

TEST PAPER OF JEE(MAIN) EXAMINATION – 2019
(Held On Friday 11th JANUARY, 2019) TIME : 02 : 30 PM To 05 : 30 PM
PHYSICS

1. A paramagnetic substance in the form of a cube with sides 1 cm has a magnetic dipole moment of 20×10^{-6} J/T when a magnetic intensity of 60×10^3 A/m is applied. Its magnetic susceptibility is :-

- (1) 2.3×10^{-2} (2) 3.3×10^{-2}
 (3) 3.3×10^{-4} (4) 4.3×10^{-2}

Ans. (3)

Sol. $\chi = \frac{I}{H}$

$$I = \frac{\text{Magnetic moment}}{\text{Volume}}$$

$$I = \frac{20 \times 10^{-6}}{10^{-6}} = 20 \text{ N/m}^2$$

$$\chi = \frac{20}{60 \times 10^3} = \frac{1}{3} \times 10^{-3}$$

$$= 0.33 \times 10^{-3} = 3.3 \times 10^{-4}$$

2. A particle of mass m is moving in a straight line with momentum p . Starting at time $t = 0$, a force $F = kt$ acts in the same direction on the moving particle during time interval T so that its momentum changes from p to $3p$. Here k is a constant. The value of T is :-

- (1) $2\sqrt{\frac{p}{k}}$ (2) $\sqrt{\frac{2p}{k}}$ (3) $\sqrt{\frac{2k}{p}}$ (4) $2\sqrt{\frac{k}{p}}$

Ans. (1)

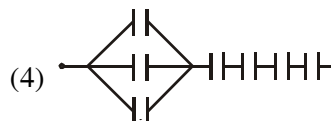
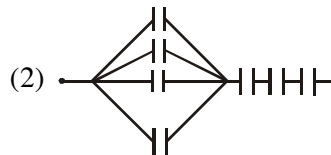
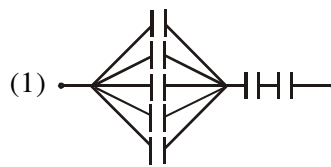
Sol. $\frac{dp}{dt} = F = kt$

$$\int_p^{3p} dP = \int_0^T kt \, dt$$

$$2p = \frac{KT^2}{2}$$

$$T = 2\sqrt{\frac{p}{K}}$$

3. Seven capacitors, each of capacitance $2 \mu\text{F}$, are to be connected in a configuration to obtain an effective capacitance of $\left(\frac{6}{13}\right) \mu\text{F}$. Which of the combinations, shown in figures below, will achieve the desired value ?



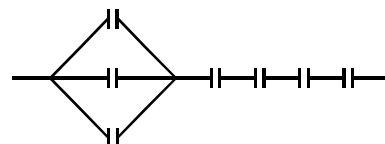
Ans. (4)

Sol. $C_{eq} = \frac{6}{13} \mu\text{F}$

Therefore three capacitors must be in parallel to get 6 in

$$\frac{1}{C_{eq}} = \frac{1}{3C} + \frac{1}{C} + \frac{1}{C} + \frac{1}{C} + \frac{1}{C}$$

$$C_{eq} = \frac{3C}{13} = \frac{6}{13} \mu\text{F}$$



4. An electric field of 1000 V/m is applied to an electric dipole at angle of 45° . The value of electric dipole moment is 10^{-29} C.m. What is the potential energy of the electric dipole ?

- (1) -9×10^{-20} J
(2) -7×10^{-27} J
(3) -10×10^{-29} J
(4) -20×10^{-18} J

Ans. (2)

Sol. $U = -\vec{p} \cdot \vec{E}$
 $= -pE \cos \theta$
 $= -(10^{-29})(10^3) \cos 45^\circ$
 $= -0.707 \times 10^{-26}$ J
 $= -7 \times 10^{-27}$ J.

