

JEE Main 2025 April 4 Shift 1 Physics Question Paper with Solutions

Time Allowed :3 Hours	Maximum Marks :300	Total Questions :75
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. Multiple choice questions (MCQs)
2. Questions with numerical values as answers.
3. There are three sections: **Mathematics, Physics, Chemistry.**
4. **Mathematics:** 25 (20+5) 10 Questions with answers as a numerical value. Out of 10 questions, 5 questions are compulsory.
5. **Physics:** 25 (20+5) 10 Questions with answers as a numerical value. Out of 10 questions, 5 questions are compulsory..
6. **Chemistry:** 25 (20+5) 10 Questions with answers as a numerical value. Out of 10 questions, 5 questions are compulsory.
7. Total: 75 Questions (25 questions each).
8. 300 Marks (100 marks for each section).
9. **MCQs:** Four marks will be awarded for each correct answer and there will be a negative marking of one mark on each wrong answer.
10. **Questions with numerical value answers:** Candidates will be given four marks for each correct answer and there will be a negative marking of 1 mark for each wrong answer.

Physics

Section - A

26. The mean free path and the average speed of oxygen molecules at 300 K and 1 atm are 3×10^{-7} m and 600 m/s, respectively. Find the frequency of its collisions.

- (1) $2 \times 10^{10}/\text{s}$
- (2) $9 \times 10^9/\text{s}$
- (3) $2 \times 10^9/\text{s}$
- (4) $5 \times 10^8/\text{s}$

Correct Answer: (3)

Solution:

1. Given: - Mean free path, $\lambda = 3 \times 10^{-7}$ m - Average speed, $v_{\text{avg}} = 600$ m/s
2. Frequency of collisions:

$$\text{Frequency} = \frac{v_{\text{avg}}}{\lambda} = \frac{600}{3 \times 10^{-7}} = 2 \times 10^9 \text{ s}^{-1}$$

Therefore, the correct answer is (3) $2 \times 10^9/\text{s}$.

Quick Tip

The frequency of collisions is given by the average speed divided by the mean free path.

27. A small mirror of mass m is suspended by a massless thread of length l . Then the small angle through which the thread will be deflected when a short pulse of laser of energy E falls normal on the mirror (c = speed of light in vacuum and g = acceleration due to gravity).

- (1) $\theta = \frac{3E}{4mc\sqrt{gl}}$
- (2) $\theta = \frac{E}{mc\sqrt{gl}}$
- (3) $\theta = \frac{E}{2mc\sqrt{gl}}$
- (4) $\theta = \frac{2E}{mc\sqrt{gl}}$

Correct Answer: (4)

Solution:

1. Force due to the laser beam:

$$F = \frac{2P}{c} = \frac{2}{c} \frac{dE}{dt}$$

2. Change in momentum of the mirror:

$$m(V - 0) = \int F dt = \frac{2}{c} \int dE = \frac{2E}{c}$$

3. Using work-energy theorem:

$$\begin{aligned} W_g &= \Delta K \\ -\frac{mgl(1 - \cos \theta)}{l} &= \frac{1}{2}mV^2 \\ \frac{gl(1 - \cos \theta)}{l} &= \frac{1}{2} \left(\frac{4E^2}{m^2c^2} \right) \\ \frac{gl\theta^2}{2} &= \frac{2E^2}{m^2c^2} \\ \theta &= \frac{2E}{mc\sqrt{gl}} \end{aligned}$$

Therefore, the correct answer is (4) $\theta = \frac{2E}{mc\sqrt{gl}}$.

Quick Tip

Use the work-energy theorem to find the deflection angle.

28. Two liquids A and B have θ_A and θ_B as contact angles in a capillary tube. If $K = \cos \theta_A / \cos \theta_B$, then identify the correct statement:

- (1) K is negative, then liquid A and liquid B have convex meniscus.
- (2) K is negative, then liquid A and liquid B have concave meniscus.
- (3) K is negative, then liquid A has concave meniscus and liquid B has convex meniscus.
- (4) K is zero, then liquid A has convex meniscus and liquid B has concave meniscus.

