# Magnetic Effect of Current and Magnetism

## SOLUTIONS

### Exercise-I (Conceptual Questions)

**2.** $B_{net} = B_1 + B_2 + B_3 + B_4$

$= 4B \quad (B_1 = B_2 = B_3 = B_4 = B)$

**4.** $B = \dfrac{\mu_0 I}{2\pi r} = \dfrac{\mu_0 10}{2\pi(1)}$

$= 2 \times 10^{-7} \times 10 = 2 \times 10^{-6}\,T = 2\mu T$

direction of $\vec{B} \Rightarrow i\vec{d\ell} \times \vec{r} = \hat{k} \times \hat{i} = +\hat{j}$

**5.** $B_x = \dfrac{B_0}{\left(1+\dfrac{x^2}{R^2}\right)^{3/2}}$

$x = \sqrt{3}R$

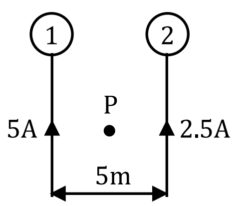
$\dfrac{B_x}{B_0} = \dfrac{1}{8} \Rightarrow \dfrac{B_0}{B_x} = \dfrac{8}{1}$

**6.** $B \propto N^2$ (for $\ell$ = constant)

**9.** $B = \dfrac{\mu_0 I}{2r} \Rightarrow I = \dfrac{2Br}{\mu_0}$

$I \propto Br \Rightarrow \dfrac{I_1}{I_2} = \dfrac{B_1 r_1}{B_2 r_2} = \dfrac{1}{3} \times \dfrac{1}{2} = \dfrac{1}{6}$

**10.**




$B = \underset{\otimes}{B_1} - \underset{\odot}{B_2}$

$B = \dfrac{\mu_0 I_1}{2\pi d} - \dfrac{\mu_0 I_2}{2\pi d}$

$= \dfrac{\mu_0}{2\pi d}(I_1 - I_2)$

$= \dfrac{\mu_0}{2\pi(5/2)}(5 - 2.5) = \mu_0/2\pi \otimes$

**13.** $B = \dfrac{\mu_0 N i}{2R}$

**14.** $B = \dfrac{\mu_0 i}{2\pi d} \Rightarrow d = \dfrac{\mu_0 i}{2\pi B}$

**15.** $B_x = \dfrac{B_0}{\left(1+\dfrac{x^2}{R^2}\right)^{3/2}}$

$\because x = R$

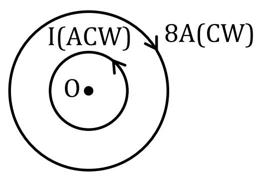
$\therefore B_x = \dfrac{B_0}{(1+1)^{3/2}} = \dfrac{B_0}{(2)^{3/2}} \Rightarrow \dfrac{B_x}{B_0} = \left(\dfrac{1}{2}\right)^{3/2}$

**18.** $B_x = \dfrac{\mu_0 N I R^2}{2(r^2+R^2)^{3/2}}$

If $r >> R$ then $\dfrac{R^2}{r^2} <<< 1$ (negligible)

$B_x \simeq \dfrac{\mu_0 N I R^2}{2(r^2)^{3/2}} \simeq \dfrac{\mu_0 N I R^2}{2r^3} \Rightarrow B_x \propto \dfrac{1}{r^3}$

**19.** $(B_0)_{net} = 0$

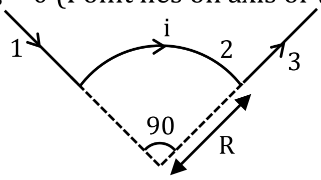



$\underset{\otimes}{\dfrac{\mu_0 I_1}{2r_1}} = \underset{\odot}{\dfrac{\mu_0 I_2}{2r_2}}$

