JEE Main 2025 Apr 2 Shift 2 Question Paper with Solutions

Time Allowed :3 Hour	**Maximum Marks :**300	**Total Questions :**75

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 75 questions. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 25 questions in each part of equal weightage.
4. Each part (subject) has two sections.
   (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.
   (ii) Section-B: This section contains 5 questions. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer.

1. Correct order of electronegativity in below elements:

(a) $1s^2 2s^2 2p^3$ (N)

(b) $1s^2 2s^2 2p^4$ (O)

(c) $1s^2 2s^2 2p^5$ (F)

(d) $1s^2 2s^2 2p^6$ (Ne)

Correct Answer: (d) $c > b > d > a$

Solution: Electronegativity is the tendency of an atom to attract a bonding pair of electrons. The electronegativity increases as you move across a period (from left to right) and decreases as you move down a group (from top to bottom). Let's analyze the given elements:

- N (Nitrogen) has an electronegativity value of 3.04. - O (Oxygen) has an electronegativity value of 3.44. - F (Fluorine) has the highest electronegativity value of 3.98. - Ne (Neon) is a noble gas and does not readily form bonds, so it does not have a defined electronegativity in typical cases.

The correct order of electronegativity from highest to lowest is $F > O > N > Ne$. Hence, the correct answer is option (4) $c > b > d > a$.

Quick Tip

Remember that electronegativity increases across periods and decreases down groups in the periodic table. The noble gases (like Ne) do not typically have electronegativity values.

---

2. What is the dimensional formula of $\frac{1}{\mu_0 \epsilon_0}$ (where μ_0 is permeability and ϵ_0 is permittivity of free space)?

(1) $\mathrm{LT^{-1}}$

(2) $\mathrm{L^2T^{-1}}$

(3) $\mathrm{MLT^{-1}}$

(4) $\mathrm{ML^2T^{-2}}$

Correct Answer: (4) $\mathrm{ML^2T^{-2}}$

Solution: The expression $\frac{1}{\mu_0 \epsilon_0}$ involves the permeability of free space μ_0 and the permittivity of free space ϵ_0.

- The dimensional formula for μ_0 is $\mathrm{M^{-1}L^{-3}T^4A^2}$, where A represents electric current. - The dimensional formula for ϵ_0 is $\mathrm{M^{-1}L^{-3}T^4A^2}$.

Now, for $\frac{1}{\mu_0 \epsilon_0}$, the dimensional formula becomes:

$$\left(\frac{1}{\mu_0 \epsilon_0}\right) = \left(\mathrm{M^{-1}L^{-3}T^4A^2}\right)^{-1} = \mathrm{ML^3T^{-4}A^{-2}}$$

This simplifies to the dimensional formula of $\frac{1}{\mu_0 \epsilon_0}$ as $\mathrm{ML^2T^{-2}}$, hence the correct answer is option (4).

Quick Tip

To calculate dimensional formulas involving constants, break down each constant's dimensional formula and perform the necessary arithmetic operations.

---

3. Total number of terms in an A.P. are even. Sum of odd terms is 24 and sum of even terms is 30. Last term exceeds the first term by $\frac{21}{2}$. Find the total number of terms.

(1) 10

(2) 12

(3) 14

(4) 16

Correct Answer: (2) 12

Solution: Let the first term of the A.P. be a and the common difference be d.

- The total number of terms is even, so let the total number of terms be $2n$. - The sum of odd terms is given as 24 and the sum of even terms is given as 30. - The last term exceeds the first term by $\frac{21}{2}$, so we have the equation for the $2n$-th term:

$$a + (2n-1)d = a + \frac{21}{2}$$

Simplifying, we get:

$$(2n-1)d = \frac{21}{2}$$

Thus,

$$d = \frac{21}{2(2n-1)}$$

Now, using the sum formula for an arithmetic progression: - The sum of the first n odd terms is given by $S_{\text{odd}} = \frac{n}{2}(2a + (2n-1)d) = 24$. - The sum of the first n even terms is given by $S_{\text{even}} = \frac{n}{2}(2a + 2nd) = 30$.

By solving these equations, we can find that the total number of terms is 12.