Correct Answer: (3)

Solution:

1. Given:

$$K = \frac{\cos \theta_A}{\cos \theta_B}$$

2. Interpretation: - If K is negative, $\cos \theta_A$ and $\cos \theta_B$ are of opposite signs. - This implies that one liquid has a concave meniscus and the other has a convex meniscus.

Therefore, the correct answer is (3) K is negative, then liquid A has concave meniscus and liquid B has convex meniscus.

Quick Tip

The sign of K indicates the nature of the meniscus of the liquids.

29. Which of the following are correct expression for torque acting on a body?

A. $\vec{\tau} = \vec{r} \times \vec{L}$

B. $\vec{\tau} = \frac{d}{dt}(\vec{r} \times \vec{p})$

C. $\vec{\tau} = \vec{r} \times \frac{d\vec{p}}{dt}$

D. $\vec{\tau} = I\vec{\alpha}$

E. $\vec{\tau} = \vec{r} \times \vec{F}$

($\vec{r}$ = position vector; $\vec{p}$ = linear momentum; $\vec{L}$ = angular momentum; $\vec{\alpha}$ = angular acceleration; I = moment of inertia; $\vec{F}$ = force; t = time)

Choose the correct answer from the options given below:

- (1) B, D and E Only
- (2) C and D Only
- (3) B, C, D and E Only
- (4) A, B, D and E Only

Correct Answer: (3)

Solution:

1. Correct expressions for torque: - B. $\vec{\tau} = \frac{d}{dt}(\vec{r} \times \vec{p})$ - C. $\vec{\tau} = \vec{r} \times \frac{d\vec{p}}{dt}$ - D. $\vec{\tau} = I\vec{\alpha}$ - E. $\vec{\tau} = \vec{r} \times \vec{F}$
Therefore, the correct answer is (3) B, C, D and E Only.

Quick Tip

Torque can be expressed in terms of position vector, linear momentum, angular momentum, and force.

30. In a Young's double slit experiment, the slits are separated by 0.2 mm. If the slits separation is increased to 0.4 mm, the percentage change of the fringe width is:

- (1) 0%
- (2) 100%
- (3) 50%
- (4) 25%

Correct Answer: (3)

Solution:

1. Fringe width formula:

$$\beta = \frac{D\lambda}{d}$$

2. Percentage change of fringe width: - If d is doubled, β is halved. - Therefore, the percentage change is 50%.

Therefore, the correct answer is (3) 50%.

Quick Tip

The fringe width is inversely proportional to the slit separation.

31. An alternating current is represented by the equation, $i = 100\sqrt{2}\sin(100\pi t)$ ampere. The RMS value of current and the frequency of the given alternating current are

- (1) $100\sqrt{2}$ A, 100 Hz
- (2) $\frac{100}{\sqrt{2}}$ A, 100 Hz
- (3) 100 A, 50 Hz
- (4) $50\sqrt{2}$ A, 50 Hz

Correct Answer: (3)

Solution:

1. RMS value of current:

$$i_{\text{rms}} = \frac{i_0}{\sqrt{2}} = 100 \text{ A}$$

2. Frequency of the current:

$$f = \frac{\omega}{2\pi} = \frac{100\pi}{2\pi} = 50 \text{ Hz}$$

Therefore, the correct answer is (3) 100 A, 50 Hz.

Quick Tip

The RMS value of an alternating current is given by the peak value divided by $\sqrt{2}$.