$\dfrac{8}{0.1} = \dfrac{I}{0.08}$

$I = \dfrac{8 \times 0.08}{0.1} = 6.4A, ACW$

**24.** $B_1 = B_3 = 0$ (Point lies on axis of wire)




$B_2 = \dfrac{\mu_0 i}{2R} \times \left(\dfrac{90}{360}\right)$

$B_2 = \dfrac{\mu_0 i}{8R} \otimes$

**27.** Apply $B = \mu_0 n i$

$n = \dfrac{N}{\ell}$

According to the question,

$n' = \dfrac{N/2}{\ell/2} = \dfrac{N}{\ell}$

$\therefore$ B remains same

**28.** $B = \mu_0 \dfrac{N}{\ell} I$

$B' = \dfrac{\mu_0 (2N)(2I)}{\ell} = 4B$

**29.** $B = \mu_0 \dfrac{N}{2\pi R_m}.I$

$= 4\pi\times10^{-7}\times1000\times\dfrac{1}{4\pi}$ = $10^{-4}$ (Wb/m$^2$)

**30.** $B = \mu_0 \dfrac{N}{2\pi R_m}.I$ (given $R_m$ = 10 cm)

**31.** $B = \mu_0\left(\dfrac{nN}{L}\right)i$ nN = total turns

$B \propto D^\circ$

**32.** $B = \mu_0 ni$

$\dfrac{B_2}{B_1} = \dfrac{n_2 i_2}{n_1 i_1}$ ; $n_2 = \dfrac{n_1}{2}$, $i_2 = 2i_1$

$= \dfrac{(n_1/2)(2i_1)}{n_1 i_1} = 1$

$B_2 = B_1 = B$

**33.** $B = \mu_0 ni$

$\dfrac{B_2}{B_1} = \dfrac{n_2\, i_2}{n_1\, i_1} = \dfrac{100\times(i/3)}{200\times i}$

$B_2 = \dfrac{1}{6}\times 6{\cdot}28\times10^{-2} = 1{\cdot}05\times10^{-2}$ Wb/m$^2$

**34.** $r = \dfrac{P}{qB} \Rightarrow P = qBr$

$P \propto q$ (B, r $\rightarrow$ same)

$\dfrac{p_P}{p_\alpha} = \dfrac{q_P}{q_\alpha} = \dfrac{1}{2} = \dfrac{e}{2e} = \dfrac{1}{2}$

**36.** $f = \dfrac{qB}{2\pi m} \Rightarrow f \propto \dfrac{q}{m}$

**37.** $F = qvB \Rightarrow F \propto q$ (v, B $\rightarrow$ same)

**38.** $r = \dfrac{mv}{qB}$

$m_\beta = m_e$ $m_\alpha = 4m_p$

$q_\beta = q_e$ $q_\alpha = 2q_e$

$r_\beta < r_\alpha$ , $\because C \propto \dfrac{1}{r}$ ($\therefore C_\beta > C_\alpha$)

**39.** $r = \dfrac{\sqrt{2mqV_{acc.}}}{qB}$

According to the question

$r \propto \sqrt{m}$

$\dfrac{r_1}{r_2} = \sqrt{\dfrac{m_1}{m_2}}$

$\dfrac{r_1^2}{r_2^2} = \dfrac{m_1}{m_2}$

**42.** $r = \dfrac{mv\sin\theta}{qB} = \dfrac{v\sin\theta}{(q/m)B}$

$= \dfrac{1}{10^8}\times\dfrac{3\times10^5}{0.3}\times\dfrac{1}{2}$ = $5\times10^{-3}$ m = 0.5 cm

**43.** Kinetic energy of charge particle is always constant, if it enters perpendicular in uniform magnetic field.

**44.** $r = \dfrac{\sqrt{2mE_k}}{qB}$

$r \propto \sqrt{m}$ (q, B, $E_{k.}$ $\rightarrow$ same)

or $m \propto r^2$

$\dfrac{m_1}{m_2} = \left(\dfrac{r_1}{r_2}\right)^2$

**45.** $f = \dfrac{qB}{2\pi m}$

**46.** $r = \dfrac{mv}{qB}$ (v, B $\rightarrow$ same)

$r \propto \dfrac{m}{q}$

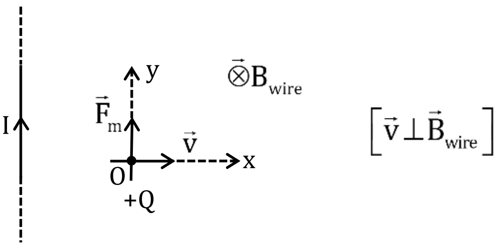
$\dfrac{r_A}{r_B} = \dfrac{m_A}{m_B}\times\dfrac{q_B}{q_A} = \left(\dfrac{24\text{a.m.u.}}{22\text{a.m.u.}}\right)\left(\dfrac{2e}{e}\right) = \dfrac{24}{11}$

