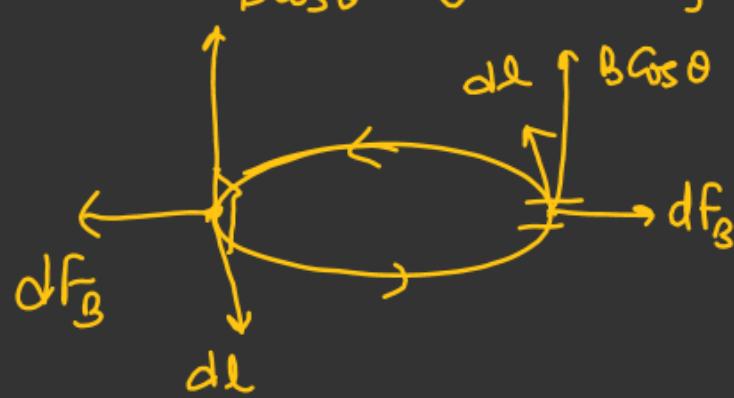


$S \rightarrow$  generating magnetic field

radially outward.



$$\vec{dl} = dl(\hat{k})$$

$$\vec{B} = BS\sin\theta \hat{i} + BCos\theta \hat{j}$$

$$\vec{dF}_B = I (\vec{dl} \times \vec{B})$$

$$\vec{dF}_B = I [dl(\hat{k}) \times (BS\sin\theta \hat{i} + BCos\theta \hat{j})]$$

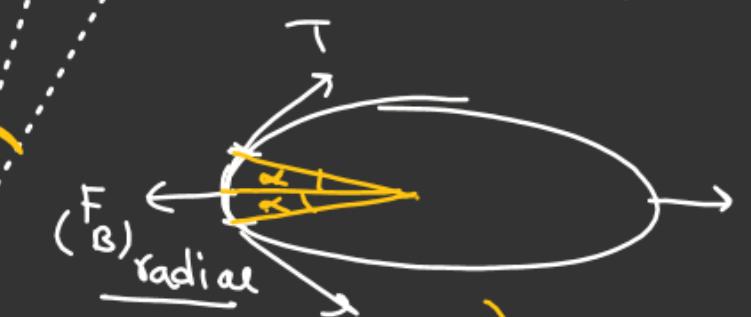
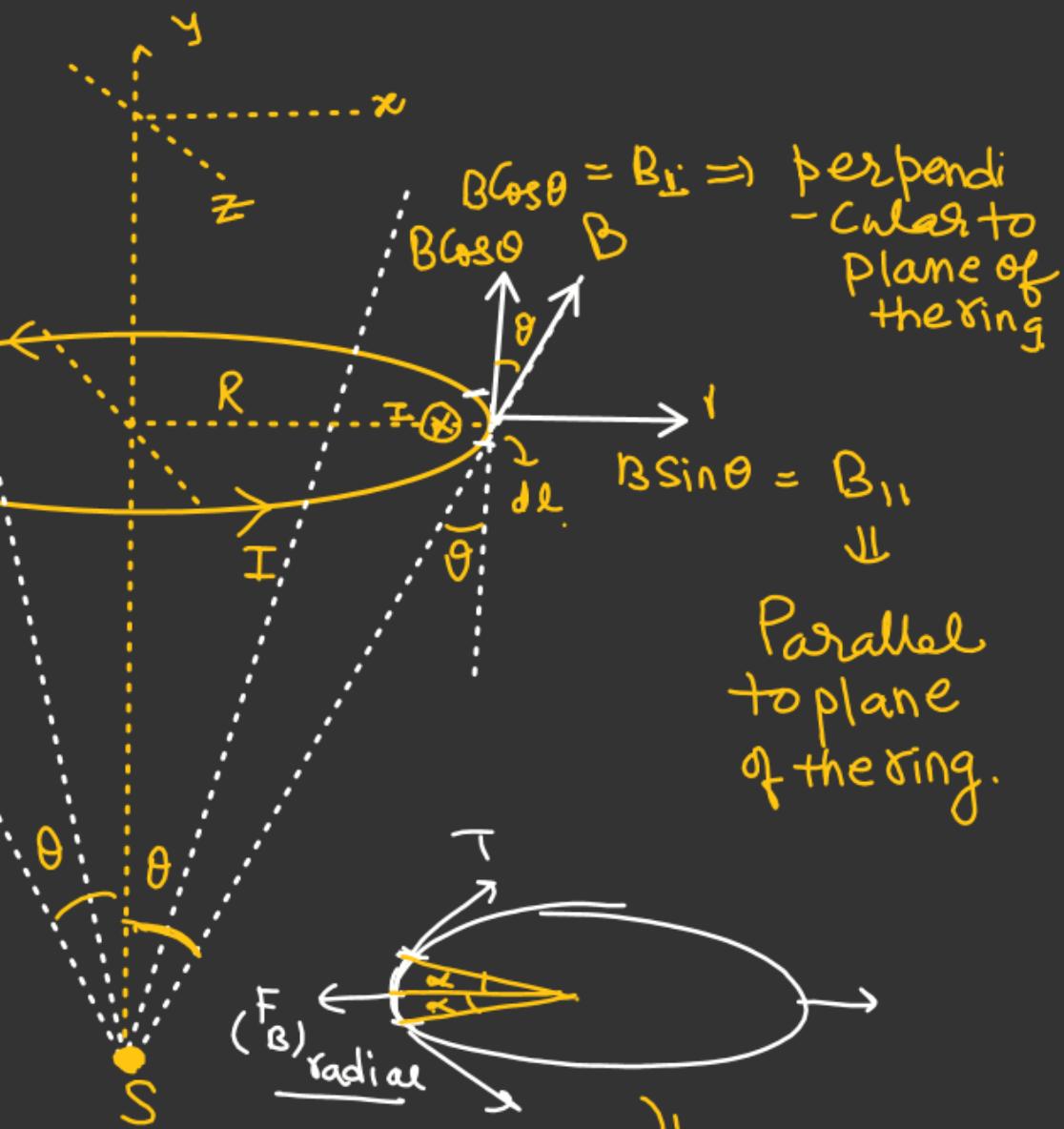
$$\int \vec{dF}_B = \int (I dl \underset{\parallel}{\underset{\downarrow}{BS\sin\theta}}) (\hat{j}) + [I \underset{\parallel}{\underset{\downarrow}{dl BCos\theta}}] (\hat{i})$$

