1. If length of simple pendulum is made $\frac{1}{16}$ times, then time period of simple pendulum changes by…

(1) $\frac{1}{3}$ times (2) $\frac{1}{4}$ times (3) $\frac{1}{5}$ times (4) $\frac{1}{6}$ times

Ans: 2

Sol: $T = 2\pi\sqrt{\frac{\ell}{g}}$

$$T' = 2\pi\sqrt{\frac{\ell}{16g}} = \frac{T}{4}$$

2. Ring, solid sphere and solid cylinder rolls an inclined plane without slipping then order of velocity at lowest point of inclined will be:

(1) $V_{Ring} > V_{solid\ sphere} > V_{solid\ cylinder}$

(2) $V_{solid\ sphere} > V_{solid\ cylinder} > V_{ring}$

(3) $V_{solid\ cylinder} > V_{solid\ sphere} > V_{ring}$

(4) $V_{ring} > V_{solid\ cylinder} > V_{solid\ sphere}$

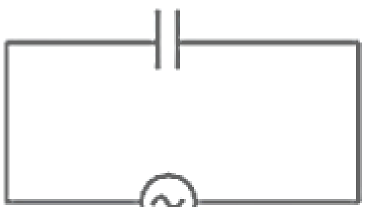
Ans: 2

Sol: $mgh = \frac{1}{2}I_{cm}\omega^2 + \frac{1}{2}mv^2$

$$V = \sqrt{\frac{2gh}{1+\frac{I_{cm}}{mR^2}}}$$

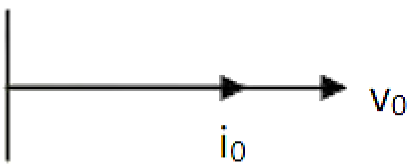
$I \uparrow \quad V \downarrow$

3. In given ac circuit correct phase diagram will be:

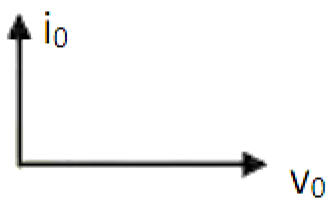


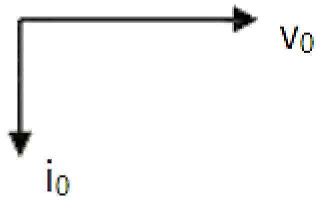
$V = V_0 \sin\omega t$

(1)




(2)



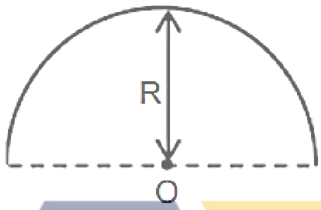
(3) 


(4) 


Ans: 2

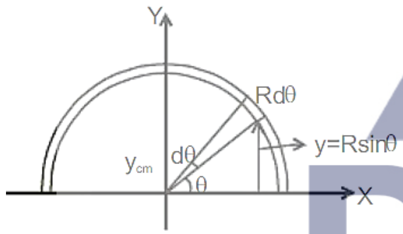
Sol: In pure capacitive circuit current leads with voltage.

4. Distance of center of mass from point O is given by $\frac{\lambda R}{\pi}$ for uniform semi-circular ring final value of $\lambda$




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

Ans: 2




To find $y_{cm}$ we use $y_{cm} = \frac{1}{M}\int dmy$ ….(i)

Here for dm we consider an elemental arc of the ring at an angle $\theta$ from the x-direction of angular width $d\theta$. If radius of the ring is R then its y coordinate will be $R\sin\theta$, here dm is given as

$$dm = \frac{M}{\pi R} \times Rd\theta$$

So from equation …(i), we have

$$y_{cm} = \frac{1}{M}\int_0^{\pi} \frac{M}{\pi R} Rd\theta \left(R\sin\theta\right) = \frac{R}{\pi}\int_0^{\pi} \sin\theta d\theta$$

$$y_{cm} = \frac{2R}{\pi} \ldots.(ii)$$

$$\therefore \lambda = 2$$

5. Find the ratio of De-Broglie wavelength of an electron and a proton when accelerated through same potential difference?