**50.** $r_p : r_d : r_\alpha$

$r \propto \sqrt{\dfrac{m}{q}}$

$\sqrt{\dfrac{1}{1}} : \sqrt{\dfrac{2}{1}} : \sqrt{\dfrac{4}{2}} = 1 : \sqrt{2} : \sqrt{2}$

**54.** Use right hand palm rule to find direction of magnetic force.




OR

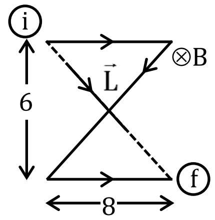
$\vec{F}_m \rightarrow (\vec{v}\times\vec{B})$

$\vec{F}_m \rightarrow (\hat{i}\times-\hat{k}) = +\hat{j} = y-\text{axis}$

(current carrying wire produces cross field therefore $-\hat{k}$ is taken in vector product)

$\vec{F}_m \rightarrow +\hat{j} = +y-\text{axis}$

**60.** $F_m = BiL_{eff} \quad (\vec{L} \perp \vec{B})$

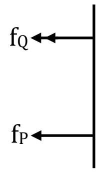



$L_{eff} = \sqrt{6^2 + 8^2} = 10$

$F_m = 10 \times 3 \times 10 \times 10^{-2}$

$= 3N$

**62.**



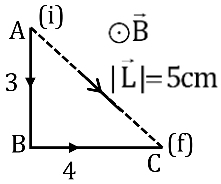

$f_{net} \Rightarrow$ (towards left)

like currents always attracts to each other

**63.** $f = \frac{\mu_0 I_1 I_2}{2\pi d} = \frac{4\pi \times 10^{-7} \times 10 \times 10}{2\pi \times 10 \times 10^{-2}} = 2 \times 10^{-4} N$

(Like currents $\rightarrow$ Attraction)

**64.** $\vec{F}_m = I(\vec{L} \times \vec{B})$




$|\vec{F}_m| = BIL$, where $\vec{L} \perp \vec{B}$

$= 5 \times 10 \times \frac{5}{100} = 2.5N$

**65.** When direct current flows in spring, any two adjacent turns having the current in same direction so there is attractive magnetic force between them hence spring contracts.

**69.** $B = \frac{\mu_0 I}{2R}$ ...(1)

$M = I(\pi R^2)$ ...(2)

divide eqn. (2) by(1)

$\frac{M}{B} = \frac{I(\pi R^2)2R}{\mu_0 I}$

$M = \frac{2\pi BR^3}{\mu_0}$

**71.** $I = ef$

**73.** $B_0 = \frac{\mu_0 e\omega}{4\pi r} \Rightarrow \omega = \frac{4\pi r B_0}{\mu_0 e}$

**77.** $B = \frac{\mu_0 ef}{2r}$

**78.** $\vec{M} \,||\, \vec{B} \Rightarrow \tau = 0$

**81.** $W_{90^\circ} = MB\,(1 - \cos 90^\circ)$

$= MB\,(1 - 0) = MB$

$W_{60^\circ} = MB\,(1 - \cos 60^\circ)$

$= MB\,(1 - \frac{1}{2}) = \frac{MB}{2}$

$W_{90^\circ} = n\, W_{60^\circ}$

$MB = n\left(\frac{MB}{2}\right) \qquad \therefore n = 2$

**112.** Curie law $\chi_m \propto \frac{1}{T}$

**113.** A diamagnetic material in a magnetic field moves from stronger to the weaker part of the field.

## Exercise-II (Previous Year Questions)

**1.** Net magnetic field, $B = \sqrt{B_1^2 + B_2^2}$

$= \sqrt{\left(\frac{\mu_0 I_1}{2\pi d}\right)^2 + \left(\frac{\mu_0 I_2}{2\pi d}\right)^2}$

