Exercise

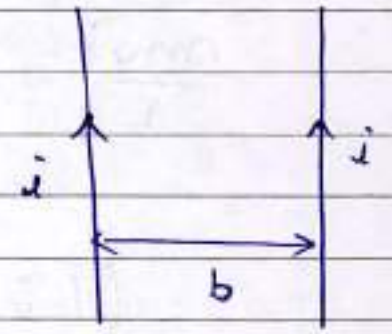
Level-I

1)

$$\frac{F}{\ell} = \frac{\mu_0}{4\pi} \times \frac{2(i_1 \times i_2)}{a}$$

$$= \frac{\mu_0}{4\pi} \times \frac{i^2 \times 2}{b}$$

$$\boxed{\frac{F}{\ell} = \frac{\mu_0 i^2}{2\pi b}}$$ Ans → (B)



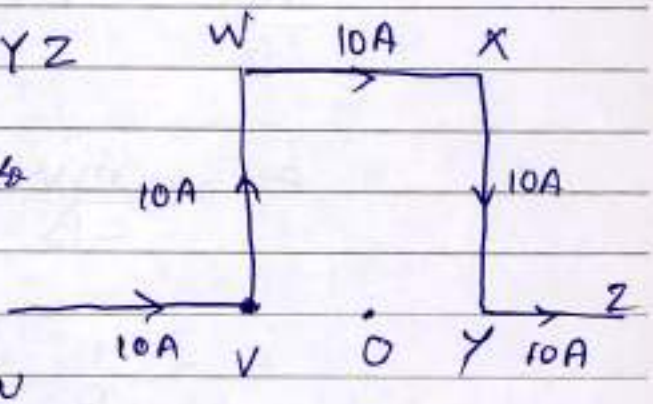
(2)

→ pt. O lies on line UV & YZ

Hence, magnetic field due to UV & YZ is zero

→ according to right hand rule,

magnetic fields due to VW, WX & XY at point O, are point into the page.



(3) $F = q(\vec{v} \times \vec{B})$

negatively charged

Ans (C)

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④ $r = 0.5 \text{ m}$

$$F = q(v \times B)$$

$$\frac{mv^2}{r} = qvB \qquad v = r\omega$$

$$qB = m\omega \qquad m_e =$$

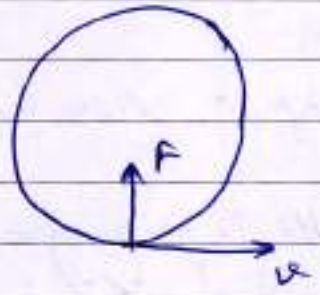
$$(1.6 \times 10^{-19})(14) = (9.1 \times 10^{-31}) \cdot \omega$$

$$\omega = 8.75 \times 10^{16} \qquad \text{Ans (A)}$$

⑤

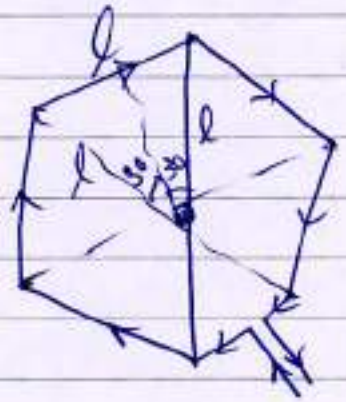
$$\frac{mv^2}{r} = evB = eV$$

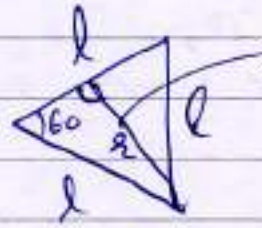
$$r = \frac{mv}{eB} = \frac{mv^2}{eV}$$



$$r = \frac{1}{B}\sqrt{\frac{2mV}{e}} \longrightarrow \text{Ans (B)}$$

⑥





$r = l \sin 60$.

$$B_1 = \frac{\mu_0}{4\pi} \frac{i\,(\sin 30 + \sin 30)}{l \sin 60}$$

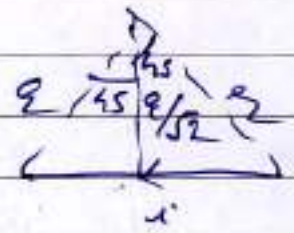
$$= \frac{\mu_0}{4\pi} \frac{i\left(\frac{2}{\sqrt{3}}\right)}{l}$$

$$B_{Total} = 6 \times B_1$$

$$= \frac{\mu_0}{4\pi} \times \frac{i}{\ell} \times \left(\frac{2}{\sqrt{3}}\right) \times 6$$

$$= \frac{\sqrt{3}\,\mu_0 i}{\pi \ell} \qquad \text{Ans} \rightarrow (A)$$

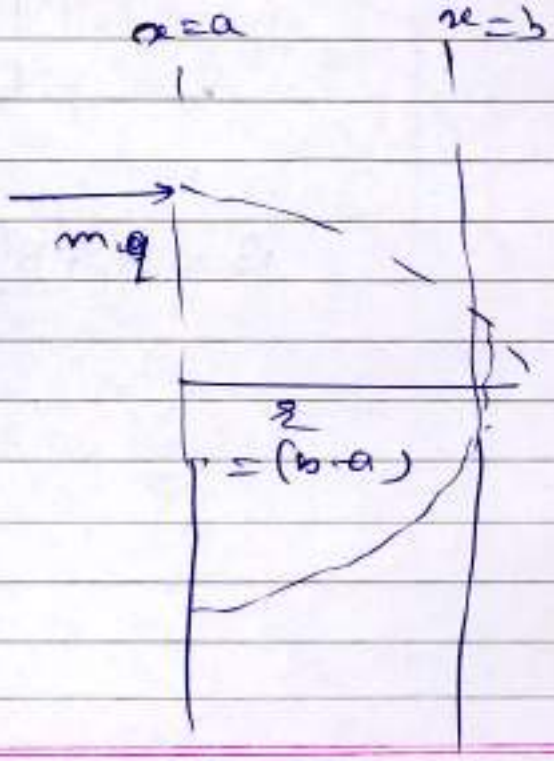
7)



$$B = \frac{\mu_0}{4\pi}\left[\frac{i}{R}\left(\frac{3}{4} \times 2\pi\right) + \frac{i}{(R/\sqrt{2})}(-\sin 45 + \sin 45)\right]$$

$$B = \frac{\mu_0}{8\pi R}(3\pi + 4)$$

8)



$$\frac{mvR}{\varepsilon} = q\,v\,B$$

$$v = \frac{qB}{m}(b-a)$$

Ans (B)

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9) $mg = B\,i\,l$

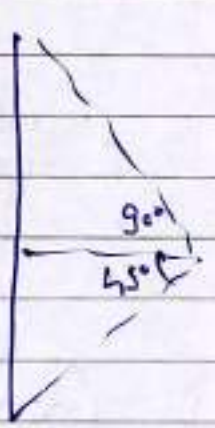
$mg = B\,i\,(\pi R)$

$\boxed{i = \frac{mg}{\pi R B}}$

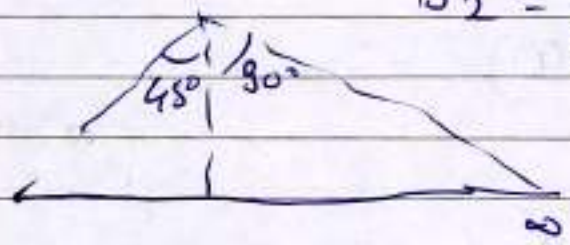
l (one edge) $= \pi R$

Ans - (B)

10)



$B_1 = \frac{\mu_0}{4\pi}\frac{i}{R}(\sin 45 + \sin 90)$

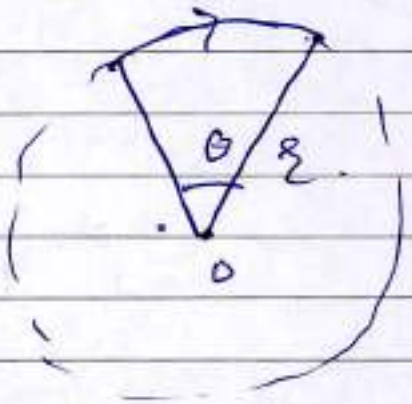


$B_2 = \frac{\mu_0}{4\pi}\frac{i}{R}(\sin 45 + \sin 90)$

$B = B_1 + B_2 = \frac{\mu_0 i}{4\pi R}(2+\sqrt{2})$

Ans - (D)

11)

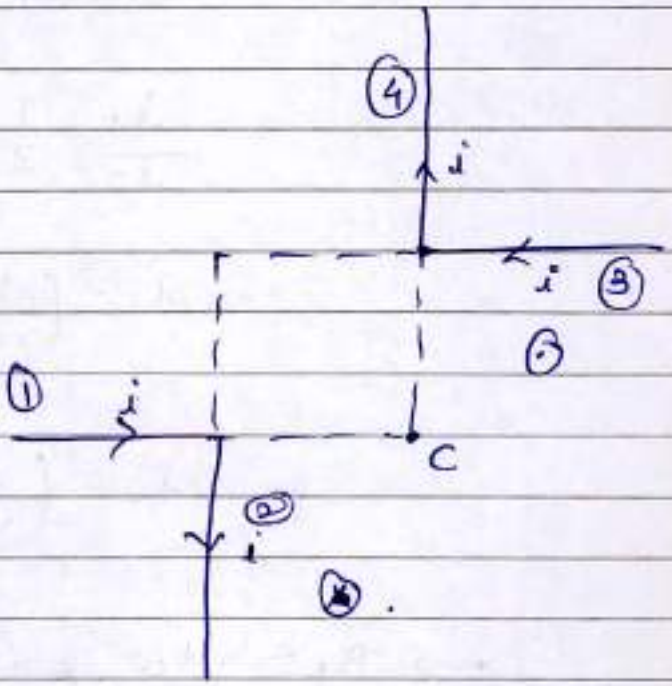


$$B = \frac{\mu_0}{4\pi} \frac{i\theta}{\ell}$$

$$= \frac{\mu_0}{2\ell} \left(\frac{\theta}{2\pi}\right)$$

$$B = \frac{\mu_0}{2\ell} \left(\frac{\theta}{360}\right)$$

12)



$B_1 = B_4 = 0$

as lines ① & ④ are passing through pt. C

$\rightarrow B_2 = B_4$

$$= \frac{\mu_0}{4\pi} \frac{i}{a}$$

$$B = B_1 + B_2 + B_3 + B_4$$

$$= 0 + \frac{\mu_0}{4\pi}\left(\frac{i}{a}\right) + 0 + \frac{\mu_0}{4\pi}\left(\frac{i}{a}\right)$$

$$\boxed{B = \frac{\mu_0 i}{2\pi a}.}$$

Ans (B)

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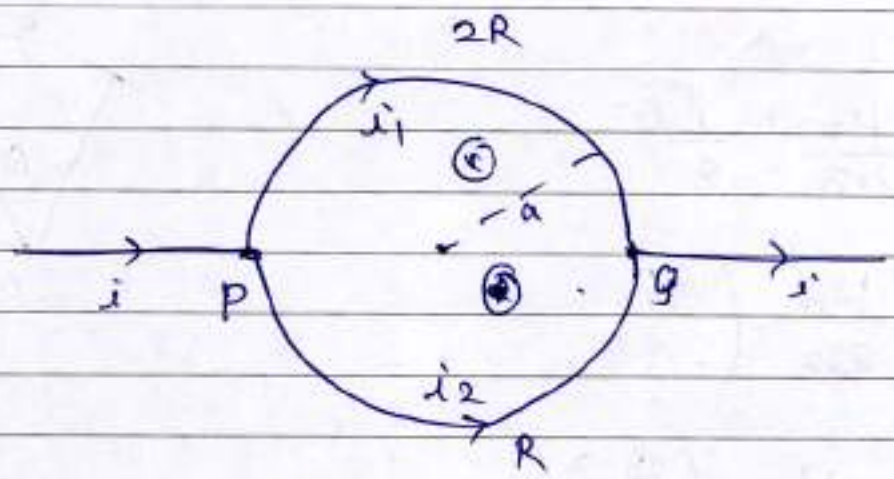
13)



$\rightarrow$ $i_1(2R) = i_2(R)$

$\frac{i_1}{i_2} = \frac{1}{2}$

$i_1 = \left(\frac{1}{1+2}\right) i = \left(\frac{1}{3}\right) i$

$i_2 = \left(\frac{2}{1+2}\right) i = \left(\frac{2}{3}\right) i$

$\rightarrow B_1 = \frac{\mu_0}{4\pi} \times \frac{(i/3)}{a}\left(\frac{1}{2} \times 2\pi\right)$ ⊗ point inwards

$B_2 = \frac{\mu_0}{4\pi} \times \frac{(2i/3)}{a}\left(\frac{1}{2} \times 2\pi\right)$ ⊙ point outwards

$B = B_1 + B_2 = \left(\frac{\mu_0}{4\pi}\right)\left(\frac{i}{3a}\right) \pi (1+2)$

$= \frac{\mu_0 i}{12a}$ Ans - (C)

14) As both wires are $\perp^{ar}$ to each other,

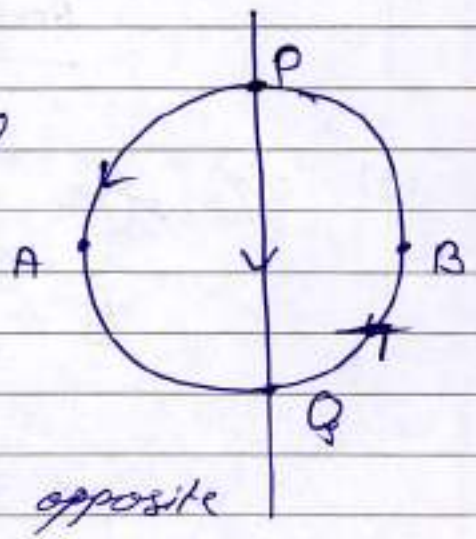
Hence net force is zero.

