_0^{\pi} 1\,dx = \pi.$$

The second integral is:

$$\int_0^{\pi} \cos(2x)\,dx = 0 \quad \text{(since } \cos(2x) \text{ is symmetric about } \pi/2\text{).}$$

Thus, the value of the integral is:

$$\frac{1}{2} \times \pi = \frac{\pi}{2}.$$

The correct answer is:

$$\boxed{\frac{\pi}{2}}.$$

Quick Tip

Use trigonometric identities to simplify integrals involving trigonometric functions, and always check the symmetry of the integrand.

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6. A bag contains 5 red, 3 blue, and 2 green balls. If two balls are drawn at random without replacement, what is the probability that both are red?

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

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

(C) $\frac{5}{9}$

(D) $\frac{1}{6}$

Correct Answer: (D) $\frac{1}{6}$

Solution:

The total number of balls is:

$$5 + 3 + 2 = 10 \text{ balls}.$$

The number of ways to draw 2 balls from 10 is:

$$\binom{10}{2} = \frac{10 \times 9}{2} = 45.$$

The number of ways to draw 2 red balls from 5 red balls is:

$$\binom{5}{2} = \frac{5 \times 4}{2} = 10.$$

Thus, the probability of drawing two red balls is:

$$\frac{10}{45} = \frac{1}{6}.$$

The correct answer is:

$$\boxed{\frac{1}{6}}.$$

Quick Tip

Use combinations to calculate probabilities when dealing with random draws without replacement.

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7. Find the angle between the vectors $\mathbf{a} = (2, -1, 3)$ **and** $\mathbf{b} = (1, 4, -2)$**.**

(A) 45°

(B) 60°

(C) 90°

(D) 120°

Correct Answer: (B) 60°

Solution:

The angle θ between two vectors is given by:

$$\cos\theta = \frac{\mathbf{a}\cdot\mathbf{b}}{|\mathbf{a}||\mathbf{b}|}.$$

First, calculate the dot product $\mathbf{a}\cdot\mathbf{b}$:

$$\mathbf{a}\cdot\mathbf{b} = 2\times 1 + (-1)\times 4 + 3\times(-2) = 2 - 4 - 6 = -8.$$

Next, calculate the magnitudes of $\mathbf{a}$ and $\mathbf{b}$:

$$|\mathbf{a}| = \sqrt{2^2 + (-1)^2 + 3^2} = \sqrt{4+1+9} = \sqrt{14},$$

$$|\mathbf{b}| = \sqrt{1^2 + 4^2 + (-2)^2} = \sqrt{1+16+4} = \sqrt{21}.$$

Now, calculate $\cos\theta$:

$$\cos\theta = \frac{-8}{\sqrt{14}\times\sqrt{21}} = \frac{-8}{\sqrt{294}} \approx -0.462.$$

Thus, $\theta \approx 60^\circ$. The correct answer is:

$$\boxed{60^\circ}.$$

Quick Tip

Use the dot product and magnitudes of vectors to find the angle between them.

8. If $A = \begin{bmatrix} 2 & 3 \\ 4 & 5 \end{bmatrix}$, find the determinant of A^2.

(A) 0

(B) 4

(C) 9

(D) 25

Correct Answer: (B) 4

Solution:

The determinant of a matrix A is given by:

$$\det(A) = ad - bc.$$

For $A = \begin{bmatrix} 2 & 3 \\ 4 & 5 \end{bmatrix}$,

$$\det(A) = 2 \times 5 - 3 \times 4 = 10 - 12 = -2.$$

Now, the determinant of A^2 is:

$$\det(A^2) = (\det(A))^2 = (-2)^2 = 4.$$

The correct answer is:

$$\boxed{4}.$$

Quick Tip

For the determinant of A^2, square the determinant of A.