$= \frac{\mu_0}{2\pi d}\sqrt{I_1^2 + I_2^2}$

**2.** Magnetic field due to a circular loop

$B = \frac{\mu_0 NI}{2r}$ Where N $\rightarrow$ no. of loops

$I = \frac{q}{T} = \frac{e}{1/n} = ne$

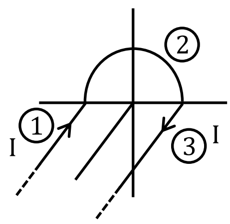
$B = \frac{\mu_0 ne}{2r}$

(Here N =1 as electron makes only one loop)

**3.** 'B' due to segment '1'

$\vec{B}_1 = \frac{\mu_0 I}{4\pi R}\,[\sin 90^\circ + \sin\theta]\,(-\hat{k})$

$B_1 = \frac{\mu_0 I}{4\pi R}\,(-\hat{k}) = B_3$



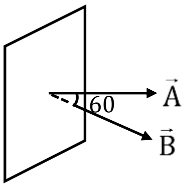
B due to segment '2'

$B_2 = \dfrac{\mu_0 I}{4R}$

so 'B' at center $\vec{B}_c = \vec{B}_1 + \vec{B}_2 + \vec{B}_3$

$\Rightarrow \vec{B}_C = \dfrac{-\mu_0 I}{4R}\left(\hat{i} + \dfrac{2\hat{k}}{\pi}\right) = \dfrac{-\mu_0 I}{4\pi R}(\pi\hat{i} + 2\hat{k})$

**4.**




$\vec{\tau} = \vec{M} \times \vec{B}$

$|\vec{\tau}| = MB\sin\theta = NIAB\sin\theta = 0.20\,Nm$

**5.** $R = \dfrac{mv}{q_B} = \dfrac{\sqrt{2mK}}{q_B}$

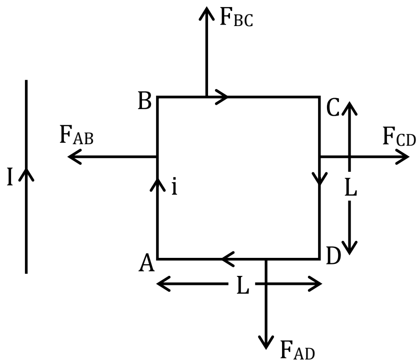
$\because$ $R_\alpha = R_p$

$\therefore$ $\dfrac{4m_\alpha k_a}{q_\alpha^2 B^2} = \dfrac{4m_p K_p}{q_p^2 B^2}$

$\Rightarrow$ $\dfrac{4m_p k_\alpha}{4e^2} = \dfrac{m_p(1MeV)}{e^2}$

$\Rightarrow$ $K_\alpha = 1MeV$

**6.**




$F_{AB} = i\ell B$ (Attractive)

$F_{AB} = i(L).\dfrac{\mu_0 I}{2\pi\left(\dfrac{L}{2}\right)}(\leftarrow) = \dfrac{\mu_0 iI}{\pi}(\leftarrow)$

$F_{BC}$ ($\uparrow$) and $F_{AD}$ ($\downarrow$) $\Rightarrow$cancels each other

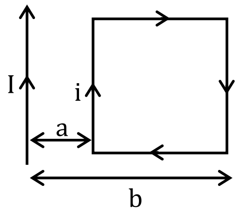
$F_{CD} = i\ell B$ (Repulsive)

$F_{CD} = i(L)\dfrac{\mu_0 I}{2\pi\left(\dfrac{3L}{2}\right)}(\rightarrow) = \dfrac{\mu_0 iI}{3\pi}(\rightarrow)$

$\Rightarrow F_{net} = \dfrac{\mu_0 iI}{\pi} - \dfrac{\mu_0 iI}{3\pi} = \dfrac{2\mu_0 iI}{3\pi}$

OR

Trick




$F_{net} = \dfrac{\mu_0 IiL}{2\pi}\left[\dfrac{1}{a} - \dfrac{1}{b}\right]$ (Attractive)