$$(\vec{F}_B)_{net} = [(I BS\sin\theta) \int dl] \hat{j}$$

$$(\vec{F}_B)_{net} = (2\pi R I BS\sin\theta) \hat{j}$$

(Radial force  
cancel out)

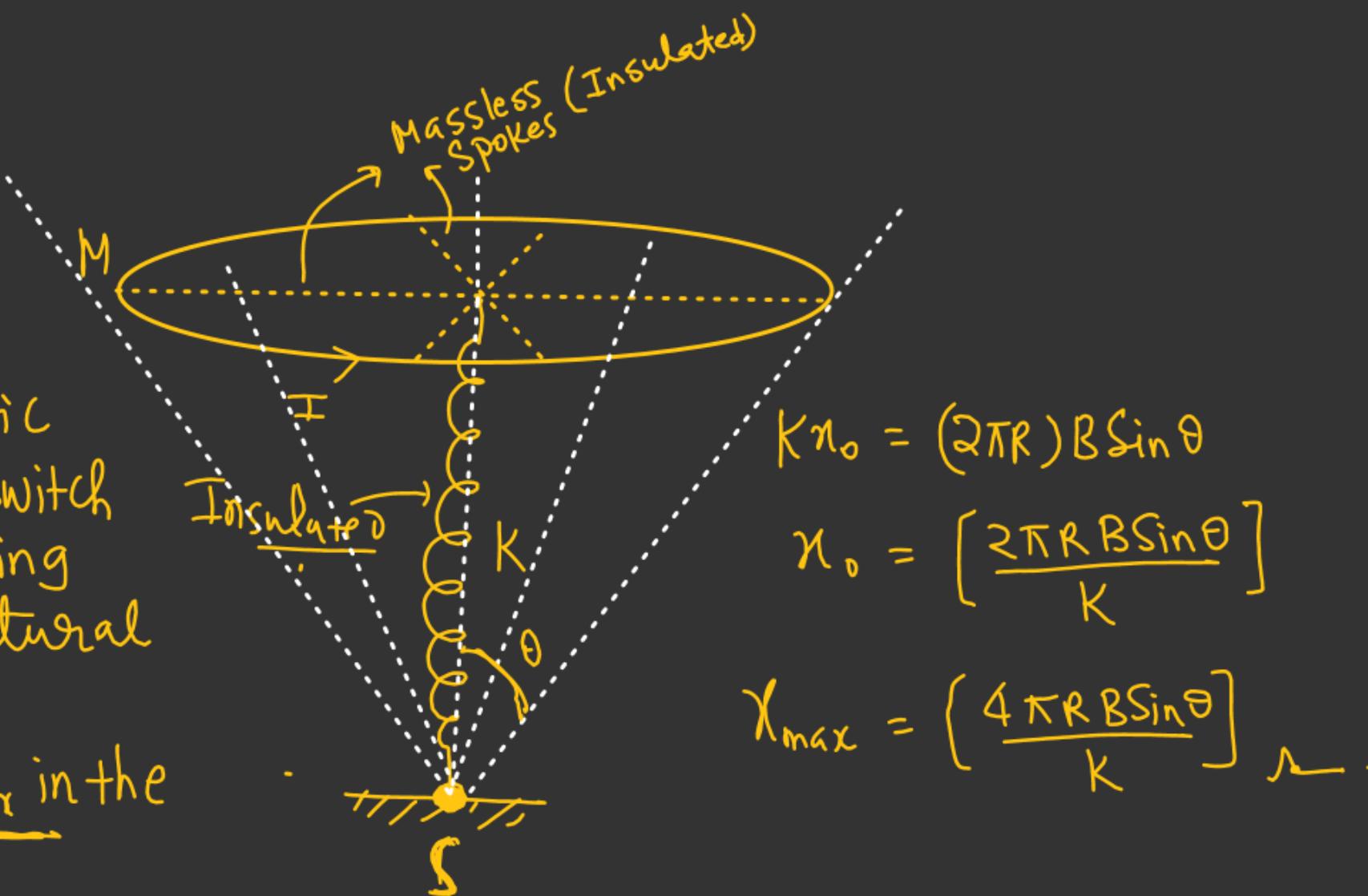
(only responsible for  
tension in the string)



$$T = (BCos\theta)IR$$

#

Before.  
magnetic  
field. is switch  
on. Spring  
at its natural  
length.  
Find  $\chi_{\max}$  in the  
Spring.