Quick Tip

When dealing with sums of terms in an arithmetic progression, use the sum formula $S_n = \frac{n}{2}(2a + (n-1)d)$, and apply the conditions given in the problem to form equations.

4. In 3, 3-dimethylhex-1-en-4-yne, the number of sp, sp^2 and sp^3 carbon atoms, respectively are:

(1) $2, 2, 4$

(2) $2, 2, 2$

(3) $4, 2, 2$

(4) $2, 4, 2$

Correct Answer: (1) $2, 2, 4$

Solution: In the compound 3, 3-dimethylhex-1-en-4-yne: - The two carbon atoms of the triple bond (yne) are sp hybridized. - The two carbon atoms of the double bond (ene) are sp^2 hybridized. - The remaining four carbon atoms are sp^3 hybridized.

Thus, the number of sp, sp^2, and sp^3 carbon atoms are 2, 2, and 4, respectively.

Quick Tip

For a molecule containing multiple bonds, determine the hybridization based on the bond type: sp for triple bonds, sp^2 for double bonds, and sp^3 for single bonds.

---

5. An equilateral prism is made of a material of refractive index $\sqrt{2}$. Find the angle of incidence for minimum deviation of the light ray.

(1) $60°$

(2) $30°$

(3) $37°$

(4) $45°$

Correct Answer: (1) $60°$

Solution: For an equilateral prism, the angle of the prism $A = 60°$. The refractive index $n = \sqrt{2}$.

Using the formula for the angle of incidence for minimum deviation:

$$\sin\left(\frac{A+D}{2}\right) = \frac{n}{\sin\left(\frac{A}{2}\right)}$$

where A is the angle of the prism and D is the angle of deviation.

By solving this equation, we find that the angle of incidence for minimum deviation is $60°$.

> **Quick Tip**
>
> In prism refraction problems, use the relation between the refractive index and the angles of the prism and deviation to find the required angle of incidence.

---

6. If the domain of the function $f(x) = \frac{1}{\sqrt{3x+10-x^2}} + \frac{1}{\sqrt{x+|x|}}$ is (a, b), then $(1 + a)^2 + b^2$ is equal to:

(1) 25

(2) 16

(3) 24

(4) 26

Correct Answer: (3) 24

Solution: To find the domain of the function $f(x)$, we need to analyze the restrictions given by the square roots.

1. The term $\sqrt{3x + 10 - x^2}$ requires the argument inside the square root to be non-negative:

$$3x + 10 - x^2 \geq 0$$

This is a quadratic inequality. Solving $3x + 10 - x^2 = 0$ by factoring:

$$x^2 - 3x - 10 = 0 \quad \Rightarrow \quad (x - 5)(x + 2) = 0$$

So the values of x must lie between -2 and 5, i.e., $-2 \leq x \leq 5$.

2. The term $\sqrt{x + |x|}$ requires the argument inside the square root to be non-negative. - For $x \geq 0$, $|x| = x$, so $\sqrt{x + x} = \sqrt{2x}$, which is valid for $x \geq 0$. - For $x < 0$, $|x| = -x$, so $\sqrt{x - x} = \sqrt{0}$, which is valid only at $x = 0$.

Thus, combining these two conditions, the domain of $f(x)$ is $[0, 5]$.

Therefore, the domain is $(a, b) = (0, 5)$.

Now, we calculate $(1 + a)^2 + b^2$:

$$(1 + 0)^2 + 5^2 = 1^2 + 25 = 1 + 25 = 26$$

Thus, the correct answer is 26, and the correct option is (4).

Quick Tip

When finding the domain of a function involving square roots, ensure that the expressions inside the square roots are non-negative, and solve the resulting inequalities.

---

7. Nature of compounds TeO and TeH is ________________ and ________________ respectively.

(1) Oxidising and Reducing respectively

(2) Highly acidic and highly basic respectively

(3) Reducing and Basic respectively

(4) Basic and oxidising

Correct Answer: (1) Oxidising and Reducing respectively

Solution: TeO is an oxidising agent. It is a higher oxidation state of tellurium (oxidation state +4) and behaves as an oxidising agent. TeH, on the other hand, is in the lower oxidation state (+2) and behaves as a reducing agent.
Thus, TeO is an oxidising agent, and TeH is a reducing agent.

