JEE–MAIN EXAMINATION – APRIL 2025

(HELD ON THURSDAY 03rd APRIL 2025) **TIME : 9:00 AM TO 12:00 NOON**

PHYSICS **TEST PAPER WITH SOLUTION**

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.

Ans. (4)

Sol. 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

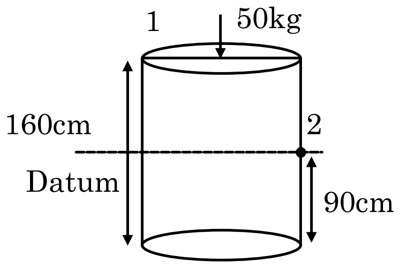
27. Consider a completely full cylindrical water tank of height 1.6 m and cross-sectional area 0.5 m^2. It has a small hole in its side at a height 90 cm from the bottom. Assume, the cross-sectional area of the hole to be negligibly small as compared to that of the water tank. If a load 50 kg is applied 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

Ans. (4)

Sol.



Apply Bernouli equation between points 1 & 2

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho gh = P_2 + \frac{1}{2}\rho v_2^2 + 0$$

$$P_0 + \frac{mg}{A} + \rho g\frac{70}{100} = P_0 + \frac{1}{2}\rho v_2^2$$

$$\frac{5000}{0.5} + 10^3 \times 10\frac{70}{100} = \frac{1}{2}\times 10^3 v_2^2$$

$$10^3 + 10^3 \times 7 = \frac{10^3}{2}v_2^2$$

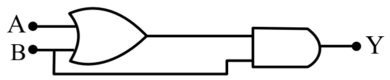
$$v_2^2 = 16$$

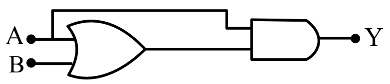
$$v_2 = 4\text{m/s}$$

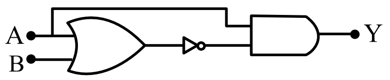
As the tank area is large v_1 is negligible compared to v_2

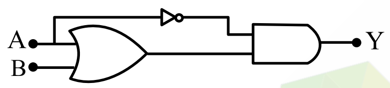
28. Choose the correct logic circuit for the given truth table having inputs A and B.

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

(1) 

(2) 

(3) 

(4) 

Ans. **(2)**

Sol. Only option (2) matches with the truth table

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^{-8} Pascals

(2) 0

(3) 6×10^{-8} Pascals

(4) 3×10^{-8} Pascals

Ans. **(3)**

Sol. $P_{rad} = \frac{2I}{C}$

Where I = intensity at surface

C = Speed of light

$$I = \frac{\text{Power}}{\text{Area}} = \frac{450}{4\pi r^2}$$

$$= \frac{450}{4\pi \times 4} = \frac{450}{16\pi}$$

$$P_{rad} = \frac{2 \times 450}{16\pi \times 3 \times 10^8} = \frac{150}{8\pi \times 10^8}$$

$= 5.97 \times 10^{-8} \approx 6 \times 10^{-8}$ Pascals

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

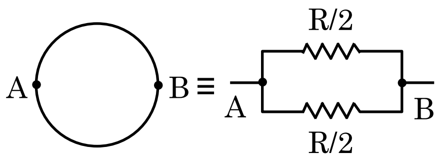
(1) 12.5 Ω (2) 50 Ω

(3) 100 Ω (4) 25 Ω

Allen Ans. (Bonus)

NTA Ans. (4)

Sol.



$L = 25$ m, $A = 5\ mm^2 = 5 \times 10^{-6}\ m^2$

$\rho = 2 \times 10^{-6}$ Ωm

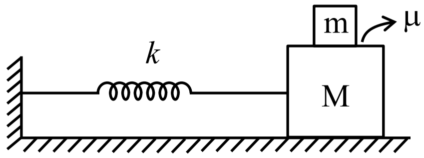
$$R_{wire} = \frac{\rho L}{A} = \frac{2 \times 10^{-6} \times 25}{5 \times 10^{-6}} = 10$$

$$R_{eq} = \frac{R}{4} = \frac{10}{4} = 2.5\Omega$$

Answer does not match with NTA option.