$$Kx_0 = (2\pi R)B \sin \theta$$

$$x_0 = \left[ \frac{2\pi R B \sin \theta}{K} \right]$$

$$\chi_{\max} = \left[ \frac{4\pi R B \sin \theta}{K} \right] n$$

$$\underline{\chi_{\max} = 2x_0}$$

$$\underline{x_0 = (\text{Compression in equilibrium})}$$

~~xx~~

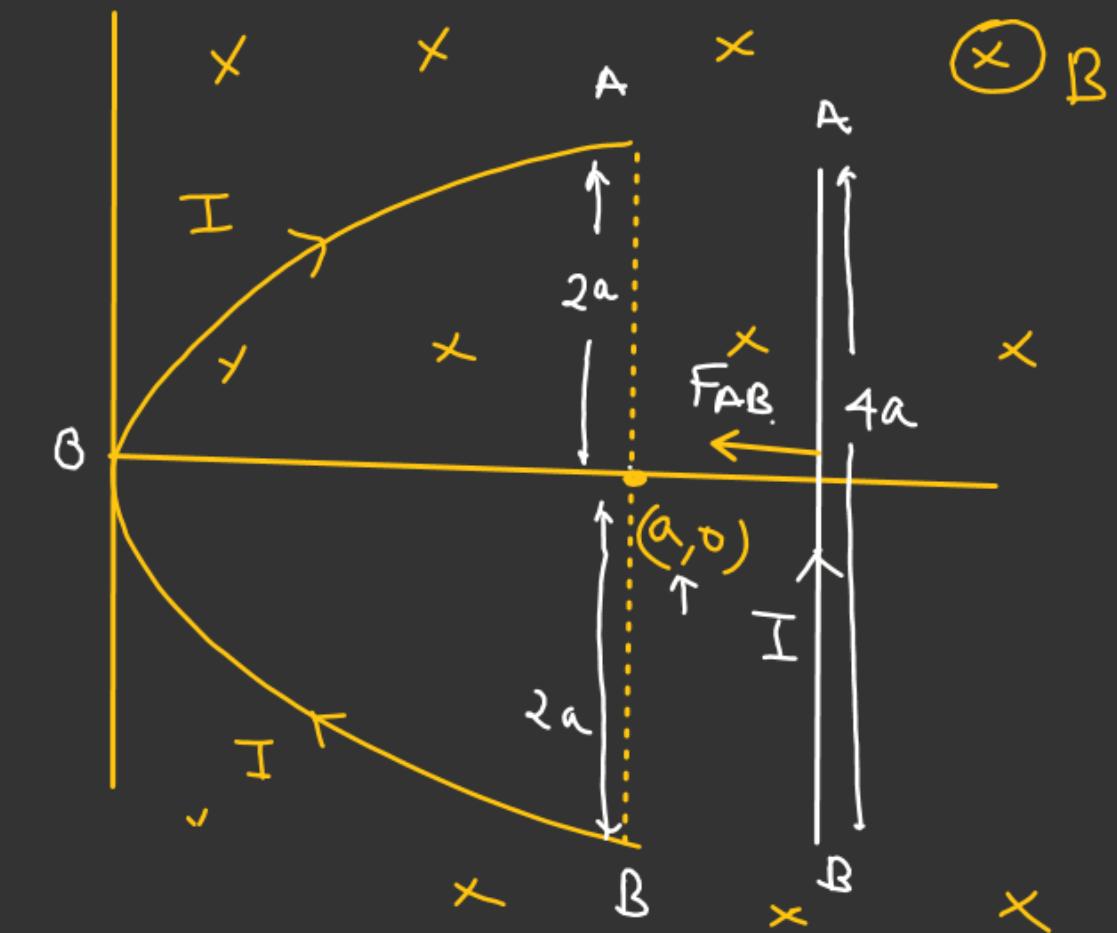
A Current Carrying wire of parabolic shape  
 whose equation is  $y^2 = 4ax$ , as shown in the fig  
 find Net force on the wire.

$$\text{At } x=a, F_{OAB} = F_{AB}$$

$$y^2 = 4a^2$$

$$y = \pm 2a$$

$$\vec{F}_{AB} = (I4a_B)(-\hat{j})$$



# A Current Carrying wire of the form.

$y = a \sin\left(\frac{\pi x}{L}\right)$  is placed in a uniform magnetic field.

find net force on the wire if :

- a)  $\vec{B} = B_0 \hat{i}$
- b)  $\vec{B} = B_0 \hat{j}$
- c)  $\vec{B} = B_0 \hat{k}$

