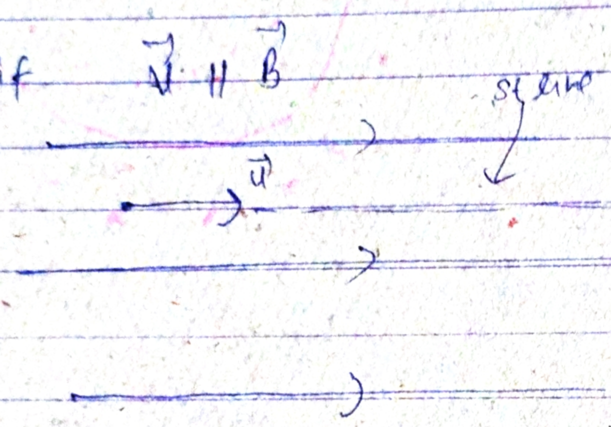
force on a moving charge in a magnetic field

$$f = \underset{\text{with sign}}{q}\,(\vec{v} \times \vec{B})$$

① if $\vec{v} \parallel \vec{B}$

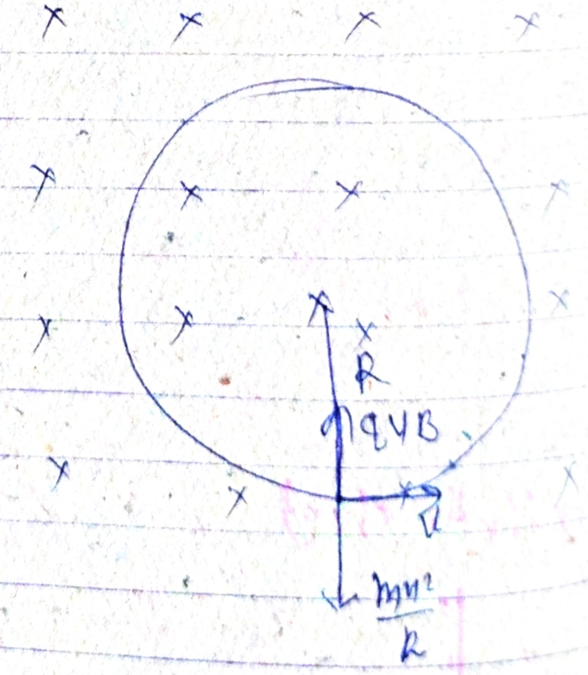


② if $\vec{v} \perp \vec{B}$

$f = q\,\vec{v} \times \vec{B}$

$|\vec{F}_m| = qvB$

$\vec{F}_m \perp \vec{v}$



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

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

$$T = \frac{2\pi R}{v} = \frac{2\pi m}{qB}$$ → independent of v

$f = \frac{qB}{2\pi m}$ $\quad \omega = \frac{qB}{m}$

ex.

$\vec{B} = B_0 \hat{i}$ $\quad\quad$ $\vec{r}(t) = ?$

$\vec{u} = u_0 \hat{j}$

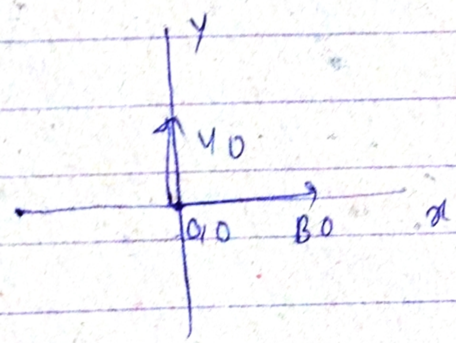
q, m

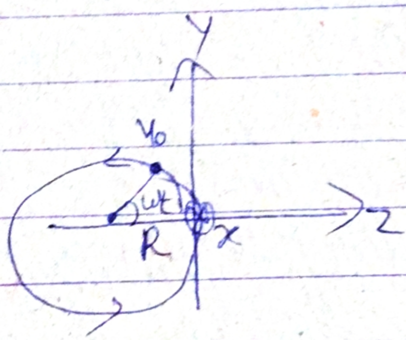
(0,0) $\quad$ $F = q\, v\hat{j} \times B\hat{i}$

$= q\, vB\, -\hat{k}$

$q \cancel{v} B = \frac{m v \cancel{^2}}{R}$

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





$$\begin{cases} x = 0 \\ y = \frac{mu}{qB} \sin\left(\frac{qB}{m} t\right) \\ z = \frac{mv}{qB}\left(1 - \cos\left(\frac{qB}{m}\right)t\right) \end{cases}$$