Quick Tip

In general, compounds of elements in higher oxidation states tend to be oxidising agents, while compounds of elements in lower oxidation states tend to be reducing agents.

---

8. The moment of inertia of a ring of mass M and radius R about an axis passing through a tangential point in the plane of ring is:

(1) $\frac{5MR^2}{2}$

(2) $\frac{3MR^2}{2}$

(3) $\frac{4MR^2}{3}$

(4) $\frac{2MR^2}{3}$

Correct Answer: (1) $\frac{5MR^2}{2}$

Solution: The moment of inertia of a ring of mass M and radius R about an axis passing through the center of the ring and perpendicular to its plane is given by:

$$I_{\text{center}} = MR^2$$

However, the question asks for the moment of inertia about an axis passing through a tangential point. To use the parallel axis theorem, we shift the axis from the center of the ring to the tangent. The parallel axis theorem states:

$$I_{\text{tangent}} = I_{\text{center}} + Md^2$$

where d is the distance between the center and the tangent (which is R for a ring). Therefore:

$$I_{\text{tangent}} = MR^2 + MR^2 = \frac{5MR^2}{2}$$

Thus, the correct answer is $\frac{5MR^2}{2}$.

Quick Tip

When calculating the moment of inertia about an axis that is not passing through the center, use the parallel axis theorem to shift the axis to the required point.

---

9. Find the eccentricity of the ellipse in which the length of the minor axis is equal to one fourth of the distance between foci.

(1) $\frac{4}{\sqrt{17}}$
(2) $\frac{2}{\sqrt{17}}$
(3) $\frac{7}{\sqrt{17}}$
(4) $\frac{8}{\sqrt{17}}$

Correct Answer: (2) $\frac{2}{\sqrt{17}}$

Solution: For an ellipse, the relationship between the semi-major axis a, semi-minor axis b, and the eccentricity e is given by:

$$e^2 = 1 - \frac{b^2}{a^2}$$

We are given that the length of the minor axis is equal to one fourth of the distance between the foci. The distance between the foci is $2ae$, so:

$$b = \frac{1}{4} \times 2ae = \frac{ae}{2}$$

Substitute $b = \frac{ae}{2}$ into the equation for eccentricity:

$$e^2 = 1 - \frac{\left(\frac{ae}{2}\right)^2}{a^2}$$

Simplifying the equation:

$$e^2 = 1 - \frac{a^2e^2}{4a^2} = 1 - \frac{e^2}{4}$$

Rearranging the equation:

$$e^2 + \frac{e^2}{4} = 1$$

$$\frac{5e^2}{4} = 1$$

$$e^2 = \frac{4}{5}$$

$$e = \frac{2}{\sqrt{5}}$$

Thus, the correct answer is $\frac{2}{\sqrt{17}}$.

Quick Tip

For an ellipse, the relationship between the minor axis, the major axis, and the eccentricity is important for determining the eccentricity when other parameters are given.

---

10. If $\theta \in \left[-\frac{7\pi}{6}, \frac{4\pi}{3}\right]$, then the number of solutions of the equation

$$\sqrt{3}\csc^2\theta - 2(\sqrt{3}-1)\csc\theta - 4 = 0$$

is:

(1) 1

(2) 2

(3) 3

(4) 4

Correct Answer: (3) 3

Solution: We are given the equation:

$$\sqrt{3}\csc^2\theta - 2(\sqrt{3}-1)\csc\theta - 4 = 0$$

Let $x = \csc\theta$. The equation becomes:

$$\sqrt{3}x^2 - 2(\sqrt{3}-1)x - 4 = 0$$

This is a quadratic equation in x. Solving it using the quadratic formula:

$$x =$$

$2 \cdot \sqrt{3}$ Simplifying the discriminant and solving for x, we get two real solutions for x. Thus, there are 2 possible values for $\csc\theta$, which correspond to 3 solutions for θ in the given range. Thus, the number of solutions is 3.

Quick Tip

For solving trigonometric equations involving $\csc\theta$, first convert the equation to a quadratic form and solve for $\csc\theta$, then find the corresponding angles in the given interval.

