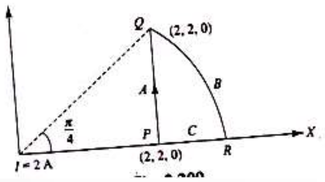
PHYSICS

24. The particle have equal and opposite charges but different masses. They trace equal radii in opposite direction but with different time periods.

25. Circulation due to I_3 is zero. I_1 and I_2 produce positive circulation.

26. Use the idea of symmetry.

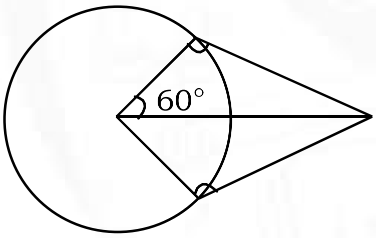
27.



$$\int_{PAQ} \vec{B}.d\vec{l} = \int_{RBQ} \vec{B}.d\vec{l} \quad \left(\because \int_{PCR} \vec{B}.d\vec{l} = 0\right) = \left(\frac{\mu_0 I}{2\pi R}\right)\left(\frac{\pi}{4}R\right)$$

$$= \frac{\left(4\pi\times10^{-7}\right)(2)}{8} = \pi\times10^{-7} \text{ S.I. units}$$

28.



$$T = 3t,\ \omega = \frac{2\pi}{T} = \frac{2\pi}{3t}$$

29. $\tau_g = mg\left(2a/3\right)\sin\theta \qquad T_B = BIa\left(a\cos\theta\right)$

Net torque is zero.

30. $B_1 = \frac{\mu_0}{4\pi}\times\frac{2\pi I}{R} = \frac{\mu_0}{4\pi}\times\frac{2\pi I\times 2\pi}{L}$ $\quad$ ($\therefore$ $L = 2\pi R$, for circular loop)

$$B_2 = \frac{\mu_0}{4\pi}\times\frac{1}{(a/2)}\left[\sin 45^0 + \sin 45^0\right]\times 4$$

Where $a = (L/4)$

$$\therefore B_2 = \frac{\mu_0 I}{4\pi L}\times 8\times 4\times\left[\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{2}}\right] = \frac{\mu_0 I}{4\pi L}\times\frac{64}{\sqrt{2}}$$

$\therefore \; \frac{B_1}{B_2} = \left(\frac{\mu_0}{4\pi}\right)\frac{4\pi^2 I}{L} / \frac{\mu_0 I}{4\pi L} \times \frac{64}{\sqrt{2}} = \frac{\pi^2}{8\sqrt{2}}$.

31. Use right hand thumb rule.

Magnetic force per unit length near end C is more than that near end D.

32. $B2\pi r = \mu_0 \int S2\pi r dr$

For $r < a, \; RHS = \mu_0 \frac{2\pi k r^4}{4}$

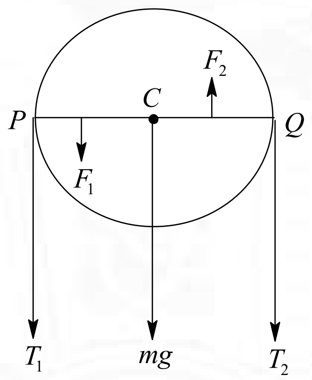
And $r < a, \; RHS = \mu_0 2\pi \frac{ka^4}{4}$

33. $B = \frac{\mu_0 k}{2} = \frac{\mu_0}{2}\sigma v, \; E = \frac{\sigma}{2\epsilon_0}$

34. A solenoid can be visualized as a bar magnet. Inside the bar magnet, field lines are directed from south pole to north pole.

SOL. 35 TO 36

PC and *CQ* are parallel. So, equivalent resistance of the circuit is $R/2$. In static condition, current through the battery as $I = 2V/R$.



The current through *CP* and *CQ* is $i = I/2 = V/R$.

