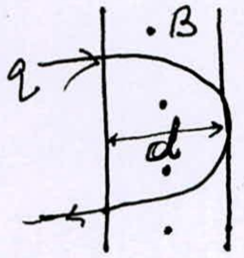
Magnetic Effect of Current

Force on a moving charge

1. (4)



d = Radius

$d = \frac{mV}{qB} = \frac{\sqrt{2mE}}{qB}$ $\left(\because \frac{p^2}{2m} = E\right)$

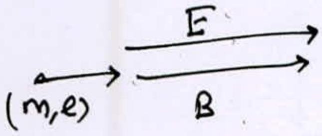
$B = \frac{\sqrt{2mE}}{qd}$

2 (3) $R_1 = \frac{\sqrt{2m_1 E}}{qB}$ $\quad \frac{R_1}{R_2} = \sqrt{\frac{m_1}{m_2}} \Rightarrow \left(\frac{R_1}{R_2}\right)^2 = \frac{m_1}{m_2}$

$R_2 = \frac{\sqrt{2m_2 E}}{qB}$

3 (2) $r = \frac{mV}{qB}$

4 (4)



It will move in a straight line with decreasing speed.

5 (1) $\frac{r_1}{r_2} = \sqrt{\frac{m_1}{m_2}}\,\frac{q_2}{q_1} = \sqrt{\frac{m}{4m}} \times \frac{2q}{q} = \frac{1}{1}$

6 (4) $r \propto \sqrt{V}$

$2r \propto \sqrt{V'}$

$\frac{1}{2} = \sqrt{\frac{V}{V'}}$

$\boxed{V' = 4V}$

7 (3) Same as 2nd Question.

8 (3) Theory Based.

9 (1) $M = nIA$

$= e\nu\pi r^2$

10 (i)

11 (1)

12 (4)

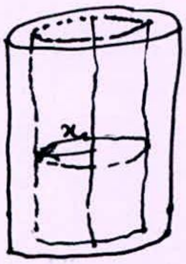
13 (2) $r_A > r_B$

$m_A v_A > m_B v_B$

Biot Savart's Law

14 (i) $\vec{B} = \frac{\mu_0 I}{2\pi r} + \frac{\mu_0 I}{4r}$ out of the page.

15 (4)



Apply Amperes circuital Law,

$\oint B \cdot ds = \mu_0 I$

$I = 0$

$\Rightarrow B = 0$

16 (2) $B = B_{Small} + B_{Big}$

$= \frac{\mu_0 I}{4r_2} + \frac{\mu_0 I}{4r_1}$

$= \frac{\mu_0 I}{4}\left(\frac{r_1 + r_2}{r_1 r_2}\right)$ [Into the page]

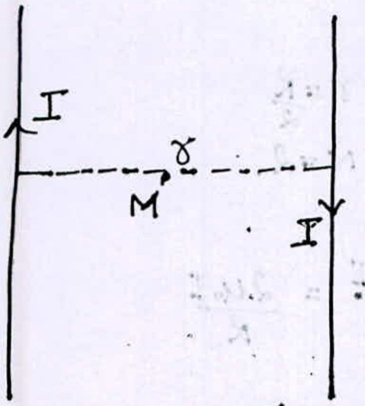
17. (2)

18. (3)

19 (1)

θ	B
2π	$\frac{\mu_0 I}{2r}$
1	$\frac{\mu_0 I}{4\pi r}$
θ	$\frac{\mu_0 I \theta}{4\pi r}$

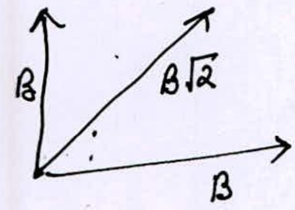
20. (2)



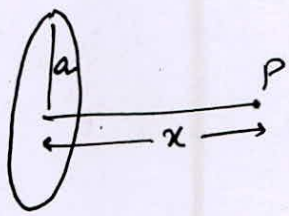
Magnetic Field will add up (Into the page)

$$B = \frac{\mu_0 I}{2\pi \frac{r}{2}} + \frac{\mu_0 I}{2\pi \frac{r}{2}} = \frac{2\mu_0 I}{\pi r}$$

