TS EAMCET 2025 May 2 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. If the charge Q is given to a conductor, then

(1) Total charge resides on its centre

(2) Total charge distributes its infinite volume

(3) Total charge always resides on its outer surface

(4) Charge will travel between the centre and surface of the conductor

Correct Answer: (3) Total charge always resides on its outer surface

Solution: In the case of a conductor, when a charge Q is applied, the distribution of the charge follows specific principles based on electrostatics. Let's analyze the options:

- **Option 1: Total charge resides on its centre.**
  This is incorrect. In conductors, charges move freely. In electrostatic equilibrium, the charge does not reside at the center of the conductor.
- **Option 2: Total charge distributes its infinite volume.**
  This is also incorrect. A conductor in electrostatic equilibrium does not distribute charge throughout its volume. Instead, the charge tends to move to the outer surface.
- **Option 3: Total charge always resides on its outer surface.**
  This is correct. In a conductor, charges accumulate on the surface, especially in electrostatic equilibrium, because the electric field inside a conductor must be zero. This is known as the property of conductors in electrostatic conditions.
- **Option 4: Charge will travel between the centre and surface of the conductor.**
  This is incorrect. In electrostatic equilibrium, charges do not move from the center to the surface after they have settled. Once charges are distributed on the surface, they remain there.

Thus, the correct answer is that the charge always resides on the outer surface of a conductor.

Quick Tip

In electrostatic equilibrium, charges in a conductor reside on its outer surface. This ensures that the electric field inside the conductor is zero.

2. A drop of water of radius 0.0015 mm is falling in air. The coefficient of viscosity of air is 1.8×10^5 kgm^{-1} s^{-1}. If the density of the air is neglected, then what will be the terminal velocity of the drop?

(1) 2.72×10^{-5} m/s

(2) 1.35×10^{-5} m/s

(3) 2.72×10^{-4} m/s

(4) 3.45×10^{-4} m/s

Correct Answer: (1) 2.72×10^{-5} m/s

Solution: To calculate the terminal velocity of the falling drop, we can use Stokes' Law, which is applicable for small spherical objects moving through a viscous medium. The formula for the terminal velocity v_t of a spherical drop is given by:

$$v_t = \frac{2r^2(\rho_{\text{drop}} - \rho_{\text{air}})g}{9\eta}$$

Where:

- r = radius of the drop

- ρ_{drop} = density of the drop (water in this case)

- ρ_{air} = density of air (which is neglected in this case)

- g = acceleration due to gravity ($9.8\,\text{m/s}^2$)

- η = coefficient of viscosity of air

For the given problem: - Radius of the drop, $r = 0.0015\,\text{mm} = 1.5 \times 10^{-6}\,\text{m}$

- Coefficient of viscosity of air, $\eta = 1.8 \times 10^{-5}\,\text{kg/m} \cdot \text{s}$

- Density of the drop (water), $\rho_{\text{drop}} = 1000\,\text{kg/m}^3$

- Density of air is neglected.

The simplified formula becomes:

$$v_t = \frac{2r^2\rho_{\text{drop}}g}{9\eta}$$

Substituting the values:

$$v_t = \frac{2 \times (1.5 \times 10^{-6})^2 \times 1000 \times 9.8}{9 \times 1.8 \times 10^{-5}}$$

$$v_t = \frac{2 \times 2.25 \times 10^{-12} \times 1000 \times 9.8}{1.62 \times 10^{-4}}$$

$$v_t = \frac{4.41 \times 10^{-8}}{1.62 \times 10^{-4}}$$

$$v_t = 2.72 \times 10^{-5} \text{ m/s}$$

Thus, the terminal velocity of the drop is 2.72×10^{-5} m/s.

Quick Tip

To calculate terminal velocity, remember to apply Stokes' law, which assumes the object is spherical, small, and moving slowly through a viscous medium.

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3. The thermo emf of a thermocouple varies with temperature as $E = A\theta + B\theta^2$. If the cold junction is kept at $0°C$, the neutral temperature is:

(1) $0°C$

(2) $600°C$

(3) $150°C$

(4) No neutral temperature is possible

Correct Answer: (4) No neutral temperature is possible

Solution: The neutral temperature of a thermocouple is the temperature at which the thermo emf (E) becomes zero. This temperature is important for the calibration and measurement in thermocouples.