5. A simple pendulum of length 1 m is oscillating with an angular frequency 10 rad/s. The support of the pendulum starts oscillating up and down with a small angular frequency of 1 rad/s and an amplitude of 10^{-2} m. The relative change in the angular frequency of the pendulum is best given by :-

- (1) 10^{-3} rad/s
(2) 10^{-1} rad/s
(3) 1 rad/s
(4) 10^{-5} rad/s

Ans. (1)

Sol. Angular frequency of pendulum

$$\omega = \sqrt{\frac{g_{\text{eff}}}{\ell}}$$

$$\therefore \frac{\Delta \omega}{\omega} = \frac{1}{2} \frac{\Delta g_{\text{eff}}}{g_{\text{eff}}}$$

$$\Delta \omega = \frac{1}{2} \frac{\Delta g}{g} \times \omega$$

$[\omega_s = \text{angular frequency of support}]$

$$\Delta \omega = \frac{1}{2} \times \frac{2A\omega_s^2}{100} \times 100$$

$$\Delta \omega = 10^{-3} \text{ rad/sec.}$$

6. Two rods A and B of identical dimensions are at temperature 30°C . If A is heated upto 180°C and B upto $T^\circ\text{C}$, then the new lengths are the same. If the ratio of the coefficients of linear expansion of A and B is 4 : 3, then the value of T is :-

- (1) 270°C (2) 230°C
(3) 250°C (4) 200°C

Ans. (2)

Sol. $\Delta \ell_1 = \Delta \ell_2$

$$\ell \alpha_1 \Delta T_1 = \ell \alpha_2 \Delta T_2$$

$$\frac{\alpha_1}{\alpha_2} = \frac{\Delta T_1}{\Delta T_2}$$

$$\frac{4}{3} = \frac{T - 30}{180 - 30}$$

$$\boxed{T = 230^\circ\text{C}}$$

7. In a double-slit experiment, green light ($5303 \text{ \AA}$) falls on a double slit having a separation of $19.44 \mu\text{m}$ and a width of $4.05 \mu\text{m}$. The number of bright fringes between the first and the second diffraction minima is :-

- (1) 09 (2) 10
(3) 04 (4) 05

Ans. (4)

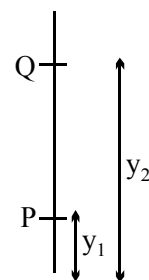
Sol. For diffraction

location of 1st minime

$$y_1 = \frac{D\lambda}{a} = 0.2469 D\lambda$$

location of 2nd minima

$$y_2 = \frac{2D\lambda}{a} = 0.4938 D\lambda$$



Now for interference

Path difference at P.

$$\frac{dy}{D} = 4.8\lambda$$

path difference at Q

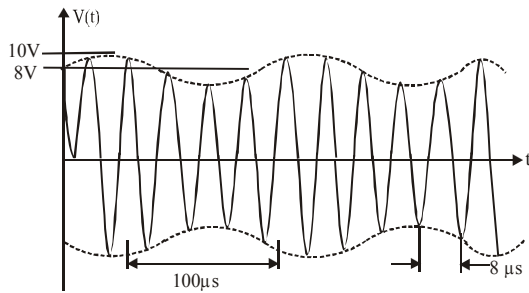
$$\frac{dy}{D} = 9.6\lambda$$

So orders of maxima in between P & Q is

5, 6, 7, 8, 9

So 5 bright fringes all present between P & Q.

8. An amplitude modulated signal is plotted below :-



Which one of the following best describes the above signal ?

- (1) $(9 + \sin(2.5\pi \times 10^5 t)) \sin(2\pi \times 10^4 t)V$
 (2) $(9 + \sin(4\pi \times 10^4 t)) \sin(5\pi \times 10^5 t)V$
 (3) $(1 + 9\sin(2\pi \times 10^4 t)) \sin(2.5\pi \times 10^5 t)V$
 (4) $(9 + \sin(2\pi \times 10^4 t)) \sin(2.5\pi \times 10^5 t)V$

Ans. (4)

