JEE Main 2025 April 3 Shift 1 Physics
Question Paper with Solutions

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

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. During the melting of a slab of ice at 273 K at atmospheric pressure:

(1) Internal energy of ice-water system remains unchanged.
(2) Positive work is done by the ice-water system on the atmosphere.
(3) Internal energy of the ice-water system decreases.
(4) Positive work is done on the ice-water system by the atmosphere.

Correct Answer: (4)

Solution: Volume decreases during melting of ice so positive work is done on ice water system by atmosphere. Heat absorbed by ice water so ΔQ is positive, work done by ice water

system is negative. Hence by first law of thermodynamics $\Delta U = \Delta Q + \Delta W$ = Positive So internal energy increases.

Quick Tip

Apply the first law of thermodynamics and consider the sign conventions for work and heat. Melting ice results in a decrease in volume, indicating work done on the system.

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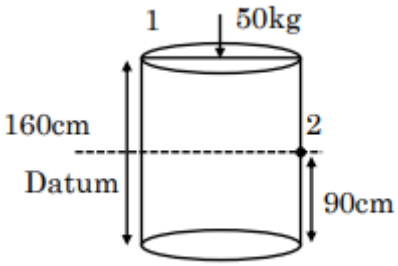
27. Consider a completely full cylindrical water tank of height 1.6 m and cross-sectional area 0.5 m^2. It has a small hole in its side at a height 90 cm from the bottom. Assume, the cross-sectional area of the hole to be negligibly small as compared to that of the water tank. If a load 50 kg is applied at the top surface of the water in the tank then the velocity of the water coming out at the instant when the hole is opened is : (g = 10 m/s^2)

(1) 3 m/s
(2) 5 m/s
(3) 2 m/s
(4) 4 m/s

Correct Answer: (4) 4 m/s

Solution:



Apply Bernoulli equation between points 1 and 2.
$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h = P_2 + \frac{1}{2}\rho v_2^2 + 0$
$P_0 + \frac{mg}{A} + \rho g \frac{70}{100} = P_0 + \frac{1}{2}\rho v_2^2$
$\frac{5000}{0.5} + 10^3 \times 10 \times \frac{70}{100} = \frac{1}{2} \times 10^3 v_2^2$
$10^4 + 10^3 \times 7 = \frac{10^3}{2} v_2^2$
$v_2^2 = 16$
$v_2 = 4m/s$
As the tank area is large v_1 is negligible compared to v_2.

Quick Tip

Use Bernoulli's equation to relate the pressure, velocity, and height at two points in a fluid flow. Consider the pressure due to the applied load and the hydrostatic pressure.

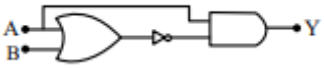
28. Choose the correct logic circuit for the given truth table having inputs A and B.

Inputs		Output
A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

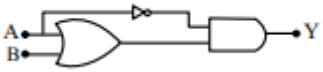
(1)

(2)

(3)



(4)



Correct Answer: (2)

Solution: Only option (2) matches with the truth table.

Quick Tip

Analyze each logic gate combination and compare its output with the given truth table to find the correct match.

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29. The radiation pressure exerted by a 450 W light source on a perfectly reflecting surface placed at 2m away from it, is :

(1) 1.5×10^{-4} Pascals
(2) 0

(3) 6 $\times 10^{-5}$ Pascals
(4) 3 $\times 10^{-5}$ Pascals

Correct Answer: (3) 6 $\times 10^{-5}$ Pascals

Solution: $P_{rad} = \frac{2I}{C}$ Where I = intensity at surface C = Speed of light
$Power = \frac{450}{Area} = \frac{450}{4\pi r^2}$ $I = \frac{450}{4\pi \times 4} = \frac{450}{16\pi}$
$P_{rad} = \frac{2\times 450}{16\pi \times 3\times 10^8} = \frac{150}{8\pi \times 10^8}$
$= 5.97 \times 10^{-8} \approx 6 \times 10^{-8}$ Pascals

Quick Tip

Use the formula for radiation pressure on a perfectly reflecting surface. Remember to calculate the intensity of the light at the given distance.