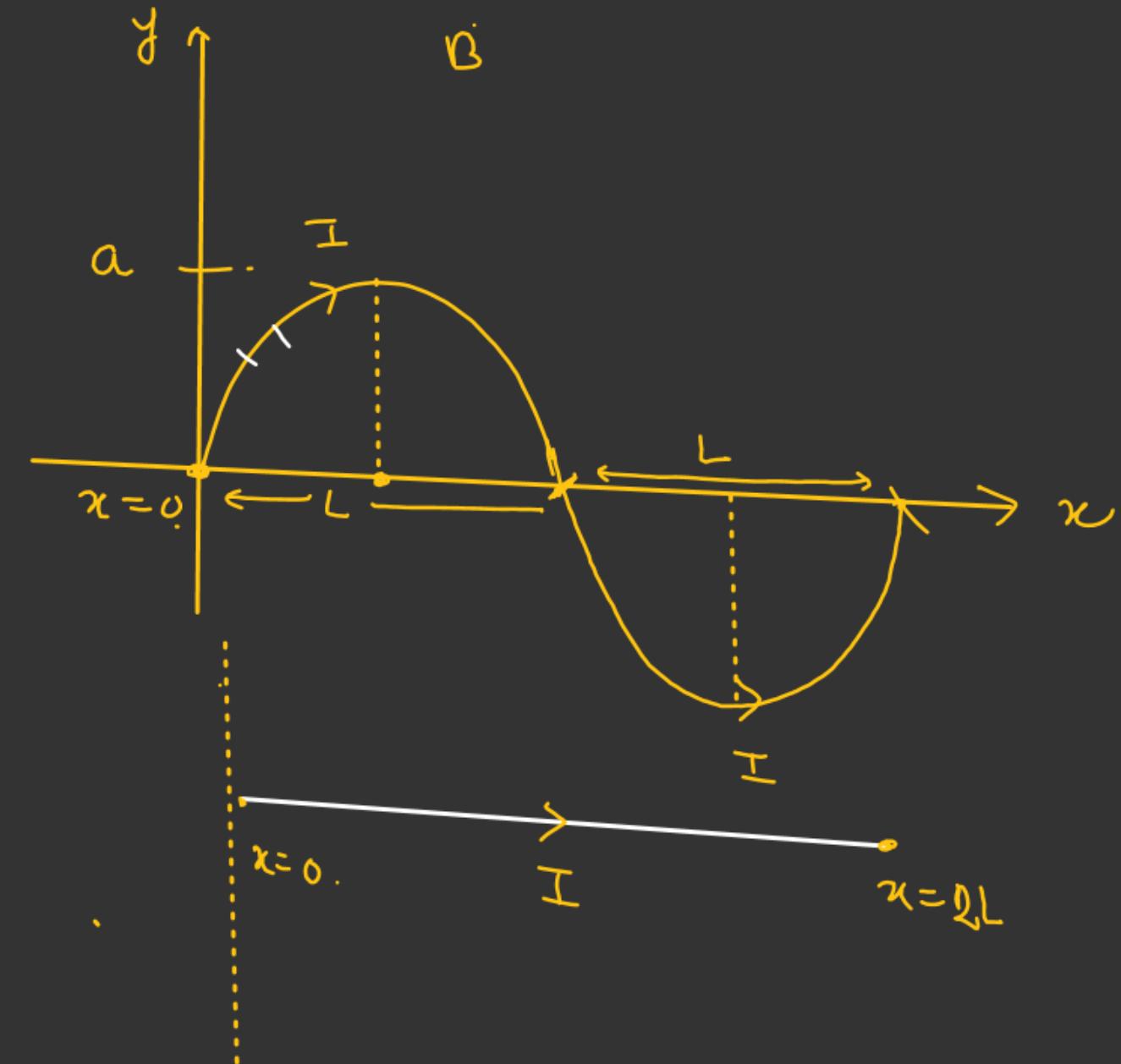
$$\text{a) } \vec{B} \parallel \vec{l} \quad \frac{\pi x}{L} = \pi \quad n = L$$