15) $$\frac{mv^2}{\ell} = qvB$$

$$\ell = \frac{v}{(q/m)B} = \frac{2\times10^5}{(5\times10^7)\times(4\times10^{-2})} = 0.1\ m$$

Ans (A)

16)



Currents through PAQ & PQ are in same direction,

Hence, PAQ attracts PQ towards (left)

But PQ & PBQ are in opposite direction,

Hence PBQ repels PQ $\perp^{ar}$ towards (left) → Ans (D)

17) magnetic force will apply $\perp^{ar}$ to velocity

→ ∴ no change in magnitude of velocity i.e speed.

→ But it will change the path from linear to circular Ans - (B)

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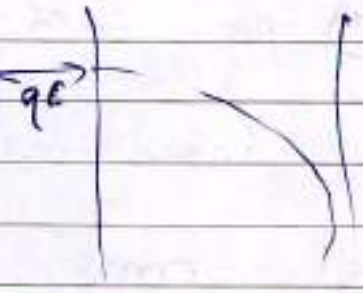
18)

$$\frac{mv^2}{R} = qvB = qE$$



$$\frac{m_x}{m_y} = m \propto \frac{R}{v}$$

$$\left(\frac{m_x}{m_y}\right) = \left(\frac{R_x}{R_y}\right)^2$$

$$= \left(\frac{R_1}{R_2}\right)^2$$

Ans (C)

$$ma = qE$$

$$a = \frac{qE}{m}$$

$$a \propto \frac{1}{m}.$$

19) Eg: a coil.

$$B = \frac{\mu_0}{4\pi} \frac{i\theta}{R}.$$

$$\mu_0 = \frac{B \times R}{i} \left(\frac{4\pi}{\theta}\right)$$

$$= \frac{Wb}{m^2} \times \frac{m}{A} \times \frac{rad}{rad}$$

$$\mu_0 = Wb\ m^{-1} A^{-1}$$

Ans - (B)

20) for cylinder.

$i_{enclosed} = 0$.

$\oint \vec{B} \cdot d\vec{l} = \mu_0 i_{enclosed}$

$i_{enclosed} = 0$.

$B = 0$.

Ans-(B)

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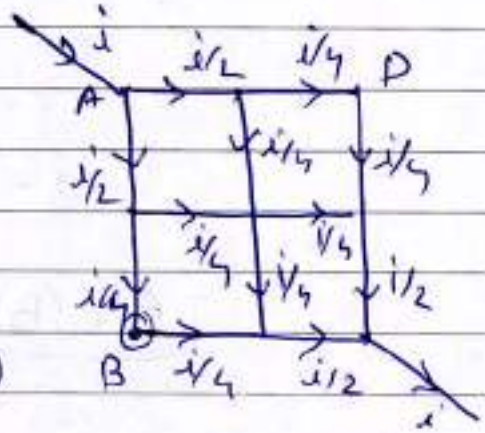
LEVEL - II

1) $T = \frac{2\pi m}{qB} = \frac{2(\pi)2}{2 \times 2} = \pi = 3.14\ s$

Ans (C)



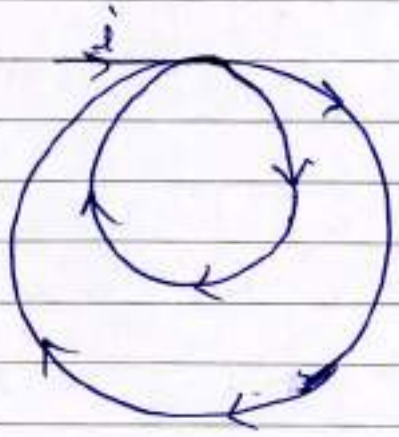
(2) @ B, $I = i/4$

@ D, $I = i/4$.

$\ell(AB) = \ell(AD)$, $\rightarrow R(AB) = R(AD)$

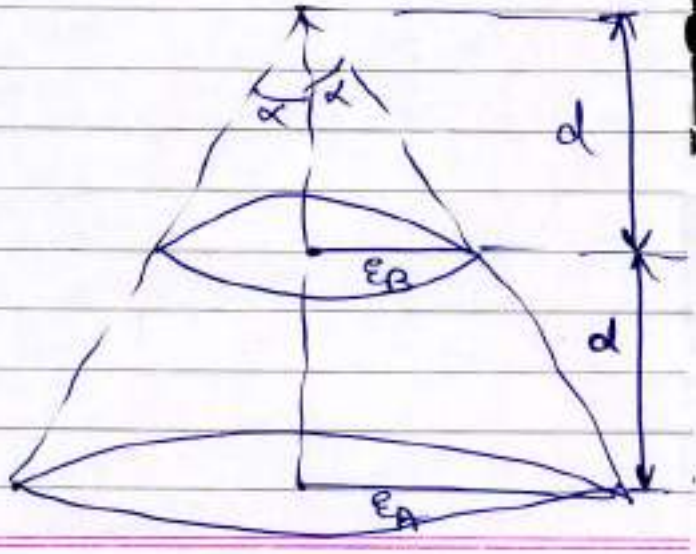
$\therefore V_B = V_D$ Ans (B)

(3)



Ans - (D)

(4)



$\rightarrow$ $\tan\alpha = \frac{\ell_B}{d} = \frac{\ell_A}{2d} \rightarrow \ell_B = \frac{\ell_A}{2} = \ell$ (say)

$$B_1 = B_A = \frac{\mu_0}{2} \frac{i\,(4\ell^2)}{(4\ell^2+4d^2)^{3/2}}$$

$$B_2 = B_B = \frac{\mu_0}{2} \frac{i\,(\ell^2)}{(\ell^2+d^2)^{3/2}}$$

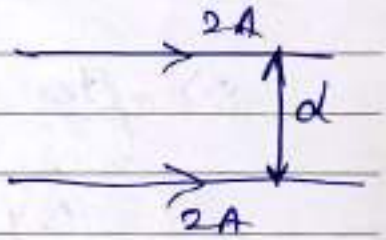
$$B_2 = \frac{B_1}{2} \rightarrow \boxed{\frac{B_1}{B_2} = \frac{1}{2}}$$

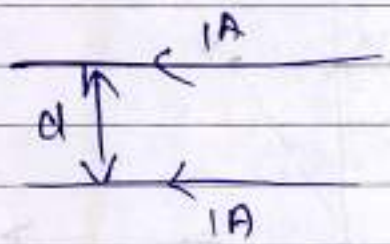
Ans – (D)

(5) Ans (A)

(6) $F = \frac{\mu_0}{4\pi} \frac{2 i_1 i_2}{a} \times \ell$.

$F = \frac{\mu_0}{4\pi} \frac{2\times2\times2}{d} \times \ell$





$F_1 = \frac{\mu_0}{4\pi} \times \frac{2\times1\times1}{d} \times \ell$

$= \frac{F}{4}$

Ans – (A)

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7) $F = qE = ma$

$\frac{dv}{dt} = a = \frac{qE}{m}$

$u = v_0 \cos\theta$

$\int_u^0 dv = \frac{qE}{m} \int_0^t dt$

$0 - u = \frac{qE}{m} t$

$t = \frac{-mu}{qE}$

$t = \frac{-mv_0 \cos\theta}{qE}$

$\frac{dt}{dx} = 0 = \frac{mv_0 \sin\theta}{qE}$.

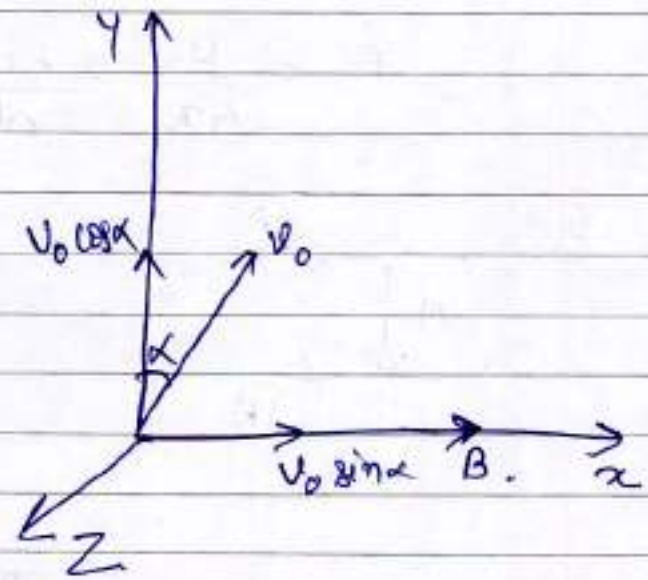
Ans – (B)

8) after 1 revolution,

$\Delta y = \Delta z = 0$.

$\Delta x = (v_0 \sin\alpha)\, T$

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



$\alpha + \beta + \alpha + x = \pi$

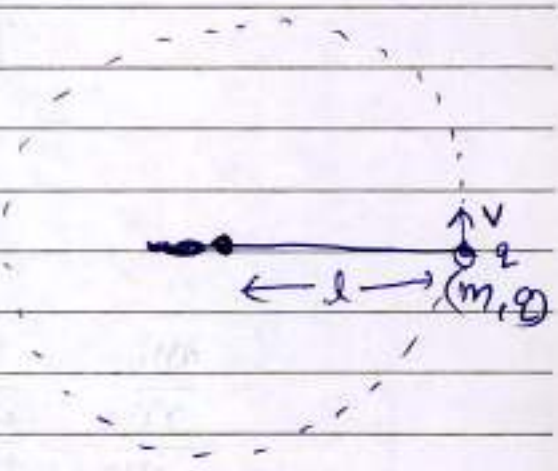
$x = (\pi - \beta)$

$\Delta x = x - 0 = \frac{2\pi m}{qB}(v_0 \sin\alpha)$

Ans - (B)

9)

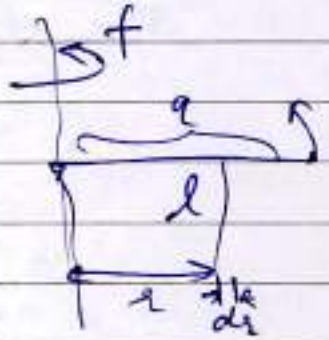
$i = \frac{q}{2\pi/2\pi f} = qf$



$i = \frac{qw}{2\pi}$

$\frac{M}{L} = \frac{\frac{qw}{2\pi} \pi l^2}{m l^2 w} = \frac{q}{2m}$

10)



11) $dM = (\pi r^2)\, dq\, f$

12) $\int dM = \int (\pi r^2)\left(\frac{q}{l}\right) f\, dr$

$dq = \frac{q}{l}\, dr$

$M = \frac{\pi q f}{l} \frac{l^3}{3} = \frac{1}{3}\pi q f l^2$

Ans (D)