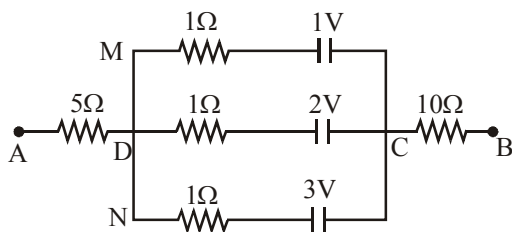
Sol. Analysis of graph says

- (1) Amplitude varies as $8 - 10$ V or 9 ± 1
 (2) Two time period as
 $100 \mu s$ (signal wave) & $8 \mu s$ (carrier wave)

$$\text{Hence signal is } \left[9 \pm 1 \sin\left(\frac{2\pi t}{T_1}\right) \right] \sin\left(\frac{2\pi t}{T_2}\right)$$

$$= 9 \pm 1 \sin(2\pi \times 10^4 t) \sin 2.5\pi \times 10^5 t$$

9. In the circuit, the potential difference between A and B is :-



- (1) 6 V (2) 1 V (3) 3 V (4) 2 V

Ans. (4)

Sol. Potential difference across AB will be equal to battery equivalent across CD

$$V_{AB} = V_{CD} = \frac{\frac{E_1}{r_1} + \frac{E_2}{r_2} + \frac{E_3}{r_3}}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}} = \frac{\frac{1}{1} + \frac{2}{1} + \frac{3}{1}}{\frac{1}{1} + \frac{1}{1} + \frac{1}{1}}$$

$$= \frac{6}{3} = 2V$$

10. A 27 mW laser beam has a cross-sectional area of 10 mm^2 . The magnitude of the maximum electric field in this electromagnetic wave is given by [Given permittivity of space $\epsilon_0 = 9 \times 10^{-12} \text{ SI units}$, Speed of light $c = 3 \times 10^8 \text{ m/s}$]:-

- (1) 1 kV/m (2) 2 kV/m
 (3) 1.4 kV/m (4) 0.7 kV/m

Ans. (3)

Sol. Intensity of EM wave is given by

$$I = \frac{\text{Power}}{\text{Area}} = \frac{1}{2} \epsilon_0 E_0^2 C$$

$$= \frac{27 \times 10^{-3}}{10 \times 10^{-6}} = \frac{1}{2} \times 9 \times 10^{-12} \times E^2 \times 3 \times 10^8$$

$$E = \sqrt{2} \times 10^3 \text{ kv/m}$$

$$= 1.4 \text{ kv/m}$$

11. A pendulum is executing simple harmonic motion and its maximum kinetic energy is K_1 . If the length of the pendulum is doubled and it performs simple harmonic motion with the same amplitude as in the first case, its maximum kinetic energy is K_2 . Then :-

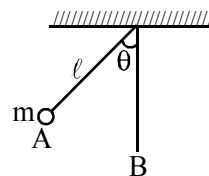
- (1) $K_2 = \frac{K_1}{4}$ (2) $K_2 = \frac{K_1}{2}$
 (3) $K_2 = 2K_1$ (4) $K_2 = K_1$

Ans. (3)

Sol. Maximum kinetic energy at lowest point B is given by

$$K = mgl(1 - \cos \theta)$$

where θ = angular amp.



$$K_1 = mgl(1 - \cos \theta)$$

$$K_2 = mg(2l)(1 - \cos \theta)$$

$$K_2 = 2K_1.$$

12. In a hydrogen like atom, when an electron jumps from the M - shell to the L - shell, the wavelength of emitted radiation is λ . If an electron jumps from N-shell to the L-shell, the wavelength of emitted radiation will be :-

(1) $\frac{27}{20}\lambda$ (2) $\frac{16}{25}\lambda$ (3) $\frac{20}{27}\lambda$ (4) $\frac{25}{16}\lambda$

Ans. (3)

Sol. For $M \rightarrow L$ steel

$$\frac{1}{\lambda} = K \left(\frac{1}{2^2} - \frac{1}{3^2} \right) = \frac{K \times 5}{36}$$

for $N \rightarrow L$

$$\frac{1}{\lambda'} = K \left(\frac{1}{2^2} - \frac{1}{4^2} \right) = \frac{K \times 3}{16}$$

$$\lambda' = \frac{20}{27}\lambda$$

13. If speed (V), acceleration (A) and force (F) are considered as fundamental units, the dimension of Young's modulus will be :-

- (1) $V^{-2} A^2 F^2$ (2) $V^{-4} A^2 F$
 (3) $V^{-4} A^{-2} F$ (4) $V^{-2} A^2 F^{-2}$

Ans. (2)

