MAGNETIC FIELD

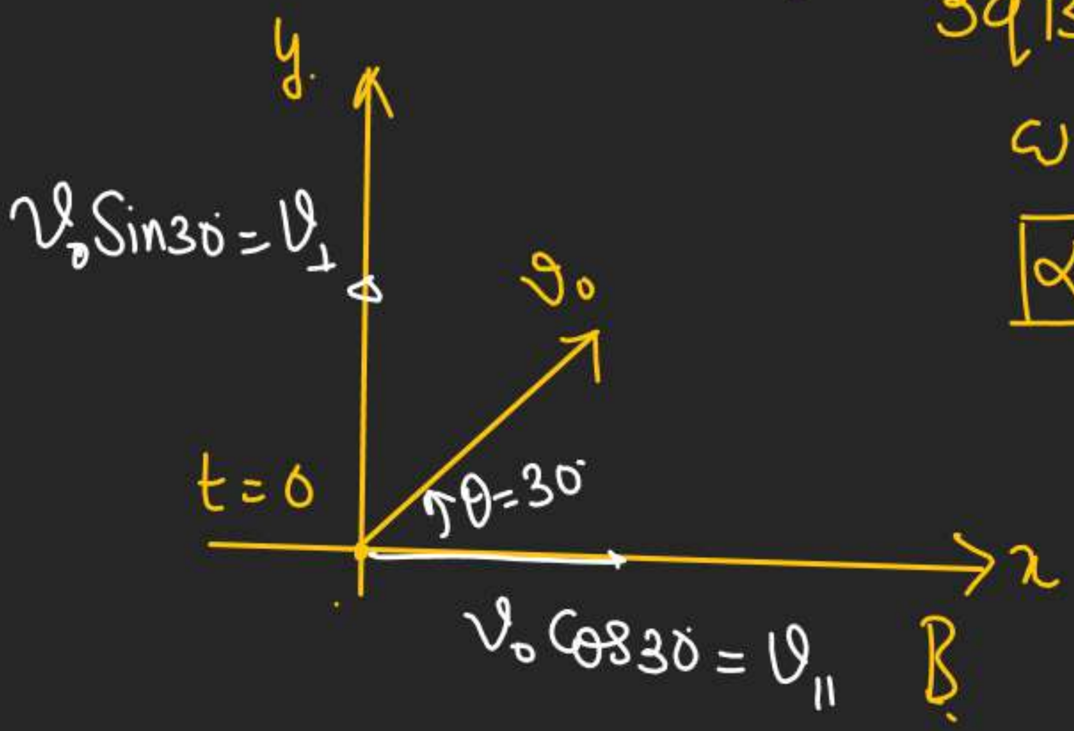
Motion of charge particle in a magnetic field

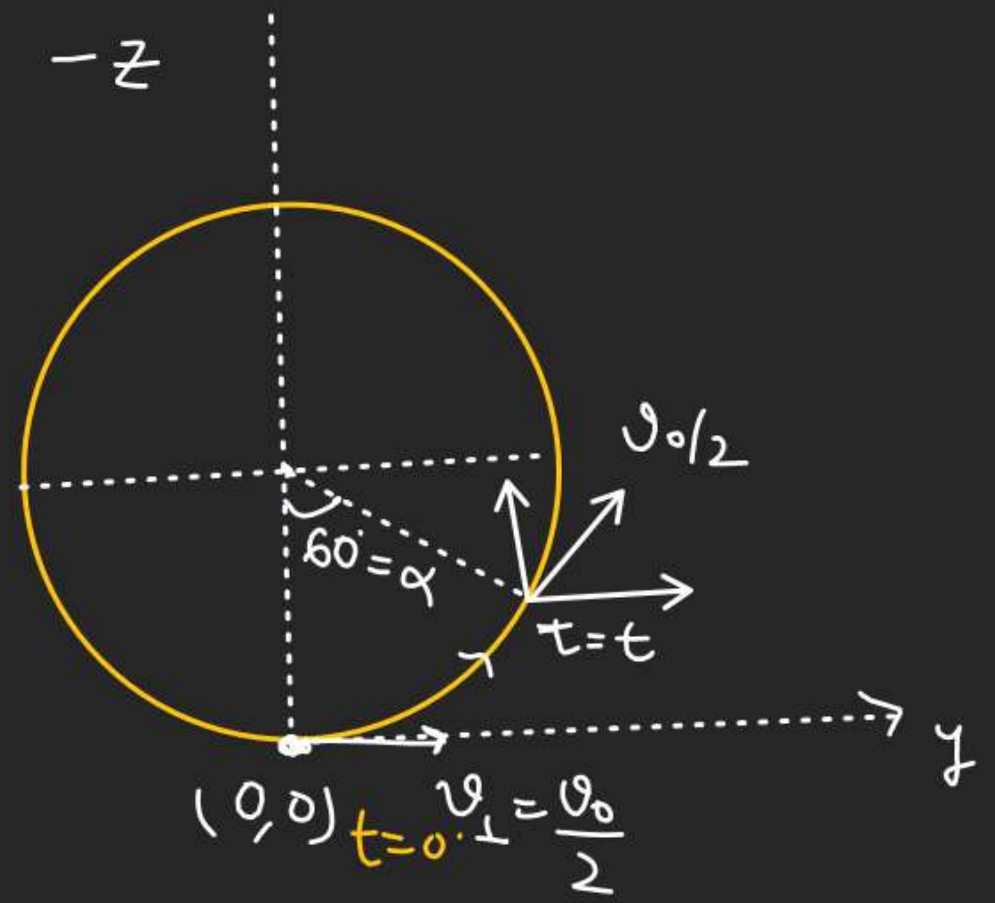
Position and velocity of Charge particle