(1) $\sqrt{1803}$ (2) $\sqrt{1621}$ (3) $\sqrt{1417}$ (4) $\sqrt{1230}$

Ans: 1

Sol:- $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mqV}}$

$$\frac{\lambda_e}{\lambda_\rho} = \sqrt{\frac{m_\rho \times 1}{m_e \times e}} = \sqrt{1803}$$

6. For an iron rod temperature is increased by $10^0 C$. Give $\alpha = 10^{-5}\, per\ {}^0C$, $Y = 10^{11} N/m^2$, area cross section $A = 10^{-2} m^2$. Find energy stored per unit length

(1) 5 J/m (2) 10 J/m (3) 15 J/m (4) 20 J/m

Ans: 1

Sol: $U = \frac{1}{2} \times \text{stress} \times \text{strain} \times \text{volume}$

$$U = \frac{1}{2} \times \text{stress } \times \text{strain } \times \text{volume} \times \text{A}l$$

$$\frac{U}{l} = \frac{1}{2} \times \text{stress} \times \text{strain} \times \text{volume} \times \text{A}$$

$$= \frac{1}{2} \times Y \times (strain)^2 \times A$$

$$= \frac{1}{2} \times Y \left(\frac{\Delta l}{l}\right)^2 \times A$$

$$= \frac{1}{2} Y \left(\frac{l\alpha\Delta t}{l}\right)^2 \times A$$

$$= \frac{1}{2} Y\alpha^2 \Delta t^2 A$$

$$= \frac{1}{2} \times 10^{11} \times 10^{-10} \times 10 \times 10 \times 10^{-2}$$

$$= 5 Joule/m$$

7. A gun of mass 4 kg fire a bullet of mass 4g with muzzle velocity equal to 50m/s. find the velocity of bullet.

(1) 48.59m/s (2) 49.95 m/s (3) 45.59 m/s (4) 40.59 m/s

Ans: 2

Sol:

Initial momentum=final momentum

$$0 = m_G V_G + M_B V_b$$

$$\Rightarrow 0 = 4 \times V_g + \frac{4}{1000} V_b$$

$$\Rightarrow V_G = -\frac{V_b}{1000} \ldots(1)$$

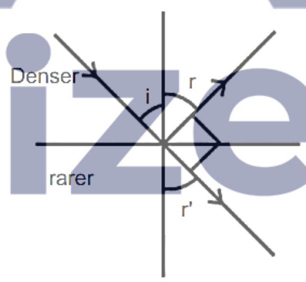
$$V_{bG} = V_b - V_G$$

$$\Rightarrow 50 = V_B - V_G \ldots .(2)$$

$$\Rightarrow 50 = \frac{+V_b}{1000} + V_b$$

$$\Rightarrow V_b = \frac{50 \times 1000}{1001} \Rightarrow V_b = 49.95 m/s$$

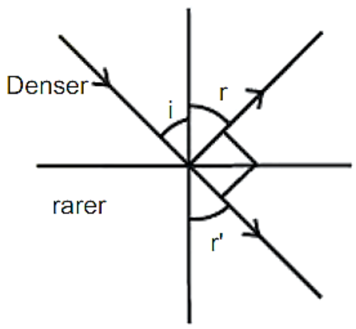
8. A ray incident from denser medium rarer medium. If angle between reflected and refracted ray is $90^\circ$ then angle of reflection r and angle of refraction $r'$ will be respectively:




(1) $i, \sin^{-1}(\sin i)$ (2) $\sin^{-1}(\cos i), i$ (3) $i, \sin^{-1}(\cos i)$ (4) $i, \sin^{-1}(\tan i)$

Ans: 3

Sol:




$$r' + 90^0 + r = 180^0$$

$r' + 90^0 + 1 = 180^0$

$r' = 90 - I = \sin^{-1}(\cos i)$

9. The average kinetic energy of a molecule of a monoatomic gas is:

(1) 5/2kT (2) 3/2 kT (3) 7/2 kT (4) 1/2 kT

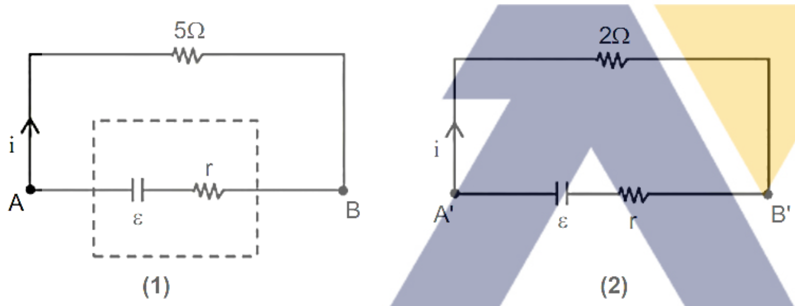
Ans: 2

10. A cell first connected across $5\Omega$ resistance develops a potential difference of $1.25V$ across it. Same cell again connected across $2\Omega$ resistance develops $1V$ potential difference across it find the emf of cell:

(1) 5V (2) 15V (3) 7V (4) 4V

Ans: 2

Sol:




(1) $I = \frac{1.25}{5} = 0.25A$

$V_{AB} = 5V = \varepsilon - ir$

$1.25 = \varepsilon - 0.25r \ldots(1)$

(2) $I = \frac{1}{2} = 0.5A$

$V_{A'B'} = 1 = \varepsilon - 0.5r \ldots(2)$

Solving (1) & (2)

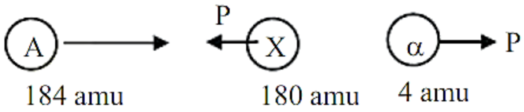
$\varepsilon = 15V$

11. An element of mass number 184 decays by emitting an $\alpha$-particle. If Q-value of the reaction is 5.5 MeV, then find the kinetic energy of $\alpha$-particle. Assume that there is no $\gamma$ emission

(1) 5.0 MeV (2) 5.38 MeV (3) 3.60 MeV (4) 2.10 MeV

Ans: 2

Sol:




$$k_\alpha = \left(\frac{A-4}{A}\right)Q = 5.38MeV$$

12. If $\vec{A} = \hat{i} + \hat{j} + \hat{k}$

$\vec{B} = \hat{i} + \hat{j}$

Find the projection of $\vec{A}$ on $\vec{B}$

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

Ans: 1

Sol: Projection of $\vec{A}$ on $\vec{B} = \vec{A}.\vec{B}$

$$= \left(\hat{i} + \hat{j} + \hat{k}\right).\left(\frac{\hat{i} + \hat{j}}{\sqrt{2}}\right) = \frac{1+1}{\sqrt{2}} = \sqrt{2}$$

13. In a room of temperature $25^0 C$, a body in initial temperature of $75^0 C$ cools down to $65^0$C in 5 min. After 5 more minutes, the final temperature of body will be?

(1) $60^0$C (2) $58^0$C (3) $57^0$C (4) $55^0$C

Ans: 3

Sol: $$\frac{\Delta T}{t} = K\left(\frac{T_1 + T_2}{2} - T_0\right)$$

$$\frac{75-65}{5} = K\left(\frac{75+65}{2} - 25\right) ...(1)$$

$$\frac{65-T}{5} = K\left(\frac{T+65}{2} - 25\right) ...(2)$$

Eq(2)/Eq(1)

$$\frac{65-T}{75-65} = \frac{\frac{T+65}{2}}{\frac{75+65}{2} - 25}$$

$$\frac{65-T}{10} = \frac{T+15}{90}$$

$$90 \times 65 - 90T = 10T + 10 \times 15$$

$$100T = 90 \times 65 - 15 \times 10$$

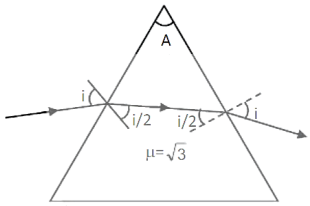
$T = 57^0 C$

14. A ray is incident on prism of refractive index $\mu = \sqrt{3}$. If range of incident is twice of angle of refraction when deviation of ray is minimum. Then find the prism angle.