Sol. $\frac{F}{A} = y \cdot \frac{\Delta \ell}{\ell}$

$$[Y] = \frac{F}{A}$$

Now from dimension

$$F = \frac{ML}{T^2}$$

$$L = \frac{F}{M} \cdot T^2$$

$$L^2 = \frac{F^2}{M^2} \left(\frac{V}{A} \right)^4 \therefore T = \frac{V}{A}$$

$$L^2 = \frac{F^2}{M^2 A^2} \frac{V^4}{A^2} \quad F = MA$$

$$L^2 = \frac{V^4}{A^2}$$

$$[Y] = \frac{[F]}{[A]} = F^1 V^{-4} A^2$$

14. A particle moves from the point $(2.0\hat{i} + 4.0\hat{j})$ m, at $t = 0$, with an initial velocity $(5.0\hat{i} + 4.0\hat{j}) \text{ ms}^{-1}$.

It is acted upon by a constant force which produces a constant acceleration $(4.0\hat{i} + 4.0\hat{j}) \text{ ms}^{-2}$. What is the distance of the particle from the origin at time 2 s ?

- (1) $20\sqrt{2}$ m (2) $10\sqrt{2}$ m
 (3) 5 m (4) 15 m

Ans. (1)

Sol. $\vec{S} = (5\hat{i} + 4\hat{j})2 + \frac{1}{2}(4\hat{i} + 4\hat{j})4$

$$= 10\hat{i} + 8\hat{j} + 8\hat{i} + 8\hat{j}$$

$$\vec{r}_f - \vec{r}_i = 18\hat{i} + 16\hat{j}$$

$$\vec{r}_f = 20\hat{i} + 20\hat{j}$$

$$|\vec{r}_f| = 20\sqrt{2}$$

15. A monochromatic light is incident at a certain angle on an equilateral triangular prism and suffers minimum deviation. If the refractive index of the material of the prism is $\sqrt{3}$, then the angle of incidence is :-

- (1) 30° (2) 45°
 (3) 90° (4) 60°

Ans. (4)

Sol. $i = e$

$$r_1 = r_2 = \frac{A}{2} = 30^\circ$$

by Snell's law

$$1 \times \sin i = \sqrt{3} \times \frac{1}{2} = \frac{\sqrt{3}}{2}$$

$$i = 60$$

16. A galvanometer having a resistance of 20Ω and 30 divisions on both sides has figure of merit 0.005 ampere/division. The resistance that should be connected in series such that it can be used as a voltmeter upto 15 volt, is :-

- (1) 80Ω (2) 120Ω
 (3) 125Ω (4) 100Ω

Ans. (1)

Sol. $R_g = 20\Omega$

$$N_L = N_R = N = 30$$

$$\text{FOM} = \frac{I}{\phi} = 0.005 \text{ A/Div.}$$

$$\text{Current sensitivity} = \text{CS} = \left(\frac{1}{0.005} \right) = \frac{\phi}{I}$$

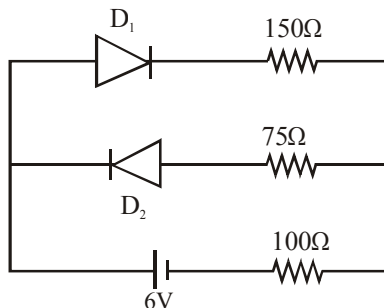
$$I_{g_{\max}} = 0.005 \times 30 \\ = 15 \times 10^{-2} = 0.15$$

$$15 = 0.15 [20 + R]$$

$$100 = 20 + R$$

$$R = 80$$

- 17.** The circuit shown below contains two ideal diodes, each with a forward resistance of 50Ω . If the battery voltage is 6 V , the current through the 100Ω resistance (in Amperes) is :-



- (1) 0.027 (2) 0.020
(3) 0.030 (4) 0.036

Ans. (2)

Sol. $I = \frac{6}{300} = 0.002$ (D_2 is in reverse bias)

- 18.** When 100 g of a liquid A at 100°C is added to 50 g of a liquid B at temperature 75°C , the temperature of the mixture becomes 90°C . The temperature of the mixture, if 100 g of liquid A at 100°C is added to 50 g of liquid B at 50°C , will be :-