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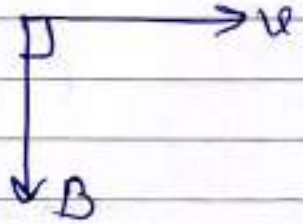
12) $H^{\oplus} \rightarrow (1)$
$He^{++} \rightarrow (2)$
$O^{++} \rightarrow (3)$

$\frac{q_1}{q_2}\frac{1}{1}$
$\frac{}{q_3}\frac{}{2}$

K.E (K)

$K_1 = K_2 = K_3$

$B_1 = B_2 = B_3$



$\frac{m_1}{m_2}\frac{1}{4}$
$\frac{}{m_3}\frac{}{16}$

$$\varepsilon = \frac{\sqrt{2mK}}{qB}$$

K & B → const

$$\varepsilon \propto \frac{\sqrt{m}}{q}$$

$$\frac{\varepsilon_1}{\varepsilon_2} = \sqrt{\frac{m_1}{m_2}} \times \frac{q_2}{q_1}$$

$$= \frac{1}{2} \times \frac{1}{1}$$

$$= \frac{1}{2}$$

$$\frac{\varepsilon_2}{\varepsilon_3} = \sqrt{\frac{m_2}{m_3}} \times \frac{q_3}{q_2}$$

$$= \frac{1}{2} \times \frac{2}{1}$$

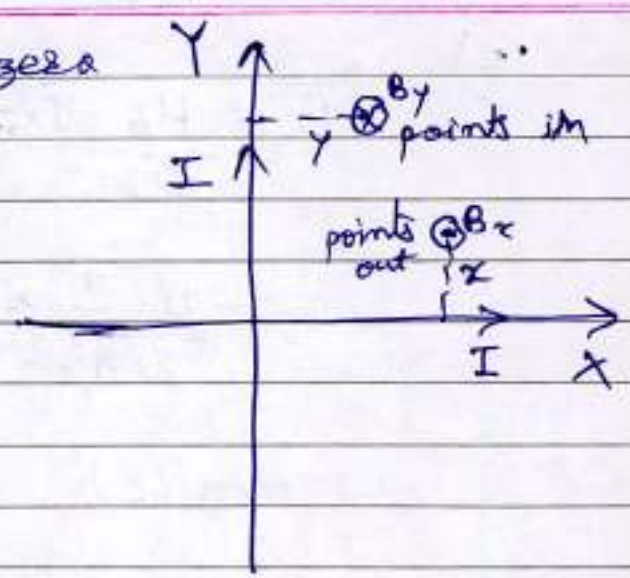
$$= \frac{1}{1} = \frac{2}{2}$$

$\frac{\varepsilon_1}{\varepsilon_2}\frac{1}{2} = \frac{\varepsilon}{2\varepsilon}$
$\frac{}{\varepsilon_3}\frac{}{2}\frac{}{2\varepsilon}$

ε_1 → minimum
∴ maximum deviation

Ans (A)

13) magnetic field will be zero @ $B_x = B_y$

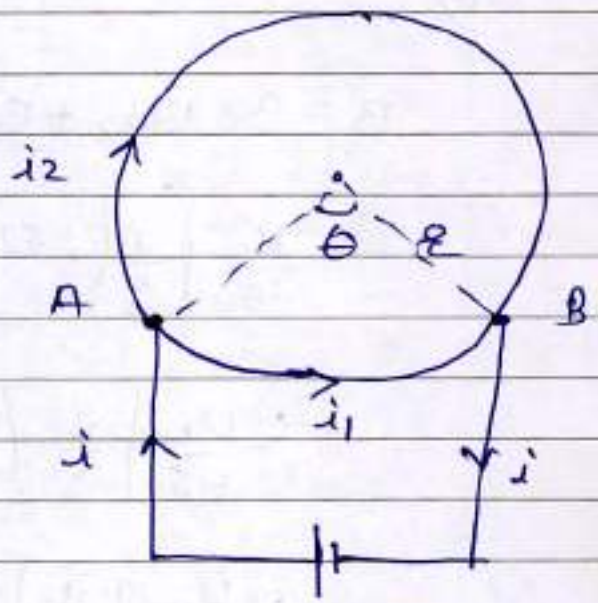


$$\frac{\mu_0}{4\pi}\frac{2I}{x} = \frac{\mu_0}{4\pi}\frac{2I}{y}$$

$$\therefore \boxed{x = y}$$

Ans (A)

14)



$$i_1 R_1 = i_2 R_2$$

$$R = \frac{\rho l}{A}$$

$$R \propto l \rightarrow \frac{R_1}{R_2} = \frac{l_1}{l_2}$$

$$\rightarrow i_1 l_1 = i_2 l_2$$

$$\rightarrow \frac{l_1}{l_2} = \frac{\theta_1}{\theta_2}$$

$$\rightarrow i_1\theta_1 = i_2\theta_2$$

$$\rightarrow B_\phi = \frac{\mu_0}{4\pi}\frac{i\theta}{\ell^2}$$

$$\frac{B_1}{B_2} = \frac{i_1\theta_1}{i_2\theta_2} = 1$$

$$\therefore B_1 - B_2 = 0$$

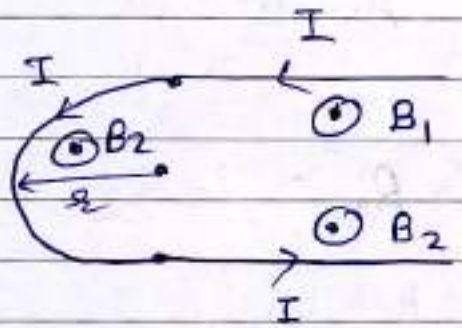
Ans (D)

15) $\vec{B} = \frac{\mu_0}{2} \vec{J} \times \vec{x}$ $\qquad J = \frac{I}{\pi R^2}$

$= \frac{\mu_0 I x}{2\pi R^2}$

Ans (C)

16)



$B = B_1 + B_2 + B_3$

$= \frac{\mu_0}{4\pi}\left[\frac{i}{R}\left(\frac{1}{2}\pi 2\pi\right)\right] \leftarrow B_2 \odot$

$+ \frac{\mu_0}{4\pi}\left[\frac{i}{R}\right] \leftarrow B_1 \odot$

$+ \frac{\mu_0}{4\pi}\left(\frac{i}{R}\right) \leftarrow B_3 \odot$

$= \frac{\mu_0 I}{4R}\left(1+\frac{2}{\pi}\right) \odot$

Ans (C)

17) $\frac{mv^2}{R} = qvB$

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

$R \propto \frac{m}{q}$

$R_p < R_Q$

$\left(\frac{m}{q}\right)_p < \left(\frac{m}{q}\right)_Q$

$\left(\frac{q}{m}\right)_p > \left(\frac{q}{m}\right)_Q$

Ans (B)

18) $F = q(\vec{i} \times \vec{B})$

$F \perp i$ & $F \perp B$

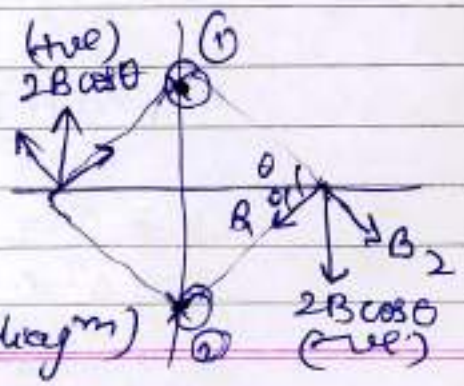
Hence F goes downwards

Ans (B)

19) $B = B_1 = B_2$

$B' = 2B\cos\theta = 2B \frac{x}{\sqrt{a^2+x^2}}$

for $x > 0$, $B < 0$ & vice versa



(from diagram)

Ans (D)

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20) ~~B~~ =

$$\bar{F} = l(\bar{I} \times \bar{B})$$

$l_1 = l_2 = l_3 = l$

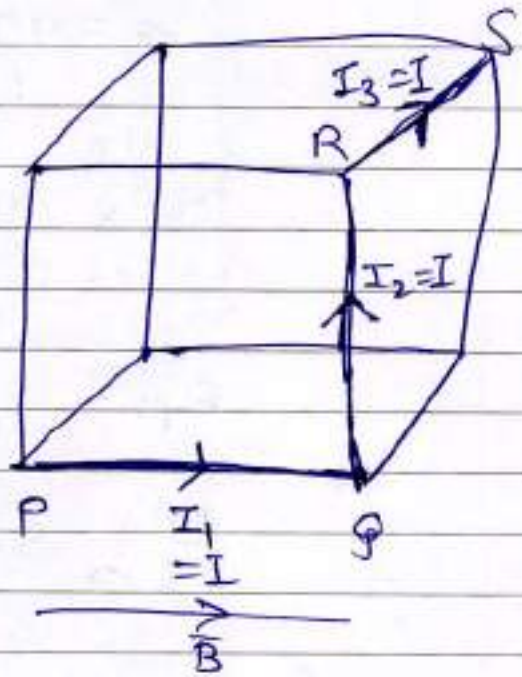
Assume,

$\bar{B}_1 = \bar{B}_2 = \bar{B}_3 = \bar{B}\,\hat{\imath}$

$\bar{I}_1 = \bar{I}\,\hat{\imath}$

$\bar{I}_2 = \bar{I}\,\hat{\jmath}$

$\bar{I}_3 = I\,\hat{k}$



$F_1 = l_1(\bar{I}_1 \times \bar{B}_1) = 0$

$\bar{F}_2 = l_2(\bar{I}_2 \times \bar{B}_2) = BIl\,\hat{k}$

$\bar{F}_3 = l_3(\bar{I}_3 \times \bar{B}_3) = BIl\,\hat{\jmath}$

$|\bar{F}| = \sqrt{F_1^2 + F_2^2 + F_3^2} = \sqrt{2}BIl$

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21)

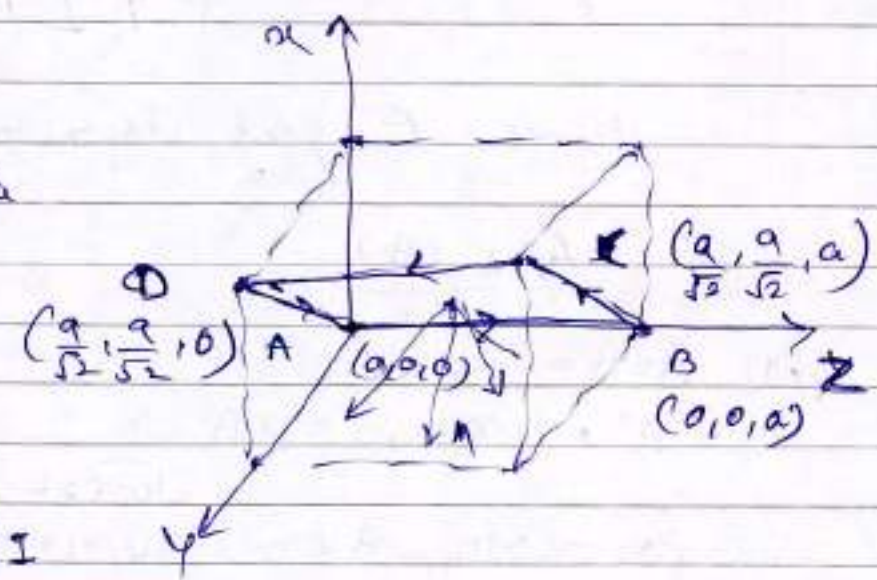
$AB = a$

$AD = \sqrt{\frac{a^2}{2} + \frac{a^2}{2}} = a$

$m = nAI$

$= a^2 I$

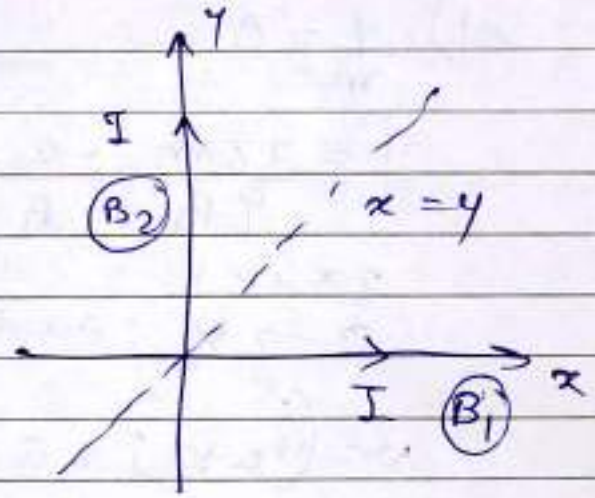
$= \left(\frac{a^2}{\sqrt{2}}\hat{\jmath} - \frac{a^2}{\sqrt{2}}\hat{\imath}\right) I$