21 (2)



22. (3) $\vec{B_p} = \frac{\mu_0 I a^2}{2(a^2+x^2)^{3/2}}$



$x >> a$

$$\vec{B_p} = \frac{\mu_0 I a^2}{2x^3}$$

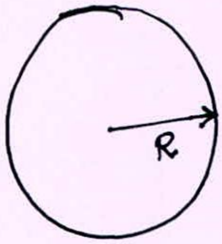
$B \propto x^{-3}$

23 (3). $B_{Net} = B_{circle} + B_{wire}$ (same direction)

$$= \frac{\mu_0 I}{2r} + \frac{\mu_0 I}{2\pi r}$$

$$= \frac{\mu_0 I}{2\pi r}(\pi + 1)$$

24 (3)



$r = \frac{R}{2}$

$N = 2$

$B_1 = \frac{\mu_0 I}{2R}$ $\qquad$ $B_2 = \frac{\mu_0 2 I}{2\frac{R}{2}} = \frac{2\mu_0 I}{R}$

$$\boxed{B_2 = 4B_1}$$

25 (1) $\quad B_c = B_1 - B_2$ (out of the page)

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

$$B_c = \frac{\mu_0 I}{4}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

26 (4) $\quad B = \frac{\mu_0 N i}{2\pi r}$

27 (3) $\quad B = \frac{\mu_0 I \theta}{4\pi r} = \frac{\mu_0 I \, 3\pi}{8\pi r} \quad \left(\theta = \frac{3\pi}{2}\right)$

Force on current carrying conductor

28. (3) Force of Attraction > Force of Repulsion.

29 (3) same as above.

30 (4)

$\because \vec{v} \parallel \vec{B}$

$\vec{F} = q\vec{v} \times \vec{B}$

$\therefore \vec{F} = 0$

31 (1) $r = \frac{mv}{qB}$

$r \propto P = mv$

32 (3) Theory Based

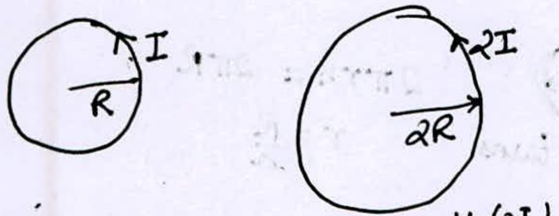
33 (3) Theory Based

34 (4) $\tau = NIAB$

35 (2) Theory Based.

WINDOW TO JEE MAIN

1. (1)



$B_1 = \frac{\mu_0 I}{2R}$ $B_2 = \frac{\mu_0(2I)}{2 \times 2R}$

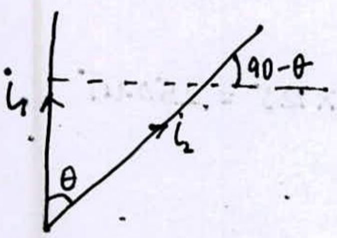
$B_1 = B_2 \Rightarrow \frac{B_1}{B_2} = 1$

2 (i) $r = \frac{P}{qB}$

3 (i) $T = \frac{2\pi m}{qB}$

4 (i) Theory Based

5 (3)



$\left(\frac{\mu_0 i_1}{2\pi r}\right) i_2 \, dl \sin(90-\theta)$

$\frac{\mu_0 i_1 i_2}{2\pi x} dl \cos\theta$

(6) (2) Work Done $=0$

$\because \vec{F}\cdot\vec{ds}=0$

7 (1) $\cancel{q}E = \cancel{q}vB$

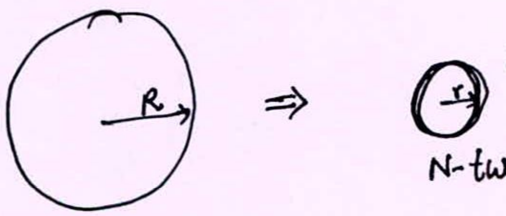
$B = \frac{E}{V}$

$= \frac{10^4}{10}$

$= 10^3\ Wb/m^2$

8 (2) $i_{in} = 0.$

9 (2)