**7.** Magnetic susceptibility $= \chi$

It is negative for diamagnetic materials only

**8.** For points inside the wire

$B = \dfrac{\mu_0 Ir}{2\pi R^2}$ $(r \le R)$

For points outside the wire

$B = \dfrac{\mu_0 I}{2\pi r}$ $(r \ge R)$

according to the question

$\dfrac{B}{B'} = \dfrac{\dfrac{\mu_0 I(a/2)}{2\pi a^2}}{\dfrac{\mu_0 I}{2\pi(2a)}} = 1 : 1$

**9.** Since $\ell = 2\pi R = n(2\pi r) \Rightarrow r = \dfrac{R}{n}$

For one turn $B = \dfrac{\mu_0 i}{2R}$ and

For n turn $B' = \dfrac{\mu_0 ni}{2r} \Rightarrow B' = \dfrac{\mu_0 n^2 i}{2R} = n^2 B$

**10.** $\tau = MB\sin 60°$ .....(1)

$W = MB(1 - \cos 60°)$ .....(2)

From (1) and (2)

$\dfrac{\tau}{W} = \dfrac{\sqrt{3}/2}{1/2} \Rightarrow \tau = W\sqrt{3}$

**11.** $f = \dfrac{eB}{2\pi m}$

$f = \dfrac{1.76\times10^{11}\times3.57\times10^{-2}}{2\times3.14}$ Hz

$f = 10^9$ Hz or 1 GHz

**12.** Work = $MB[\cos\theta_1 - \cos\theta_2]$

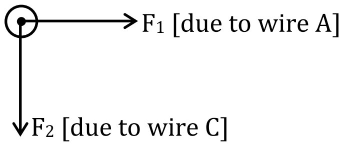
Work = $MB[\cos 0 - \cos 180°]$

$W = NiAB[1 - (-1)]$

$W \simeq 9.1\ \mu J$

**13.** $F=\dfrac{\mu_0 i_1 i_2}{2\pi d}$ = force per unit length

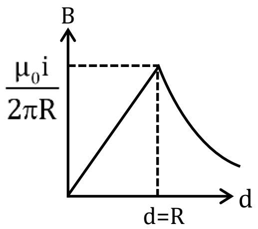
$F_1=\dfrac{(\mu_0 i)i}{2\pi d}=\dfrac{\mu_0 i^2}{2\pi d}=F_2$




$F_{net}=\sqrt{F_1^2+F_2^2}=\dfrac{\mu_0 i^2}{\sqrt{2}\pi d}$

**14.** When current source is switched on, magnetic field sets up between poles on electromagnet.
Diamagnetic material, due to its tendency to move from stronger to weaker field, is thus repelled out.

**15.** $B=\begin{cases}\dfrac{\mu_0 i d}{2\pi R^2} & : \ d\le R \\ \dfrac{\mu_0 i}{2\pi d} & : \ d>R\end{cases}$




**16.** $\dfrac{q_H}{q_\alpha}=\dfrac{1}{2}$

$r=\dfrac{mv}{qB}$

For same momenta, $r\propto\dfrac{1}{q}$

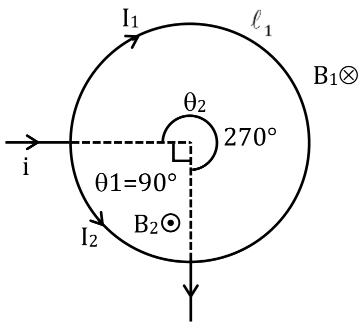
$\dfrac{r_H}{r_\alpha}=\dfrac{q_\alpha}{q_H}=\dfrac{2}{1}$

**17.** $B=\dfrac{\mu_0 N i}{2\pi r}$

$\dfrac{B_1}{B_2}=\dfrac{N_1}{N_2}\dfrac{r_2}{r_1}=\left(\dfrac{200}{100}\right)\left(\dfrac{20}{40}\right)=1:1$

**18.** $\dfrac{R_1}{R_2}=\dfrac{\ell_1}{\ell_2}=\dfrac{I_2}{I_1}=\dfrac{\theta_1}{\theta_2}$

$\Rightarrow\quad \theta_1 I_1=\theta_2 I_2$




$\left.\begin{aligned}B_1&=\dfrac{\mu_0}{4\pi}\dfrac{I_1\theta_1}{r}\\ B_2&=\dfrac{\mu_0}{4\pi}\dfrac{I_1\theta_1}{r}\end{aligned}\right\}\Rightarrow B_1=B_2$

$B_1$ and $B_2$ are in opposite directions, hence resultant field at centre is zero.