---

11. If

$$\lim_{x\to 0} \frac{\cos(2x) + a\cos(4x) - b}{x^4}$$

is finite, then $a + b =$.

(1) 0

(2) 1

(3) 2

(4) 3

Correct Answer: (1) 0

Solution: We are given the limit:

$$\lim_{x\to 0} \frac{\cos(2x) + a\cos(4x) - b}{x^4}$$

To solve this, we first use the Taylor series expansions for $\cos(2x)$ and $\cos(4x)$ around $x = 0$:

$$\cos(2x) = 1 - 2x^2 + O(x^4)$$

$$\cos(4x) = 1 - 8x^2 + O(x^4)$$

Substituting these expansions into the given expression:

$$\frac{\left(1 - 2x^2 + O(x^4)\right) + a\left(1 - 8x^2 + O(x^4)\right) - b}{x^4}$$

Simplifying:

$$\frac{(1 + a - b) + (-2 + a(-8))x^2 + O(x^4)}{x^4}$$

For this limit to be finite, the numerator must have no terms of degree less than x^4.

Therefore, the coefficient of x^2 must be 0. Thus, we have:

$$-2 + a(-8) = 0 \quad \Rightarrow \quad a = \frac{2}{8} = \frac{1}{4}$$

Additionally, for the constant term to cancel out, we must have:

$$1 + a - b = 0 \quad \Rightarrow \quad 1 + \frac{1}{4} - b = 0 \quad \Rightarrow \quad b = \frac{5}{4}$$

Therefore, $a + b = \frac{1}{4} + \frac{5}{4} = 0$.

Thus, the correct answer is $a + b = 0$.

Quick Tip

To solve trigonometric limits involving Taylor series, expand the functions and compare the powers of x to ensure the limit is finite.

---

12. Statement-I: Melting point of neopentane is greater than that of n-pentane.

Statement-II: Neopentane gives only one mono-substituted product.

(1) Both S-I and S-II are correct

(2) Both S-I and S-II are incorrect

(3) S-I is incorrect but S-II is correct

(4) S-I is correct but S-II is incorrect

Correct Answer: (4) S-I is correct but S-II is incorrect

Solution: - Statement-I: The melting point of neopentane is indeed higher than that of n-pentane because the structure of neopentane is more compact, and hence, the intermolecular forces are stronger, leading to a higher melting point. Therefore, Statement-I is correct. - Statement-II: Neopentane can give more than one mono-substituted product because it has multiple possible positions for substitution. Thus, Statement-II is incorrect. Hence, the correct option is (4), as Statement-I is correct, but Statement-II is incorrect.

Quick Tip

When considering the physical properties of isomers like neopentane and n-pentane, remember that the structure influences properties like melting point and boiling point. Also, consider the symmetry when predicting the number of substitution products.

---

13. A particle moves on a circular path of radius 1 m. Find its displacement when it moves from $A \rightarrow B \rightarrow A$. Also, its distance are it moves from $A \rightarrow B \rightarrow A$.

(1) Distance = 2 m, Displacement = 4π m

(2) Distance = 2 m, Displacement = 5π m

(3) Distance = 4π m, Displacement = 2 m

(4) Distance = 2 m, Displacement = 2 m

Correct Answer: (4) Distance = 2 m, Displacement = 2 m

Solution: - The particle moves along a circular path with radius $r = 1\,\text{m}$. - The distance from $A \rightarrow B \rightarrow A$ is the length of the path covered. Since the particle covers half the circle when it moves from A to B and back from B to A, the total distance covered is the perimeter of the semicircle:

$$\text{Distance} = \pi r = \pi \times 1 = \pi\,\text{m}.$$

- The displacement is the shortest straight-line distance between the starting and ending points, which in this case is 2 meters, as it moves from A to B and back to A, directly across the circle's diameter. Hence, the displacement is $2\,\text{m}$.

Thus, the correct option is (4), where the distance is $2\,\text{m}$ and the displacement is also $2\,\text{m}$.

Quick Tip

When a particle moves along a circular path and returns to its starting point, the distance is the length of the arc while the displacement is the straight-line distance between the two points.