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 μ(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

Ans. **(1)**

Sol. (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

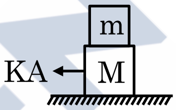
(M + m)a = –Kx

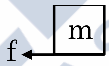
$$a = -\frac{Kx}{(M+m)}$$

(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

$$a = \frac{KA}{(M+m)}$$

$$f = ma = \frac{mKA}{(M+m)}$$

$f_{max} = f_L = \mu mg$

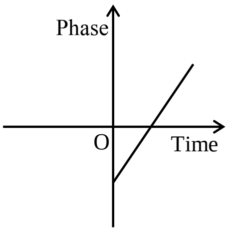
$f = \mu mg$

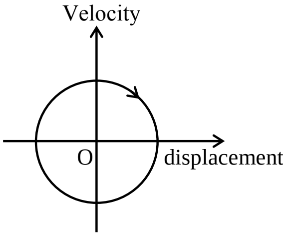
$$\frac{mKA}{(M+m)} = \mu mg$$

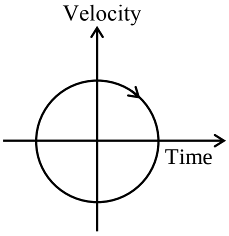
$$A = \frac{\mu(M+m)g}{K}$$

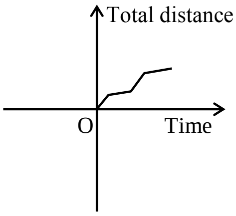
(E) Maximum friction can be μmg as force is acting between blocks & normal force here is mg.

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

Ans. **(1)**

Sol. For option (A)

$\phi = kt + C$ it can be 1D motion

eg $\rightarrow x = A \sin \phi$ (SHM)

For option (B)

$v^2 + x^2$ = constant yes 1D

For option (C)

time can't be negative Not possible

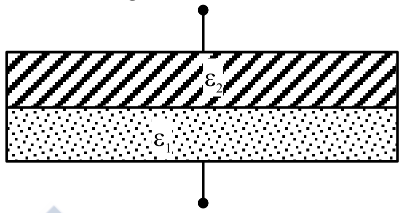
For option (D)

Possible

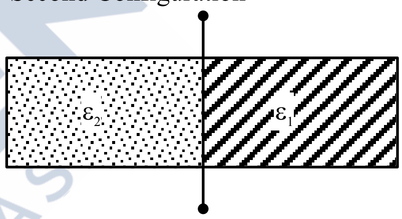
A, B & D only

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 :

First Configuration



Second Configuration

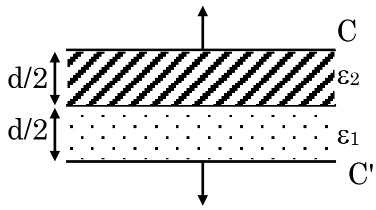


(1) $\frac{\varepsilon_1\varepsilon_2^2}{(\varepsilon_1+\varepsilon_2)^2}$ (2) $\frac{4\varepsilon_1\varepsilon_2}{(\varepsilon_1+\varepsilon_2)^2}$

(3) $\frac{\varepsilon_1\varepsilon_2}{\varepsilon_1+\varepsilon_2}$ (4) $\frac{\varepsilon_0(\varepsilon_1+\varepsilon_2)}{2}$

Ans. **(2)**

Sol.



First configuration

Area of plate is A.

then

$$C = \frac{\varepsilon_2\varepsilon_0 A}{d/2} = \frac{2\varepsilon_2\varepsilon_0 A}{d}$$

$$C' = \frac{\varepsilon_1\varepsilon_0 A}{d/2} = \frac{2\varepsilon_1\varepsilon_0 A}{d}$$

Let $C_0 = \dfrac{\varepsilon_0 A}{d}$

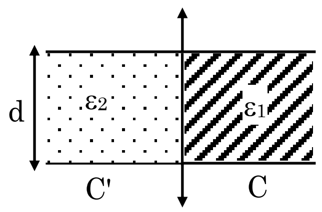
$C = 2\varepsilon_2 C_0$

$C' = 2\varepsilon_1 C_0$

C & C' are in series

$$C_1 = \frac{CC'}{C+C'} = \frac{4\varepsilon_2\varepsilon_1 C_0^2}{2C_0(\varepsilon_2+\varepsilon_1)}$$

$$= \frac{2\varepsilon_2\varepsilon_1 C_0}{(\varepsilon_2+\varepsilon_1)}$$



Second configuration

Here $C = \dfrac{\varepsilon_1\varepsilon_0 A}{2d} = \dfrac{\varepsilon_1 C_0}{2}$

$C' = \dfrac{\varepsilon_2 C_0}{2}$

C & C' are inparallel

$$C_2 = C' + C = (\varepsilon_1+\varepsilon_2)\frac{C_0}{2}$$

Thus $\dfrac{C_1}{C_2} = \dfrac{2\varepsilon_2\varepsilon_1 C_0}{(\varepsilon_2+\varepsilon_1)} \times \dfrac{2}{(\varepsilon_1+\varepsilon_2)C_0}$

$$= \frac{4\varepsilon_2\varepsilon_1}{(\varepsilon_2+\varepsilon_1)^2}$$

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

Ans. (1)