Hence, $F_1 = F_2 = Bir$

Consider the FBD of ring and the blocks FBD of ring:

Consider torque about '*C*',

$$T_1 r + F_1 r/2 + F_2 r/2 = T_2 r$$

FBD of block: $T_1 = mg$ and $T_2 = 2mg$

So, $mgr + Bir^2/2 + Bir^2/2 = 2mgr$

or $i = \frac{mg}{Br}$ or $\frac{V}{R} = \frac{mg}{Br}$

or $v = \frac{mgR}{Br}$

Net torque of tension

$$= (T_2 - T_1)r = mgr = \frac{BVr^2}{R}.$$

Passage-2:- (38,39)

38. $\vec{J} \times \vec{B}$ must be parallel to +ve Z-axis.

39. $F = BI\Delta x$

$= B(J\ a\Delta y)\Delta x$

$\Rightarrow P = BJa$

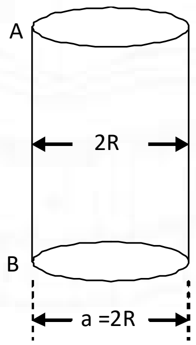
40. the element of length dx carrying the current i_1 crates a magnetic induction

$= \frac{\mu_0 i_1}{4\pi a}[\sin\alpha_1 + \sin\alpha_2]$

$= \frac{\mu_0 i}{2\pi a}, \text{since} \alpha_1 = \alpha_2 = 90^0$

At the diametrically opposite section Force on the diametrically opposite element

$dF = \frac{\mu_0 i_1 \times i_1 \times i}{2\pi a}$



But $i_1 = \frac{i}{2\pi R}dx$

$$dF = \frac{\mu_0}{2\pi a}\left(\frac{i}{2\pi R}dx\right)^2 l = \frac{\mu_0}{2\pi \times 2R}.\frac{i^2}{4\pi^2 R^2}.dx.dx.l$$

Pressure on the element $=\frac{\mu_0}{2\pi.2R}.\frac{i^2dx}{4\pi^2R^2}.\frac{dx.l}{dx.l}$

Since area of element $=dxl$

$$dP=\frac{\mu_0 i^2}{2\pi.2R.4\pi^2.R^2}\times dx$$

Effective pressure $=\frac{\mu_0 i^2}{2\pi.2R.4\pi^2.R^2}\times 2\pi r$

Since $\int dx=2\pi R$

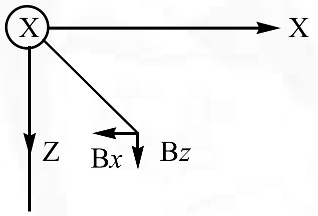
$$P=\frac{\mu_0 i^2}{8\pi^2R^2}$$

41. $dB=\frac{\mu_0 dI}{2r}=\left(\frac{\mu_0 I}{2r}\right)\left(\frac{N}{b-a}\right)dr$

42. $\frac{B_1}{B_2}=\frac{\frac{I_1}{r_1}+\frac{I_2}{r_2}}{\frac{I_1}{r_1}-\frac{I_2}{r_2}}$

43. $B=\frac{\mu_0 I}{4R}\left(-\hat{i}+\hat{j}\right)$, $\vec{F}=q\quad \vec{V}\times\vec{B}$

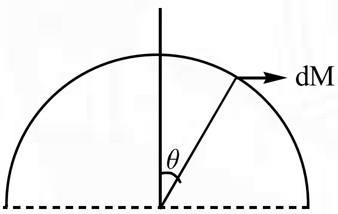
44. $r=\sqrt{2},\quad B=\frac{\mu_0 I}{2\pi r}$



$$B_y=B_x=B/\sqrt{2}=7\times10^{-7}$$

$$B_{net}=B_y=7\times10^{-7}.$$

45.



$$dM=dn\left(\pi a^2 I\right)$$

$$dN=\frac{N}{\pi}d\theta$$

$$M=\int_{-\pi/2}^{\pi/2} dM\cos\theta$$