- (1) 80°C (2) 60°C
(3) 70°C (4) 85°C

Ans. (1)

Sol. $100 \times S_A \times [100 - 90] = 50 \times S_B \times (90 - 75)$
 $2S_A = 1.5 S_B$

$$S_A = \frac{3}{4} S_B$$

$$\text{Now, } 100 \times S_A \times [100 - T] = 50 \times S_B (T - 50)$$

$$2 \times \left(\frac{3}{4} \right) (100 - T) = (T - 50)$$

$$300 - 3T = 2T - 100$$

$$400 = 5T$$

$$T = 80$$

- 19.** The mass and the diameter of a planet are three times the respective values for the Earth. The period of oscillation of a simple pendulum on the Earth is 2 s . The period of oscillation of the same pendulum on the planet would be :-

- (1) $\frac{2}{\sqrt{3}} \text{ s}$ (2) $2\sqrt{3} \text{ s}$
(3) $\frac{\sqrt{3}}{2} \text{ s}$ (4) $\frac{3}{2} \text{ s}$

Ans. (2)

Sol. $\because g = \frac{GM}{R^2}$

$$\frac{g_p}{g_e} = \frac{M_e}{M_p} \left(\frac{R_e}{R_p} \right)^2 = 3 \left(\frac{1}{3} \right)^2 = \frac{1}{3}$$

$$\text{Also } T \propto \frac{1}{\sqrt{g}}$$

$$\Rightarrow \frac{T_p}{T_e} = \sqrt{\frac{g_e}{g_p}} = \sqrt{3}$$

$$\Rightarrow T_p = 2\sqrt{3} \text{ s}$$

- 20.** The region between $y = 0$ and $y = d$ contains a magnetic field $\vec{B} = B\hat{z}$. A particle of mass m and charge q enters the region with a velocity

$$\vec{v} = v\hat{i}. \text{ If } d = \frac{mv}{2qB}, \text{ the acceleration of the}$$

charged particle at the point of its emergence at the other side is :-

$$(1) \frac{qvB}{m} \left(\frac{\hat{i} + \hat{j}}{\sqrt{2}} \right)$$

$$(2) \frac{qvB}{m} \left(\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{\sqrt{2}}\hat{j} \right)$$

$$(3) \frac{qvB}{m} \left(\frac{-\hat{j} + \hat{i}}{\sqrt{2}} \right)$$

$$(4) \frac{qvB}{m} \left(\frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j} \right)$$

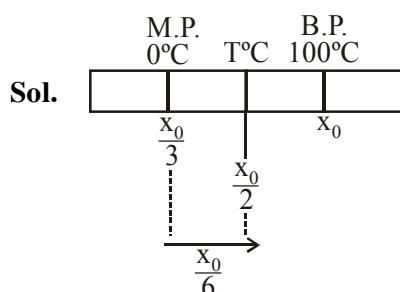
Ans. (BONUS)

- 21.** A thermometer graduated according to a linear scale reads a value x_0 when in contact with boiling water, and $x_0/3$ when in contact with ice.

What is the temperature of an object in 0°C , if this thermometer in the contact with the object reads $x_0/2$?

- (1) 35 (2) 25
(3) 60 (4) 40

Ans. (2)

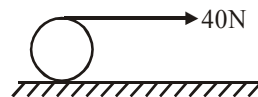


$$\Rightarrow T^\circ\text{C} = \frac{x_0}{6} \quad \& \quad \left(x_0 - \frac{x_0}{3} \right) = (100 - 0^\circ\text{C})$$

$$x_0 = \frac{300}{2}$$

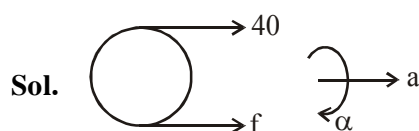
$$\Rightarrow T^\circ\text{C} = \frac{150}{6} = 25^\circ\text{C}$$

- 22.** A string is wound around a hollow cylinder of mass 5 kg and radius 0.5 m. If the string is now pulled with a horizontal force of 40 N, and the cylinder is rolling without slipping on a horizontal surface (see figure), then the angular acceleration of the cylinder will be (Neglect the mass and thickness of the string) :-