$2\pi r n = 2\pi R$

$r = \frac{R}{n}$

$B = \frac{\mu_0 I}{2R}$ $B' = \frac{\mu_0 n I}{2\frac{R}{n}} = \frac{n^2 \mu_0 I}{2R}$

$\boxed{B' = n^2 B}$

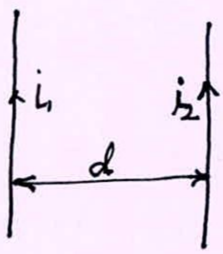
10 (1) Field along the axis of coil $B = \frac{\mu_0 i R^2}{2(R^2+x^2)^{3/2}}$

At the centre of coil $B' = \frac{\mu_0 i}{2R}$

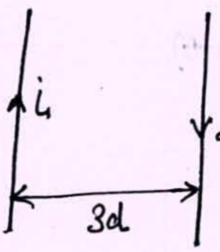
$\frac{B'}{B} = \frac{(R^2+x^2)^{3/2}}{R^3}$

$B' = \frac{B(R^2+x^2)^{3/2}}{R^3} = \frac{54(3^2+4^2)^{3/2}}{3^3} = 2\times 125 = 250\mu T$

11. (3)



$F = \frac{\mu_0 i_1 i_2}{2\pi d}$

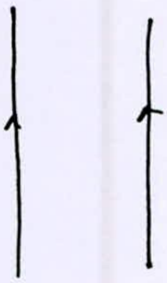


$F' = \frac{\mu_0 i_1 (2i_2)}{2\pi(3d)} = \frac{2}{3}F$

$\because$ Direction is opposite

$F' = -\frac{2}{3}F$

12(i)



Force of Attraction $= \frac{\mu_0 I^2}{(2\pi d)}$

13 (3) $\vec{B_1} = \frac{\mu_0 i_1}{2r} = \frac{\mu_0 3}{4\pi \times 10^{-2}} = 3\times10^{-5}$

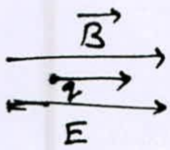
$\vec{B_2} = \frac{\mu_0 i_2}{2r} = 4\times10^{-5}$

$B_{Net} = \sqrt{B_1^2 + B_2^2} = 5\times10^{-5}.$

14 (4) $r = \frac{mv}{qB}$

$T = \frac{2\pi r}{v} = \frac{2\pi m}{qB}$

15 (2)



16 (2)

$\vec{B_1} = \frac{\mu_0 I_1}{2\pi d}.$ $\vec{B_2} = \frac{\mu_0 I_2}{2\pi d}.$

$\vec{B_1} \perp \vec{B_2}$

$B_{Net} = \frac{\mu_0\sqrt{[I_1^2 + I_2^2]}}{2\pi d}$

17. (3) Uniform current is flowing. Current enclosed in the 1st ampereen path is $\frac{I_1 \pi r_1^2}{\pi R^2} = \frac{I r_1^2}{R^2}$

$\therefore B = \frac{\mu_0}{2\pi r_1} \frac{I r_1^2}{R^2} = \frac{\mu_0 I r_1}{2\pi R^2}$

Magnetic induction at a distance $r_2 = \frac{\mu_0 I}{2\pi r_2}$

$\frac{B_1}{B_2} = \frac{r_1 r_2}{R^2} = \frac{\frac{a}{2} . 2a}{a^2} = 1.$

(18) (1)

$$v = \frac{\vec{E} \times \vec{B}}{B^2} = \frac{EB\sin 90^\circ}{B^2} = \frac{E}{B}$$

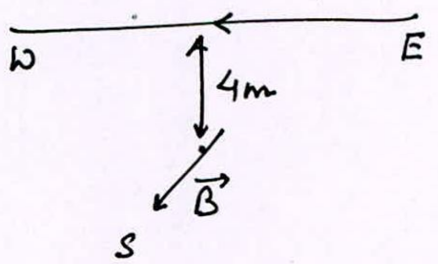
$$(qv \times B = qE)$$

$$v = \frac{E}{B}$$

(19 (3)) Theory Based

20 (1)

21 (3)