(1) $30^0$ (2) $60^0$ (3) $45^0$ (4) $90^0$

Ans: 2

Sol:




$A = \frac{i}{2} + \frac{i}{2} = i$

$1 \sin i = \mu \sin \frac{i}{2}$

$2 \sin \frac{i}{2} \cos \frac{i}{2} = \sqrt{3} \sin \frac{i}{2}$

$\cos \frac{i}{2} = \frac{\sqrt{3}}{2}$

$\frac{i}{2} = 30^0$

$i = 60^0$

$\therefore A = i = 60^0$

15. Find height of antenna if coverage of signals from Antenna is 150 km and radius of earth is 6400 km. Also find the total population covered by antenna signal, if population density is 200 people/km$^2$

(1) $\frac{625}{124} \times 10^3 m$; $6.057 \times 10^6$ people (2) $\frac{225}{128} \times 10^3 m; 14.13 \times 10^6$ people

(3) $\frac{125}{84} \times 10^3 m; 8.057 \times 10^9$ people (4) $\frac{725}{72} \times 10^3 m; 10.057 \times 10^7$ people

Ans: 2

Sol: Radius of earth =6400 km

$d = 150$ km

Height of Antena=?

$d = \sqrt{2Rh}$

$$h=\frac{d^2}{2R}=\frac{150\times150\times10^6}{2\times6400\times10^3}=\frac{225}{128}\times10^{8-5}=\frac{225}{128}\times10^3\,m$$

Population covered $\Rightarrow 2\pi Rh\times density$

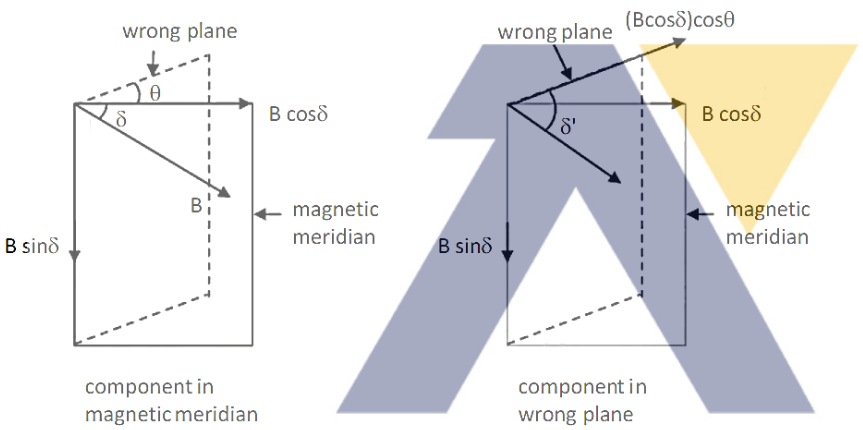
$$=2\pi\times6400\times\frac{225}{128}\times200=14.13\times10^6$$

16. A magnetic needle is placed vertically but in a wrong plane, which is at an angle (1 with the magnetic meridian. If apparent dip in this wrong plane is $\delta'$, then find the real dip angle.

(1) $\tan^{-1}(\tan\delta'\sec\theta)$ (2) $\tan^{-1}(\tan\delta'\cos\theta)$

(3) $\tan^{-1}(\tan\delta'\sin\theta)$ (4) $\tan^{-1}(\tan\delta'\operatorname{cosec}\theta)$

Ans: 2

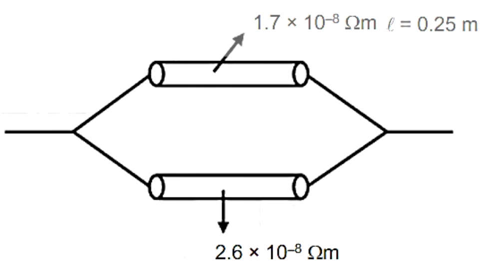



$$\tan\delta'=\frac{B\sin\delta}{(B\cos\delta)\cos\theta}$$

$$\Rightarrow \tan\delta=\tan\delta'\cos\theta$$

$$\delta=\tan^{-1}(\tan\delta'\cos\theta)$$

17. Two rods of length 0.25 m and area 3mm$^2$ are connected as shown in figure & their resistivities are $1.7\times10^{-8}\,\Omega m$ & $2.6\times10^{-8}\,\Omega m$. Find the equivalent resistance?