- (1) 12 rad/s^2 (2) 16 rad/s^2
(3) 10 rad/s^2 (4) 20 rad/s^2

Ans. (2)



$$40 + f = m(R\alpha) \dots\dots(i)$$

$$40 \times R - f \times R = mR^2\alpha$$

$$40 - f = mR\alpha \dots\dots(ii)$$

From (i) and (ii)

$$\alpha = \frac{40}{mR} = 16$$

- 23.** In a process, temperature and volume of one mole of an ideal monoatomic gas are varied according to the relation $VT = K$, where K is a constant. In this process the temperature of the gas is increased by ΔT . The amount of heat absorbed by gas is (R is gas constant) :

- (1) $\frac{1}{2}R\Delta T$ (2) $\frac{3}{2}R\Delta T$
(3) $\frac{1}{2}KR\Delta T$ (4) $\frac{2K}{3}\Delta T$

Ans. (1)

Sol. $VT = K$

$$\Rightarrow V \left(\frac{PV}{nR} \right) = k \Rightarrow PV^2 = K$$

$$\therefore C = \frac{R}{1-x} + C_v \quad (\text{For polytropic process})$$

$$C = \frac{R}{1-2} + \frac{3R}{2} = \frac{R}{2}$$

$$\therefore \Delta Q = nC \Delta T$$

$$= \frac{R}{2} \times \Delta T$$

- 24.** In a photoelectric experiment, the wavelength of the light incident on a metal is changed from 300 nm to 400 nm. The decrease in the stopping

potential is close to : $\left(\frac{hc}{e} = 1240 \text{ nm} \cdot \text{V} \right)$

- (1) 0.5 V (2) 1.0 V
(3) 2.0 V (4) 1.5 V

Ans. (2)

Sol. $\frac{hc}{\lambda_1} = \phi + eV_1$ (i)

$\frac{hc}{\lambda_2} = \phi + eV_2$ (ii)

(i) – (ii)

$$hc \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2} \right) = e(V_1 - V_2)$$

$$\Rightarrow V_1 - V_2 = \frac{hc}{e} \left(\frac{\lambda_2 - \lambda_1}{\lambda_1 \lambda_2} \right)$$

$$= (1240 \text{ nm} \cdot \text{V}) \frac{100 \text{ nm}}{300 \text{ nm} \times 400 \text{ nm}}$$

$$= 1 \text{ V}$$

- 25.** A metal ball of mass 0.1 kg is heated upto 500°C and dropped into a vessel of heat capacity 800 JK⁻¹ and containing 0.5 kg water. The initial temperature of water and vessel is 30°C. What is the approximate percentage increment in the temperature of the water ? [Specific Heat Capacities of water and metal are, respectively, 4200 Jkg⁻¹K⁻¹ and 400 Jkg⁻¹K⁻¹]

- (1) 30% (2) 20%
(3) 25% (4) 15%

Ans. (2)

Sol. $0.1 \times 400 \times (500 - T) = 0.5 \times 4200 \times (T - 30) + 800 (T - 30)$

$$\Rightarrow 40(500 - T) = (T - 30) (2100 + 800)$$

$$\Rightarrow 20000 - 40T = 2900 T - 30 \times 2900$$

$$\Rightarrow 20000 + 30 \times 2900 = T(2940)$$

$$T = 30.4^\circ\text{C}$$

$$\frac{\Delta T}{T} \times 100 = \frac{6.4}{30} \times 100$$

$$\approx 20\%$$

- 26.** The magnitude of torque on a particle of mass 1kg is 2.5 Nm about the origin. If the force acting on it is 1 N, and the distance of the particle from the origin is 5m, the angle between the force and the position vector is (in radians) :-

- (1) $\frac{\pi}{8}$ (2) $\frac{\pi}{6}$ (3) $\frac{\pi}{4}$ (4) $\frac{\pi}{3}$

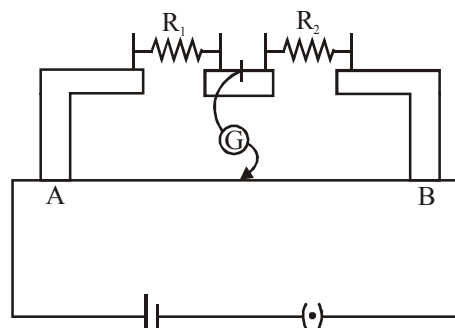
Ans. (2)