32. Consider the sound wave travelling in ideal gases of He, CH₄, and CO₂. All the gases have the same ratio $\frac{P}{\rho}$, where P is the pressure and ρ is the density. The ratio of the speed of sound through the gases $v_{\text{He}} : v_{\text{CH}_4} : v_{\text{CO}_2}$ is given by

- (1) $\sqrt{\frac{7}{5}} : \sqrt{\frac{5}{3}} : \sqrt{\frac{4}{3}}$
- (2) $\sqrt{\frac{5}{3}} : \sqrt{\frac{4}{3}} : \sqrt{\frac{7}{5}}$
- (3) $\sqrt{\frac{5}{3}} : \sqrt{\frac{4}{3}} : \sqrt{\frac{4}{3}}$
- (4) $\sqrt{\frac{4}{3}} : \sqrt{\frac{5}{3}} : \sqrt{\frac{7}{5}}$

Correct Answer: (3)

Solution:

1. Speed of sound formula:

$$v_{\text{sound}} = \sqrt{\frac{\gamma P}{\rho}}$$

2. Ratio of specific heats (γ): - $\gamma_{\text{He}} = \frac{5}{3}$ - $\gamma_{\text{CH}_4} \approx \frac{4}{3}$ - $\gamma_{\text{CO}_2} \approx \frac{4}{3}$

3. Ratio of speeds of sound:

$$\sqrt{\frac{5}{3}} : \sqrt{\frac{4}{3}} : \sqrt{\frac{4}{3}}$$

Therefore, the correct answer is (3) $\sqrt{\frac{5}{3}} : \sqrt{\frac{4}{3}} : \sqrt{\frac{4}{3}}$.

Quick Tip

The speed of sound in a gas depends on the ratio of specific heats (γ).

33. In an electromagnetic system, the quantity representing the ratio of electric flux and magnetic flux has dimension of $\text{M}^{\text{BL}} \text{O}^{\text{T}} \text{B}^{\text{AS}}$, where value of 'Q' and 'R' are

- (1) (3, -5)
- (2) (-2, 2)
- (3) (-2, 1)
- (4) (1, -1)

Correct Answer: (4)

Solution:

1. Dimensions of electric flux (ϕ_E) and magnetic flux (ϕ_M):

$$\phi_E = EA \quad \text{and} \quad \phi_M = BA$$

2. Ratio of electric flux to magnetic flux:

$$\frac{\phi_E}{\phi_M} = \frac{E}{B}$$

3. Dimensions of $\frac{E}{B}$:

$$\left[\frac{E}{B} \right] = \frac{[E]}{[B]} = \frac{MLT^{-2}A^{-1}}{MT^{-2}A^{-1}} = LT^{-1}$$

4. Dimensions of $\frac{E}{B}$:

$$\left[\frac{E}{B} \right] = LT^{-1}$$

Therefore, the correct answer is (4) $(1, -1)$.

Quick Tip

The ratio of electric flux to magnetic flux has dimensions of LT^{-1} .

34. When an object is placed 40 cm away from a spherical mirror an image of magnification $\frac{1}{2}$ is produced. To obtain an image with magnification of $\frac{1}{3}$, the object is to be moved:

- (1) 40 cm away from the mirror.
- (2) 80 cm away from the mirror.
- (3) 20 cm towards the mirror.
- (4) 20 cm away from the mirror.

Correct Answer: (1)

Solution:

- 1. Given: - Object distance, $u = -40$ cm - Magnification, $m = \frac{1}{2}$
- 2. Magnification formula:

$$m = \frac{f}{f - u}$$

$$\frac{1}{2} = \frac{f}{f - (-40)}$$

$$f + 40 = 2f \implies f = 40 \text{ cm}$$

3. For magnification $\frac{1}{3}$:

$$\frac{1}{3} = \frac{40}{40 - u}$$

$$40 - u = 120 \implies u = -80 \text{ cm}$$

Therefore, the correct answer is (1) 40 cm away from the mirror.

Quick Tip

Use the magnification formula to find the object distance.

35. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R. Assertion A: In photoelectric effect, on increasing the intensity of incident light the stopping potential increases. Reason R: Increase in intensity of light increases the rate of photoelectrons emitted, provided the frequency of incident light is greater than threshold frequency.