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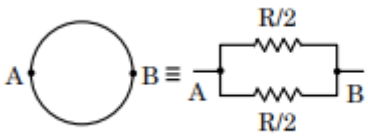
30. A wire of length 25 m and cross-sectional area 5 mm^2 having resistivity $2 \times 10^{-6}\,\Omega \cdot$ m is bent into a complete circle. The resistance between diametrically opposite points will be:

(1) 12.5 Ω
(2) 50 Ω
(3) 100 Ω
(4) 25 Ω

Correct Answer: (Bonus) NTA Ans. (4)

Solution: The wire is bent into a circle. The resistance between diametrically opposite points will be the resistance of two semicircles in parallel.

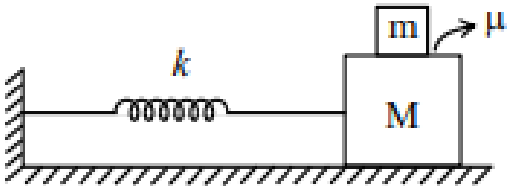


$L = 25$ m, $A = 5mm^2 = 5 \times 10^{-6}m^2$ $\rho = 2 \times 10^{-6}\Omega m$
$R_{wire} = \frac{\rho L}{A} = \frac{2\times 10^{-6}\times 25}{5\times 10^{-6}} = 10\Omega$
The resistance of each semicircle is $\frac{R_{wire}}{2} = \frac{10}{2} = 5\Omega$
The equivalent resistance of two semicircles in parallel is: $R_{eq} = \frac{R/2}{2} = \frac{10}{4} = 2.5\Omega$
Answer does not match with NTA option.

Quick Tip

When a wire is bent into a circle, the resistance between diametrically opposite points is the parallel combination of the resistances of the two semicircles.

31. Two blocks of masses m and M, (M ¿ m), are placed on a frictionless table as shown in figure. A massless spring with spring constant k is attached with the lower block. If the system is slightly displaced and released then (μ = coefficient of friction between the two blocks)

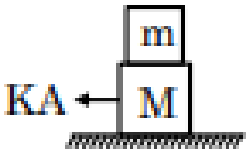


(A) The time period of small oscillation of the two blocks is T = $2\pi\sqrt{\frac{M+m}{k}}$
(B) The acceleration of the blocks is a = $\frac{kx}{M+m}$ (x = displacement of the blocks from the mean position)
(C) The magnitude of the frictional force on the upper block is $\frac{m\mu x}{M+m}$
(D) The maximum amplitude of the upper block, if it does not slip, is $\frac{\mu(M+m)g}{k}$
(E) Maximum frictional force can be $\mu(M+m)g$.
Choose the **correct** answer from the options given below :

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

Correct Answer: (1) A, B, D Only

Solution: (A) As both blocks moving together so time period = $2\pi\sqrt{\frac{m}{k}}$; where m = M + m
T = $2\pi\sqrt{\frac{M+m}{k}}$
(B) Let block is displaced by x in (+ve) direction so force on block will be in (-ve) direction F = Kx (M + m)a = -Kx a = $\frac{-Kx}{M+m}$
(C) As upper block is moving due to friction thus f = ma = $\frac{mKx}{M+m}$
(D) This option is like two block problem in friction for maximum amplitude, force on block is also maximum, for which both blocks are moving together.



KA = (M + m)a a = $\frac{KA}{M+m}$ f = ma = $\frac{mKA}{M+m}$ $f_{max} = f_L = \mu mg$ f = μmg $\frac{mKA}{M+m} = \mu mg$ A = $\frac{\mu(M+m)g}{K}$

(E) Maximum friction can be μmg as force is acting between blocks and normal force here is mg.

Quick Tip

Analyze the forces acting on the blocks and apply Newton's second law to determine the acceleration and frictional force. Consider the conditions for maximum amplitude and maximum frictional force.

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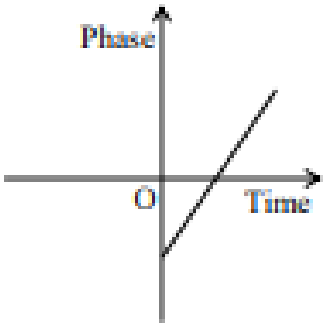
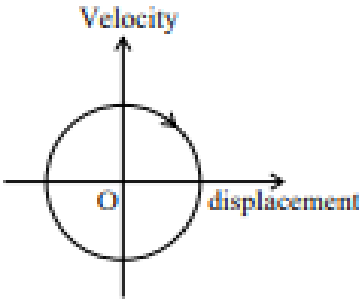
32. Which of the following curves possibly represent one-dimensional motion of a particle?