Sol. **(A)** $G = \dfrac{Fr^2}{m^2}$

$$[G] = \frac{[MLT^{-2}][L^2]}{[M^2]} = [M^{-1}L^3T^{-2}] \text{(IV)}$$

(B) P.E. = mgh = $[MLT^{-2}L]$

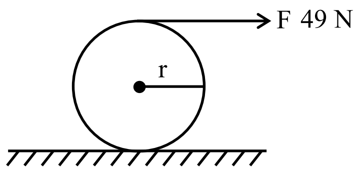
$= [ML^2T^{-2}]$ (III)

(C) Gravitational Potential = $\dfrac{GM}{r}$

$$= \frac{[M^{-1}L^3T^{-2}][M]}{[L]} = [M^0L^2T^{-2}] = [L^2T^{-2}] \text{(II)}$$

(D) Acceleration due to gravity = [g] = $[LT^{-2}]$ (I)

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

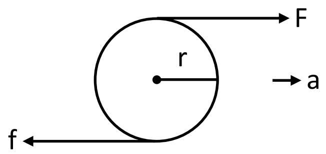


(1) 3.5 m/s^2 (2) 0.35 m/s^2

(3) 2.5 m/s^2 (4) 0.25 m/s^2

Ans. (1)

Sol.



Torque about bottom point

$F \times 2r = I\alpha$

$49 \times 2r = \frac{7}{5} mr^2\alpha$

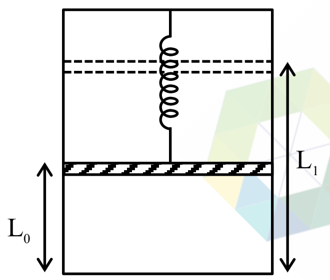
$14 = 4r\alpha$

As sphere rolls without slipping

$a = r\alpha$

$a = \frac{14}{4} = \frac{7}{2} = 3.5 m/s^2$

36. A piston of mass M is hung from a massless spring whose restoring force law goes as $F = -kx^3$, 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) $nRT\ln\left(\frac{L_1^2}{L_0^2}\right) + \frac{Mg}{2}(L_1 - L_0) + \frac{k}{4}(L_1^4 - L_0^4)$

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

Ans. (3)

Sol. Using WET

Total energy supplied = gravitational potential energy + spring potential energy + work done by gas

$$Mg\ (L_1 - L_0) + \int_{L_0}^{L_1} kx^3 dx + nRT\ell n\left[\frac{L_1 A}{L_0 A}\right] + W_{ext} = 0$$

$$\frac{K}{4}\left[x^4\right]_{L_0}^{L_1} + Mg\ (L_1 - L_0) + \int_{L_0}^{L_1} kx^3 dx + nRT\ell n\left[\frac{L_1}{L_0}\right] + W_{ext} = 0$$

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

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

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

Ans. (4)

Sol. $V_1 = 800\ cm^3 \quad V_2 = 200\ cm^3$

$T_1 = 300\ K$

for adiabatic

$TV^{\gamma-1} = \text{const.}$

$(300)\ (800)^{1.5-1} = T_2(200)^{1.5-1}$

$$T_2 = 300\left[\frac{800}{200}\right]^{0.5} = 300 \times \left(2^2\right)^{1/2}$$

$T_2 = 600\ K$

$\Delta T = 600 - 300 = 300\ K$

38. Match the **LIST-I** with **LIST-II**

	LIST-I		LIST-II
A.	$^{1}_{0}n + ^{235}_{92}U \rightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + 2^{1}_{0}n$	I.	Chemical reaction
B.	$2H_2 + O_2 \rightarrow 2H_2O$	II.	Fusion with +ve Q value
C.	$^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He + ^{1}_{0}n$	III.	Fission
D.	$^{1}_{1}H + ^{3}_{1}H \rightarrow ^{2}_{1}H + ^{2}_{1}H$	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

Ans. (2)

Sol. Conceptual

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

Ans. (1)

Sol. Potential inside shell is equal to potential on surface

$$V_{in} = V_{surface} = \frac{kQ}{R} = 120V$$

at r = 15 cm

$$V = \frac{kQ}{r} = \frac{120\times10}{15} = 80V$$

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

Ans. (2)

Sol. $$(KE)_{max} = \frac{hc}{\lambda} - \phi$$

$$\frac{hc}{\lambda} > \phi[\text{for emission}]$$

$$\lambda < \frac{hc}{\phi} \Rightarrow \lambda < \frac{1242}{3}\text{nm}$$

So blue light option (B)

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

Ans. (4)