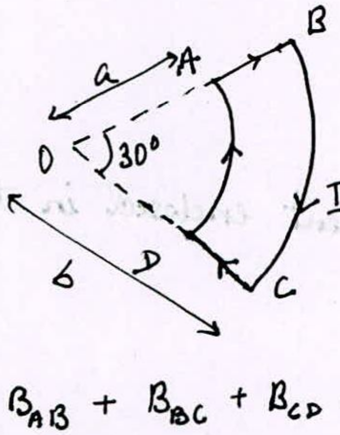


$$B = \frac{\mu_0 i}{2\pi r} = \frac{\mu_0}{4\pi}\frac{2i}{r} = \frac{10^{-7} \times 200}{4}$$

$$B = 50 \times 10^{-7}$$

$$= 5 \times 10^{-6} \text{ (Southwards)}.$$

22 (2)



$$B_0 = B_{AB} + B_{BC} + B_{CD} + B_{DA}$$

$$= 0 \quad \frac{-\mu_0 I}{4\pi b} \times \frac{\pi}{6} + 0 + \frac{\mu_0 I}{4\pi a} \times \frac{\pi}{6}$$

$$B = \frac{\mu_0 I}{24ab}(b-a) \text{ out of the paper.}$$

23. (2) For AD & BD, fields are perpendicular to current.

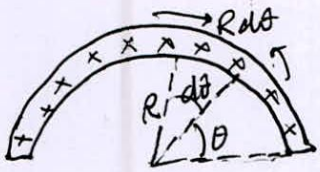
24 (4)

$$\vec{M} = \frac{q}{2m}\vec{L}$$

$$= \frac{\sigma(\pi R^2)}{2m} \times \frac{mR^2}{2}\omega$$

$$= \frac{\sigma \pi R^4 \omega}{4}$$

25 (4)



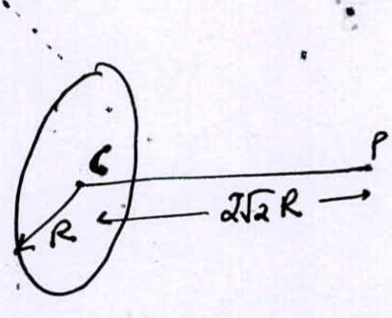
$$\frac{I}{\pi R} R\,d\theta = \frac{I}{\pi} d\theta$$

$$dB = \frac{\mu_0 I\,d\theta}{2\pi^2 R}$$

$$= \int_0^{\pi/2} \frac{\mu_0 I}{2\pi^2 R}\,d\theta \cos\theta$$

$$= \frac{\mu_0 I}{\pi^2 R}(\sin\theta)_0^{\pi/2} = \frac{\mu_0 I}{\pi^2 R}$$

26 (2) $B_c = \frac{\mu_0 I}{2R}$



$$B_p = \frac{\mu_0 I R^2}{2(d^2+R^2)^{3/2}} = \frac{\mu_0 I R^2}{2 \times 27 R^3} \quad [d = 2\sqrt{2}R]$$

$$B_p = \frac{\mu_0 I}{54R}$$

$$\frac{B_c}{B_p} = 27$$

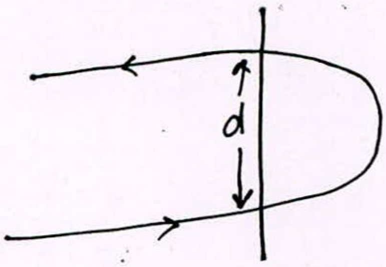
27 (1) Theory Based.