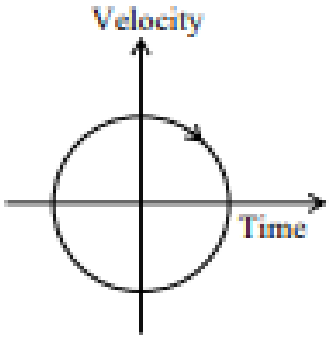
(A)

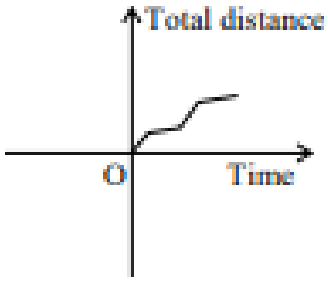


(B)



(C)





(D)

Choose the **correct** answer from the options given below :

(1) A, B and D only
(2) A, B and C only
(3) A and B only
(4) A, C and D only

Correct Answer: (1) A, B and D only

Solution: For option (A) $\phi = kt + C$ it can be 1D motion eg -¿ $x = A\sin\phi$ (SHM)
For option (B) $v^2 + x^2 =$ constant yes 1D
For option (C) time can't be negative Not possible
For option (D) Possible
A, B and D only

Quick Tip

Analyze each graph to determine if it can represent one-dimensional motion. Consider the physical quantities involved and their relationships.

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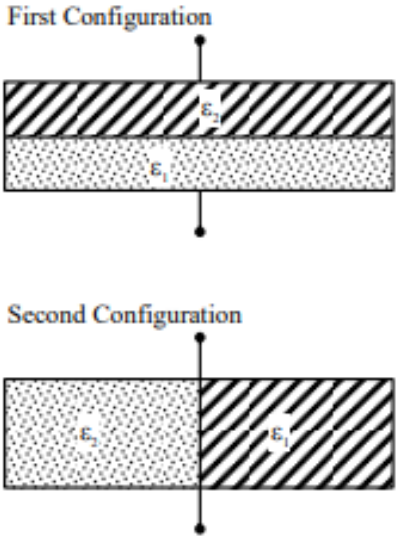
33. A parallel plate capacitor is filled equally (half) with two dielectrics of dielectric constant ϵ_1 and ϵ_2, as shown in figures. The distance between the plates is d and area of each plate is A. If capacitance in first configuration and second configuration are C_1 and C_2 respectively, then $\frac{C_1}{C_2}$ is:



(1) $\frac{\epsilon_1\epsilon_2}{(\epsilon_1+\epsilon_2)^2}$
(2) $\frac{4\epsilon_1\epsilon_2}{(\epsilon_1+\epsilon_2)^2}$
(3) $\frac{\epsilon_1\epsilon_2}{\epsilon_1+\epsilon_2}$
(4) $\frac{\epsilon_0(\epsilon_1+\epsilon_2)}{2}$

Correct Answer: (2) $\frac{4\epsilon_1\epsilon_2}{(\epsilon_1+\epsilon_2)^2}$

Solution: Let $C_0 = \frac{\epsilon_0 A}{d}$
First Configuration: Area of plate is A. Then $C = \frac{\epsilon_2\epsilon_0 A}{d/2} = \frac{2\epsilon_2\epsilon_0 A}{d} = 2\epsilon_2 C_0$
$C' = \frac{\epsilon_1\epsilon_0 A}{d/2} = \frac{2\epsilon_1\epsilon_0 A}{d} = 2\epsilon_1 C_0$
C and C' are in series.
$C_1 = \frac{CC'}{C+C'} = \frac{4\epsilon_1\epsilon_2 C_0^2}{2C_0(\epsilon_2+\epsilon_1)}$ $C_1 = \frac{2\epsilon_2\epsilon_1 C_0}{(\epsilon_2+\epsilon_1)}$
Second Configuration:
Here $C = \frac{\epsilon_1\epsilon_0 A}{2d} = \frac{\epsilon_1 C_0}{2}$ $C' = \frac{\epsilon_2 C_0}{2}$ C and C' are in parallel.
$C_2 = C' + C = (\epsilon_1+\epsilon_2)\frac{C_0}{2}$
Thus $\frac{C_1}{C_2} = \frac{2\epsilon_1\epsilon_2 C_0}{(\epsilon_2+\epsilon_1)} \times \frac{2}{(\epsilon_1+\epsilon_2)C_0}$ $\frac{C_1}{C_2} = \frac{4\epsilon_1\epsilon_2}{(\epsilon_2+\epsilon_1)^2}$

Quick Tip

Use the formula for capacitance in series and parallel configurations. Remember to define a common term C_0 to simplify the calculations.