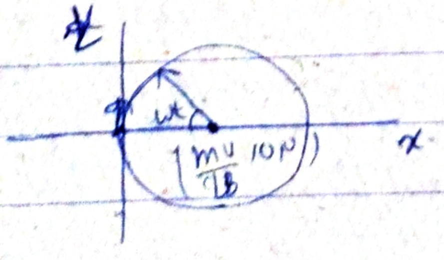
ex $\quad$ $\vec{B} = -B\hat{j}$

$\vec{u} = u_0 \hat{k}$ $\quad\quad$ $F = q\, \vec{u} \times \vec{B}$

$- \hat{k} \times \hat{j}$

q, m $\quad$ (0,0) $\quad\quad$ $= q\, vB\, \hat{i}$

$\vec{r} = t$

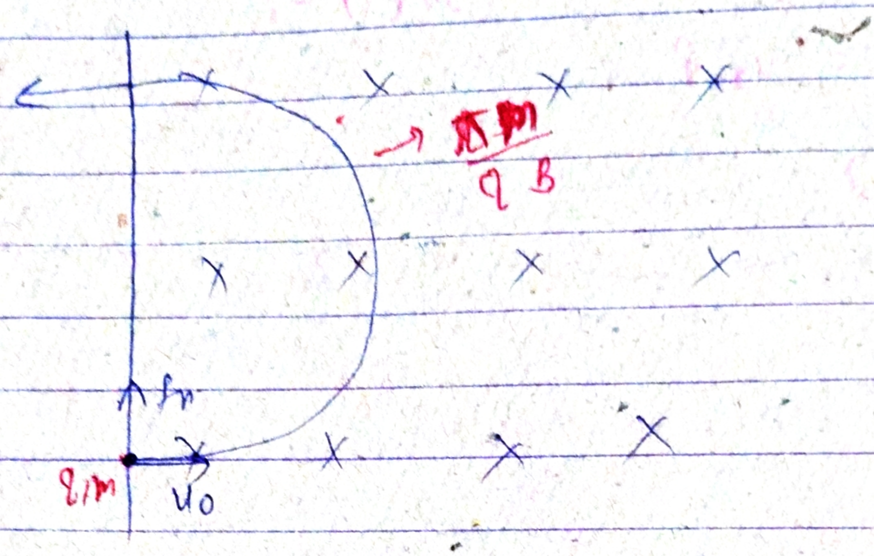


$y = 0$

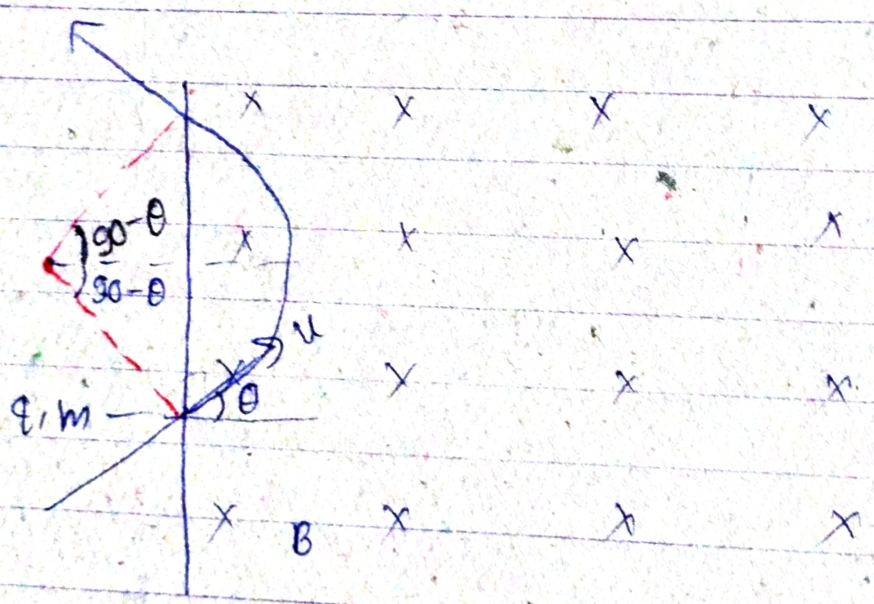
$z = \frac{mu}{qB}$ $\cancel{z =}$ $\sin \frac{qB t}{m}$