$$F_B = 0 \quad \vec{B} \quad \vec{l}$$

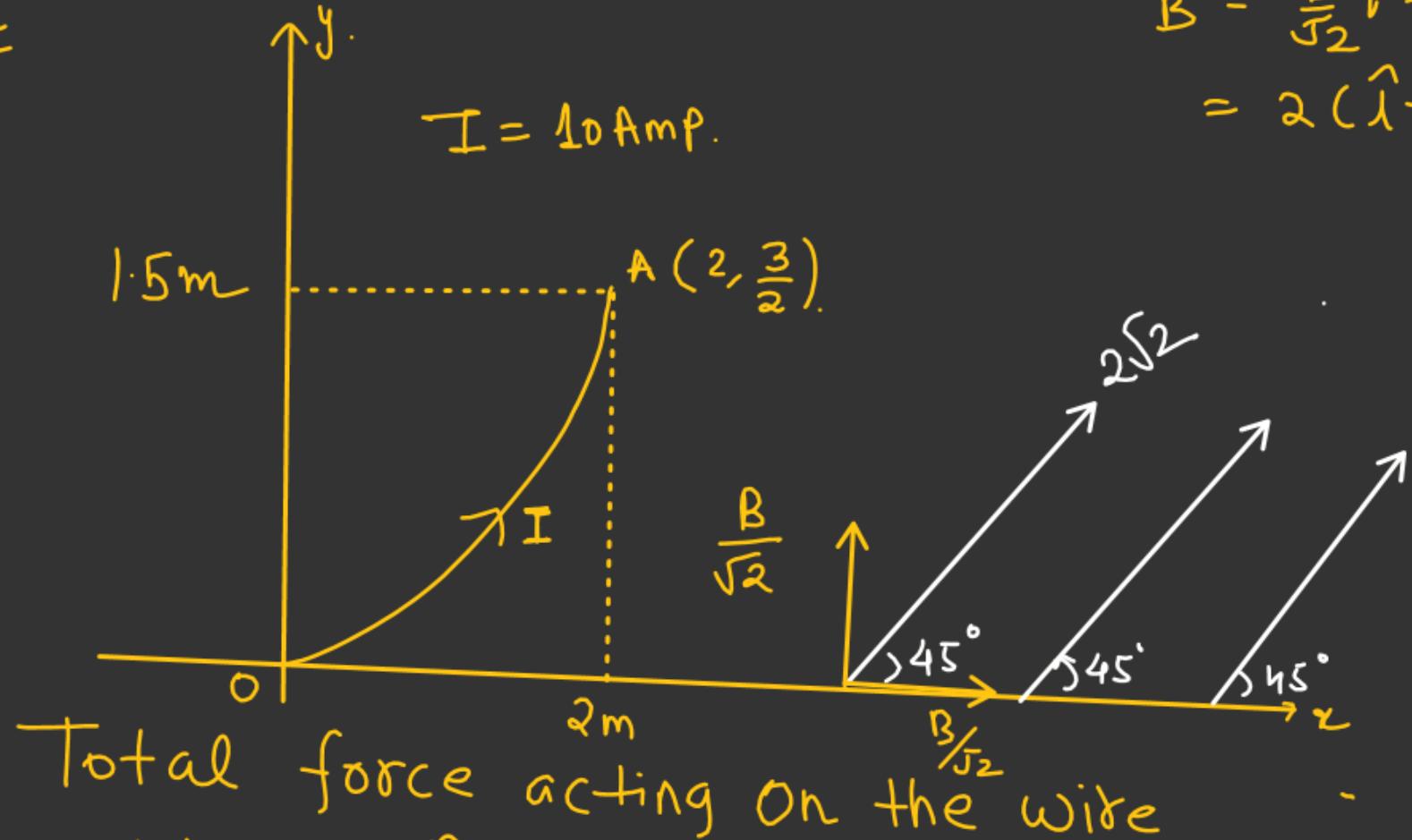
$$\text{b) } F = \underline{(I 2LB)} \quad \theta = 90^\circ$$