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34. Match the LIST-I with LIST-II

LIST-I	LIST-II
A. Gravitational constant	I. $[LT^{-2}]$
B. Gravitational potential energy	II. $[L^2T^{-2}]$
C. Gravitational potential	III. $[ML^2T^{-2}]$
D. Acceleration due to gravity	IV. $[M^{-1}L^3T^{-2}]$

Choose the **correct** answer from the options given below :

(1) A-IV, B-III, C-II, D-I
(2) A-III, B-II, C-I, D-IV
(3) A-II, B-IV, C-III, D-I
(4) A-I, B-III, C-IV, D-II

Correct Answer: (1) A-IV, B-III, C-II, D-I

Solution: (A) $G = \frac{Fr^2}{m^2}$ $[G] = \frac{[MLT^{-2}][L^2]}{[M^2]} = [M^{-1}L^3T^{-2}]$ (IV)
(B) P.E. = mgh $= [MLT^{-2}L] = [ML^2T^{-2}]$ (III)
(C) Gravitational Potential $= \frac{GM}{r}$ $[M^{-1}L^3T^{-2}]\frac{[M]}{[L]} = [M^0L^2T^{-2}] = [L^2T^{-2}]$ (II)
(D) Acceleration due to gravity $= \frac{GM}{r^2}$ $[M^{-1}L^3T^{-2}]\frac{[M]}{[L^2]} = [M^0LT^{-2}] = [LT^{-2}]$ (I)

Quick Tip

Use the formulas for gravitational constant, gravitational potential energy, gravitational potential, and acceleration due to gravity to derive their dimensional formulas.

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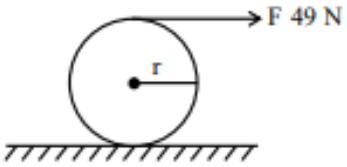
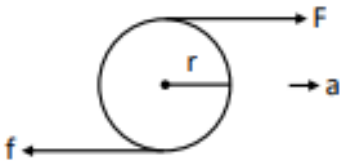
35. A force of 49 N acts tangentially at the highest point of a sphere (solid) of mass 20 kg, kept on a rough horizontal plane. If the sphere rolls without slipping, then the acceleration of the center of the sphere is



(1) 3.5 m/s^2
(2) 0.35 m/s^2
(3) 2.5 m/s^2
(4) 0.25 m/s^2

Correct Answer: (1) 3.5 m/s^2

Solution:



Torque about bottom point: $F \times 2r = I\alpha$ $49 \times 2r = \frac{7}{5}mr^2\alpha$ $14 - 4r\alpha$ As sphere rolls without slipping $a = r\alpha$ $a = \frac{14}{4} = \frac{7}{2} = 3.5m/s^2$

Quick Tip

Apply the torque equation about the point of contact to find the angular acceleration. Use the relation between linear acceleration and angular acceleration for rolling without slipping.

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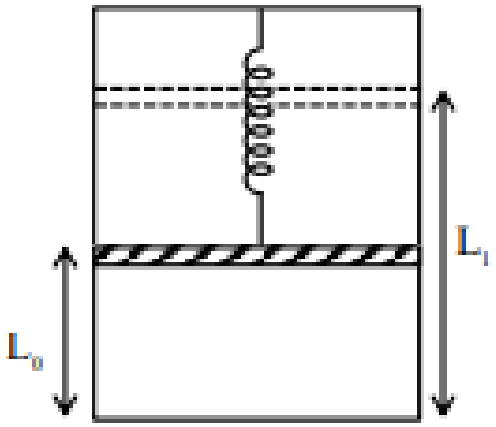
36. A piston of mass M is hung from a massless spring whose restoring force law goes as F = -kx, where k is the spring constant of appropriate dimension. The piston separates the vertical chamber into two parts, where the bottom part is filled with 'n' moles of an ideal gas. An external work is done on the gas

isothermally (at a constant temperature T) with the help of a heating filament (with negligible volume) mounted in lower part of the chamber, so that the piston goes up from a height L_0 to L_1, the total energy delivered by the filament is (Assume spring to be in its natural length before heating)



(1) $3nRT\ln\left(\frac{L_1}{L_0}\right)+2Mg(L_1-L_0)+\frac{k}{3}(L_1^3-L_0^3)$

(2) $nRT\ln\left(\frac{L_1}{L_0}\right)+\frac{Mg}{2}(L_1-L_0)+\frac{k}{4}(L_1^4-L_0^4)$