at $t = \frac{\pi m}{3qB}$

$\omega t = \alpha$

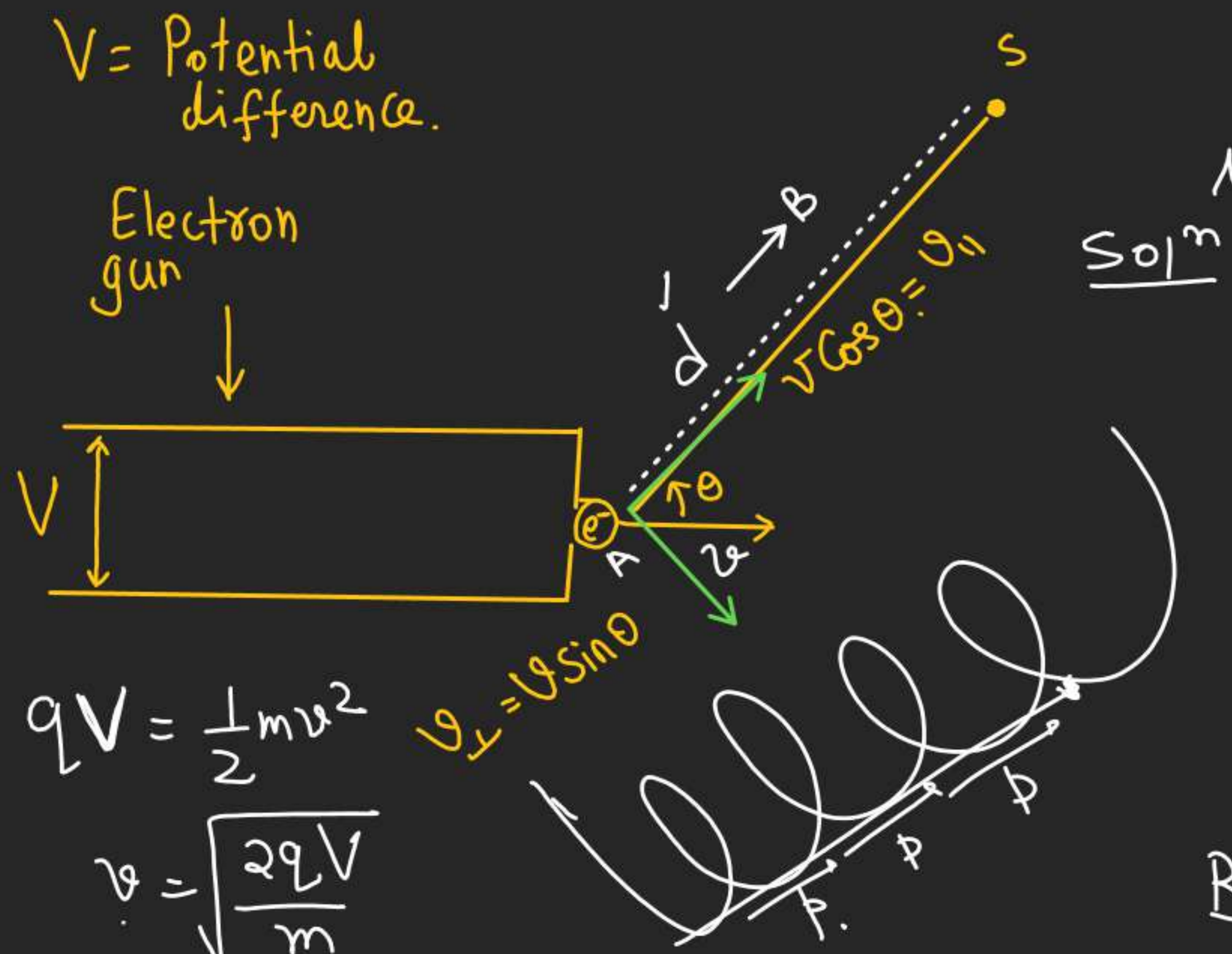
$\boxed{\alpha = 60^\circ}$ ✓





MAGNETIC FIELD

Motion of charge particle in a magnetic field



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

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

electron's are acclerated through a potential difference V. they have to hit a target 'S'. for this What Should be the min value B.

Sol^n

For electron to hit the target

$d = np.$

$p = (v\cos\theta)\left(\frac{2\pi m}{qB}\right)$