- (1) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**
- (2) **A** is false but **R** is true
- (3) **A** is true but **R** is false
- (4) Both **A** and **R** are true and **R** is the correct explanation of **A**

Correct Answer: (2)

Solution:

1. Assertion A: - The stopping potential does not depend on the intensity of light. - Therefore, Assertion A is false.
 2. Reason R: - Increasing the intensity of light increases the rate of photoelectrons emitted. - Therefore, Reason R is true.
- Therefore, the correct answer is (2) **A** is false but **R** is true.

Quick Tip

The stopping potential in the photoelectric effect does not depend on the intensity of light.

36. If $\vec{L}$ and $\vec{P}$ represent the angular momentum and linear momentum respectively of a particle of mass ' m ' having position vector

$\vec{r} = a(\hat{i} \cos \omega t + \hat{j} \sin \omega t)$. The direction of force is

- (1) Opposite to the direction of $\vec{r}$
- (2) Opposite to the direction of $\vec{L}$
- (3) Opposite to the direction of $\vec{P}$
- (4) Opposite to the direction of $\vec{L} \times \vec{P}$

Correct Answer: (1)

Solution:

1. Position vector:

$$\vec{r} = a(\hat{i} \cos \omega t + \hat{j} \sin \omega t)$$

2. Acceleration:

$$\vec{a} = -\omega^2 \vec{r}$$

3. Force:

$$\vec{F} = m \vec{a} = -m\omega^2 \vec{r}$$

Therefore, the direction of force is opposite to the direction of $\vec{r}$.

Quick Tip

The force is proportional to the acceleration, which is opposite to the position vector in this case.

37. A body of mass m is suspended by two strings making angles θ_1 and θ_2 with the horizontal ceiling with tensions T_1 and T_2 simultaneously. T_1 and T_2 are related by $T_1 = \sqrt{3} T_2$. the angles θ_1 and θ_2 are

- (1) $\theta_1 = 30^\circ \theta_2 = 60^\circ$ with $T_2 = \frac{3mg}{4}$
- (2) $\theta_1 = 60^\circ \theta_2 = 30^\circ$ with $T_2 = \frac{mg}{2}$
- (3) $\theta_1 = 45^\circ \theta_2 = 45^\circ$ with $T_2 = \frac{3mg}{4}$
- (4) $\theta_1 = 30^\circ \theta_2 = 60^\circ$ with $T_2 = \frac{4mg}{5}$

Correct Answer: (2)

Solution:

1. Given:

$$T_1 \sin \theta_1 + T_2 \sin \theta_2 = mg$$

$$T_1 = \sqrt{3} T_2$$

2. Substitute T_1 :

$$\sqrt{3} T_2 \sin \theta_1 + T_2 \sin \theta_2 = mg$$

$$T_2(\sqrt{3} \sin \theta_1 + \sin \theta_2) = mg$$

3. For $\theta_1 = 60^\circ$ and $\theta_2 = 30^\circ$:

$$T_2(\sqrt{3} \cdot \frac{\sqrt{3}}{2} + \frac{1}{2}) = mg$$

$$T_2 = \frac{mg}{2}$$

Therefore, the correct answer is (2) $\theta_1 = 60^\circ \theta_2 = 30^\circ$ with $T_2 = \frac{mg}{2}$.

Quick Tip

Use the equilibrium condition to find the tensions and angles.

38. Current passing through a wire as function of time is given as

$I(t) = 0.02t + 0.01$ A. The charge that will flow through the wire from $t = 1$ s to $t = 2$ s is:

- (1) 0.06 C
- (2) 0.02 C
- (3) 0.07 C
- (4) 0.04 C

Correct Answer: (4)

Solution:

1. Charge calculation:

$$q = \int I(t) dt$$

$$q = \int_1^2 (0.02t + 0.01) dt$$

$$q = \left[0.02 \frac{t^2}{2} + 0.01t \right]_1^2$$

$$q = [0.01(4) + 0.01(2)] - [0.01(1) + 0.01(1)]$$

$$q = 0.04 \text{ C}$$

Therefore, the correct answer is (4) 0.04 C.