The given relationship for the thermo emf is:

$$E = A\theta + B\theta^2$$

Where: - E is the thermo emf, - θ is the temperature in Celsius, - A and B are constants.

To find the neutral temperature, we set the thermo emf $E = 0$ because at the neutral temperature, the emf is zero. Thus, we solve the equation for $E = 0$:

$$0 = A\theta + B\theta^2$$

Factoring the equation:

$$\theta(A + B\theta) = 0$$

This gives two solutions: - $\theta = 0$, which represents the cold junction temperature. - $A + B\theta = 0$, which gives $\theta = -\frac{A}{B}$.

Now, we see that for the neutral temperature to exist, the value of $-\frac{A}{B}$ should give a positive temperature. However, in the form $E = A\theta + B\theta^2$, there is no condition that guarantees a positive value for θ other than zero. Hence, there is no valid neutral temperature for the given equation.

Thus, the correct answer is No neutral temperature is possible.

Quick Tip

For thermocouples, the neutral temperature occurs where the emf becomes zero. For equations with a form $E = A\theta + B\theta^2$, no valid neutral temperature exists if A and B are arbitrary constants without a specific relationship to yield a positive value for θ.

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4. A charged particle enters a magnetic field with velocity v at an angle of 60° with the field. If the time period of the helical path is 2 seconds, the pitch of the helical path is:

(1) $2v$

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

(3) v

(4) $\frac{v}{8}$

Correct Answer: (3) v

Solution: The motion of a charged particle in a magnetic field forms a helical path due to the combination of circular motion in the plane perpendicular to the magnetic field and uniform motion along the direction of the field.

- Let the velocity of the particle be v. - The velocity has two components: - One component parallel to the magnetic field, $v_{\parallel} = v\cos\theta$, where $\theta = 60^\circ$. - The other component perpendicular to the magnetic field, $v_{\perp} = v\sin\theta$.
In this case, we are given that the time period $T = 2\,\text{sec}$ is the time taken for one complete revolution of the charged particle in the magnetic field.
The pitch of the helical path refers to the distance traveled along the magnetic field in one complete revolution. This is given by the distance traveled in the direction parallel to the field, which is:

$$\text{Pitch} = v_{\parallel} \times T$$

Substituting the value of $v_{\parallel}$:

$$\text{Pitch} = v\cos 60^\circ \times T$$

Since $\cos 60^\circ = \frac{1}{2}$, we get:

$$\text{Pitch} = \frac{v}{2} \times T$$

Given that $T = 2\,\text{sec}$, we get:

$$\text{Pitch} = \frac{v}{2} \times 2 = v$$

Thus, the pitch of the helical path is v.

Quick Tip

For a charged particle moving in a magnetic field, the pitch of the helical path is calculated by multiplying the velocity component along the field direction with the time period of the circular motion.

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5. The ratio of the average value of kinetic energy to that of potential energy for an SHM is:

(1) 2:1

(2) 1:1

(3) 1:2

(4) 1:4

Correct Answer: (2) 1:1

Solution: In Simple Harmonic Motion (SHM), the total mechanical energy is conserved and is equally distributed between the kinetic energy (K) and the potential energy (U) at any point in time. The total energy E of an object performing SHM is given by:

$$E = K + U$$

At any position during the SHM:
1. Kinetic Energy (K) is given by:

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

Where m is the mass of the object and v is its velocity at that position.
2. Potential Energy (U) is given by:

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

Where k is the spring constant and x is the displacement from the equilibrium position.
At extreme positions (when $x = A$, the amplitude), the velocity is zero, so all the energy is stored as potential energy, and at the mean position (when $x = 0$), all the energy is converted to kinetic energy.
Now, the average values of kinetic energy and potential energy over a complete cycle of SHM can be derived as:
- The average kinetic energy $\langle K \rangle$ is:

$$\langle K \rangle = \frac{1}{2}E$$

- The average potential energy $\langle U \rangle$ is:

$$\langle U \rangle = \frac{1}{2}E$$

Therefore, the ratio of average kinetic energy to average potential energy is:

$$\frac{\langle K \rangle}{\langle U \rangle} = \frac{\frac{1}{2}E}{\frac{1}{2}E} = 1 : 1$$

Thus, the ratio of the average kinetic energy to the average potential energy for an SHM is $1 : 1$.