$d = n \cdot v\cos\theta \left(\frac{2\pi m}{qB}\right)$

$B = \left[\frac{2\pi m}{qd}\sqrt{\frac{2qV}{m}} \cdot \cos\theta\right] \times n$

For B_{min}, $n = 1$

$B_{min} = \frac{2\pi}{d}\sqrt{\frac{2mV}{q}}\cos\theta$

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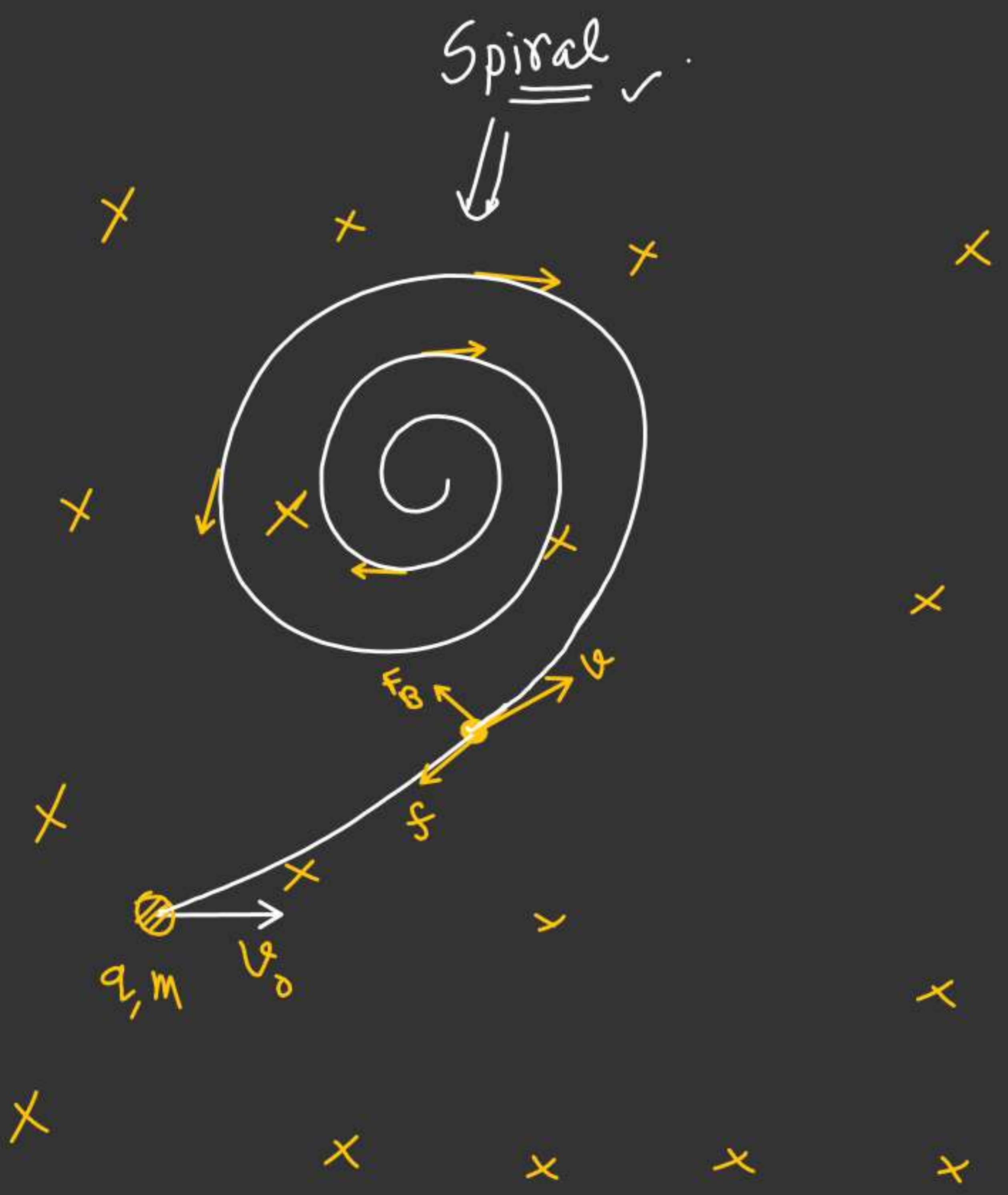
On a Rough horizontal Surface a Charge particle is projected horizontally. The kinetic friction acting on the charge particle is ($f = kv$) where v is instantaneous velocity of the charge particle.