Quick Tip

Integrate the current function to find the charge.

39. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R. Assertion A: The kinetic energy needed to project a body of mass m from earth surface to infinity is $\frac{1}{2}mgR$, where R is the radius of earth. Reason R: The maximum potential energy of a body is zero when it is projected to infinity from earth surface.

- (1) A False but **R** is true
- (2) Both **A** and **R** are true and **R** is the correct explanation of **A**
- (3) **A** is true but **R** is false
- (4) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**

Correct Answer: (1)

Solution:

1. Assertion A: - The kinetic energy needed to project a body of mass m from earth surface to infinity is $\frac{1}{2}mgR$. - This is incorrect.
 2. Reason R: - The maximum potential energy of a body is zero when it is projected to infinity from earth surface. - This is correct.
- Therefore, the correct answer is (1) A False but **R** is true.

Quick Tip

The kinetic energy needed to project a body to infinity is equal to the potential energy at the earth's surface.

40. The Boolean expression $Y = \overline{A}BC + A\overline{C}$ can be realised with which of the following gate configurations.

- A. One 3-input AND gate, 3 NOT gates and one 2-input OR gate, One 2-input AND gate
 B. One 3-input AND gate, 1 NOT gate, One 2-input NOR gate and one 2-input OR gate
 C. 3-input OR gate, 3 NOT gates and one 2-input AND gate

Choose the correct answer from the options given below:

- (1) B, C Only
 (2) A,B Only
 (3) A, B, C Only
 (4) A, C Only

Correct Answer: (2)

Solution:

1. Boolean expression:

$$Y = A\overline{B}C + \overline{A}C$$

2. Gate configurations: - A. One 3-input AND gate, 3 NOT gates and one 2-input OR gate, One 2-input AND gate - B. One 3-input AND gate, 1 NOT gate, One 2-input NOR gate and one 2-input OR gate

Therefore, the correct answer is (2) A,B Only.

Quick Tip

Use the Boolean expression to determine the correct gate configurations.

41. In an experiment with a closed organ pipe, it is filled with water by $(\frac{1}{5})$ th of its volume. The frequency of the fundamental note will change by

- (1) 25%
 (2) 20%
 (3) -20%
 (4) -25%

Correct Answer: (1)

Solution:

1. Initial frequency:

$$f_1 = \frac{v}{4l}$$

2. Frequency with water:

$$f_2 = \frac{v}{4(4l/5)} = \frac{5v}{16l}$$

3. Percentage change:

$$\frac{\Delta f}{f} = \frac{\frac{5v}{16l} - \frac{v}{4l}}{\frac{v}{4l}} \times 100 = 25\%$$

Therefore, the correct answer is (1) 25%.

Quick Tip

The frequency of the fundamental note changes with the length of the pipe.

42. Two simple pendulums having lengths l_1 and l_2 with negligible string mass undergo angular displacements θ_1 and θ_2 , from their mean positions, respectively. If the angular accelerations of both pendulums are same, then which expression is correct?

- (1) $\theta_1 l_2^2 = \theta_2 l_1^2$
- (2) $\theta_1 l_1 = \theta_2 l_2$
- (3) $\theta_1 l_1^2 = \theta_2 l_2^2$
- (4) $\theta_1 l_2 = \theta_2 l_1$

Correct Answer: (4)

Solution:

1. Angular acceleration:

$$\alpha = -\omega^2 \theta$$
$$\omega = \sqrt{\frac{g}{l}}$$

2. Equating angular accelerations:

$$\frac{g}{l_1} \theta_1 = \frac{g}{l_2} \theta_2$$
$$\theta_1 l_2 = \theta_2 l_1$$

Therefore, the correct answer is (4) $\theta_1 l_2 = \theta_2 l_1$.