Sol. $V^2 = 0 + 2g(S - x)$

$V^2 = 2g(S - x)$

At B, Potential energy = mgx

$$mgx = 3 \times \frac{1}{2}mv^2$$

$$gx = \frac{3}{2}\times 2g(S-x)$$

$$4x = S$$

$$x = \frac{S}{4}$$

$$\Rightarrow V = \sqrt{2g\times\frac{3S}{4}} = \sqrt{\frac{3gS}{2}}$$

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

Ans. **(3)**

Sol. $m_1 + m_2 + m_3 = 435.42 + 226.3 + 0.125$

According to least significant digits m = 661.8 g

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

Ans. **(3)**

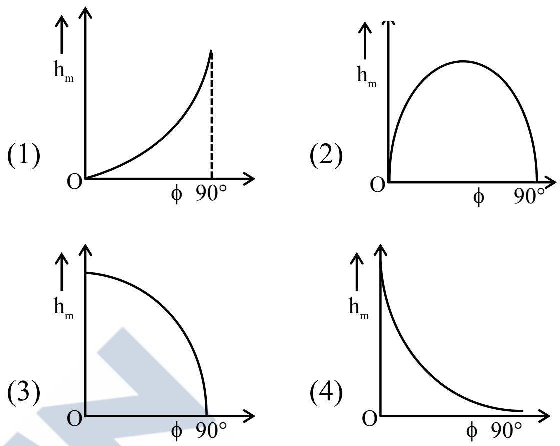
Sol. $$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{12} = (\mu - 1)\left(\frac{1}{10} - \frac{1}{-15}\right)$$

$$\frac{1}{12} = (\mu - 1)\left(\frac{3+2}{30}\right)$$

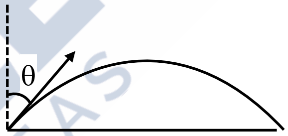
$$\mu = \frac{3}{2}$$

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



Ans. **(3)**

Sol.



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

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

Ans. **(1)**

Sol. $\delta = I + e - A$

For $\delta_{min} \Rightarrow I = e$

and refracted ray is parallel to base

A, C, D are correct

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.

Ans. **(8)**

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

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

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

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

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

$\Rightarrow 3y + z = 0$

$z = -3y = \frac{3}{2}$

Hence

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

$T \propto \left(\frac{a^3}{m}\right)^{1/2}$

$T = 4\times\left(\frac{2^3}{2}\right)^{1/2} = 8s$

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.

Ans. **(48)**

Sol. $F = I\ell B$

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

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

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 __________ .

Ans. **(24)**

Sol. $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

$= \left(\sqrt{4I} + \sqrt{9I}\right)^2 = 25I$

$I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$

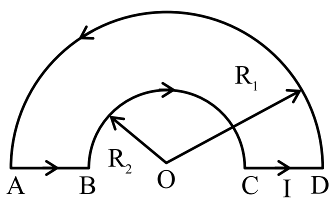
$= \left(\sqrt{4I} - \sqrt{9I}\right)^2 = I$

$I_{max} - I_{min} = 24\,I$

$x = 24$

49. A loop ABCDA, 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 $\mu_0 = 4\pi \times 10^{-7}$ Tm A^{-1})



Ans. **(1)**

Sol. Magnetic field due to AB & CD = 0

$B_0 = \left|B_{R_1} - B_{R_2}\right|$

$= \frac{\mu_0 I}{4R_2} - \frac{\mu_0 I}{4R_1}$

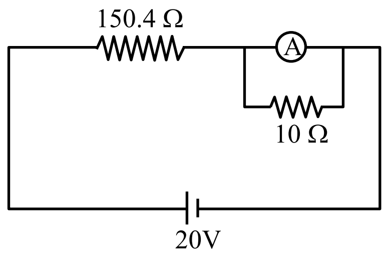
$= \frac{4\pi\times10^{-7}\times12}{4}\left(\frac{1}{4\pi} - \frac{1}{6\pi}\right)$

$= 12\pi\times10^{-7}\left(\frac{1}{12\pi}\right)$

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

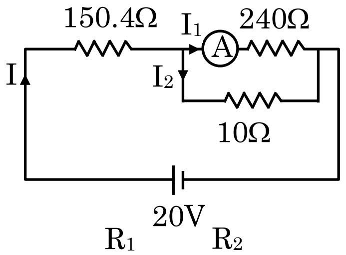
K = 1

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.

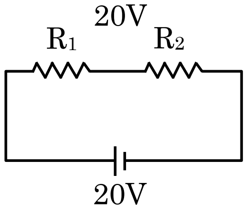


Allen Ans. (5)

NTA Ans. (125)



Sol.



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

$$R_{eq} = 150.4 + \frac{240\times10}{250}$$

$= 150.4 + 9.6 = 160\ \Omega$

$$I_1 = \frac{IR_2}{240}$$

$$I_1 = \frac{I\times9.6}{240}$$

$$= \frac{20}{160}\times\frac{9.6}{2400} = \frac{1}{200} = 5\times10^{-3}\text{ A} = 5\text{mA}$$