(1) $0.85m\Omega$ (2) $0.95m\Omega$ (3) $0.80m\Omega$ (4) $0.75m\Omega$

Ans: 1

Sol: $R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{\rho_1 \frac{l}{A} \rho_2 \left(\frac{l}{A}\right)}{\rho_1 \left(\frac{l}{A}\right) + \rho_2 \left(\frac{l}{A}\right)}$

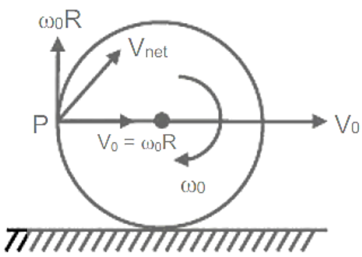
$$= \frac{l}{A}\left(\frac{\rho_1 \rho_2}{\rho_1 + \rho_2}\right) = \frac{0.25}{3\times10^{-6}}\left(\frac{1.7\times10^{-8}\times2.6\times10^{-8}}{1.7\times10^{-8}+2.6\times10^{-8}}\right)$$

$$= 0.085\times10^{-2} = 0.85 m\Omega$$

18. A ring is rolling without sliding, such that the velocity of its centre of mass is $V_0$. Find the speed of a point, which is in the same horizontal level as the centre of mass.

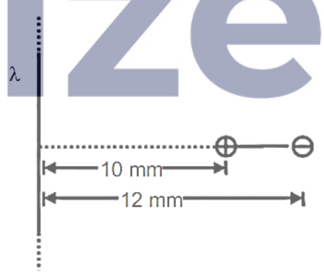
(1) $V_0$ (2) $2V_0$ (3) $\sqrt{2}V_0$ (4) zero

Ans: 3




$$(V_p)_{net} = \sqrt{V_0^2 + (\omega_0 R)^2} = \sqrt{V_0^2 + V_0^2} = \sqrt{2}V_0$$

19. A dipole is kept near the infinite linear charge of density $3\times10^{-6} C/m$ along its perpendicular direction as shown in figure. The dipole is experiencing a force of 4 N then find charge of dipole.




(1) $2.14\mu C$ (2) $2.24\mu C$ (3) $4.44\mu C$ (4) $3.14\mu C$

Ans: 3

Sol: Let charge be Q

$$\text{Net force} = \frac{2k\lambda Q}{r_1} + \frac{2k\lambda(-Q)}{r_2}$$

$$4N = 2k\lambda Q\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$$

$$4N = 2\times9\times10^9\times3\times10^{-6} Q\left[\frac{1}{10} - \frac{1}{12}\right]\times10^3$$

$$4N = 54\times10^6 Q\times\frac{1}{60}$$

$$Q = 4.44\times10^{-6}C = 4.44\mu C$$

20. A photo diode activeness when photon of wavelength 612 nm incident on it. Then depletion layer voltage of photodiode will be: (Given hc=1224ev-nm)

(1) 2 volt (2) 1 volt (3) 4 volt (4) 3 volt

Ans: 1

Sol: $E = \frac{hc}{\lambda} = eV$

$$V = \frac{hc}{\lambda e}$$

$$= \frac{1224ev - nm}{e\times612nm}$$

=2 volt

21. $\vec{p}$ is vector perpendicular to both $\vec{a} = \hat{i}+\hat{j}$ & $\vec{b} = \hat{j}+\hat{k}$ vector along $\vec{a}\times\vec{b}$.q is a vector perpendicular to both $\vec{b} = \hat{j}+\hat{k}$ and $\vec{c} = -\hat{i}+\hat{j}$ vector along $\vec{b}\times\vec{c}$. Find the angle between $\vec{p}$ and $\vec{q}$

(1) $\cos^{-1}\left(\frac{-1}{3}\right)$ (2) $\pi-\cos^{-1}\left(\frac{2}{3}\right)$ (3) $\pi-\cos^{-1}\left(\frac{3}{4}\right)$ (4) $\pi-\cos^{-1}\left(\frac{1}{2}\right)$

Ans: 1

Sol: $\vec{p} = \vec{a}\times\vec{b}$

$$\begin{bmatrix} i & j & k \\ 1 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix}$$

$$= \hat{i} - \hat{j} + \hat{k}$$

$$\vec{q} = \vec{b}\times\vec{c}$$

$$\begin{bmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 1 & 1 \\ -1 & 1 & 0 \end{bmatrix}$$

$$= -\hat{i} + \hat{j} + \hat{k}$$

$$\cos\theta = \frac{\vec{p}\bullet\vec{q}}{|\vec{p}||\vec{q}|} = \frac{-1-1+1}{3} = \frac{-1}{3}$$