**19.** $\mu_r=\chi_m+1=599+1=600$

$\mu=\mu_0\mu_r=4\pi\times10^{-7}\times600=2.4\pi\times10^{-4}\ \dfrac{Tm}{A}$

**20.** $B=\mu_0\dfrac{N}{\ell}I$

$=4\pi\times10^{-7}\times\dfrac{100}{(0.5)}\times2.5$

$=6.28\times10^{-4}$ T

**21.** $M=I(\pi r^2)$ Where, $r=\dfrac{L}{2\pi}$

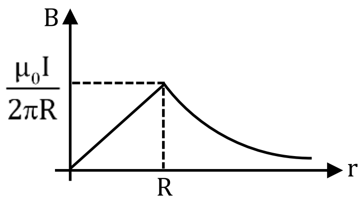
$\Rightarrow M=I(\pi)\left(\dfrac{L}{2\pi}\right)^2=\dfrac{IL^2}{4\pi}$

**22.** Inside a current carrying cylindrical conductor,

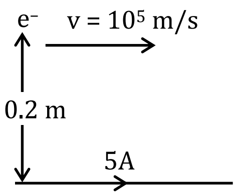
$B=\dfrac{\mu_0 I}{2\pi R^2}r \qquad \therefore B\propto r$

Outside the conductor,

$B=\dfrac{\mu_0 I}{2\pi r}\ \therefore B\propto\dfrac{1}{r}$




**23.**




F = qVB

$$F = ev\left(\frac{\mu_0 i}{2\pi r}\right)$$

$$F = \frac{1.6\times10^{-19}\times10^{5}\times2\times10^{-7}\times5}{0.2}$$

$F = 8 \times 10^{-20}$ Newton

**24.** $\vec{F} = q(\vec{v}\times\vec{B})$

$$4i - 20j + 12\hat{k} = 1\begin{vmatrix} i & j & \hat{k} \\ 2 & 4 & 6 \\ B & B & B_0 \end{vmatrix}$$

Comparing

$$\left.\begin{aligned} \Rightarrow\ 4 &= 4B_0 - 6B \\ -20 &= -2B_0 + 6B \\ 12 &= 2B - 4B \end{aligned}\right\} \begin{aligned} &\text{Solving} \\ &B = -6 \\ &B_0 = -8 \end{aligned}$$

$\therefore\ \vec{B} = -6\hat{i} - 6\hat{j} - 8\hat{k}$

**25.** $M_1 = \left(\frac{\sqrt{3}}{4}a^2\right)I\times4 = \sqrt{3}\,Ia^2$ (no. of turns = 4)

$M_2 = a^2I \times 3 = 3Ia^2$ (no. of turns = 3)

**32.** Magnetic field exist in
Closed Loops (Monopoles do not exist)

$\boxed{\oint\vec{B}.d\vec{A} = 0}$

(Gauss law for magnetism)

**33.** $\vec{F} = I(\vec{\ell}\times\vec{B})$

$= I\left[\left(L\hat{i}\right)\times\left(2\hat{i}+3\hat{j}-4\hat{k}\right)\right]$

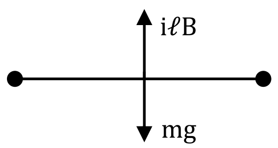
$= I\left(4L\hat{j}+3L\hat{k}\right)$

$|\vec{F}| = 5\ IL$

**34.** $B = \frac{\mu_0}{4\pi}\frac{I}{R}(\pi) - \frac{\mu_0}{4\pi}\frac{2I}{R}$

$= \frac{\mu_0 I}{4R}\left[1 - \frac{2}{\pi}\right]$ outward i.e away from page.