$x = \frac{mu}{qB}\left(1 - \cos \frac{qB}{m} t\right)$

find out the time spent by the charge in magnetic field ⇒



find out the time spent by the particle in magnetic field

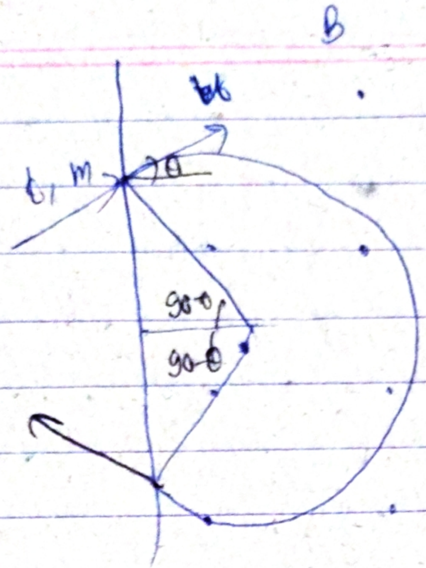


$\boxed{\text{angle} = \omega t}$

$$180 - 2\theta = \omega t$$

$$\pi - 2\theta = \frac{qB}{m} t$$

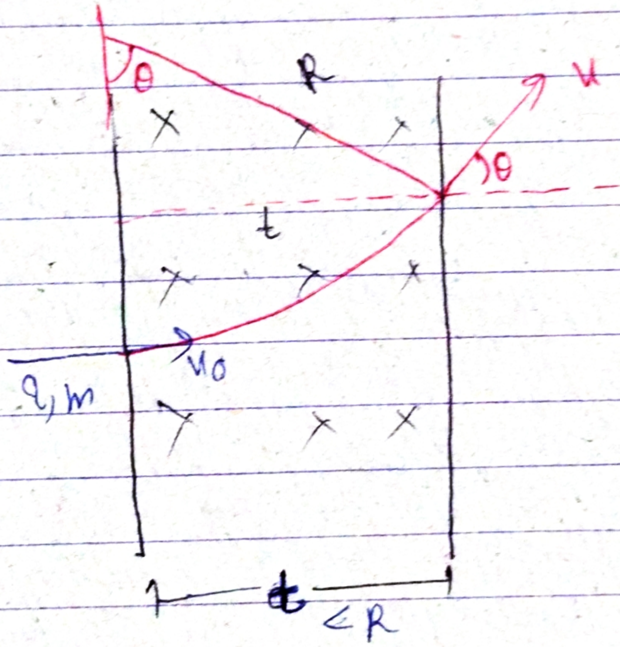
हमेशा 180 − 2θ होगा (by commonsense use करो किस तरफ के लिए)



$$2\pi - \pi + 2\theta = \frac{qB}{m}\cdot t$$

$$\pi + 2\theta = \frac{qB}{m}\, t$$

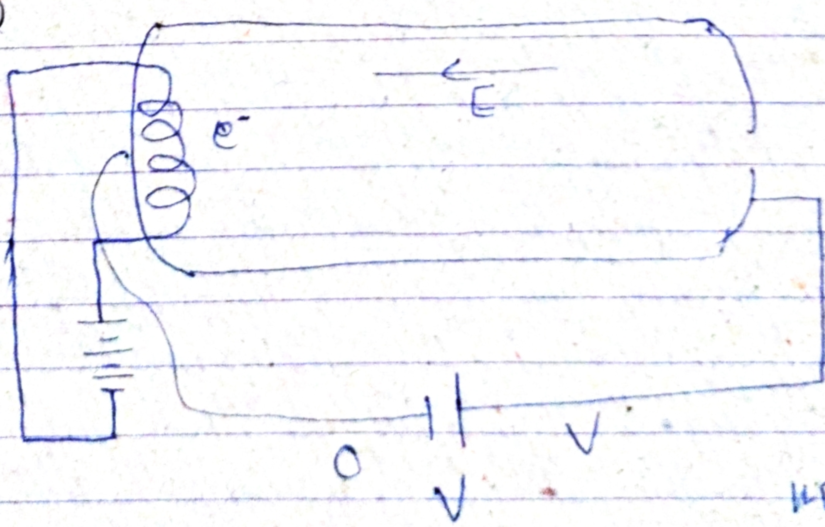
angle of deviation = θ



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

$$\theta = \sin^{-1}\left(\frac{t}{R}\right)$$

electron gun =)