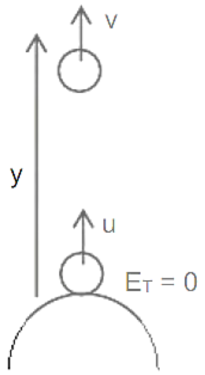
$$\theta = \cos^{-1}\left(\frac{-1}{3}\right)$$

22. An object is projected from earth surface to reach infinity. Find expression for time required to reach y height

(1) $\dfrac{\frac{2}{3}\left[(R-y)^{\frac{3}{2}} + R^{\frac{3}{2}}\right]}{\sqrt{Gm}}$ (2) $\dfrac{\frac{2}{3}\left[(R+y)^{\frac{3}{2}} - R^{\frac{3}{2}}\right]}{\sqrt{Gm}}$

(3) $\dfrac{\frac{2}{3}\left[(R+y)^{\frac{3}{2}} + R^{\frac{3}{2}}\right]}{\sqrt{Gm}}$ (4) $\dfrac{\frac{2}{3}\left[(R-y)^{\frac{3}{2}} + R^{\frac{3}{2}}\right]}{\sqrt{Gm}}$

Ans: 2




$$\frac{1}{2}mv^2 - \frac{GMm}{R+y} = 0$$

$$\Rightarrow v = \sqrt{\frac{2GM}{R+y}}$$

$$\Rightarrow \frac{dy}{dt} = \sqrt{\frac{2Gm}{R+y}}$$

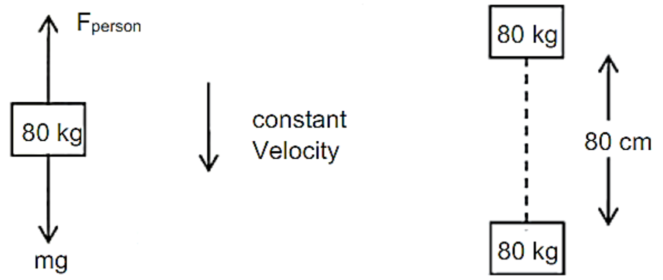
$$= \int_0^y \sqrt{R+y}dy = \sqrt{2Gm}\int_0^t dt \Rightarrow \left[\frac{2(R+y)^{\frac{3}{2}}}{3}\right]_0^y = \sqrt{2Gmt}$$

$$\Rightarrow \frac{2}{3}\left[\left((R+y)^{\frac{3}{2}} - R^{\frac{3}{2}}\right)\right] = \sqrt{2Gm.t} \Rightarrow t = \frac{\frac{2}{3}\left[(R+y)^{\frac{3}{2}} - R^{\frac{3}{2}}\right]}{\sqrt{2Gm}}$$

23. A man is standing on horizontal platform carrying a heavy box of mass 80 kg. Suddenly he lowered heavy box constant velocity downward by 80 cm find the work done by person?

(1) -640 J (2) 640 J (3) 740 J (4) 840 J

Ans: 1




$F_{person}=mg=800N$

$W_{person}=F_p s\cos 180^0=-800\times 80\times 10^{-2}=-640J$

24. If intensity of sunlight at a point is $92W/m^2$, then find amplitude of magnetic filed at this point?

(Given $\mu_0=4\pi\times 10^{-7}$)

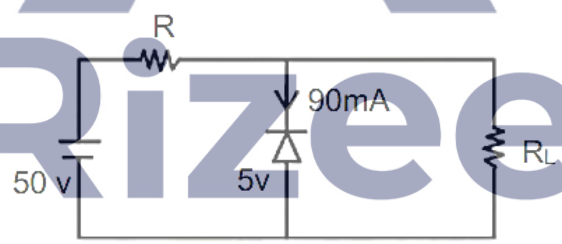
(1) 100 T (2) 200 T (3) 352 T (4) 500 T

Ans: 3

Sol: $I=\frac{1}{2}\frac{B_0^2}{\mu_0}C$

$B_0=\sqrt{\frac{2\mu_0 I}{C}}=\sqrt{\frac{2\times 4\pi\times 10^{-7}\times 92}{3\times 10^8}}=351.5\approx 352$