28 (4) Due to eddy currents, $T < 2\pi\sqrt{\frac{l}{g}}$

29 (2) $qVB = qE$

$$B = \frac{E}{V} = \frac{10^4}{10} = 10^3 \text{ Wb/m}^2$$

30 (3)



$$R = \frac{mV}{qB}$$

$$\Rightarrow B = \frac{mV}{qR}$$

$$\because R = \frac{d}{2}$$

$$B = \frac{2mV}{qd}$$

$$2\Delta t = \frac{2\pi R}{V} = \frac{\pi d}{V}$$

time taken $\Delta t = \frac{\pi d}{2V}$

31 (2)

$$B_1 = \frac{\mu_0 I_1 N_1}{2R_1}$$

$$B_2 = \frac{\mu_0 I_2 N_2}{2R_2}$$

$N_2 = 3N_1$

$I_2 = \frac{I_1}{3}$

$R_2 = \frac{R_1}{3}$

$$B_2 = \frac{B_1}{3}$$

$$\frac{B_2}{B_1} = \frac{1}{3}$$

32. (1) The Force will be towards right.

$$F = \frac{\mu_0 I_1 I_2 l}{2\pi R}$$

33 (1). Force on conductor, $\vec{F} = I(\vec{l} \times \vec{B})$

$$\vec{F} = 10(-3\hat{a}_z) \times (3 \times 10^{-4} e^{-0.2x} \hat{a}_y)$$

$$\vec{F} = 90 \times 10^{-4}(e^{-0.2x}) \text{ along } x\text{-Axis.}$$

Work done on the conductor in moving along x-Axis,

$$W = \int_{x=0}^{x=2} \vec{F} \cdot d\vec{x}$$

$$= 90 \times 10^{-4} \int_{x=0}^{x=2} e^{-0.2x} dx$$

$$= 90 \times 10^{-4} \left[\frac{e^{-0.2x}}{-0.2}\right]_0^2$$

$$W = \frac{90 \times 10^{-4}(e^{-0.4} - 1)}{-0.2} \text{ J.}$$

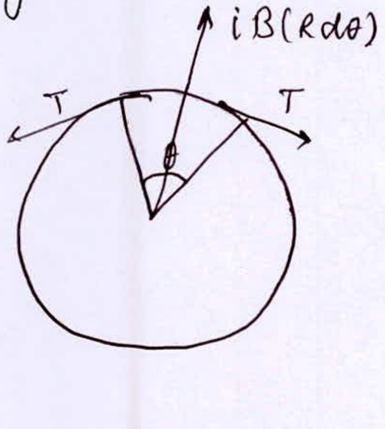
Avg Power $P_{Avg} = \frac{\text{Work}}{\text{time}}$

$$P_{Avg} = \frac{90 \times 10^{-4}(e^{-0.4} - 1)}{5 \times 10^{-3} \times -0.2} \Rightarrow P_{Avg} = 2.97 W.$$

34 (4) if $I_1 I_2 > 0$, $F \rightarrow$ -ive

if $I_1 I_2 < 0$, $F \rightarrow$ +ive.

35.

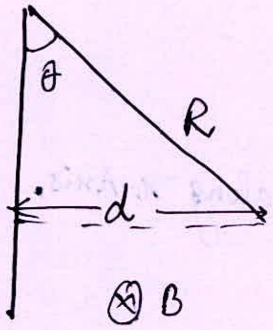


$$2T\sin\left(\frac{\theta}{2}\right) = iBR\theta$$

$$2T\frac{\theta}{2} = iBR\theta$$

$$\boxed{T = iBR}$$

36 (3)



$R\sin\theta = d$

$\sin\theta = \frac{d}{R}$

$R = \frac{mv}{qB}$

$(mv)^2 = 2mqV$

$(mv) = \sqrt{2mqV}$

$\sin\theta = \frac{dqB}{mv} = \frac{dqB}{\sqrt{2mqV}} = dB\sqrt{\frac{q}{2mV}}$

37. (1) Theory based.

38 (2) $\left[\frac{\mu_0 I^2}{4\pi L\sin\theta}\right] l = T\sin\theta$

$dlg = T\cos\theta$

$\tan\theta = \frac{\mu_0 I^2}{4\pi L\sin\theta\, dlg}$

$I = \sqrt{\frac{4\pi L\sin^2\theta\, dlg}{\mu_0\cos\theta}}$

$= 2\sin\theta\sqrt{\frac{\pi dgL}{\mu_0\cos\theta}}$

39 (3) In (b), $\vec{A} \parallel \vec{B}$ $\Rightarrow$ Stable Equilibrium.

In (d), $\vec{A} \uparrow\downarrow \vec{B}$ $\Rightarrow$ unstable " .