$$0 + 0 = -eV + K.E.$$

$$K.E. = eV$$

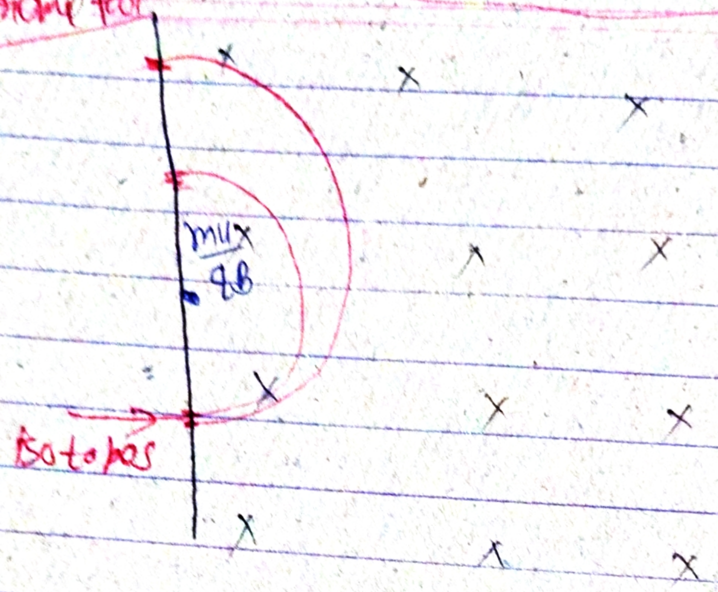
$$\frac{1}{2}mv^2 = eV$$

$$v = \sqrt{\frac{2eV}{m}}$$

A charge particle is accelerated through V potential

$\Rightarrow q_p V = \frac{1}{2} m_p v^2$

mass spectrometer

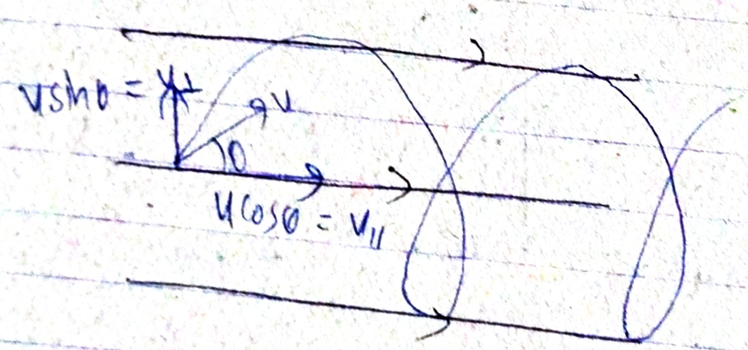


$R = \frac{mv}{qB}$

$= \frac{\sqrt{2mKE}}{qB}$

$= \frac{\sqrt{2m_{p} q V}}{qB}$

Angle b/w B and v is θ



$F_m = qvB\sin\theta$

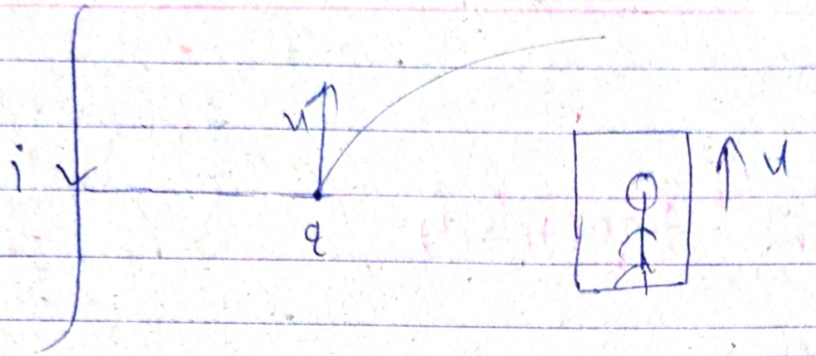
$R = \frac{mv_\perp}{qB} = \frac{mv\sin\theta}{qB}$

Pitch $= v_\parallel T$

$= v_\parallel \frac{2\pi m}{qB}$

$= v\cos\theta \frac{2\pi m}{qB}$

in reallity electric force and magnetic force are nothing but only the component of lorenz force as friction force and Normal force are nothing but only the component of contact force.

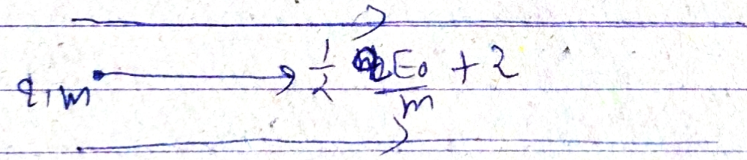


इस आदमी के लिए ~~net~~ deviation का कारण electric field है magnetic field नहीं।

$$\boxed{\underbrace{\vec{F}_{net}}_{\text{Lorenz force}} = q\vec{E} + q(\vec{v} \times \vec{B})}$$

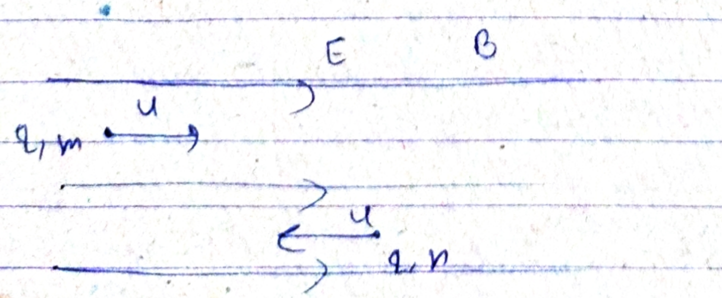
★ Actully मे electric ~~field~~ force और Magnetic force दोनो frame पर Depend करता है लेकिन Lorenz force frame पर Depend नही करता है।

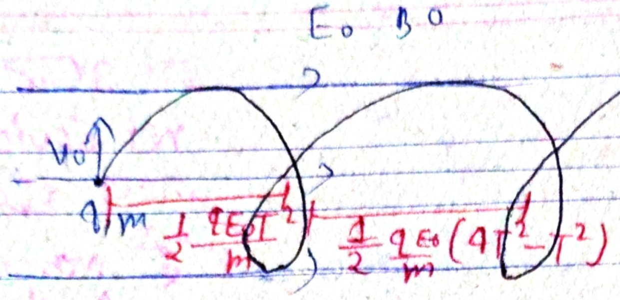
when $\vec{E}$ and $\vec{B}$ are parallel