22)

$$B_1 = \frac{\mu_0}{4\pi}\frac{2I}{x}$$

$$B_2 = \frac{\mu_0}{4\pi}\frac{2I}{y}$$



But $x = y$

$B_1 = B_2$

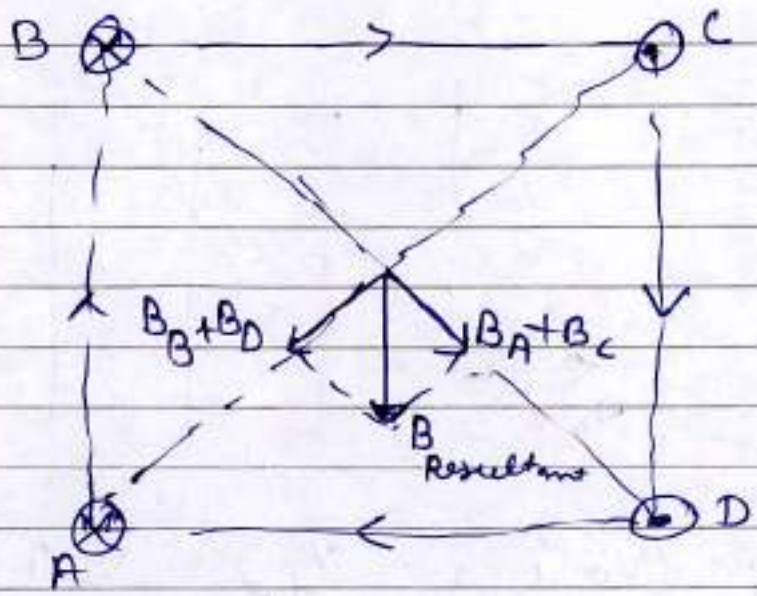
⊙ ⊗

but in opposite direction

$B_1 - B_2 = 0$ @ $x = y$

Ans (D)

23)



$B_{Resultant}$ is along CD

Ans (D)

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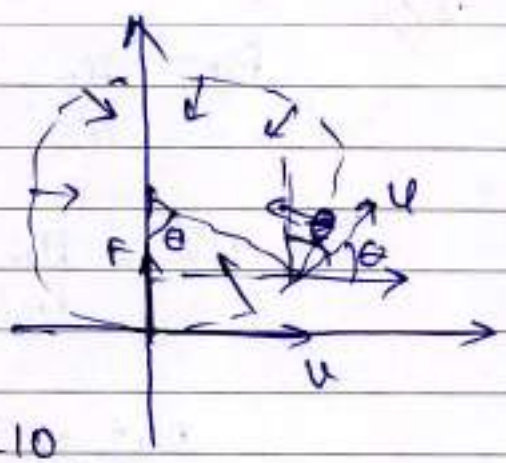
24) $\frac{q}{m} = \pi$

$T = \frac{2\pi m}{qB} = \frac{2}{B} = 1$

$2\pi \to 1$

$\theta \to 1/6 \to \theta = \pi/3$ rad

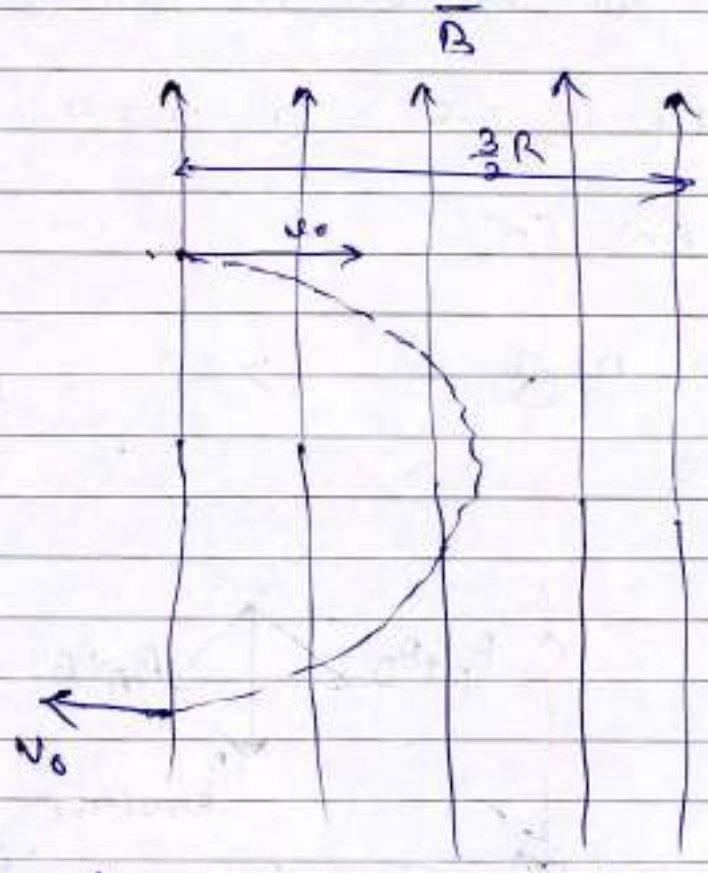


$v = (v\cos\theta\,\hat{i} + v\sin\theta\,\hat{j})$ $v = 10$, $\theta = 60°$

$= (5\hat{i} + 5\sqrt{3}\hat{j})$

Ans (A)

25)



$v_i = v_0\,\hat{i}$, $v_f = -v_0\,\hat{i}$

$\Delta = v_i - v_f = v_0 - (-v_0) = 2v_0$.

26) $\frac{mv^2}{r} = qvB = qV$

$$r = \frac{mv}{qB} = \frac{p}{qB} = \frac{\sqrt{2mK}}{qB} = \frac{1}{B}\sqrt{\frac{2mV}{q}}$$

Ans (C)

27) $B = \mu_0 n A I$

$\mu_0 = 4\pi \times 10^{-7}$ T/m-A

$$F = q(\bar{v} \times \bar{B})$$

$\therefore F \perp \bar{B}$

$\therefore a \perp \bar{B}$

$\therefore \bar{a} \cdot \bar{B} = 0$

$(x\hat{i} + \hat{j} - \hat{k}) \cdot (2\hat{i} + 3\hat{j} + 4\hat{k}) = 0$

$2x + 3 - 4 = 0$

$x = 1/2$

Ans (A)

μ_0

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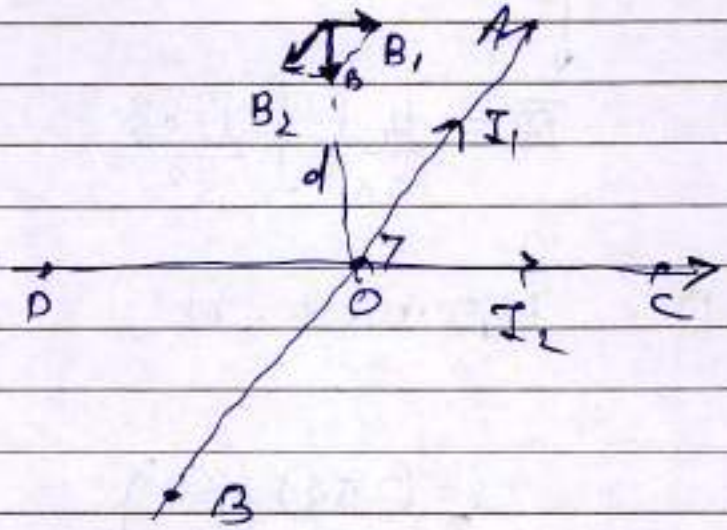
Previous Year's Questions

Question asked in 2014

1)

$$B_1 = \frac{\mu_0}{4\pi} \cdot \frac{2I_1}{d}$$

$$B_2 = \frac{\mu_0}{4\pi} \cdot \frac{2I_2}{d}$$



$$B = \sqrt{B_1^2 + B_2^2}$$

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

Ans (B)

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Biot-Savart's Law

&

Ampeel's Circuital Law

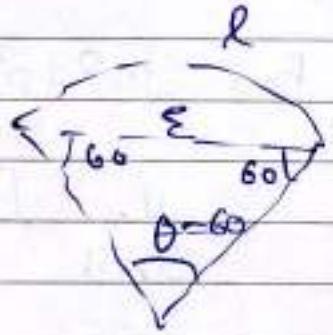
$$\vec{B} = \frac{\mu_0 i}{4\pi} \int \frac{d\hat{l} \times \hat{r}}{r^2}$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 (i_{net})$$

1) $M_1 = m \times l = M$

$$l = (2\pi r)\left(\frac{60}{360}\right)$$

$$l = \left(\frac{\pi r}{3}\right).$$



$$M_2 = m \times l \times r.$$

$$M_2 = m\left(\frac{\pi r}{3}\right) =$$

$$M_2 = m\left(\frac{3l}{\pi}\right) =$$

$$M_2 = \frac{3}{\pi} M$$

Ans (C)

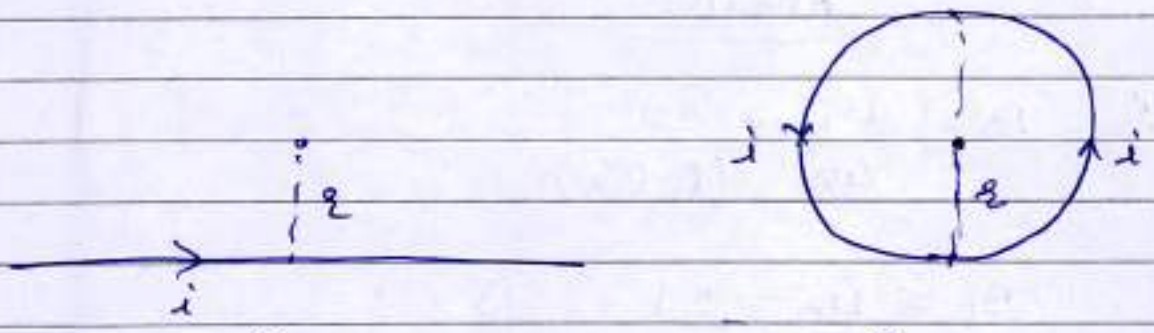
2) as midpoint lies on wire

in I^{st} case, $B = 0$

in II^{nd} case, $B' = 0 = B$.