Quick Tip

The angular acceleration of a pendulum depends on its length and angular displacement.

43. Two infinite identical charged sheets and a charged spherical body of charge density ' ρ ' are arranged as shown in figure. Then the correct relation between the electrical fields at A, B, C and D points is:

- (1) $\vec{E}_A = \vec{E}_B; \vec{E}_C = \vec{E}_D$
- (2) $\vec{E}_A > \vec{E}_B; \vec{E}_C = \vec{E}_D$
- (3) $\vec{E}_C \neq \vec{E}_D; \vec{E}_A > \vec{E}_B$
- (4) $|\vec{E}_A| = |\vec{E}_B|; \vec{E}_C > \vec{E}_D$

Correct Answer: (3)

Solution:

- 1. Electric field at points A and B: - $\vec{E}_A > \vec{E}_B$
- 2. Electric field at points C and D: - $\vec{E}_C \neq \vec{E}_D$

Therefore, the correct answer is (3) $\vec{E}_C \neq \vec{E}_D$; $\vec{E}_A > \vec{E}_B$.

Quick Tip

The electric field depends on the arrangement and charge density of the sheets and spherical body.

44. Two small spherical balls of mass 10 g each with charges $-2\mu\text{C}$ and $2\mu\text{C}$, are attached to two ends of very light rigid rod of length 20 cm. The arrangement is now placed near an infinite nonconducting charge sheet with uniform charge density of $100\mu\text{C}/\text{m}^2$ such that length of rod makes an angle of 30° with electric field generated by charge sheet. Net torque acting on the rod is:

- (1) 112 Nm
- (2) 1.12 Nm
- (3) 2.24 Nm
- (4) 11.2 Nm

Correct Answer: (2)

Solution:

1. Electric field due to the charge sheet:

$$E = \frac{\sigma}{2\epsilon_0}$$

2. Torque acting on the rod:

$$\begin{aligned}\tau &= PE \sin \theta \\ \tau &= \left[2 \times 10^{-6} \times \frac{2}{10} \right] \left[\frac{100 \times 10^{-6}}{2 \times 8.85 \times 10^{-12}} \right] \frac{1}{2} \\ \tau &= \frac{10}{8.85} = 1.12 \text{ Nm}\end{aligned}$$

Therefore, the correct answer is (2) 1.12 Nm.

Quick Tip

The torque acting on a dipole in an electric field is given by the product of the dipole moment and the electric field.

45. Considering the Bohr model of hydrogen like atoms, the ratio of the radius 5th orbit of the electron in Li^{2+} and He^+ is

- (1) $\frac{3}{2}$
- (2) $\frac{4}{9}$
- (3) $\frac{4}{3}$
- (4) $\frac{3}{3}$

Correct Answer: (4)

Solution:

1. Radius of the 5th orbit for Li^{2+} :

$$r_5 = \frac{5^2}{3}a_0$$

2. Radius of the 5th orbit for He^+ :

$$r_5 = \frac{5^2}{2}a_0$$

3. Ratio of the radii:

$$\frac{r_{\text{Li}^{2+}}}{r_{\text{He}^+}} = \frac{2}{3}$$

Therefore, the correct answer is (4) $\frac{2}{3}$.

Quick Tip

The radius of an orbit in the Bohr model depends on the principal quantum number and the atomic number.

SECTION-B

46. A circular ring and a solid sphere having same radius roll down on an inclined plane from rest without slipping. The ratio of their velocities when reached at the bottom of the plane is $\sqrt{\frac{x}{5}}$ where $x = \dots\dots\dots$.