$\frac{1}{2}\frac{qE_0}{m} + 2$

$\vec{F}_m = 0 \qquad \vec{F}_E = q\vec{E_0}\hat{i}$

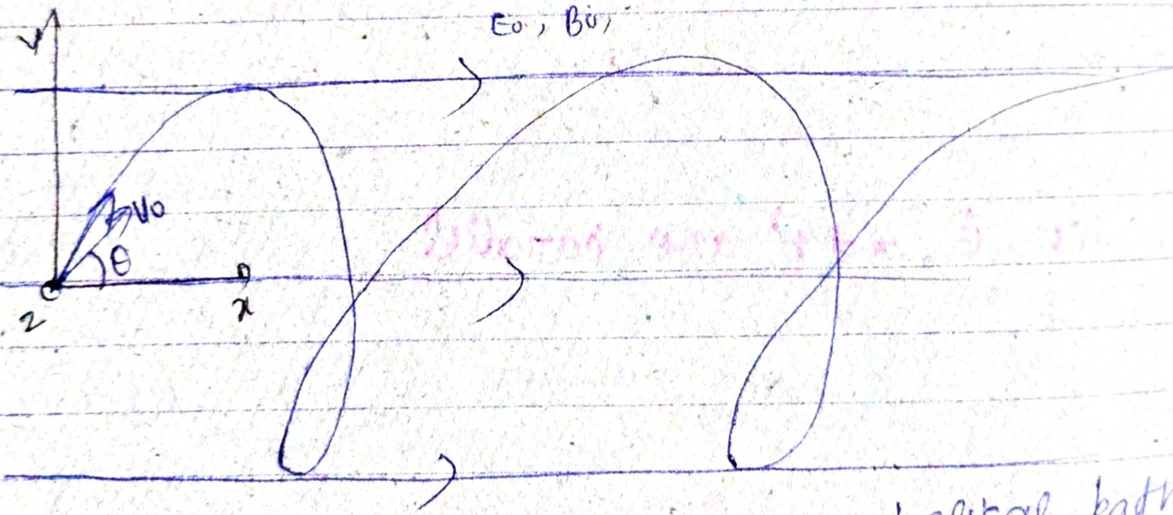




Helical path with increasing pitch

$$R = \frac{m v_0}{qB}$$

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



helical path with increasing pitch

$$R = \frac{m v_0 \sin\theta}{qB}$$

$$P_1 = v_0 \cos\theta \, T + \frac{1}{2} \frac{qE_0}{m} T^2$$

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

find speed as a function x

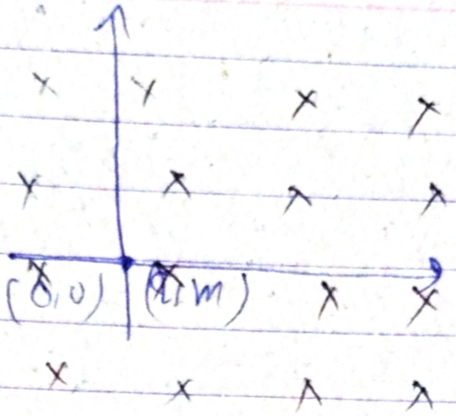
$$WD_M + WD_E = \frac{1}{2} v_f^2 - \frac{1}{2} m v_0^2$$