Ans(C)

3)



$B_1 = \frac{\mu_0}{4\pi}\left(\frac{2i}{R}\right)$ $\qquad$ $B_2 = \frac{\mu_0}{4\pi}\left(\frac{i}{R} \times 2\pi\right)$

$$B = B_1 + B_2 = \frac{\mu_0 i}{2\pi R}(\pi + 1)$$

Ans (C)

(4) $$\frac{B_{axis}}{B_{centre}} = \frac{\frac{\mu_0}{4\pi}\frac{R^2}{(R^2+x^2)^{3/2}}}{\frac{\mu_0}{4\pi}\times\frac{1}{R}} = \frac{1}{8}$$

$$\frac{R^2}{(R^2+x^2)^{3/2}} = \frac{1}{8R} \rightarrow \boxed{x = \sqrt{3}R}$$

Ans (D)

(5) $B = \frac{\mu_0}{4\pi}\left(\frac{2i}{R}\right)$

$10^{-6} = 10^{-7} \times \frac{2 \times i}{2 \times 10^{-2}}$

$\boxed{i = 0.1\,A}$

Ans (A)

(6) $B = \frac{\mu_0}{4\pi} \times \frac{2i}{(0.05)}$

$B_1 = \frac{\mu_0}{4\pi} \times \frac{2i}{0.2} = \frac{B}{4}$

Ans (B)

7)

$i = \frac{\mu_0}{4\pi}\frac{2i}{R}(\sin\alpha + \sin\alpha)$

$i = \frac{\mu_0}{2\pi}\frac{i}{R}(\sin\alpha)$

$i_{max} = \frac{\mu_0}{2\pi}\frac{i}{R}$

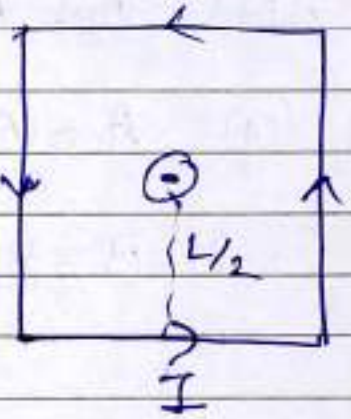
$\therefore \alpha = 90°$

Ans (B)

8)

$$B = 4 \times \frac{\mu_0}{4\pi} \frac{(2I)}{(L/2)}$$

$$B \propto \frac{1}{L}$$



Ans (C)

9)

$$B = \mu_0 N I$$

$$= (4\pi \times 10^{-7}) \times 10000 \times 5 \times \cos\theta$$

$$= 1.26 \times 10^{-2} T$$

Ans (B)

$\cos\theta = \frac{l/2}{\sqrt{R^2 + \frac{l^2}{4}}}$

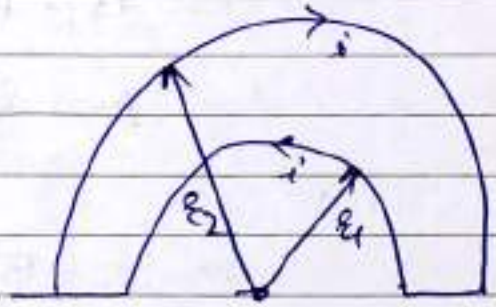
$R = 0.01$

$l = 0.5$

10)

$$B_1 = \frac{\mu_0}{4\pi} \left(\frac{i}{\ell_1} (\pi) \right) \odot$$

$$B_2 = \frac{\mu_0}{4\pi} \left(\frac{i}{\ell_2} (\pi) \right) \otimes$$



$$B = B_1 - B_2 = \frac{\mu_0 i}{4} \left[\frac{1}{\ell_1} - \frac{1}{\ell_2} \right]$$

Ans (A)

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(11) Ans A

(11) Ans (A)

(12) $B = \frac{\mu_0 N I}{2} (\cos\theta_1 + \cos\theta_2)$

$\theta_1 = \theta_2 = \theta$

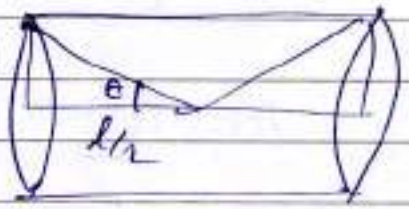
$= \mu_0 N I \times \cos\theta$

$= (4\pi \times 10^{-7}) \left(\frac{l'}{2\pi R}\right) \times I \times \frac{(l/2)}{\sqrt{R^2 + l^2/4}}$

$\varepsilon = 0.03$
$I = 10$
$l = 0.8$

$= 2.4 \times 10^{-3}$ m

Ans (C)



$\cos\theta = \frac{(l/2)}{\sqrt{R^2 + l^2/4}}$.

$N = \frac{l'}{(2\pi R)}$

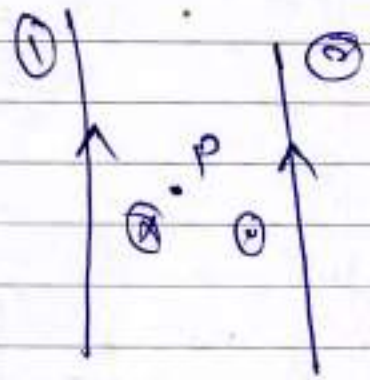
(13)

$B_1 = \frac{\mu_0 i}{2R}$ (X)

$B_2 = \frac{\mu_0 i}{2R}$ (⊙)

$B = B_1 - B_2 = 0$

Ans (C)



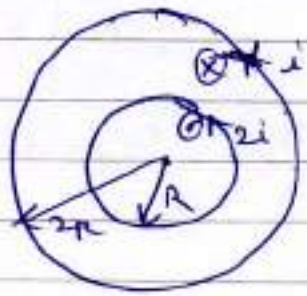
(14)

$B = B_1 - B_2$

$= \frac{\mu_0 (2i)}{2R} - \frac{\mu_0 (i)}{2(2R)}$

$= \frac{\mu_0 i}{R} \left(\frac{3}{4}\right)$

Ans (C)



15) $F = mg = B\,i\,\ell$

$2000 \times g \times g = B \times (2)\,(1.5)$

$B = 0.65\ T$

Ans (D)

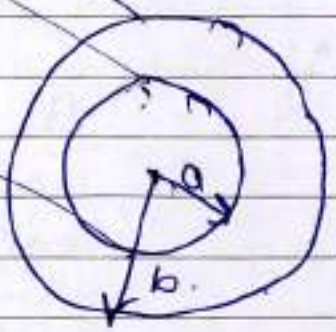
16) In magnetic field

$\Delta K.E = 0$

$W = 0$.

Ans (A)

17)



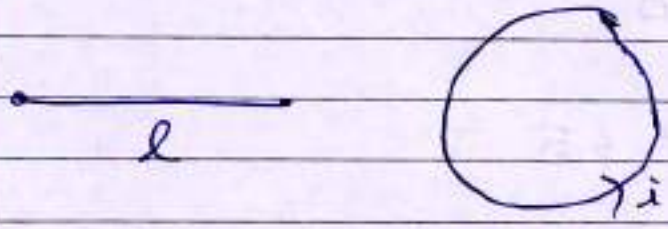
$B = \frac{\mu_0 N i}{2\pi}$

$dB = \frac{\mu_0 i n\, dx}{2\pi x}$

$\int dB = \int \frac{\mu_0 i n\, dx}{(b-a)\,2\pi x}$

$B = \frac{\mu_0 n I}{2(b-a)} \int_a^b \frac{dx}{x} = \frac{\mu_0 n I}{2(b-a)} \log_e\left(\frac{b}{a}\right)$

18) $B = \frac{\mu_0 N i}{2R}$.



$l = 2\pi R_1$ $\qquad$ $l = n(2\pi R_2)$

$R_1 = \frac{l}{2\pi}$ $\qquad$ $R_2 = \frac{l}{2\pi n} = \frac{R_1}{n}$

$\rightarrow$ $B_1 = \frac{\mu_0 i}{2R_1}$ $\qquad$ $B_2 = \frac{\mu_0 i \times n}{2R_2}$

$= n^2 B_1$

$= n^2 B$.

---

19)

$B \cdot l = \mu_0 i_{enclosed}$

inside pipe

$i = 0$

Ans (C)

20) $B = \frac{\mu_0}{4\pi} \frac{2i}{\ell}$

$B \propto \frac{1}{\ell}$ $\quad (i \rightarrow \text{const})$

$\frac{B_1}{B_2} = \frac{\ell_2}{\ell_1}$

$\frac{0.4T}{B_2} = \frac{2\ell}{\ell}$

$B_2 = 0.2\,T$

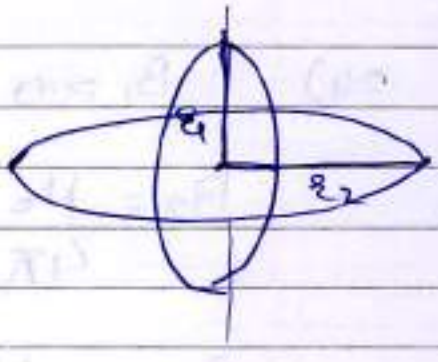
Ans (D)

21)

$$\frac{B\left(\frac{a}{2}\right)}{B(2a)} = \frac{\left(\frac{\mu_0 i}{2\pi}\right)\left(\frac{a/2}{a^2}\right)}{\left(\frac{\mu_0 i}{2\pi}\right)\frac{1}{2a}} = 1$$

Ans (C)

22)



$B_1 = \frac{\mu_0}{2(2\pi)}\, 3$

$B_2 = \frac{\mu_0}{2(2\pi)}\, 4$

$B = \sqrt{B_1^2 + B_2^2} = 5 \times 10^{-10}\ T$ $\qquad 10^{-5} T = 1\ Wb.$

$= 5 \times 10^{-5}\ Wb/m^2$

Ans (C)

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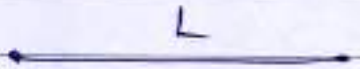
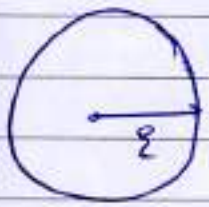
23) (A)



$L = 2\pi\ell$

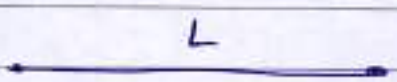


$\ell = \frac{L}{2\pi}$

$B_1 = \frac{\mu_0 I}{2\ell}$

$B_1 = \frac{\mu_0}{2} \cdot \frac{2\pi}{L} \times I$

(B)



$L = 4a$

$a = L/4$

$B_2 = \frac{\mu_0}{4\pi} \times \ell \sin 45 \frac{I}{a/2}$

$B_2 = \frac{\mu_0}{4\pi} \times \sqrt{2} \times \frac{2I}{(L/4)}$

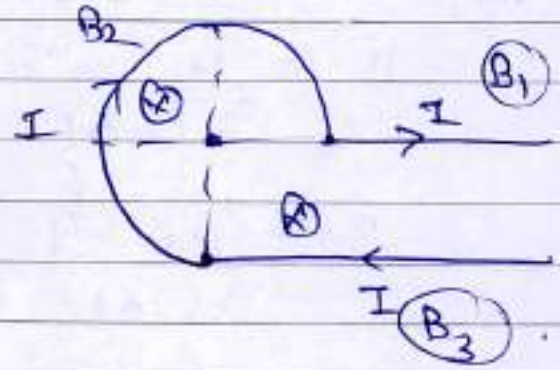
$\frac{B_1}{B_2} = \frac{\mu_0 \times I}{K} \times \frac{\pi K}{\mu_0 I (2\sqrt{2})}$

$=$

24) $B_1 = 0$

$B_2 = \frac{\mu_0}{4\pi}\left(\frac{i}{\ell} \frac{3\pi}{2}\right)\otimes$

$B_3 = \frac{\mu_0}{4\pi}\left(\frac{i}{\ell}\right)\otimes$



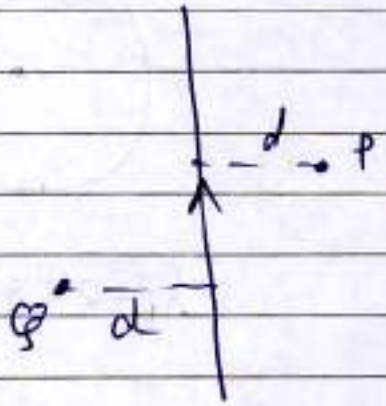
$$B = B_1 + B_2 + B_3 = \frac{\mu_0 I}{4\pi R}\left(\frac{3\pi}{2} + 1\right)$$

Ans (A)

25)

$$B = \frac{\mu_0}{4\pi}\frac{2i}{d}$$

$$B_P = B_Q$$



Ans (B)

26) $B = \mu_0 n i$

$$\frac{B}{B'} = \frac{\mu_0 n i}{\mu_0 \left(\frac{n}{2}\right)(2i)} = 1$$

$$B' = B.$$

27) $$B = \frac{\mu_0}{4\pi}\left(\frac{2i}{d}\right)$$

$$B \propto \frac{1}{d}$$

Ans (B)

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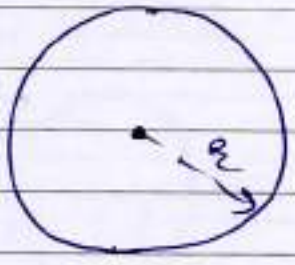
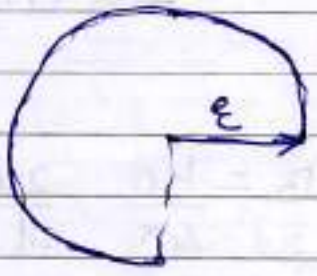
28) A B