~~(1) Trajectory of Charge particle.~~

(2) Velocity of Charge particle as a function of time.

~~(3) Find radius of Curvature of the Charge particle at $s = \left(\frac{mv_0}{2K}\right)$~~ ✓



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MAGNETIC FIELD

Motion of charge particle in a magnetic field

At any instant

$$a_t = \frac{d|v|}{dt}$$

$$a_t = \frac{\ominus K v}{m}$$

$$\frac{dv}{dt} = -\frac{K}{m} v$$

$$\int_{v_0}^{v} \frac{dv}{v} = -\frac{K}{m}\int_0^t dt$$

$$\ln\left(\frac{v}{v_0}\right) = \frac{-K}{m} t$$

$$\boxed{v = v_0 e^{-\frac{K}{m}t}}$$

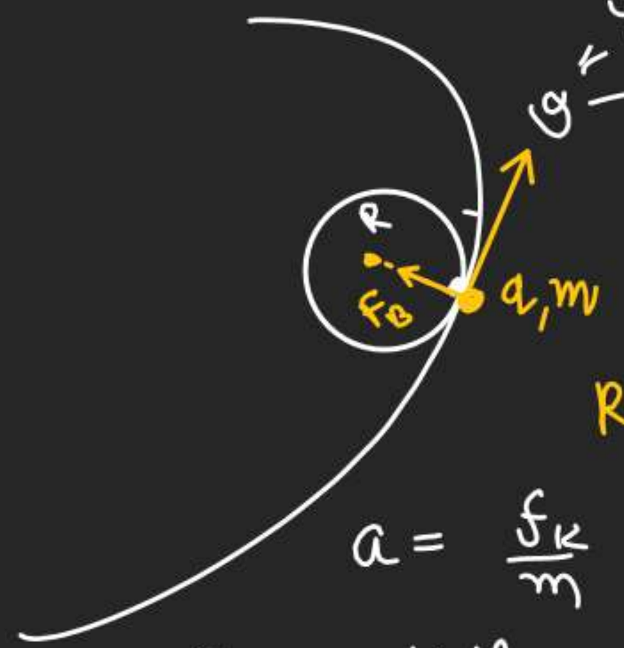
$$\frac{ds}{dt} = v_0 e^{-\frac{K}{m}t}$$