$$\sqrt{\frac{0 + \left(qE_0 x + \frac{1}{2} m v_0^2\right)^2}{m}} = v_f$$

ves

$E \perp B$

$(0,0)$ q, m



$\vec{F} = qE_0\hat{i} - q(v_x\hat{i} + v_y\hat{j}) \times B_0\hat{k}$

$\vec{E} = E_0\hat{i}$

$\vec{B} = -B_0\hat{k}$

Let $\vec{u} = v_x\hat{i} + v_y\hat{j}$

$$\vec{F} = qE_0\hat{i} + q v_x B_0\hat{j} - q v_y B_0\hat{i}$$

$$\vec{F} = (qE_0 - q v_y B_0)\hat{i} + q v_x B_0\hat{j}$$

$$a_x = \frac{qE_0}{m} - \frac{q v_y B_0}{m}, \quad a_y = \frac{q v_x B_0}{m}$$

$$\frac{d^2 v_x}{dt^2} = -\frac{qB_0}{m}\frac{dv_y}{dt}$$

$$\frac{d^2 v_x}{dt^2} = -\frac{q^2 B_0^2}{m^2} v_x$$

$$\frac{d^2 v_x}{dt^2} + \left(\frac{qB_0}{m}\right)^2 v_x = 0$$

$$\left\{ \frac{d^2 x}{dt^2} + \omega^2 x = 0 \right\}$$

$\rightarrow x = A\sin(\omega t + \phi)$

$$v_x = A\sin(\omega t + \phi)$$

$t=0 \quad v_x = 0 \Rightarrow \phi = 0$

$$a_x = A\omega \cos(\omega t)$$

at $t=0$ $\quad a_x = \frac{qE_0}{m}$

$$\frac{qE_0}{m} = A\omega$$

$$A = \frac{qE_0}{m}\frac{m}{qB_0} = \frac{E_0}{B_0}$$

$$v_x = \frac{E_0}{B_0}\sin\omega t$$

$$\int_0^x dx = \frac{E_0}{B_0}\int_0^t \sin\omega t\,dt$$

$$x = \frac{E_0}{B_0\omega}(1-\cos\omega t)$$

$$x = \frac{mE_0}{qB_0^2}(1-\cos\omega t)$$

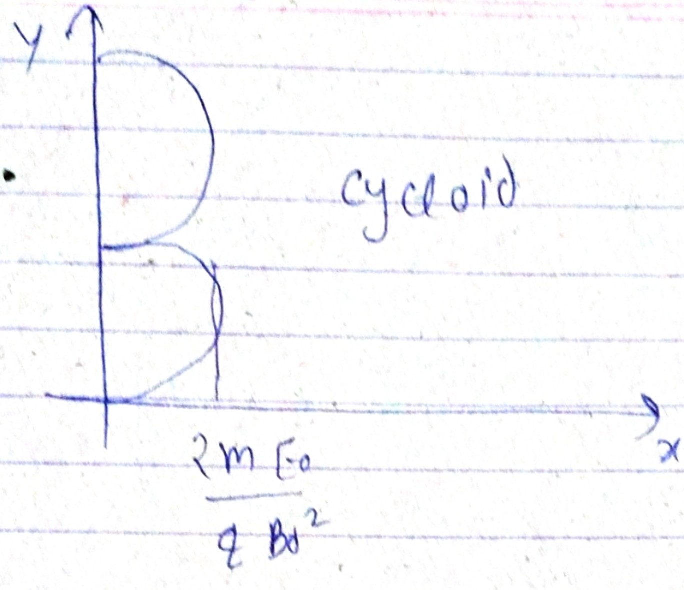
$$a_y = \frac{qB_0}{m}\frac{E_0}{B_0}\sin\omega t$$

$$\int_0^{v_y} dv_y = \frac{qE_0}{m}\int_0^t \sin\omega t\,dt$$

$$v_y = \frac{qE_0}{m}(1-\cos\omega t)$$

$$\int_0^y dy = \frac{qE_0}{m\omega}\int_0^t (1-\cos\omega t)\,dt$$

$$y = \frac{qE_0 t}{m\omega} - \frac{qE_0\sin\omega t}{m\omega^2}$$



cycloid

if a non zero uniform $\vec{E}$ & $\vec{B}$ particle (q, m) is moving with constant velocity.

$\Downarrow$

$\vec{a} = 0$

$\Downarrow$

$\vec{F}_{net} = 0$

A) $\vec{B}$ must be $\perp$ $\vec{E}$

B) $\vec{u}$ must be $\perp$ $\vec{E}$

C) $\vec{u}$ must be $\perp$ $\vec{B}$

D) All the three must be $\perp$ to each other

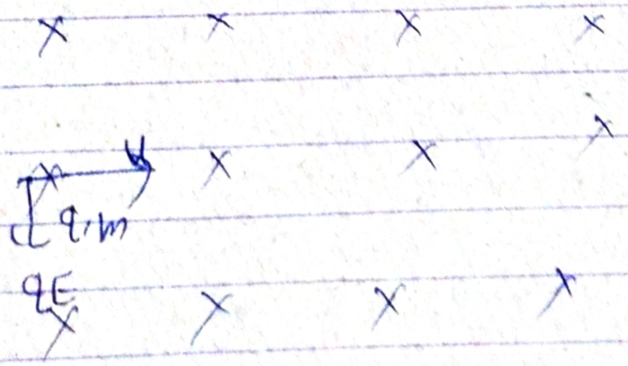
$\Downarrow$

$q\vec{E} + q(\vec{u} \times \vec{B})$

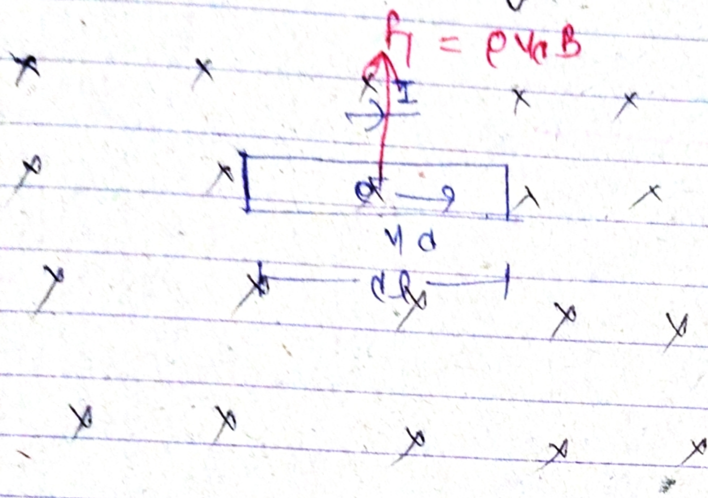
$\vec{E} = -(\vec{u} \times \vec{B})$

$qE = qvB$

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



force on current carrying wire due to magnetic field ⇒



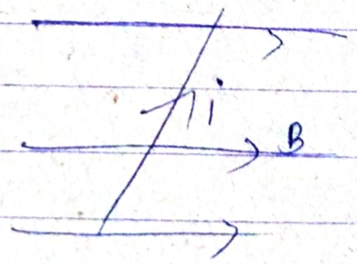
$i = neAv_d$

F_{net} = no of free charges $\times e v_d B$

$= nAdl\, e v_d B$

$= neAv_d\, dl B$

$= i dl B$



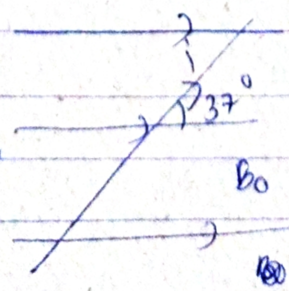
$\vec{F}_{net}$ = no of particle $\times e(\vec{V}_d \times \vec{B})$