Sol. $2.5 = 1 \times 5 \sin \theta$

$$\sin \theta = 0.5 = \frac{1}{2}$$

$$\theta = \frac{\pi}{6}$$

- 27.** In the experimental set up of metre bridge shown in the figure, the null point is obtained at a distance of 40 cm from A. If a 10Ω resistor is connected in series with R₁, the null point shifts by 10 cm. The resistance that should be connected in parallel with (R₁ + 10)Ω such that the null point shifts back to its initial position is



- (1) 40 Ω (2) 60 Ω (3) 20 Ω (4) 30 Ω

Ans. (2)

Sol. $\frac{R_1}{R_2} = \frac{2}{3} \dots\dots(i)$

$$\frac{R_1 + 10}{R_2} = 1 \Rightarrow R_1 + 10 = R_2 \dots\dots(ii)$$

$$\frac{2R_2}{3} + 10 = R_2$$

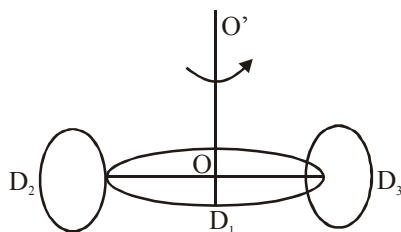
$$10 = \frac{R_2}{3} \Rightarrow R_2 = 30\Omega$$

$$\& R_1 = 20\Omega$$

$$\frac{30 \times R}{30 + R} = \frac{2}{3}$$

$$R = 60\Omega$$

- 28.** A circular disc D_1 of mass M and radius R has two identical discs D_2 and D_3 of the same mass M and radius R attached rigidly at its opposite ends (see figure). The moment of inertia of the system about the axis OO' , passing through the centre of D_1 , as shown in the figure, will be:-



- (1) $3MR^2$ (2) $\frac{2}{3}MR^2$
(3) MR^2 (4) $\frac{4}{5}MR^2$

Ans. (1)

Sol.
$$I = \frac{MR^2}{2} + 2\left(\frac{MR^2}{4} + MR^2\right)$$

$$= \frac{MR^2}{2} + \frac{MR^2}{2} + 2MR^2$$

$$= 3MR^2$$

- 29.** A copper wire is wound on a wooden frame, whose shape is that of an equilateral triangle. If the linear dimension of each side of the frame is increased by a factor of 3, keeping the number of turns of the coil per unit length of the frame the same, then the self inductance of the coil :

- (1) Decreases by a factor of $9\sqrt{3}$
 (2) Increases by a factor of 3
 (3) Decreases by a factor of 9
 (4) Increases by a factor of 27

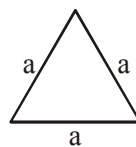
Ans. (2)

Sol. Total length L will remain constant

$$L = (3a) N \quad (N = \text{total turns})$$

and length of winding = $(d) N$

(d = diameter of wire)



$$\text{self inductance} = \mu_0 n^2 A \ell$$

$$= \mu_0 n^2 \left(\frac{\sqrt{3} a^2}{4} \right) dN$$

$$\propto a^2 N \propto a$$

So self inductance will become 3 times

- 30.** A particle of mass m and charge q is in an electric and magnetic field given by

$$\vec{E} = 2\hat{i} + 3\hat{j} ; \quad \vec{B} = 4\hat{j} + 6\hat{k}.$$

The charged particle is shifted from the origin to the point $P(x = 1 ; y = 1)$ along a straight path.

The magnitude of the total work done is :-

- (1) $(0.35)q$ (2) $(0.15)q$
 (3) $(2.5)q$ (4) $5q$

Ans. (4)

Sol.
$$\vec{F}_{\text{net}} = q\vec{E} + q(\vec{v} \times \vec{B})$$

$$= (2q\hat{i} + 3q\hat{j}) + q(\vec{v} \times \vec{B})$$

$$W = \vec{F}_{\text{net}} \cdot \vec{S}$$

$$= 2q + 3q$$

$$= 5q$$