$$\text{c) } \vec{B} \perp \vec{l} \quad \theta = 90^\circ$$

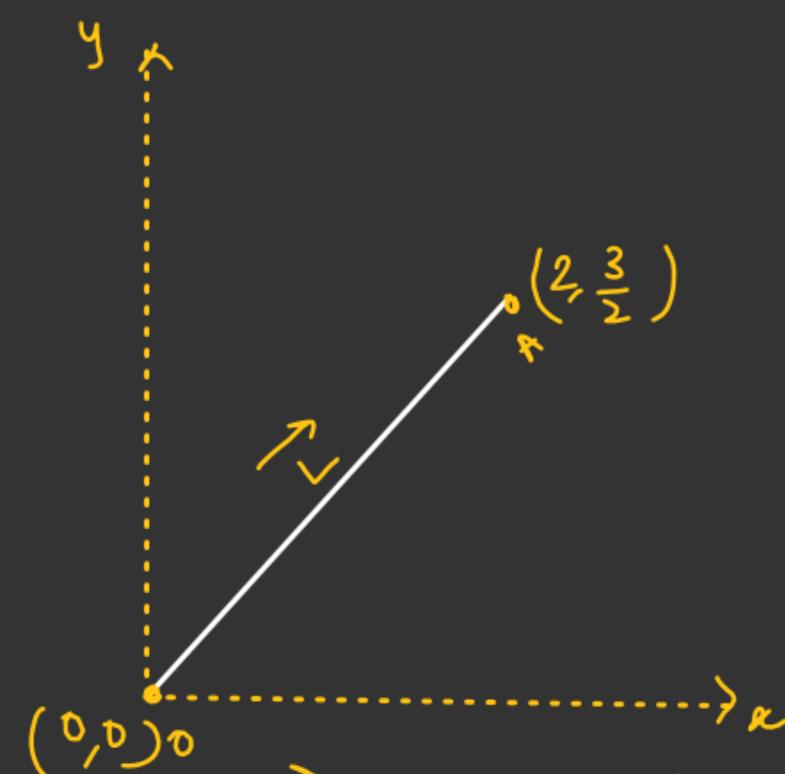
$$F = \underline{(I 2LB)}$$



#

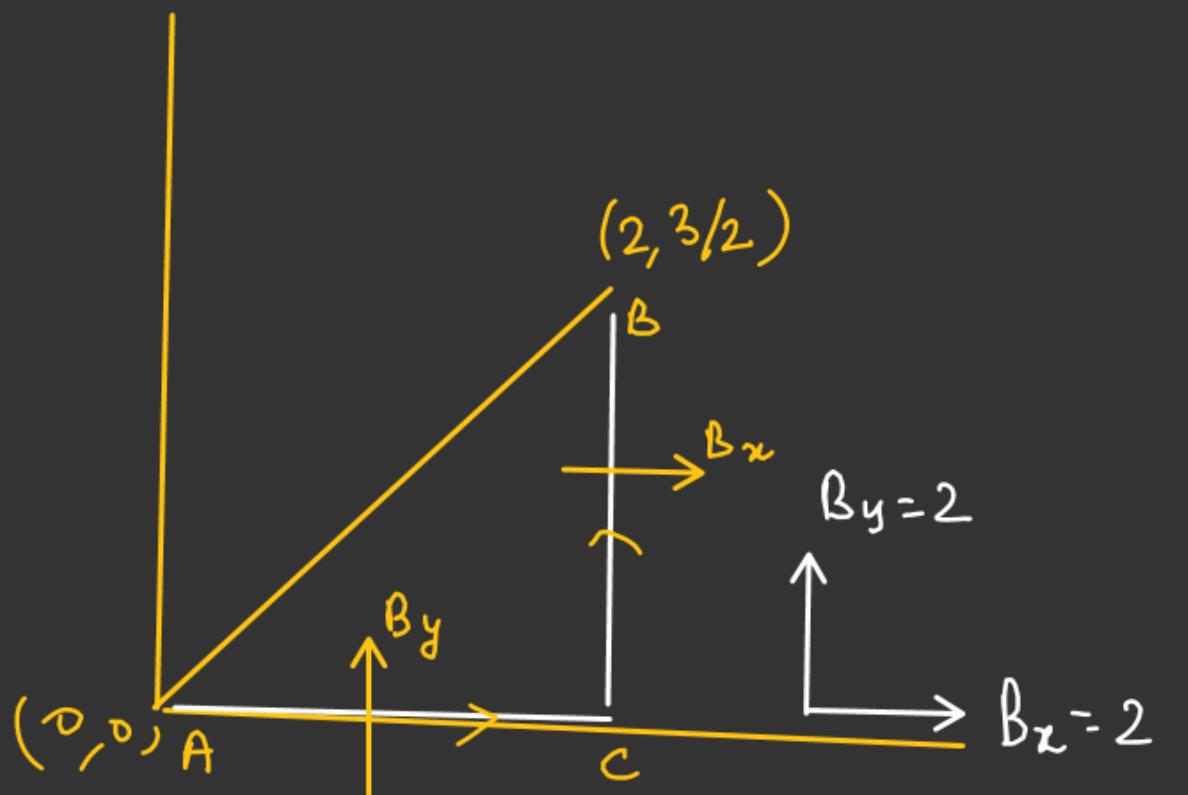


$$\begin{aligned}\vec{B} &= \frac{B}{\sqrt{2}} \hat{i} + \frac{B}{\sqrt{2}} \hat{j} \\ &= 2(\hat{i} + \hat{j})\end{aligned}$$



$$\begin{aligned}\vec{F}_B &= (4I - 3I)\hat{k} \\ &= I\hat{k} \\ &= 10\hat{k}\end{aligned}$$