**35.**



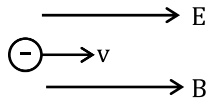

$mg = i\ell B$

$250 \times 10^{-3} \times 9.8 = i \times 2 \times 0.7$

$i = \frac{0.250\times9.8}{2\times0.7} = 0.250\times7$

$i = 1.75$ A

**36.** Speed of electron will decrease due to electric force magnetic force of electron is zero.




**37.** (A) Dia $\rightarrow$ II
(B) Ferro $\rightarrow$ III
(C) Para $\rightarrow$ (IV)
(D) Non magnetic $\rightarrow$ I

**38.** B = 0.049 T, $f = \frac{20}{5} = 4\text{Hz}$

$I = 9.8 \times 10^{-6}$ kg – m$^2$

$M = x \times 10^{-5}$ A – m$^2$

$f = \frac{1}{2\pi}\sqrt{\frac{MB}{I}}$

$M = \frac{f^2I(4\pi^2)}{B} = \frac{16\times4\pi^2\times98\times10^{-7}}{49\times10^{-3}}$

$x \times 10^{-5} = 128\pi^2 \times 10^{-4}$

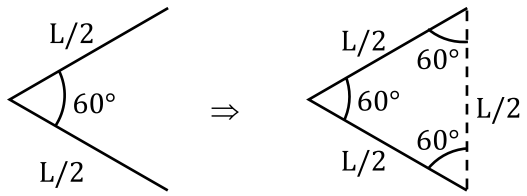
$x = 1280\ \pi^2$

**39.** $B = \frac{\mu_0 NI}{2R}$

$= \frac{4\pi\times10^{-7}\times100\times7}{2\times0.1}$

= 4.4 mT

**40.** Magnetic moment M = mL
where m is magnetic strength and L is length.
Now,

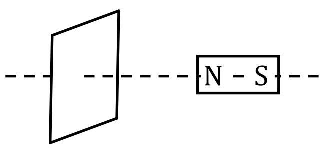



New magnetic moment,

$M' = m\times\frac{L}{2} = \frac{mL}{2}$

$M' = \frac{M}{2}$

**41.**




A force is needed to

(A) hold the sheet there if it is magnetic
(C) move the sheet away from the pole with uniform velocity if it is conducting.

**42.** $U = -mB\cos\theta$

$\because\ \theta = 90°$

$U = 0$

**43.** Diamagnetic material has

$-1 \le \chi < 0$

$0 < \mu_r < 1$

&

$\mu < \mu_0$

**44.** 10 Oscillations $\rightarrow$ 10s

$\Rightarrow$ 1 Oscillations $\rightarrow$ 1s

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

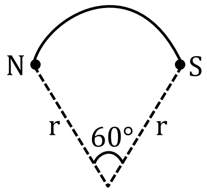
$$I = 2\pi\sqrt{\frac{10^{-6}}{\pi^2 \times 10^{-2} \times B}}$$

$$I = \frac{4\pi^2 \times 10^{-6}}{\pi^2 \times 10^{-2} B}$$

$B = 4 \times 10^{-4}$ T

$B = 0.4$ mT

**45.**




$M = m\ell$

$M' = mr$

$$M' = \frac{m3\ell}{\pi} \text{ and } \frac{\pi r}{3} = \ell$$

$$M = \frac{3M}{\pi}$$

## Exercise-III (Analytical Questions)

**1.** Magnetic field due to coil of radius 5 cm

$$B_1 = \frac{N\mu_0 I}{2R} = \frac{50 \times 4\pi \times 10^{-7} \times 2}{2 \times (5 \times 10^{-2})} = 4\pi \times 10^{-4}\ \text{T}$$

Magnetic field due to coil of radius 10 cm

$$B_2 = \frac{N\mu_0 I}{2R} = \frac{100 \times 4\pi \times 10^{-7} \times 2}{2 \times (10 \times 10^{-2})} = 4\pi \times 10^{-4}\ \text{T}$$

$\therefore$ Current in same sense ; $B_{Net} = 8\pi \times 10^{-4}$ T

$\therefore$ Current in opposite sense ; $B_{Net} = 0$

**2.** Angle between $\vec{M}$ and $\vec{B}$ is 180°.

**3.** Current carrying wire is electrically neutral.

**4.** K.E. = qV $\Rightarrow$ If V doubles, K.E. doubles

$$R = \frac{1}{B}\sqrt{\frac{2mV}{q}} \Rightarrow \text{If V doubles,}$$

R becomes $\sqrt{2}$ times

Time period $T = \dfrac{2\pi m}{qB} \Rightarrow$ Independent of speed

$\Rightarrow$ Angular velocity will not change.