$= nAdl e(\vec{V}_d \times \vec{B})$

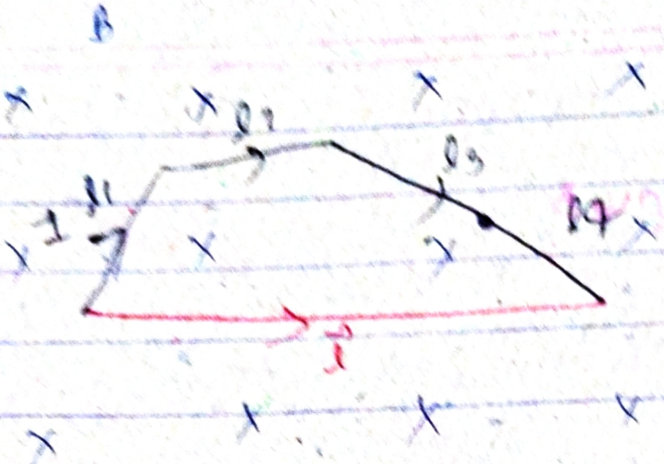
$= nAe v_d(\vec{dl} \times \vec{B})$

$$\boxed{\vec{F}_{net} = i(\vec{dl} \times \vec{B})}$$

Ques



$F = ⊗\ ilB \sin 37$

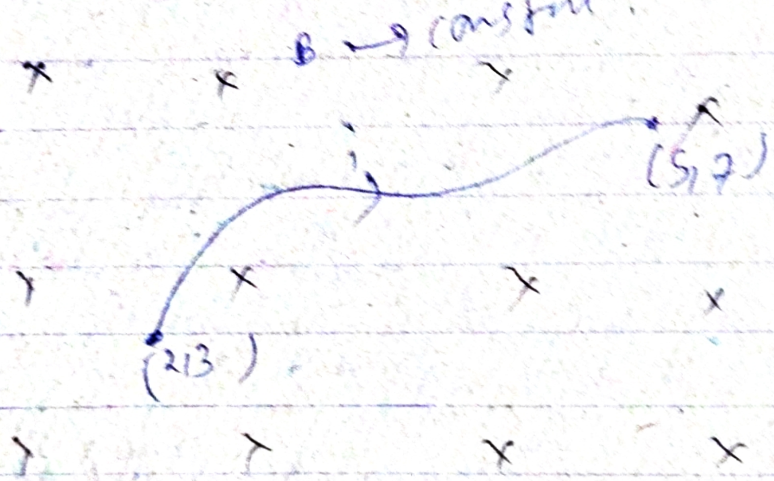


$F = i(\vec{l_1} \times \vec{B}) + i(\vec{l_2} \times \vec{B})$ ——

$= i(\vec{l_1} + \vec{l_2} + \vec{l_3}$ —— $) \times \vec{B}$

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

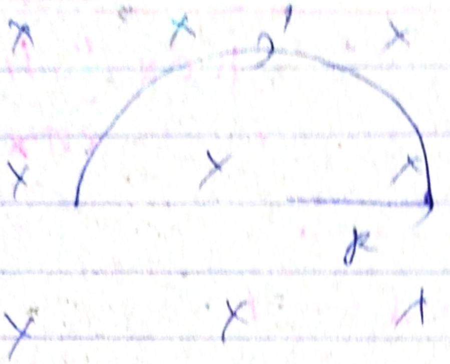
Que



$\vec{F} = I(\cancel{4\hat{i}+8}\ 3\hat{i} + 4\hat{j} \times \vec{B})$

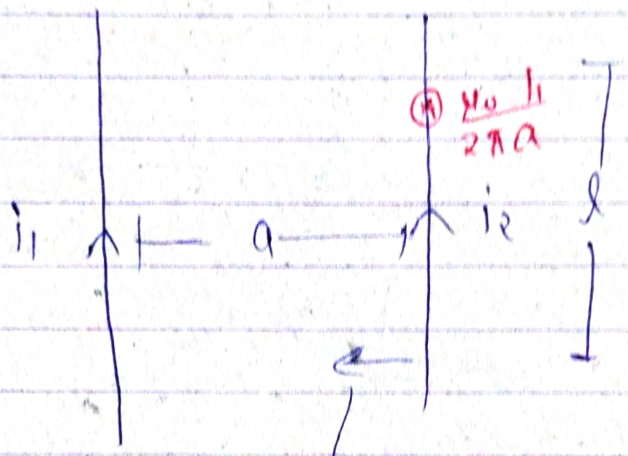