25. If current through diode is 90 mA find the maximum value of R?




(1) $200\Omega$ (2) $500\Omega$ (3) $300\Omega$ (4) $400\Omega$

Ans: 2

Sol: $\frac{45}{R}\geq 90mA$

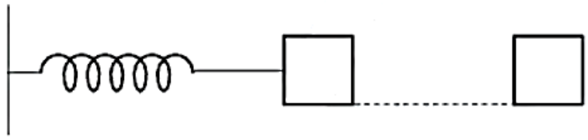
$R\leq\frac{45}{90}\times 10^3$

$R\leq 500\Omega$

26. A block is doing SHM, its displacement from mean position is given by $x(t)=A\sin\omega t+B\cos\omega t$

if at $t=0, x=0$

displacement $x(t)=C\cos(\omega t-\phi)$ then find value of C and $\phi$.

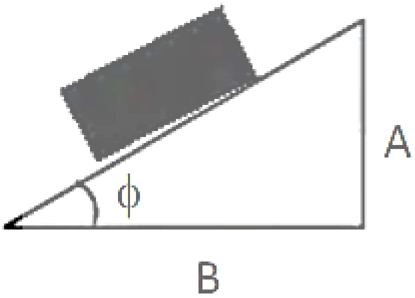


(1) $\sqrt{A^2+B^2}, \frac{\pi}{2}$ (2) $\sqrt{A^2+B^2}, 0$ (3) $A^2+B^2, \frac{\pi}{2}$ (4) $A^2+B^2, 0$

Ans: 1

Sol: $x(t) = A\sin\omega t + B\cos\omega t$

$= \sqrt{A^2+B^2}\cos(\omega t - \phi)$




At $t = 0$ $x(t) = 0$ given

$0 = \cos(\phi)$

$\phi = \frac{\pi}{2}$

$C = \sqrt{A^2+B^2}$ and $\phi = \frac{\pi}{2}$

27. Statement-1: On increase in temperature ferromagnetic material converts into paramagnetic material.

Statement-2: At high temperature, random ness of domains ferromagnetic material increases

(1) Statement 1 & 2 both are true

(2) Statement-1 & 2 both are true statemen-2 is correct explant of statement-1

(3) Statement-1 is false Statement-2 is true

(4) Statement-2 is true statement-1 is false.

Ans: 1

28. Match the column

(i) $\omega C > \frac{1}{\omega L}$ (a) Current lag behind EMF

(ii) $\omega C = \frac{1}{\omega L}$ (b) EMF lag behind current

(iii) $\omega C < \frac{1}{\omega L}$ (c) Same phase

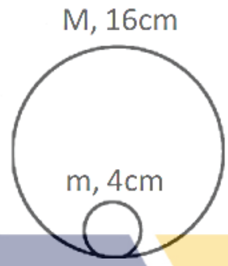
(iv) Resonant frequency (d) Minimum current

(1) (i)-a,(ii)-c,(iii)-b,(iv)-c (2) (i)-c,(ii)-a,(iii)-b,(iv)-c

(3) (i)-a,(ii)-c,(iii)-c,(iv)-b (4) (i)-c,(ii)-c,(iii)-b,(iv)-a

Ans: 1

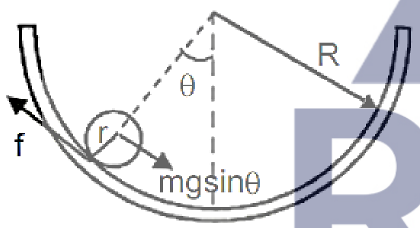
29. Find the time period of oscillation of ring of mass m while ring of mass M always remains at rest, if r=4 cm and R=16 cm.




(1) 0.7 second (2) 0.8 second (3) 1 second (4) 0.9 second

Ans: 3

Sol:




$mg\sin\theta - f = ma$

$f \times r = mr^2 \times \frac{a}{r}$ $\left[\sin\theta = \theta = \frac{x}{R-r}\right]$

$f = ma$

$\Rightarrow mg\sin\theta = 2ma$

$\Rightarrow a = \frac{gx}{2(R-r)}$ $\Rightarrow T = 2\pi\sqrt{\frac{2(R-r)}{g}} = 2\pi\sqrt{\frac{0.12}{5}} \approx 1\,\text{second}$