(3) $nRT\ln\left(\frac{L_1}{L_0}\right)+Mg(L_1-L_0)+\frac{k}{4}(L_1^4-L_0^4)$

(4) $nRT\ln\left(\frac{L_1}{L_0}\right)+Mg(L_1-L_0)+\frac{3k}{4}(L_1^4-L_0^4)$

Correct Answer: (3) $nRT\ln\left(\frac{L_1}{L_0}\right)+Mg(L_1-L_0)+\frac{k}{4}(L_1^4-L_0^4)$

Solution: Using WET: Total energy supplied = gravitational potential energy + spring potential energy + work done by gas

$Mg(L_1-L_0)+\int_0^{L_1-L_0}kxdx+nRT\ln\left(\frac{L_1}{L_0}\right)+W_{ext}=0$

$\frac{k}{4}[x^4]_0^{L_1-L_0}+Mg(L_1-L_0)+\int_0^{L_1-L_0}kxdx+nRT\ln\left(\frac{L_1}{L_0}\right)+W_{ext}=0$

$\frac{k}{4}(L_1^4-L_0^4)+Mg(L_1-L_0)+nRT\ln\left(\frac{L_1}{L_0}\right)+W_{ext}=0$

$W_{ext}=\frac{k}{4}(L_1^4-L_0^4)+Mg(L_1-L_0)+nRT\ln\left(\frac{L_1}{L_0}\right)$

Quick Tip

Apply the work-energy theorem (WET) to equate the total energy supplied to the change in potential energy and work done by the gas. Remember to consider the work done against gravity and the spring force.

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37. A gas is kept in a container having walls which are thermally non-conducting. Initially the gas has a volume of 800 cm^3 and temperature 27°C. The change in

temperature when the gas is adiabatically compressed to 200 cm^3 is: (Take $\gamma = 1.5$: γ is the ratio of specific heats at constant pressure and at constant volume)

(1) 327 K
(2) 600 K
(3) 522 K
(4) 300 K

Correct Answer: (4) 300 K

Solution: $V_1 = 800cm^3$ $V_2 = 200cm^3$ $T_1 = 300$ K
For adiabatic: $TV^{\gamma-1} =$ constant.
$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$
$(300)(800)^{1.5-1} = T_2(200)^{1.5-1}$
$T_2 = 300\left(\frac{800}{200}\right)^{0.5}$
$T_2 = 300(4)^{1/2}$
$T_2 = 600$ K
$\Delta T = 600 - 300 = 300$ K

Quick Tip

Use the adiabatic process equation to relate the initial and final temperatures and volumes. Remember to use consistent units for volume.

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38. Match the LIST-I with LIST-II

LIST-I	LIST-II
A. ${}^{236}_{92}U \rightarrow {}^{94}_{38}Sr + {}^{140}_{54}Xe + 2n$	I. Chemical Reaction
B. $2H_2 + O_2 \rightarrow 2H_2O$	II. Fusion with +ve Q value
C. ${}^{3}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He + n$	III. Fission
D. ${}^{1}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}H + \gamma$	IV. Fusion with -ve Q value

Choose the **correct** answer from the options given below :

(1) A-II, B-I, C-III, D-IV
(2) A-III, B-I, C-II, D-IV
(3) A-II, B-I, C-IV, D-III
(4) A-III, B-I, C-IV, D-II

Correct Answer: (2) A-III, B-I, C-II, D-IV

Solution: Conceptual

Quick Tip

Identify the type of reaction based on the reactants and products. Fission involves breaking a large nucleus into smaller ones, fusion involves combining smaller nuclei into a larger one, and chemical reactions involve changes in electron configuration.

39. The electrostatic potential on the surface of uniformly charged spherical shell of radius R = 10 cm is 120 V. The potential at the centre of shell, at a distance r = 5 cm from centre, and at a distance r = 15 cm from the centre of the shell respectively, are:

(1) 120V, 120V, 80V
(2) 40V, 40V, 80V
(3) 0V, 0V, 80V
(4) 0V, 120V, 40V

Correct Answer: (1) 120V, 120V, 80V

Solution: Potential inside shell is equal to potential on surface.
$V_{in} = V_{surface} = \frac{kQ}{R} = 120V$
at r = 15 cm $V = \frac{kQ}{r} = \frac{120 \times 10}{15} = 80V$

Quick Tip

Remember that the electrostatic potential inside a uniformly charged spherical shell is constant and equal to the potential on the surface. Outside the shell, the potential varies inversely with the distance from the center.