**5.** $\vec{B}$ at a is inwards

$\vec{B}$ at f is zero (point on axis of wire)

$\vec{B}$ at c is outwards

$\vec{B}$ at g is outwards

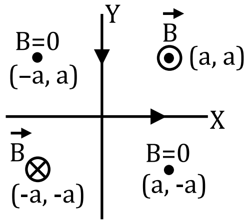
**6.** (a) $\theta = 180°$ ($\because \rightarrow$ angle between $\vec{M}$ & $\vec{B}$)

(b) $\theta = 90°$

(c) $\theta = 0°$

(d) $\theta$ is obtuse

**7.**




**8.** Wires carrying current in same direction attract each other.
Wires carrying current in opposite direction repel each other.

**9.** Use ACL and solve

for loop (1) $\oint \vec{B}\cdot\vec{d\ell} = \mu_0(-i)$

for loop (2) $\oint \vec{B}\cdot\vec{d\ell} = \mu_0 i$

for loop (3) $\oint B\cdot d\ell = 0$

for loop (4) $\oint B\cdot d\ell = 0$

**10.** $F_M = Bi\ell \sin\theta$

$F_{AB} = Bia$ $\quad$ $F_{CH} = Bia$

$F_{BC} = 0$ $\quad$ $F_{CE} = Bi\sqrt{2}\,a$

**11.** Net force on a current carrying loop in a non uniform magnetic field may or may not be zero.
e.g. when a circular current loop is placed in a circular MF at a line of force then F = 0.

**13.** Magnetic field lines always form close curve.

**14.** There is moving charge in a current carrying element.

**15.** Current carrying wires (current = constant) produces magnetic field but not electric field. Charge particle beam produces both electric and magnetic field.

**16.** Ampere's law is valid for infinite wire of symmetrical current distribution.

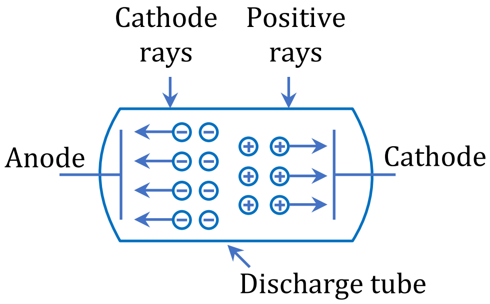
**17.** At curie point ferro start behaving as para.

**19.** (A) When V=0 or $\vec{V} \parallel \vec{E}$ $\rightarrow$ path will be straight When $\vec{V} \neq \vec{E}$ $\rightarrow$ path will be parabolic

(B) When $\vec{V} \parallel \vec{B}$ $\rightarrow$path will be straight

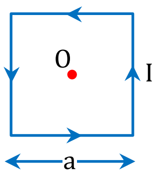
When $\vec{V} \perp \vec{B}$ $\rightarrow$ path will be circular

**21.** Nature of both type of rays are unlike and they are moving in opposite direction in same transverse field so they are deflected in same direction according to




$\vec{F}_m = \pm q(\vec{v} \times \vec{B})$ or right hand palm rule.

**22.** Magnetic field at centre of square




$B = \frac{2\sqrt{2}\mu_0 I}{\pi a}$ ...(1)

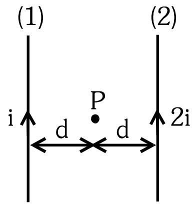
Magnetic moment

$M = Ia^2$ ...(2)

$\frac{M}{B} = \frac{Ia^2(\pi a)}{2\sqrt{2}\mu_0 I}$ [Divide equation (2) by (1)]

$M = \frac{\pi a^3 B}{2\sqrt{2}\mu_0}$

**23.** Magnetic field at mid point :-




$B = (B_2 - B_1)\odot$

$\therefore B = \left(\frac{\mu_0(2i)}{2\pi d} - \frac{\mu_0 i}{2\pi d}\right)\odot$

$= \frac{\mu_0 i}{2\pi d}\odot = B\odot$ .........(1)

After switching off 2i current, magnetic field remain due to wire (1) only :-

$B_1 = \frac{\mu_0 i}{2\pi d} = B\otimes$ [from (1)]