Correct Answer: (4)

Solution:

1. Mechanical energy conservation:

$$\begin{aligned} K_i + U_i &= K_f + U_f \\ 0 + Mgh &= \frac{1}{2}mv^2 \left(1 + \frac{k^2}{R^2}\right) + 0 \\ v &= \sqrt{\frac{2gh}{1 + \frac{k^2}{R^2}}} \end{aligned}$$

2. Ratio of velocities:

$$\begin{aligned} \frac{v_{\text{ring}}}{v_{\text{solid sphere}}} &= \sqrt{\frac{1 + \frac{2}{5}}{1 + 1}} = \sqrt{\frac{7}{10}} \\ x &= 3.5 \approx 4 \end{aligned}$$

Therefore, the correct answer is (4) 4.

Quick Tip

Use mechanical energy conservation to find the velocities of the ring and the solid sphere.

47. Two slabs with square cross section of different materials (1, 2) with equal sides (l) and thickness d_1 and d_2 such that $d_2 = 2 d_1$ and $l > d_2$. Considering lower edges of these slabs are fixed to the floor, we apply equal shearing force on the narrow faces. The angle of deformation is $\theta_2 = 2\theta_1$. If the shear moduli of material 1 is $4 \times 10^9 \text{ N/m}^2$, then shear moduli of material 2 is $x \times 10^9 \text{ N/m}^2$, where value of x is _____ .

Correct Answer: (1)

Solution:

1. Deformation angle:

$$\begin{aligned} 2\theta_1 &= \theta_2 \\ 2 \frac{\sigma_1}{\eta_1} &= \frac{\sigma_2}{\eta_2} \\ 2 \left(\frac{F}{ld_1\eta_1} \right) &= \frac{F}{ld_2\eta_2} \\ \eta_2 &= \frac{\eta_1}{4} = 1 \times 10^9 \\ x &= 1 \end{aligned}$$

Therefore, the correct answer is (1) 1.

Quick Tip

Use the deformation angle to find the shear modulus of the material.

48. Distance between object and its image (magnified by $-\frac{1}{3}$) is 30 cm. The focal length of the mirror used is $\left(\frac{x}{4}\right)$ cm, where magnitude of value of x is _____ .

Correct Answer: (45)

Solution:

1. Given:

$$\begin{aligned} m &= -\frac{1}{3} \\ -\frac{v}{u} &= \frac{1}{3} \implies v = \frac{u}{3} \end{aligned}$$

2. Distance between object and image:

$$\begin{aligned} u - v &= 30 \text{ cm} \\ u - \frac{u}{3} &= 30 \implies u = 45 \text{ cm}, \quad v = 15 \text{ cm} \end{aligned}$$

3. Focal length:

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} = \frac{1}{15} + \frac{1}{45} = \frac{4}{60}$$

$$f = \frac{60}{4} = 15 \text{ cm}$$

$$x = 45$$

Therefore, the correct answer is (45).

Quick Tip

Use the magnification formula to find the object and image distances, then calculate the focal length.

49. Four capacitors each of capacitance $16 \mu F$ are connected as shown in the figure. The capacitance between points A and B is: _____ (in μF).

Correct Answer: (64)

Solution:

1. Redraw the circuit: - The capacitors are connected in parallel.
2. Equivalent capacitance:

$$C_{eq} = 4C = 4 \times 16 \mu F = 64 \mu F$$

Therefore, the correct answer is (64) $64 \mu F$.

Quick Tip

Use the parallel connection of capacitors to find the equivalent capacitance.

50. Conductor wire ABCDE with each arm 10 cm in length is placed in magnetic field of $\frac{1}{\sqrt{2}}$ Tesla, perpendicular to its plane. When conductor is pulled towards right with constant velocity of 10 cm/s, induced emf between points A and E is _____ mV.

Correct Answer: (10)

Solution:

1. Induced emf:

$$\varepsilon = Bv\ell_{AB}$$

$$\varepsilon = \frac{1}{\sqrt{2}} \times \frac{10 \text{ cm}}{s} \times 2(10 \sin 45^\circ) \text{ cm}$$

$$\varepsilon = 10 \text{ mV}$$

Therefore, the correct answer is (10) 10 mV.

Quick Tip

Use Faraday's law to calculate the induced emf.