40. The work function of a metal is 3 eV. The color of the visible light that is required to cause emission of photoelectrons is

(1) Green
(2) Blue
(3) Red
(4) Yellow

Correct Answer: (2) Blue

Solution: $(KE)_{max} = \frac{hc}{\lambda} - \phi$
$\frac{hc}{\lambda} > \phi$ [for emission]
$\lambda < \frac{hc}{\phi}$
$\lambda < \frac{1242}{3} nm$
So blue light option (B)

Quick Tip

Use the photoelectric equation to relate the energy of incident light to the work function and kinetic energy of emitted electrons. Remember that shorter wavelengths correspond to higher energy photons, which are required to overcome the work function.

41. A particle is released from height S above the surface of the earth. At certain height its kinetic energy is three times its potential energy. The height from the surface of the earth and the speed of the particle at that instant are respectively.

(1) $\frac{S}{2}, \sqrt{\frac{3gS}{2}}$
(2) $\frac{S}{2}, \frac{3gS}{2}$
(3) $\frac{S}{4}, \sqrt{\frac{3gS}{2}}$
(4) $\frac{S}{4}, \frac{3gS}{2}$

Correct Answer: (3) $\frac{S}{4}, \sqrt{\frac{3gS}{2}}$

Solution: $V^2 = 0 + 2g(S - x)$ $V^2 = 2g(S - x)$
At B, Potential energy = mgx Kinetic energy = $\frac{1}{2}mv^2$ $\frac{1}{2}mv^2 = 3mgx$ $gx = \frac{1}{6}v^2 = \frac{1}{6}2g(S - x)$
$4x = S$ $x = \frac{S}{4}$
$V = \sqrt{2g \times \frac{3S}{4}} = \sqrt{\frac{3gS}{2}}$

Quick Tip

Use the conservation of energy principle to relate the potential and kinetic energies at different heights. Remember that the potential energy is proportional to the height above the surface.

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42. A person measures mass of 3 different particles as 435.42 g, 226.3 g and 0.125 g. According to the rules for arithmetic operations with significant figures, the additions of the masses of 3 particles will be.

(1) 661.845 g
(2) 662 g
(3) 661.8 g
(4) 661.84 g

Correct Answer: (3) 661.8 g

Solution: $m_1 + m_2 + m_3 = 435.42 + 226.3 + 0.125 = 661.845$ g
According to least significant digits m = 661.8 g

Quick Tip

When adding or subtracting measurements, the result should have the same number of decimal places as the measurement with the fewest decimal places.

43. The radii of curvature for a thin convex lens are 10 cm and 15 cm respectively. The focal length of the lens is 12 cm. The refractive index of the lens material is

(1) 1.2
(2) 1.4
(3) 1.5
(4) 1.8

Correct Answer: (3) 1.5

Solution: $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$
$\frac{1}{12} = (\mu - 1)\left(\frac{1}{10} - \frac{1}{-15}\right)$
$\frac{1}{12} = (\mu - 1)\left(\frac{3+2}{30}\right)$
$\mu = \frac{3}{2}$

Quick Tip

Use the lensmaker's formula to relate the focal length, radii of curvature, and refractive index of the lens material.

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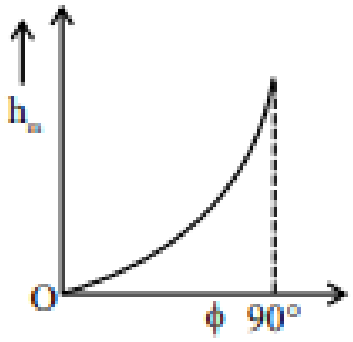
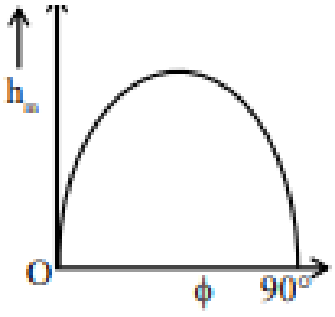
44. The angle of projection of a particle is measured from the vertical axis as ϕ and the maximum height reached by the particle is h_m. Here h_m as function of ϕ can be presented as