$l_1 = 40\,cm$ $l_2 = 30\,cm$





$l_1 = 2\pi R = 40\,cm$ $l_2 = (2\pi R)\left(\frac{30}{40}\right)$

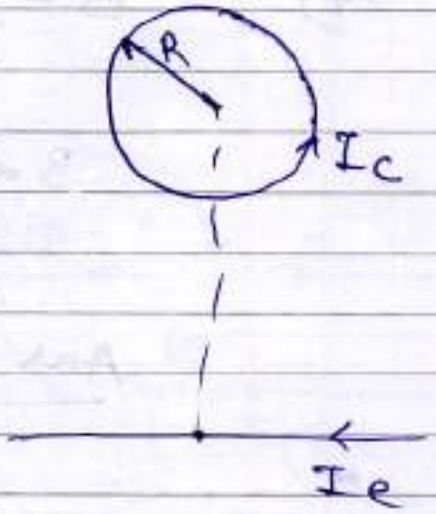
$$B_1 = B_2$$

$$\left(\frac{H_0}{4\pi}\right)\left(\frac{I_1}{\ell}(2\pi)\right) = \left(\frac{H_0}{4\pi}\right)\left(\frac{I_2}{\ell} \times \frac{3}{4}(2\pi)\right)$$

$$\boxed{\frac{I_1}{I_2} = \frac{3}{4}}$$

Ans (A)

29)



$$B_C = B_H$$

$$\frac{H_0}{4\pi}\left(\frac{I_C}{R}(2\pi)\right) = \frac{H_0}{4\pi}\left(\frac{I_e \times 2}{H}\right)$$

$$H = \frac{I_e R}{I_C \pi}$$

Ans (A)

30) $r < R$ $\qquad$ $r > R$

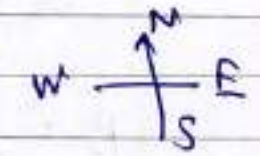
$B = \left(\frac{\mu_0 i}{2\pi R^2}\right) r$ $\qquad$ $B = \frac{\mu_0}{2\pi} \frac{i}{r}$

$B \propto r$ $\qquad$ $B \propto \frac{1}{r}$

Ans (A)

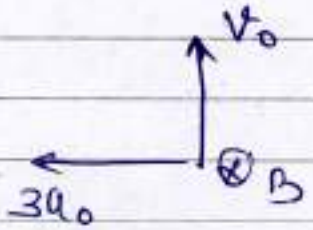
Motion of a Charged Particle in Magnetic field.

31)



$$qE = ma_0$$

$$E = \frac{ma_0}{e} \quad \text{west}$$



$$ev_0B = m(2a_0)$$

$$B = \frac{2ma_0}{ev_0} \quad \text{down}$$

$B \to 3a_0 - a_0$

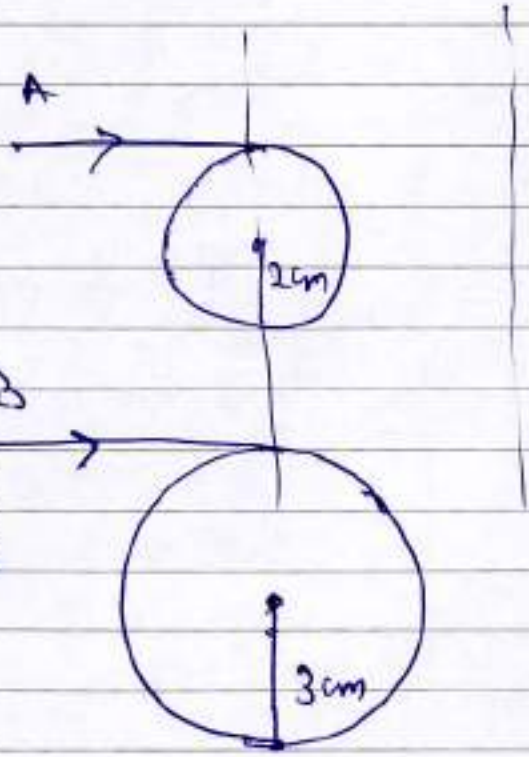
$= 2a_0$

Ans (C)

32) $q_A = q_B$

$B_A = B_B$

$F_A = F_B$



$m_A a_A = F_A = q_A E_A = qE$

$v_a = (a_A)t$

$v_b = (a_B)t$

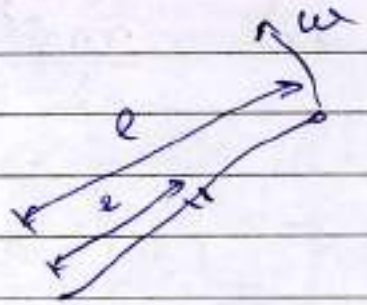
$a_A = \frac{qE}{m_A}, \quad a_B = \frac{qE}{m_B}$

$\frac{mv^2}{r} = qvB$

$\frac{m_A}{m_B} = \left(\frac{r_A}{r_B}\right)^2 = \frac{4}{9}$

Ans (A)

33) $v = \ell\omega$



$$-\frac{\partial V}{\partial x} = E = -\omega x B$$

$$\int dV = \omega B \int x\, dx$$

$$V = \omega B \left[\frac{x^2}{2}\right]_0^R$$

$$V = \frac{BR^2\omega}{2} \qquad \text{Ans (B)}$$

34)

34) $\frac{mv^2}{2} = qvB$

$$B = \frac{mv}{qx} = \frac{9.1 \times 10^{-31} \times 1.3 \times 10^6}{1.6 \times 10^{-19} \times 0.35}$$

$$= 2.1 \times 10^{-5}\ T$$

Ans (C).

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35) $\frac{mv^2}{r} = qvB$.

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

$\frac{r'}{r} = \frac{\frac{m}{e}\frac{2v}{B/2}}{\frac{m}{e}\frac{v}{B}} = 4$

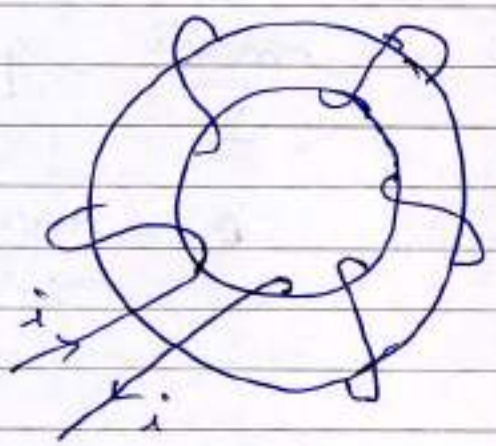
Ans (D)

36) displacement = 0

$W = 0$

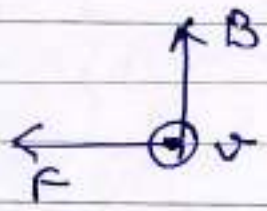
Ans(B).

37)

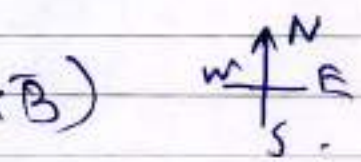


Ans (A)

38)



$F = q(v \times B)$



Ans (D)

39) $\frac{mv^2}{r} = qvB$

$qV = qvB$

$\left(\frac{q}{m}\right) = \frac{v}{r}$

$v = \frac{V}{B} = \text{const}$

$\left(\frac{q}{m}\right) \propto \frac{1}{r}$

Ans (A)

40) $F = q(\vec{v} \times \vec{B})$

$$\vec{v} \times \vec{B} = \begin{vmatrix} i & j & k \\ x & y & 0 \\ y & x & 0 \end{vmatrix} = (x^2 - y^2)\hat{k}$$

$F = q(x^2 - y^2)\hat{k}$.

Ans (B)

41) α particle has charge

Ans (B)

42) $\vec{F}_B = q(\vec{v} \times \vec{B})$

Ans (E)

H He $^{2}_{1}D$

Li

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43) $r = \frac{\sqrt{2mK}}{qB}$ $\Rightarrow r \propto \frac{\sqrt{m}}{q}$

	q	m
α	2	4
D	1	2

$\frac{r_\alpha}{r_D} = \sqrt{\frac{4}{2}} \times \frac{1}{2} = \frac{1}{\sqrt{2}}$ ($^{4}_{2}\alpha$)

Ans (C)

44) $F = qvB\sin\theta$

(i) straight line $\rightarrow \theta = 0°$, $F = 0$

(ii) circle $\rightarrow \theta = 90°$

(iii) helix $\rightarrow 0 < \theta < 90°$

Ans (D)

45) $f = \frac{qB}{2\pi m}$ $\Rightarrow f \propto \frac{q}{m}$

e^+

	q	m	q/m
proton	1	1	1
e^-	1	~~0~~	1/6
Li^+	3	~~7~~	3/7 → minm
He^+	2	4	2/4

Ans (C)

46) $$T = \frac{2\pi m}{qB}.$$

Ans (C)

47) $$P_\theta = I\omega$$

$$= (mr^2)\left(\frac{eB}{m}\right)$$

$$= a^2 eB \qquad r = a$$

Ans (C)

48) $$\frac{mv^2}{r} = qvB$$

$$K.E = \frac{1}{2}mv^2 = qvrB = \text{const}$$

$$\Delta K.E = 0$$

$$W = 0$$

Ans (A)

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49) $f = \frac{Bq}{2\pi m}$

Ans (C)

50) $\mu = AI$

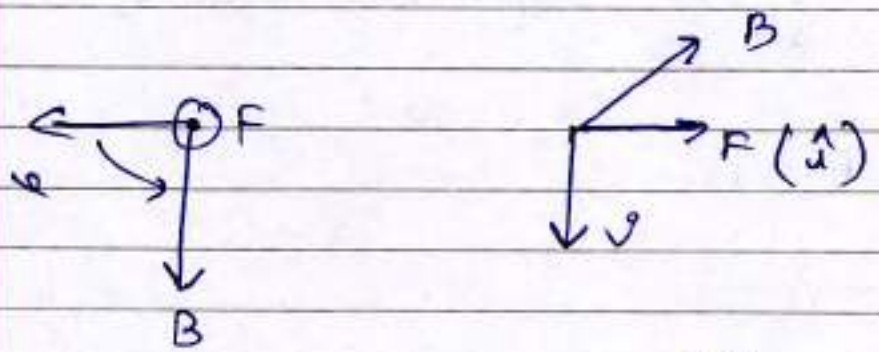
$= (\pi R^2) \, q \cdot \left(\frac{dq}{2\pi}\right)$

$= \frac{qvR}{2}$

$v = R\omega$.

Ans (A)

(51) $F = q(\vec{v} \times \vec{B})$



$F \to (-\hat{k})$

$F \to (\hat{i})$

zero

Ans (D).

52) $\frac{mv^2}{r} = qvB$

$$r = \frac{mv}{qB} = \frac{\sqrt{2mK}}{qB}$$

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

$$m_e < m_p$$

$$q_e < q_p$$

Ans (A).

53) $v = 2\hat{i} + 3\hat{j}$, $B = 4\hat{k}$

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

$$\vec{v} \times \vec{B} = \begin{vmatrix} i & j & k \\ 2 & 3 & 0 \\ 0 & 0 & 4 \end{vmatrix}$$

$$= 12\hat{i} - 8\hat{j}$$

$F = q(12\hat{i} - 8\hat{j})$

F is $\perp^{r}$ to v.

$\therefore |\Delta v| = 0$.

Ans (C)

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56)

$P = m\vec{v}$

direction of v is continuously changing

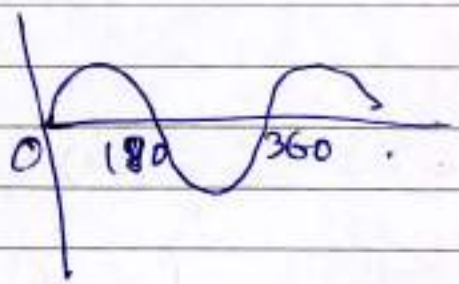
Hence, P.

Ans (C)

54) $F = q(\vec{v} \times \vec{B})$

$F = qvB\sin\theta$

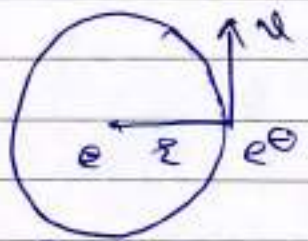
$F = 0$, @ $\theta = 0, \pi, 2\pi, \ldots n\pi$



Ans (C)

55) $r = 0.4 \times 10^{-10}$ m

$v = 10^5$ m/s.