$= 5IB$

ex



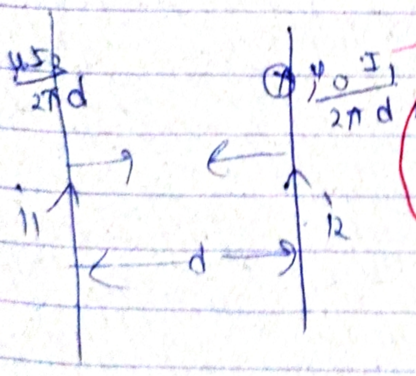
$F = 2IRB$ ऊपर

ex



$$F = I_2 l \cdot \frac{\mu_0}{4\pi} \frac{I_1 2}{a}$$

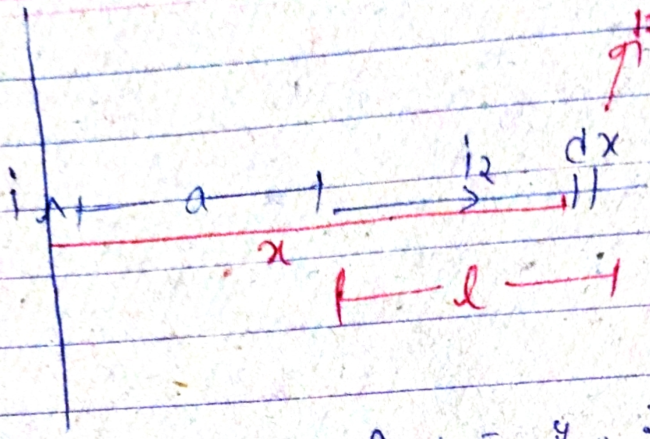
$$= \frac{\mu_0}{2\pi} \frac{I_2 I_2 l}{a}$$



$$\boxed{\frac{\text{force}}{\text{length}} = \frac{\mu_0 I_1 I_2}{2\pi d}}$$

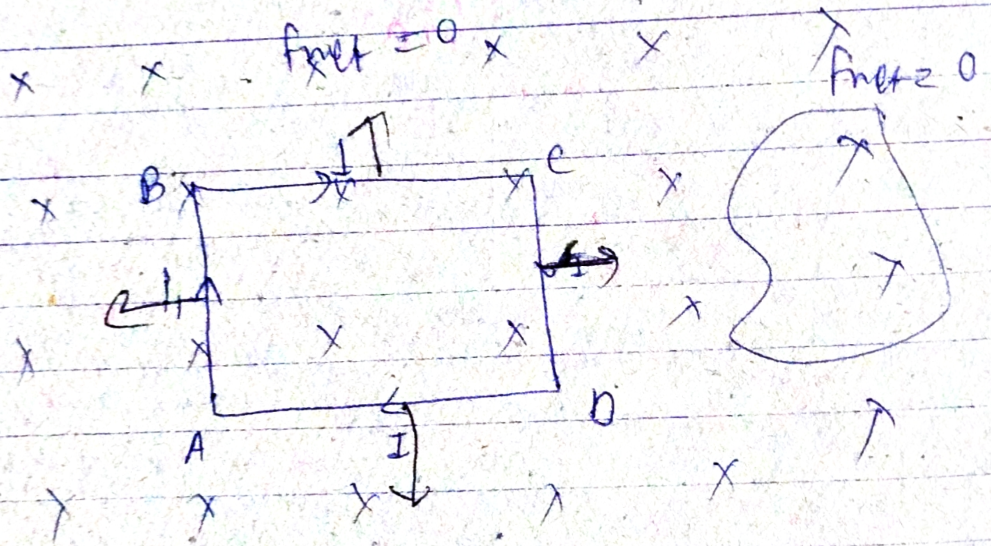
Q~

$i_2\,dx\,\frac{\mu_0 i_1}{2\pi x}$



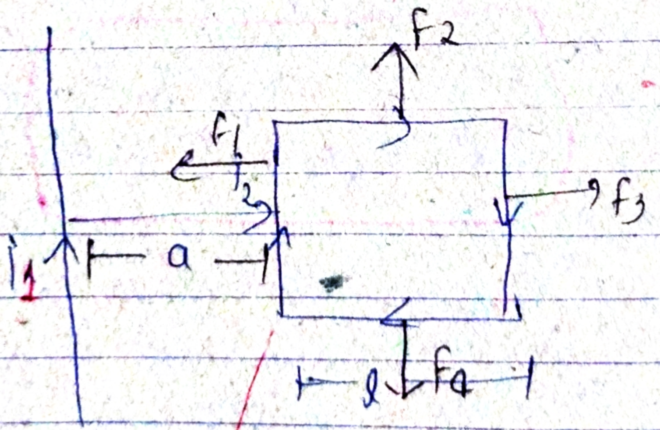
$F_{net} = \frac{\mu_0 I_1 I_2}{2\pi}\int_a^{a+l}\frac{dx}{x}$

Q~



Q~

$F_2 = F_4$



$\frac{\mu_0 i_1 i_2 l}{2\pi a} - \frac{\mu_0 i_1 I_2 l}{2\pi(a+l)}$