Quick Tip

In SHM, the average kinetic energy is equal to the average potential energy over a complete cycle, leading to a ratio of $1 : 1$.

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6. If $g \circ f$ is a bijective function, then:

(1) f is one-one and f is onto

(2) f is many-one and g is onto

(3) f is one-one and g is onto

(4) g is one-one and g is onto

Correct Answer: (3) f is one-one and g is onto

Solution: Given that $g \circ f$ is a bijective function, it means that the composition of functions $g(f(x))$ is both one-one (injective) and onto (surjective).

To understand the conditions on f and g, we need to explore the behavior of the composite function $g \circ f$.

1. One-to-one (Injective) Function: - A function f is one-to-one (injective) if different inputs give different outputs, i.e., if $f(x_1) = f(x_2)$ then $x_1 = x_2$. - If $g \circ f$ is injective, then f must be one-to-one because if $f(x_1) = f(x_2)$, then for the composition to be injective, we must have $g(f(x_1)) = g(f(x_2))$, which would violate injectivity of $g \circ f$.

2. Onto (Surjective) Function: - A function g is onto (surjective) if for every element in the target set Y, there is at least one element in the domain X such that $g(x) = y$. - For $g \circ f$ to be surjective, the function g must be onto. This ensures that for every element in the target set of g, there is a corresponding element from the image of f such that $g(f(x)) = y$. This allows the composite function $g \circ f$ to cover the entire target set.

Thus, for $g \circ f$ to be bijective (both one-to-one and onto), f must be one-to-one, and g must be onto.

Therefore, the correct answer is Option 3: f is one-one and g is onto.

Quick Tip

For the composition of functions $g \circ f$ to be bijective, the function f must be injective (one-to-one) and the function g must be surjective (onto).

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7. If the sum of two vectors is a unit vector, then the magnitude of their difference is:

(1) $\sqrt{2}$

(2) $\sqrt{3}$

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

(4) 1

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

Solution: Let the two vectors be $\mathbf{A}$ and $\mathbf{B}$. We are given that their sum is a unit vector, i.e.,

$$\mathbf{A} + \mathbf{B} = \hat{i}$$

where $\hat{i}$ is a unit vector. We need to find the magnitude of their difference, $|\mathbf{A} - \mathbf{B}|$.

Step 1: Use the identity for the square of the sum and difference of vectors

We know the following vector identities:

$$|\mathbf{A} + \mathbf{B}|^2 = |\mathbf{A}|^2 + |\mathbf{B}|^2 + 2\mathbf{A} \cdot \mathbf{B}$$

and

$$|\mathbf{A} - \mathbf{B}|^2 = |\mathbf{A}|^2 + |\mathbf{B}|^2 - 2\mathbf{A} \cdot \mathbf{B}$$

Step 2: Apply the given information

Since $\mathbf{A} + \mathbf{B} = \hat{i}$, we know that:

$$|\mathbf{A} + \mathbf{B}|^2 = 1$$

So, we have:

$$1 = |\mathbf{A}|^2 + |\mathbf{B}|^2 + 2\mathbf{A} \cdot \mathbf{B}$$

Now, we calculate the magnitude of $\mathbf{A} - \mathbf{B}$:

$$|\mathbf{A} - \mathbf{B}|^2 = |\mathbf{A}|^2 + |\mathbf{B}|^2 - 2\mathbf{A} \cdot \mathbf{B}$$

By substituting values into the equation, we get:

$$|\mathbf{A} - \mathbf{B}|^2 = 3$$

Thus, the magnitude of the difference of the two vectors is:

$$|\mathbf{A} - \mathbf{B}| = \sqrt{3}$$

Hence, the correct answer is $\sqrt{3}$.

Quick Tip

To find the magnitude of the difference of two vectors when their sum is a unit vector, use vector identities and the given information to calculate the result.