$\frac{mv^2}{r} = qvB$

$B = \frac{mv}{qr} = \frac{9.1 \times 10^{-31} \times 10^5}{(1.6 \times 10^{-19}) \times (0.4 \times 10^{-10})}$

$= 14.21 \times 10^{(-31+5+19+10)}$

57)

	m	q
P	1	1
D	1	2

$\rightarrow E = 40\ meV$

$E \propto \frac{1}{m}$

$\frac{E_p}{40} = \frac{2}{1}$

$E_p = 80\ meV$

Ans (B)

58) $\frac{mv^2}{r} = qvB$

$p = mv = qrB$.

$= (1.6 \times 10^{-19})(4 \times 10^{-3})(3 \times 10^{-3})$

$p = 1.92 \times 10^{-24}\ kg\text{-}ms$

Ans (C)

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Force & Torque on a Current Carrying Conductor

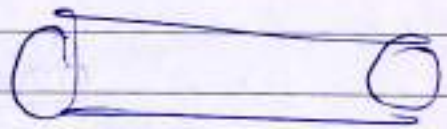
59)

Ans (D)

60) $L = \frac{\phi}{i} = \frac{10 \times 10^{-6}}{2 \times 10^{-3}} = 5 \times 10^{-3} = 5\,mH.$

Ans (B)

61)



$n = 10$

$A = 1\,mm^2$

$i = \frac{21}{44} A$

$n' = \frac{n}{\ell} = 10^3$

$i = 2.5\,A$

$\tau = M \times B$

$= (nAI)(\mu_0 n' i)$

$= 10 \times \frac{1}{10^6} \times \frac{21}{44} \times 4\pi \times 10^{-7} \times 10^3 \times 2.5$

$\tau = 1.5 \times 10^{-8}\ N\text{-}m$

Ans (B)

62) $$B = \frac{\mu_0}{4\pi} \frac{i}{2} (2\pi)$$

$$B = \frac{\mu_0 i}{2 \ell}$$

$A = \pi R^2$

$\left(\frac{A}{\pi}\right)^{1/2} = \ell$

$$B = \frac{\mu_0 i}{2 \left(\frac{A}{\pi}\right)^{1/2}}$$

$\rightarrow$ $M = i A$

$$= \frac{2B}{\mu_0} \left(\frac{A}{\pi}\right)^{1/2} \times A$$

$$= \frac{2 B A^{3/2}}{\mu_0 \pi^{1/2}}$$

Ans (D)

63) $$F = \frac{\mu_0}{4\pi} \frac{2 i_1 i_2}{a} \times \ell$$

$$\frac{F}{\ell} = \frac{\mu_0}{4\pi} \frac{2 i^2}{b}$$

$$\frac{F}{\ell} = \frac{\mu_0 i^2}{2\pi b}.$$

Ans (D)

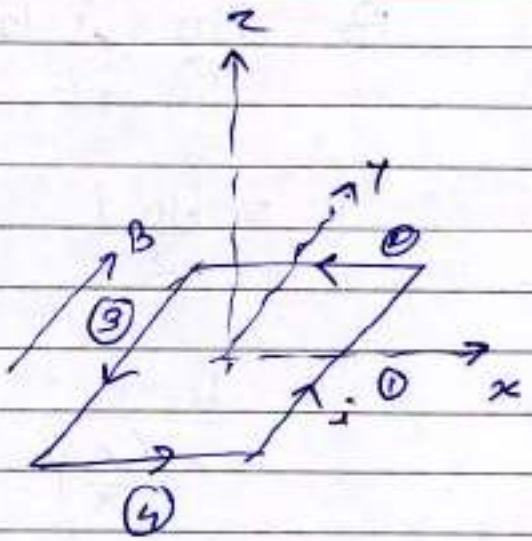
64) $\vec{B} = B\hat{j}$

$\vec{I_1} = I\hat{j}$

$\vec{I_2} = -I\hat{i}$

$\vec{I_3} = -I\hat{j}$

$\vec{I_4} = I\hat{i}$



(c) $\vec{F} = \ell(\vec{i} \times \vec{B})$ $\quad \ell_1 = \ell_2 = \ell_3 = \ell_4 = a$ (say)

$F_1 = F_3 = 0$

$\vec{F_4} = \ell(I\hat{i} \times B\hat{j})$

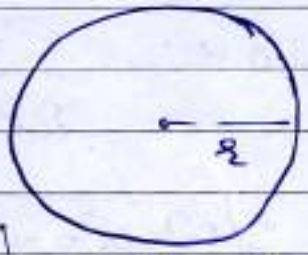
$F_4 = BI\ell\,\hat{k} = F$ (say)

$\vec{F_2} = \ell(-I\hat{i} \times B\hat{j})$

$F_2 = -BI\ell\,\hat{k} = -F$

$\therefore F_1 + F_2 + F_3 = -F$

Ans (B)

65) L ⟶ 

$\bar{\tau} = \bar{\mu} \times \bar{B}$

$= n\left(\frac{\pi . L^2 . I}{n^2 4\pi^2}\right) \cdot B$

$\tau \propto \frac{1}{n}$

$\tau(max^m)$ @ $n=1$

$L = (2\pi R) n$

$R = \frac{L}{(2\pi) n}$

$\mu = nAI$

Ans - (D)

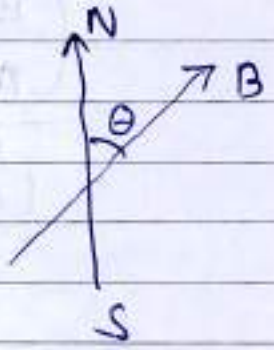
66) $\tau = \bar{\mu} \times \bar{B}$

$= nI \bar{A} \times \bar{B}$

$\tau = nBAI \sin\theta$

$B \sin\theta = \frac{\tau_0}{nAI}$

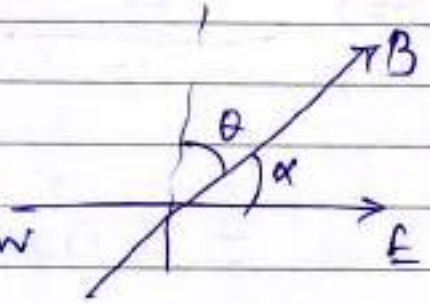
$\Rightarrow$ $B \sin\theta = \frac{\tau_1}{nAI}$



50

$\theta + \alpha = 90^\circ$

$B \sin\alpha = \frac{\tau_2}{nAI} = B\cos\theta$



$B = \sqrt{B^2\cos^2\theta + B^2\sin^2\theta}$

$= \frac{1}{nAI}\sqrt{\tau_1^2 + \tau_2^2}$

$= \frac{1}{100 \times \frac{2\times 5}{100}}\sqrt{(0.33)^2 + (0.4)^2}$

$= \underline{0.05\,T}$

Ans (D)

67) $\frac{B}{m} = \frac{\mu_0}{4\pi}\frac{\frac{I}{2}(2\pi)}{(\pi r^2)I} = \frac{1}{f}$

$\frac{B}{m} \propto \frac{1}{r^2 f}$

$r' \to 2r$

$I \to 2I$

$\frac{\left(\frac{B}{m}\right)'}{\left(\frac{B}{m}\right)} = \frac{1}{8}$

$\left(\frac{B}{m}\right) = x$

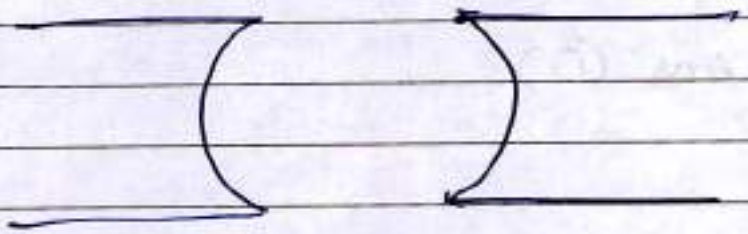
Ans (A)

68)

horse magnet.

Ans (B)

69)



concave

Ans (A)

70) $I = K \tan\theta$

$I = 3A \propto \frac{1}{\sqrt{3}}$.

$I = \sqrt{3} = 1.732\,A$

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71) $F = i(\bar{l} \times \bar{B}) = i \cdot l \cdot B \sin\theta$

$F(\min^m) \rightarrow$ when B $\min^m$

& $\theta = 0°$

& ↳ coil is $\perp^{ar}$ to field.

Ans (D)

72) Ans (B)

73) $\mu = nAI$

$= 1 \times \pi \left(\frac{l}{2\pi}\right)^2 \times I$

$= \frac{I l^2}{4\pi}$

$l \rightarrow$ ○

$l = 2\pi r$

$r = \frac{l}{2\pi}$

$A = \pi r^2$

Ans (D)

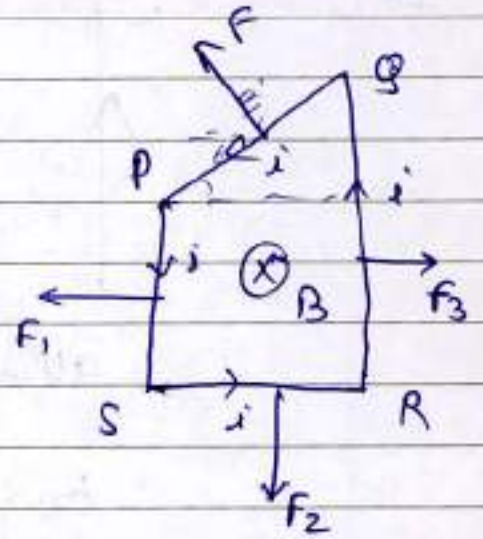
74) $M = ml$

$\frac{nAI}{l} = m$

There is no B.

Ans (A).

75) $F = l(\bar{i} \times \bar{B})$



$F\cos\theta = F_2$

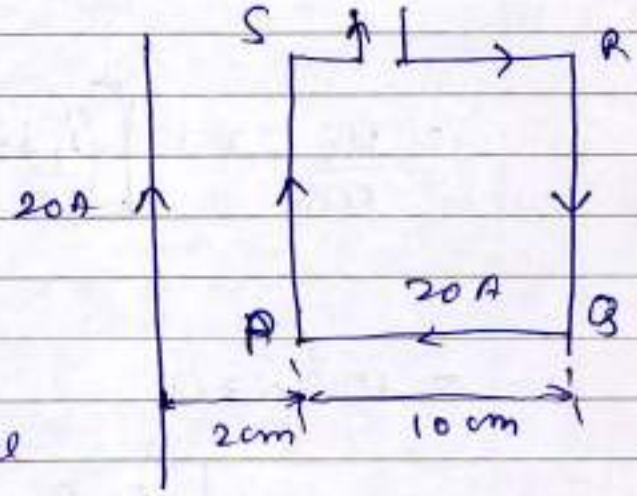
$F\sin\theta = F_3 - F_1$

$F = \sqrt{(F\cos\theta)^2 + (F\sin\theta)^2}$

$= \sqrt{(F_3 - F_1)^2 + F_2^2}$.

Ans (B)

76)



$\rightarrow F = \frac{\mu_0}{4\pi} \cdot \frac{2 i_1 i_2}{a} \times l$

$f_{SR} = f_{PQ} = 0$

as they are $\perp^{ar}$ to long wire

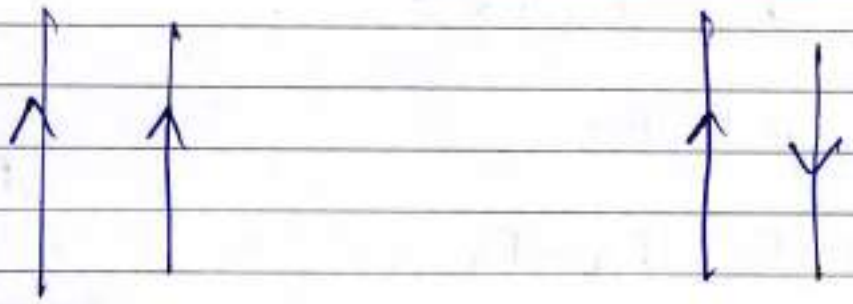
$F = F_{PS} + F_{QR}$.