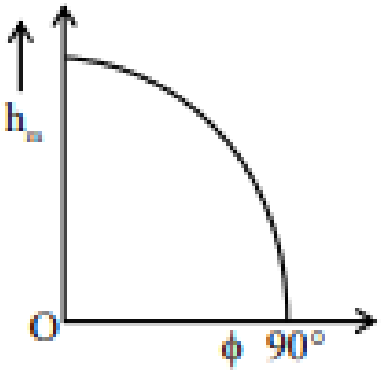


(1)

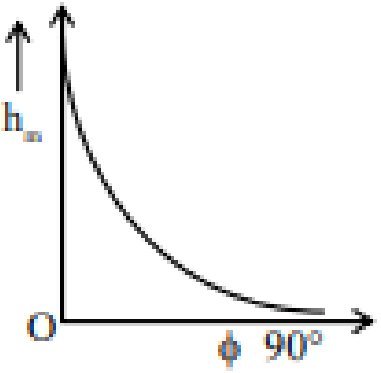


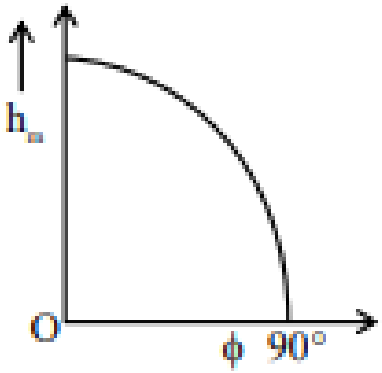
(2)

(3)



(4)





Correct Answer: (3)

Solution:

$H_{max} = \frac{u^2 \cos^2 \phi}{2g}$

Quick Tip

Use the formula for maximum height in projectile motion. Since the angle is measured from the vertical, use $\cos \phi$ instead of $\sin \theta$.

45. Consider following statements for refraction of light through prism, when angle of deviation is minimum.
(A) The refracted ray inside prism becomes parallel to the base.
(B) Larger angle prisms provide smaller angle of minimum deviation.
(C) Angle of incidence and angle of emergence becomes equal.
(D) There are always two sets of angle of incidence for which deviation will be same except at minimum deviation setting.
(E) Angle of refraction becomes double of prism angle.
Choose the **correct** answer from the options given below:

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

Correct Answer: (1) A, C and D Only

Solution: $\delta = I + e - A$
For $\delta_{min} \Rightarrow I = e$ and refracted ray is parallel to base
A, C, D are correct

Quick Tip

Remember the conditions for minimum deviation in a prism. The refracted ray becomes parallel to the base, and the angle of incidence equals the angle of emergence.

Section - B

46. Three identical spheres of mass m, are placed at the vertices of an equilateral triangle of length a. When released, they interact only through gravitational force and collide after a time T = 4 seconds. If the sides of the triangle are increased to length 2a and also the masses of the spheres are made 2m, then they will collide after _____ seconds.

Correct Answer: (8)

Solution:

$$T \propto m^x G^y a^z$$

$$T \propto M^x \left[M^{-1}L^3T^{-2}\right]^y [L]^z$$

$$T \propto M^{x-y} L^{3y+z} T^{-2y}$$

$$x - y = 0 \Rightarrow x = y$$

$$-2y = 1 \Rightarrow y = -\frac{1}{2}$$

$$3y + z = 0 \Rightarrow z = -3y = \frac{3}{2}$$

$$\Rightarrow T \propto m^{-\frac{1}{2}} G^{-\frac{1}{2}} a^{\frac{3}{2}}$$

$$T \propto \frac{a^{3/2}}{\sqrt{m}}$$

$$T = 4\left(\frac{2a}{a}\right)^{3/2} = 8s$$

Quick Tip

Use dimensional analysis to find the relationship between the collision time and the given parameters.

---

47. A 4.0 cm long straight wire carrying a current of 8A is placed perpendicular to an uniform magnetic field of strength 0.15 T. The magnetic force on the wire is _____ mN.

Correct Answer: (48)

Solution:

$$F = IlB$$

$$F = 8 \times \frac{4}{100} \times 0.15$$

$$F = \frac{48 \times 100}{10000} N$$

$$F = 48 \times 10^{-3} N$$

$$F = 48 \text{ mN}$$

Quick Tip

Use the formula for the magnetic force on a current-carrying wire in a magnetic field. Remember to convert the length to meters.

---

48. Two coherent monochromatic light beams of intensities 4I and 9I are superimposed. The difference between the maximum and minimum intensities in the resulting interference pattern is xI. The value of x is _____.