$$\int_0^s ds = v_0 \int_0^t e^{-\frac{K}{m}t}\, dt$$

$$S = \frac{v_0}{\left(-\frac{K}{m}\right)}\left[e^{-\frac{K}{m}t}\right]_0^t$$

$$S = -\frac{mv_0}{K}\left(e^{-\frac{K}{m}t} - 1\right)$$

$$\boxed{S = \frac{mv_0}{K}\left(1 - e^{-\frac{Kt}{m}}\right)}$$



$v \rightarrow \frac{v_0}{2}$ at $\left(S = \frac{mv_0}{2K}\right)$

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

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

$$a = -\frac{K}{m} v$$

$$\cancel{v}\frac{dv}{ds} = -\frac{K}{m}\cancel{v}$$

$$\int_{v_0}^{v} dv = -\frac{K}{m}\int_0^S ds \Rightarrow v = \left[v_0 - \frac{K}{m}S\right]$$

$$v - v_0 = -\frac{K}{m}S$$

$$v_{at\, S = \frac{mv_0}{2K}} = \left(v_0 - \frac{K}{m}\times\frac{mv_0}{2K}\right) = \frac{v_0}{2}$$

$R = \frac{mv_0}{2qB}$ at $S = \frac{mv_0}{2K}$

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Special Case

MAGNETIC FIELD

Motion of charge particle in a magnetic field

**: $\vec{E} \perp \vec{B}$, A Charge particle is released.

$\vec{E} = E\hat{j}$

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

S.H.M

$a = -\omega^2 x$

$\frac{d^2x}{dt^2} = -\omega^2 x$

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

$\Downarrow$

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

Sol^n let at any time t, velocity of charge particle be v

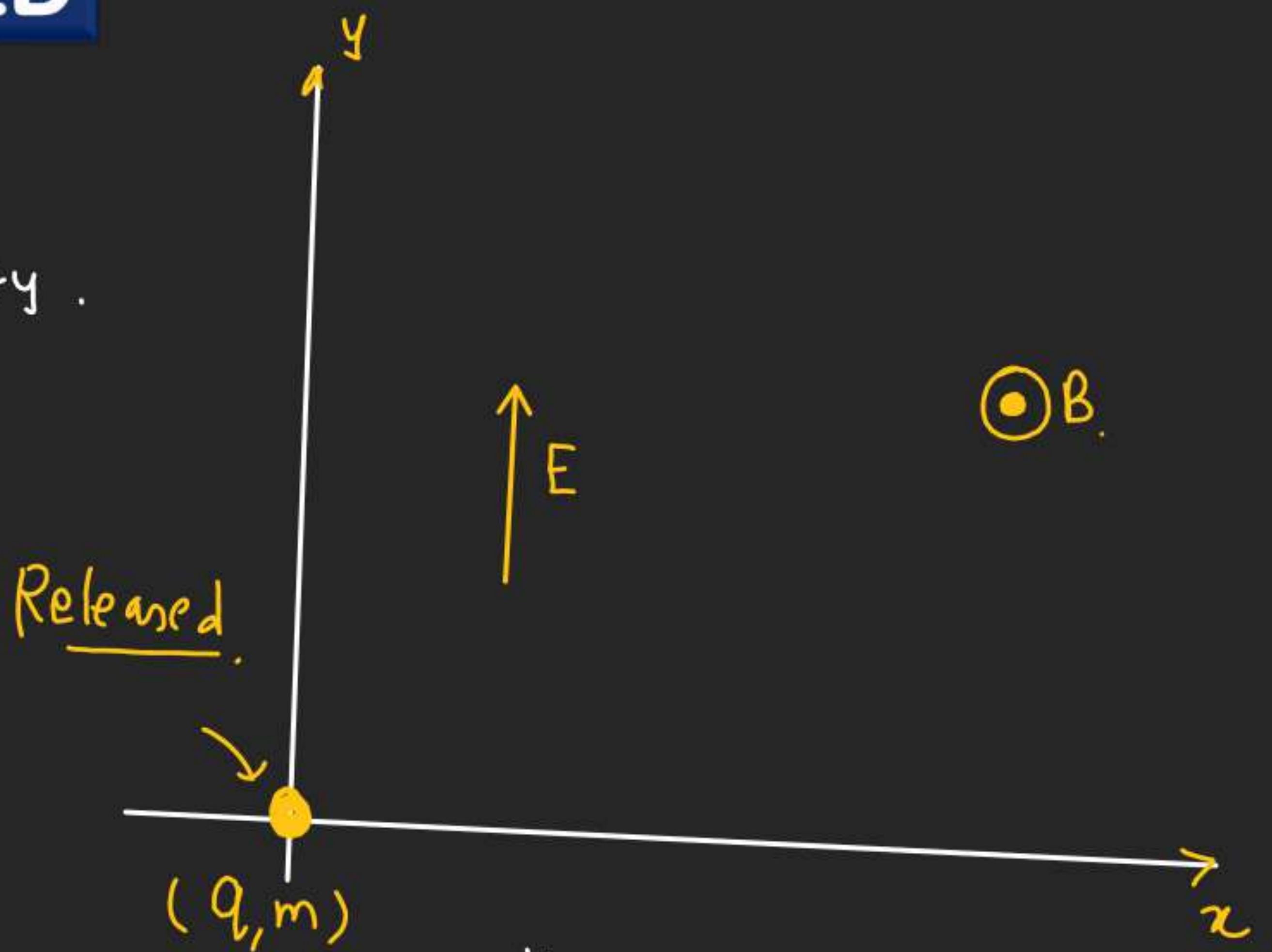
$\vec{v} = v_x\hat{i} + v_y\hat{j}$

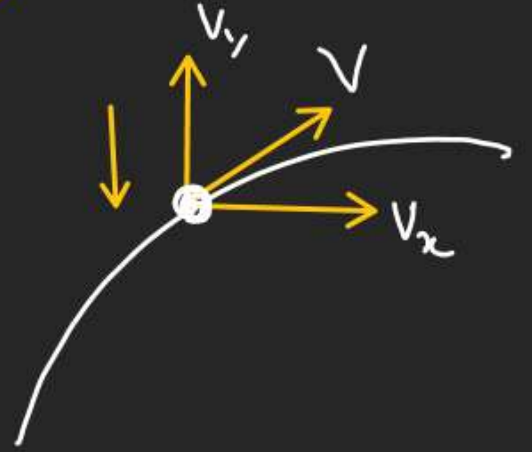