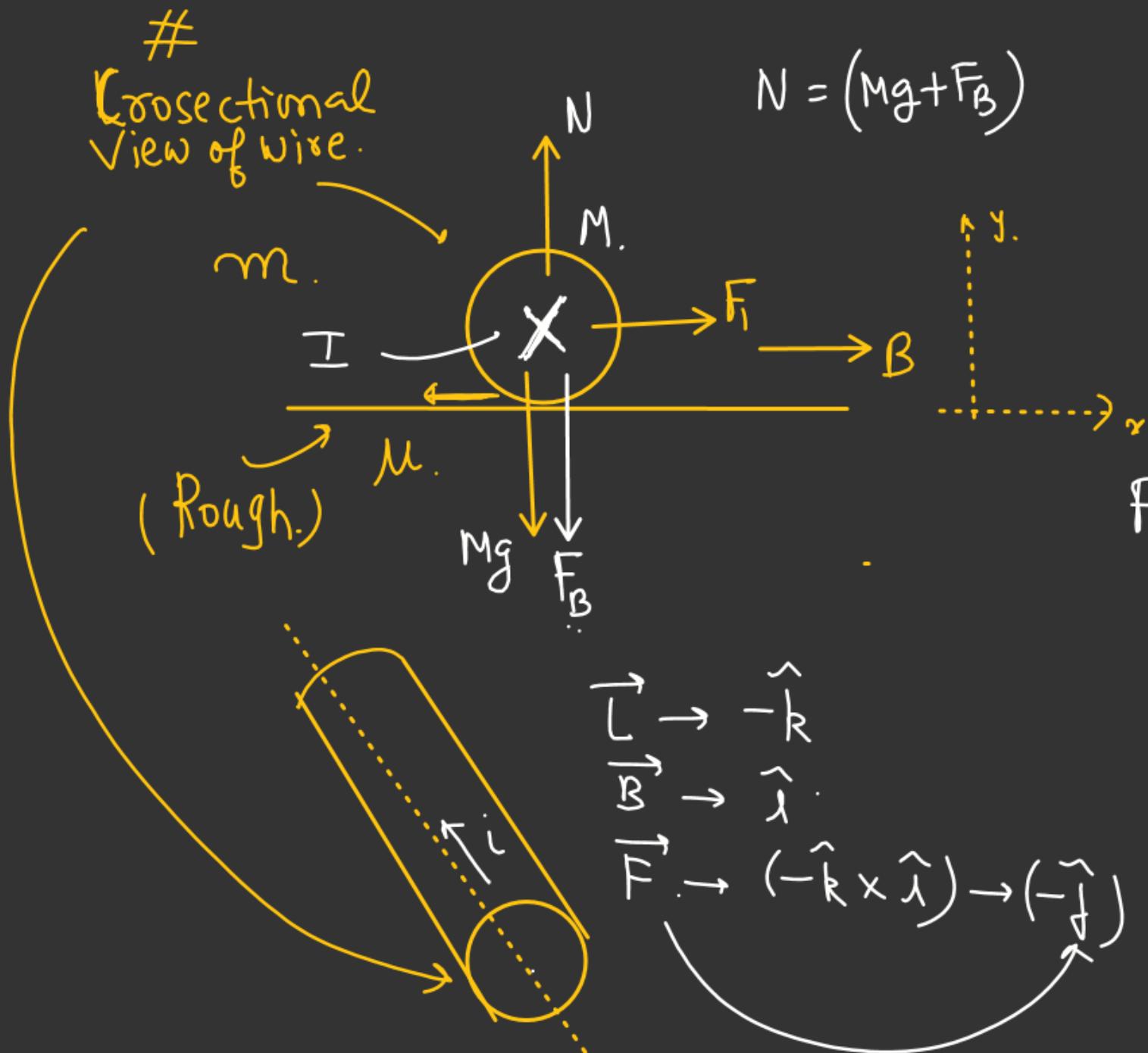
$$\vec{F}_B = I[(2\hat{i} + \frac{3}{2}\hat{j}) \times 2(\hat{i} + \hat{j})]$$



$$\vec{F}_{AC} = I(2)B_y = (4I)\hat{k}$$

$$\vec{F}_{CB} \approx \frac{3}{2}I B_x = (3I)\hat{k}$$

$$\vec{F}_{AB} = (4I - 3I)\hat{k} = I\hat{k}$$



The least force acting on the current carrying wire is  $F_1 \& F_2$ .  
 for wire just to move  $\frac{F}{\mu} (F_1 > F_2)$

- Find.. 1) Weight of the wire.  
 2)  $\mu = ??$ .