Correct Answer: (24)

Solution:

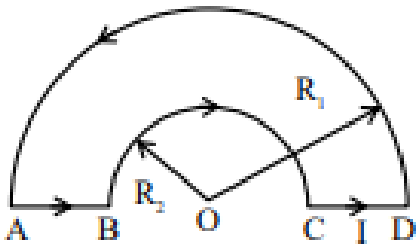
$$I_{max} = (\sqrt{I_1} + \sqrt{I_2})^2$$
$$I_{max} = (\sqrt{4I} + \sqrt{9I})^2$$
$$I_{max} = (2\sqrt{I} + 3\sqrt{I})^2$$
$$I_{max} = (5\sqrt{I})^2 = 25I$$
$$I_{min} = (\sqrt{I_1} - \sqrt{I_2})^2$$
$$I_{min} = (\sqrt{4I} - \sqrt{9I})^2$$
$$I_{min} = (2\sqrt{I} - 3\sqrt{I})^2$$
$$I_{min} = (-\sqrt{I})^2 = I$$
$$I_{max} - I_{min} = 24I$$
$$x = 24$$

Quick Tip

Use the formulas for maximum and minimum intensities in interference. Remember that the intensities are proportional to the square of the amplitudes.

---

49. A loop ABCD, carrying current $I = 12$ A, is placed in a plane, consists of two semi-circular segments of radius $R_1 = 6\pi$ m and $R_2 = 4\pi$ m. The magnitude of the resultant magnetic field at center O is $k \times 10^{-7}$ T. The value of k is _____ (Given $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})



Correct Answer: (1)

Solution:

$$B_0 = |B_{R_1} - B_{R_2}|$$
$$B_0 = \left|\frac{\mu_0 I}{4R_2} - \frac{\mu_0 I}{4R_1}\right|$$
$$B_0 = \frac{4\pi \times 10^{-7} \times 12}{4}\left|\frac{1}{4\pi} - \frac{1}{6\pi}\right|$$

$$B_0 = 12\pi \times 10^{-7}\left|\frac{1}{12\pi}\right|$$

$$B_0 = 1 \times 10^{-7}T$$

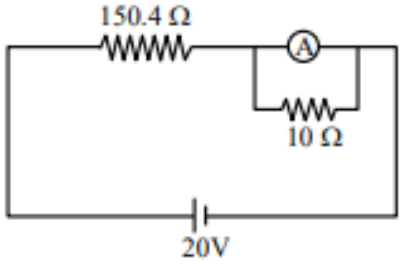
$$k = 1$$

Quick Tip

Use the formula for the magnetic field due to a circular arc at its center. Remember to consider the direction of the magnetic field due to each segment and subtract them.

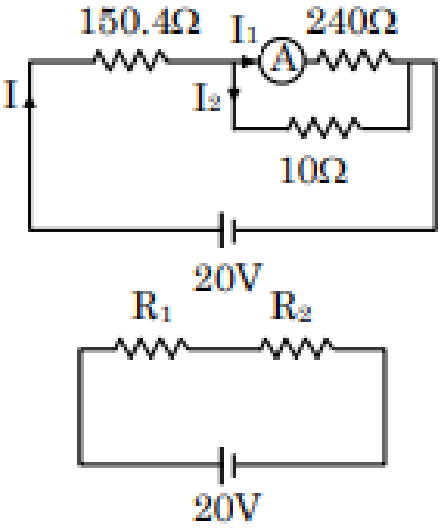
---

50. In the figure shown below, a resistance of 150.4 Ω is connected in series to an ammeter A of resistance 240 Ω. A shunt resistance of 10 Ω is connected in parallel with the ammeter. The reading of the ammeter is _____ mA.



Correct Answer: (5) NTA Ans. (125)

Solution:



$$R_{eq} = R_1 + R_2$$

$$R_{eq} = 150.4 + \frac{240 \times 10}{250}$$
$$R_{eq} = 150.4 + 9.6 = 160\Omega$$
$$I_1 = \frac{IR_2}{240}$$
$$I_1 = \frac{I \times 9.6}{240}$$
$$I = \frac{20}{160}$$
$$I_1 = \frac{20}{160} \times \frac{9.6}{240} = \frac{1}{200} = 5 \times 10^{-3} A = 5mA$$

Quick Tip

Calculate the equivalent resistance of the circuit. Then use Ohm's law and current division to find the current through the ammeter.