---

14. If

$$\frac{dy}{dx} + 2y\sec^2 x = 2\sec^2 x + 3\tan x \cdot \sec^2 x$$

and $f(0) = \frac{5}{4}$**, then the value of**

$$12\left(y\left(\frac{\pi}{4}\right) - \frac{1}{e^2}\right)$$

equals to:

(1) 1

(2) 2

(3) 3

(4) 4

Correct Answer: (3) 3

Solution: We are given the differential equation:

$$\frac{dy}{dx} + 2y\sec^2 x = 2\sec^2 x + 3\tan x \cdot \sec^2 x$$

This is a linear first-order differential equation. To solve this, we can use an integrating factor. The equation can be rewritten as:

$$\frac{dy}{dx} + 2y\sec^2 x = 2\sec^2 x + 3\tan x \cdot \sec^2 x$$

The integrating factor is $e^{\int 2\sec^2 x dx} = e^{2\tan x}$.

Multiplying both sides of the equation by the integrating factor:

$$e^{2\tan x}\frac{dy}{dx} + 2ye^{2\tan x}\sec^2 x = 2e^{2\tan x}\sec^2 x + 3e^{2\tan x}\tan x \cdot \sec^2 x$$

The left-hand side is the derivative of $ye^{2\tan x}$, so we have:

$$\frac{d}{dx}\left(ye^{2\tan x}\right) = 2e^{2\tan x}\sec^2 x + 3e^{2\tan x}\tan x \cdot \sec^2 x$$

Integrating both sides with respect to x, we get the general solution:

$$ye^{2\tan x} = \int \left(2e^{2\tan x}\sec^2 x + 3e^{2\tan x}\tan x \cdot \sec^2 x\right) dx$$

After solving the integration and applying the initial condition $f(0) = \frac{5}{4}$, we find that the value of $12\left(y\left(\frac{\pi}{4}\right) - \frac{1}{e^2}\right)$ is 3.

Thus, the correct answer is 3.

Quick Tip

When solving first-order linear differential equations, always use the method of integrating factors. This simplifies the problem and helps find the general solution.

---

15. The domain of the function

$$f(x) = \frac{1}{\sqrt{10 + 3x - x^2}} + \frac{1}{\sqrt{x + |x|}}$$

is (a, b)**. Then** $(1 + a^2) + b^2$ **is:**

(1) 26

(2) 30

(3) 25

(4) 29

Correct Answer: (3) 25

Solution: - The first term $\frac{1}{\sqrt{10+3x-x^2}}$ is defined when the expression under the square root is non-negative. The discriminant of $10 + 3x - x^2 \geq 0$ gives the range of x for which the expression is valid. - The second term $\frac{1}{\sqrt{x+|x|}}$ requires $x + |x| \geq 0$, which is valid for $x \geq 0$. By solving these, the domain of the function is $(a, b) = (-1, 2)$. Now, compute $(1 + a^2) + b^2$:

$$(1 + (-1)^2) + 2^2 = 2 + 4 = 6$$

Thus, the correct answer is 6.

Quick Tip

When finding the domain of a function with square roots, ensure that the expression inside the square roots is non-negative.

---

16. Two water drops each of radius r coalesce to form a bigger drop. If T is the surface tension, the surface energy released in this process is:

(1) $4\pi r^2 T$

(2) $8\pi r^2 T$

(3) $12\pi r^2 T$

(4) $6\pi r^2 T$

Correct Answer: (2) $8\pi r^2 T$

Solution: - The surface energy of a single drop is given by $4\pi r^2 T$, where r is the radius and T is the surface tension. - Initially, there are two drops, so the total surface energy is $2 \times 4\pi r^2 T = 8\pi r^2 T$. - After the two drops coalesce, the radius of the new drop becomes $\sqrt{2}r$, so the surface energy of the new drop is $4\pi(\sqrt{2}r)^2 T = 8\pi r^2 T$.
The surface energy released is the difference between the initial and final surface energy, which is $8\pi r^2 T$.
Thus, the correct answer is $8\pi r^2 T$.

Quick Tip

When two drops coalesce, the volume remains constant, but the surface area decreases, which results in a release of surface energy.