$= \frac{\mu_0}{4\pi} \times 2 i_1 i_2 \times l \left(\frac{1}{a_{PS}} - \frac{1}{a_{QR}}\right)$

$= 10^{-7} \times 2 \times 20 \times 20 \times \frac{15}{100} \left(\frac{1}{0.02} - \frac{1}{0.12}\right)$

$F = 5 \times 10^{-4}\ N$ Ans (D)

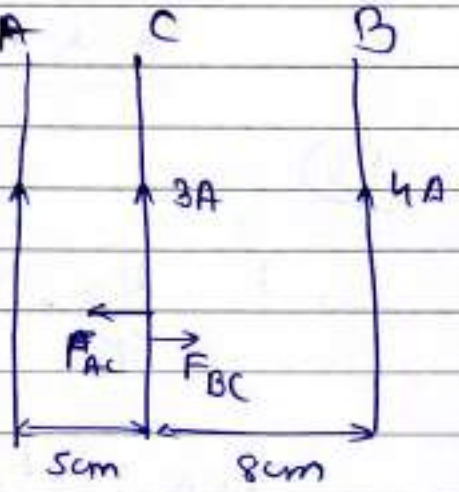
77)



attraction repulsion.

Ans (A)

78)



$$F = |F_{BC} - F_{AC}|$$

$$= \frac{\mu_0}{4\pi} \times 2l \left[\left(\frac{i_1 i_2}{a}\right)_{BC} - \left(\frac{i_1 i_2}{a}\right)_{AC} \right]$$

$$= 10^{-7} \times 2 \times 1 \times \left[\frac{4 \times 3}{0.08} - \frac{2 \times 3}{0.05} \right]$$

$$= 10^{-5} \times 12 \left[\frac{2}{8} - \frac{1}{5} \right]$$

$$= 10^{-5} \times 12 \times 0.05.$$

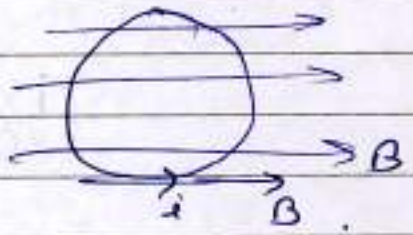
$$= 0.6 \times 10^{-5} \text{ N}$$

Ans (D).

79)

$$F = l(\bar{i} \times \bar{B})$$

$$F = Bil \sin\theta$$

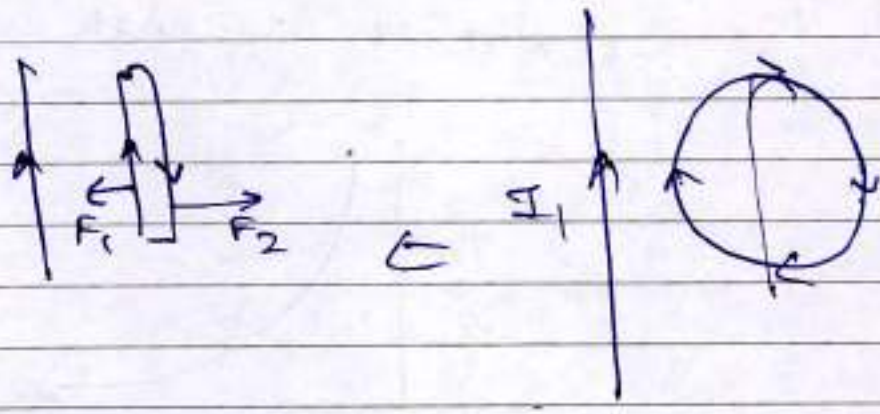


$$\theta = 0^\circ$$

$$F = 0$$

Ans (D)

80)



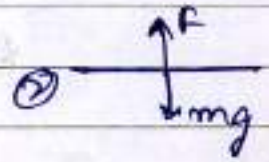
$$F_1 = F_2$$

$$F_1 - F_2 = 0$$

Ans(A)

81)

$$\left(\frac{m}{l}\right)g = \frac{F}{l} = \frac{\mu_0}{4\pi} \times \frac{2 i_1 i_2}{a}$$



$$0.144 = \frac{10^{-7} \times 2 \times 96 \times 24}{a}$$

$$a = 3.2 \text{ mm}$$

Ans (C)

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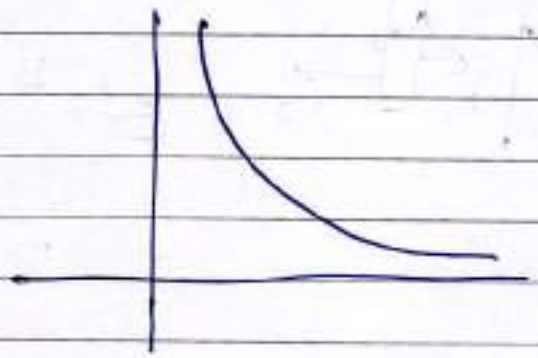
82) $\left(\frac{F}{\ell}\right) = \frac{\mu_0}{4\pi} \frac{2 i_1 i_2}{a}$

$\left(\frac{F}{\ell}\right) = (K) \cdot \frac{1}{a}$ $\quad K \to \text{const}$

$\left(\frac{F}{\ell}\right) \cdot (a) = K = \text{const}$

$x \times y = \text{const}$



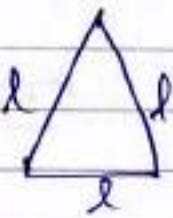
Ans (D)

83) $\tau = \bar{\mu} \times \bar{B}$

$= n B A i \sin\theta$ $\quad n = 1$, $\sin\theta = 1$

$\tau = Bi \left(\frac{\sqrt{3}}{4} \ell^2\right)$

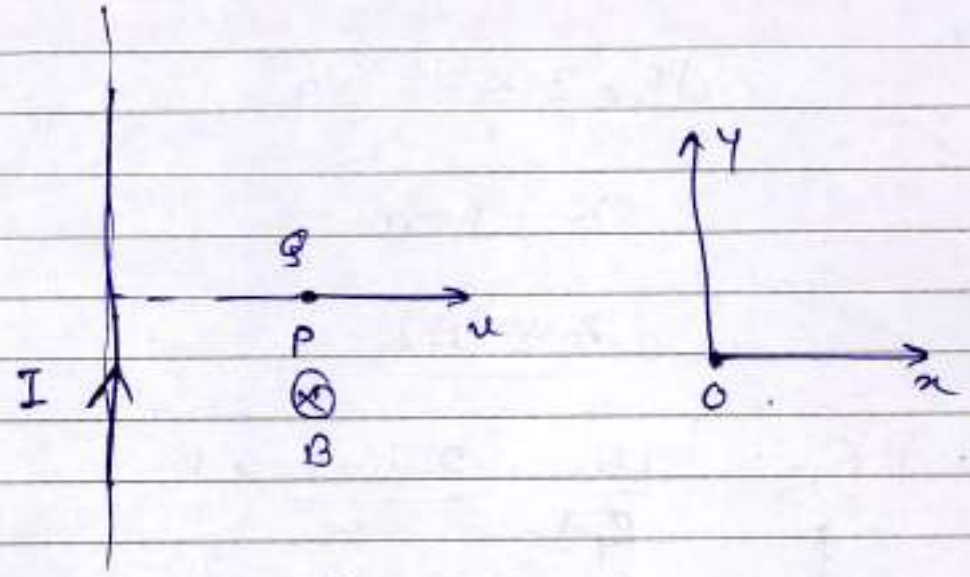
$\left(\frac{\tau}{Bi} \times \frac{4}{\sqrt{3}}\right)^{1/2} = \ell$



$A = \frac{\sqrt{3}}{4} \ell^2$

Ans (C)

84)



$\overline{B} = B\hat{k}$ (By right hand rule)

$\overline{v} = v\hat{i}$

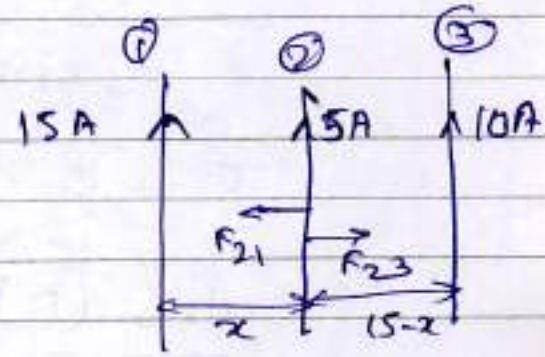
$F = q(\overline{v} \times \overline{B})$

$= qvB\hat{j}$ (along OY)

Ans (D)

85) $\frac{F}{\ell} = \frac{\mu_0}{4\pi} \frac{2 i_1 i_2}{a}$

$\left(\frac{F}{\ell}\right)_{21} = \left(\frac{F}{\ell}\right)_{23}$



$\frac{\mu_0}{4\pi} \times 2 \frac{i_1 i_2}{a} = \frac{\mu_0}{4\pi} \times 2 \frac{i_2 i_3}{a}$

$\frac{15 \times 5}{x} = \frac{5 \times 10}{15 - x}$

$45 - 3x = 2x$

$x = 9\ cm$

Ans (A)

86) $F_B = \frac{\mu_0}{4\pi} \frac{2 i_1 i_2}{a} \times l$

↑ magnetic force.

Ans (D)

87)

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

$= ni(\vec{A} \times \vec{B})$

$\tau = nBAi \sin\theta$

$\theta = 0^\circ$

$\sin\theta = 0$

$\tau = 0$

Ans (D)

88) $F = \frac{\mu_0}{4\pi} \times \frac{2 i_1 i_2}{a} \times l$

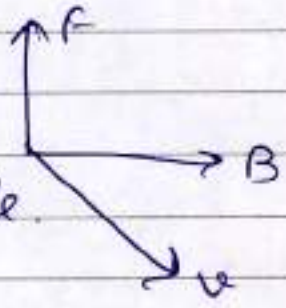
$F \propto i_1 i_2$

$F_{BA} = 1 \times 2$ < $F_{BC} = 2 \times 3$

Hence Towards C

Ans (D)

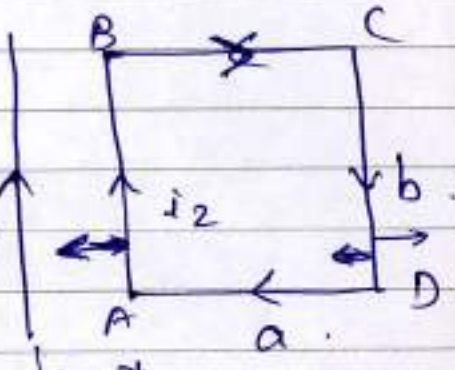
89) $F = q(\vec{v} \times \vec{B})$



Fleming's left hand rule.

Ans (B)

90)



$F = F_{AB} + F_{BC} + F_{CD} + F_{AD}$

$= \frac{\mu_0}{4\pi} \times 2 \left(\frac{i_1 i_2}{x} + 0 - \frac{i_1 i_2}{a+x} \right) \times b \, i_1$

$= \frac{\mu_0}{4\pi} (2b)(i_1 i_2) \left(\frac{1}{x} - \frac{1}{a+x} \right)$

$F_{AB} > F_{CD}$

→ more towards the wire

Ans (B)

0

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ASSERTION & REASONING

1) Both (A) & (R) are true.

effects is related with fuse

Ans (A)

2) Both (A) & (R) are True.

brightness $\propto \frac{1}{\text{resistance}}$.

Ans (A)

3) (A) is true, (R) is false

Ans (C)

4) (A) & (A) are false.

Ans (D)

5) (A) & (R) are True

Ans (A)

6) (A) & (R) are true, but not related with each other

Ans (B)

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7) Both (A) & (R) are true & interconnected

$R = R_0(1 + \alpha T)$

Ans (A)

8) Both (A) & (R) are true & inter connected

Ans (A)

9) Both (A) & (R) are true but not interconnected

Ans (B)

10) Both (A) & (R) are false

Ans (D)

11) Both (A) & (R) are True & interconnected

Ans (A)

12) Both (A) & (R) are True & interconnected

Ans (A)

13) Both (A) & (R) are false

Ans (D)

14) Both (A) & (R) are True

Ans (A)

15) (A) is True, But (R) is false.

Ans (C)

16) (A) is True, But (R) is false

Ans (C)

17) Both (A) & (R) are True

Ans (A)

18) (A) is True, But (R) is false

Ans (C)

19) (A) & (R) are True,

But not interconnected

Ans (B)

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20) Both (A) & (R) are True but not interconnected

Ans (B)

21) Both (A) & (R) are false

Ans (D)

22) (A) is True, But (R) is false

Ans (C)

23) Both (A) & (R) are True, But not interconnected

Ans (B)

24) Both (A) & R are True & interconnected

Ans (A)

25) (A) is True, but (R) is false

Ans (C)