$\vec{F} = q\vec{E} + q(\vec{v} \times \vec{B})$

$\vec{F} = (qE)\hat{j} + [q(v_x\hat{i} + v_y\hat{j}) \times B(\hat{k})]$

$\vec{F} = qE\hat{j} + [qv_xB(-\hat{j}) + qBv_y\hat{i}]$

$\vec{F} = \underline{[qE - qBv_x]\hat{j} + (qBv_y)\hat{i}}$





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$X = f(t),\ Y \to f(t)$

$$\vec{a} = \frac{\vec{F}}{m} = \frac{(qE - qBV_x)}{m}\hat{j} + \left(\frac{qBV_y}{m}\right)\hat{i}$$

$$a_x = \left(\frac{qB}{m}\right)V_y$$

$$\frac{dV_x}{dt} = \left(\frac{qB}{m}\right)V_y \quad \text{—(1)}$$

Differentiating both Side w.r.t time of eqⁿ (1)

$$\frac{d^2V_x}{dt^2} = \frac{qB}{m}\left(\frac{dV_y}{dt}\right)$$

$$\frac{d^2V_x}{dt^2} = \frac{qB}{m}\left[\frac{q}{m}(E - BV_x)\right]$$

$$a_y = \frac{q}{m}(E - BV_x)$$

$$\Downarrow$$

$$\frac{dV_y}{dt} = \frac{q}{m}(E - BV_x) \quad \text{—(2)}$$

$\Downarrow$ Differentiating both Side w.r.t time of Eqⁿ (2)

$$\frac{d^2V_y}{dt^2} = -\frac{qB}{m}\left(\frac{dV_x}{dt}\right)$$

From (1) $\dfrac{dV_x}{dt} = \dfrac{qB}{m}V_y$

$$\boxed{\frac{d^2V_y}{dt^2} = -\left(\frac{qB}{m}\right)^2 V_y}$$

$$\frac{d^2x}{dt^2} = -\omega^2 x$$

$$\Downarrow$$

$$V_y = V_0 \sin[\omega t + \phi] \qquad \left[\omega = \frac{qB}{m}\right]$$

At $t = 0,\ V_y = 0$

$0 = V_0 \sin\phi \Rightarrow \phi = 0$

$$\boxed{V_y = V_0 \sin\omega t}$$

$$\frac{d^2V_x}{dt^2} = \frac{q^2B}{m^2}(E - BV_x)$$

$$\frac{d^2V_x}{dt^2} = -\frac{q^2B^2}{m^2}V_x + \frac{q^2BE}{m^2}$$

Constant

Continue in next lecture