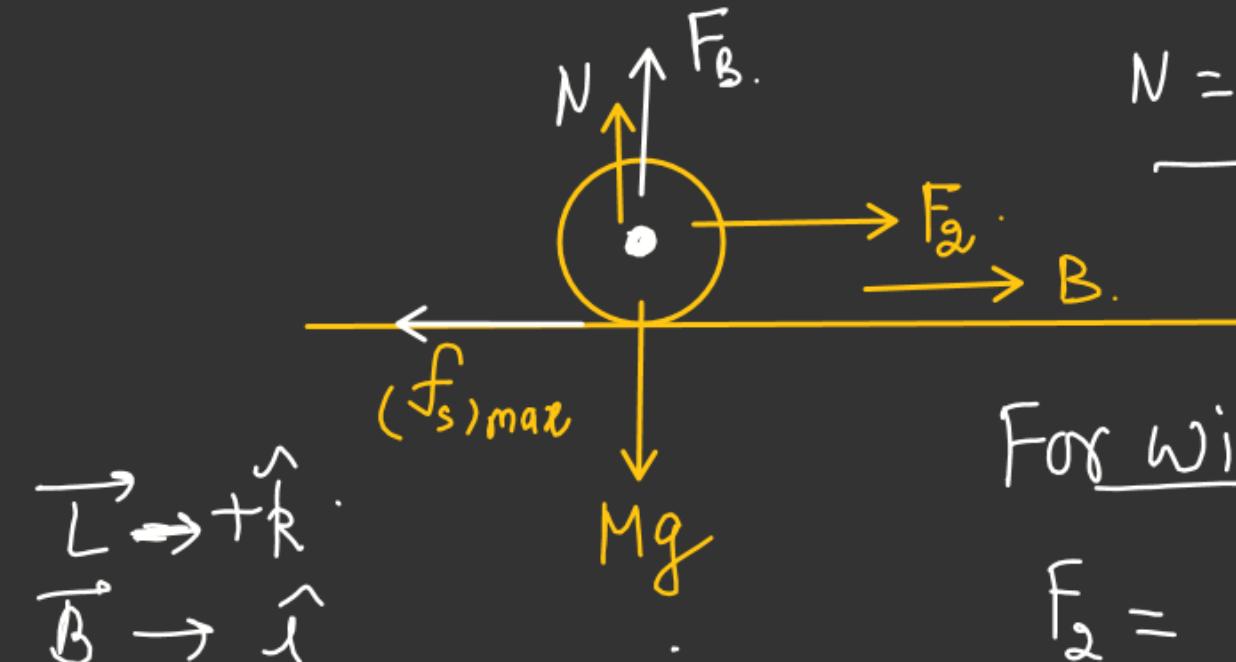
For Wire to move

$$F_1 \geq (f_s)_{\text{max}}$$

$$F_1 = (f_s)_{\text{max}}$$

$$F_1 = \mu (Mg + F_B)$$

$$F_1 = \mu (Mg + ILB) \quad \text{---(1)}$$



$$N = (Mg - F_B)$$

① ÷ ②

$$\frac{F_1}{F_2} = \left( \frac{Mg + ILB}{Mg - ILB} \right)$$

For wire to move

$$F_1 Mg - F_1(ILB) = F_2(Mg) + F_2(ILB)$$

$$\vec{L} \rightarrow +\hat{k}$$

$$\vec{B} \rightarrow \hat{i}$$

$$\vec{F} \rightarrow (\hat{i} \times \hat{k}) \rightarrow \hat{j}$$

$$F_2 = (f_s)_{\text{max}}$$

$$(F_1 - F_2)Mg = (F_2 + F_1)ILB$$

$$F_2 = \mu \underline{(Mg - F_B)}$$

$$Mg = \left( \frac{F_1 + F_2}{F_1 - F_2} \right) ILB$$

$$F_1 = \mu (Mg + ILB) \quad \text{--- ①}$$

$$F_2 = \mu \underline{(Mg - ILB)} \quad \text{--- ②}$$

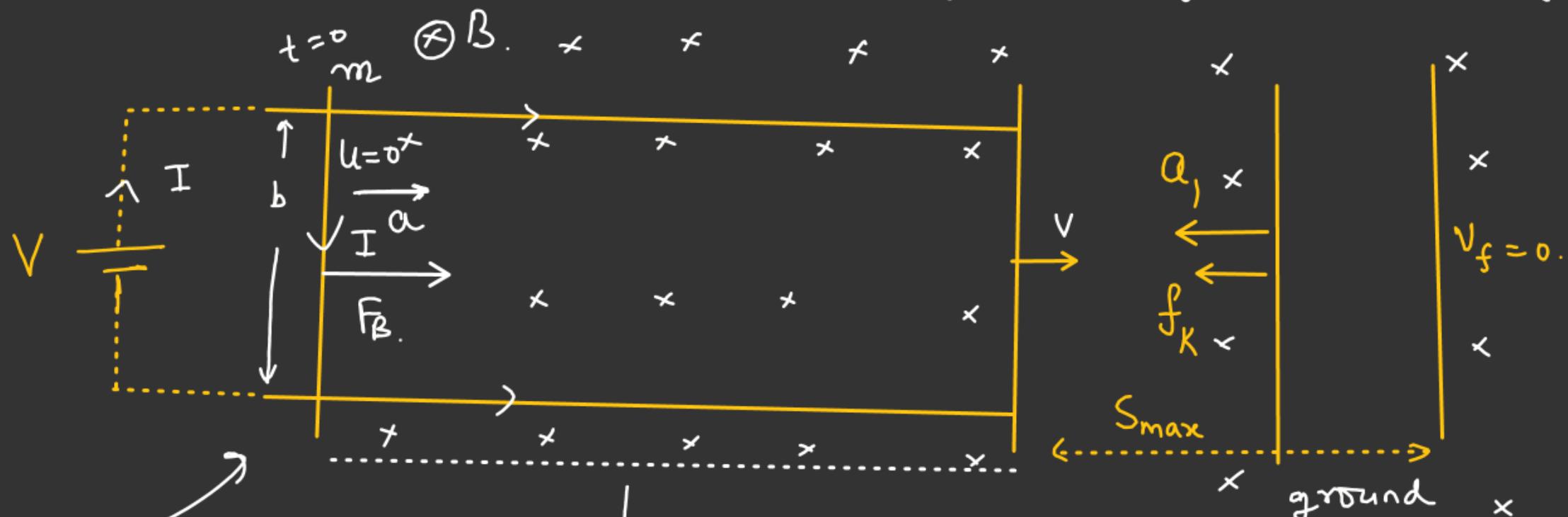
$$\frac{Mg}{ILB}^{-1} = \left( \frac{F_1 + F_2}{F_1 - F_2} \right)^{-1}$$

$$\frac{F_2}{\mu} \leftarrow \frac{Mg - ILB}{ILB} =$$

$$\frac{F_2}{\mu(ILB)} = \frac{2F_2}{F_1 - F_2}$$

$$\frac{F_2}{\mu(ILB)} = \frac{2F_2}{F_1 - F_2} \Rightarrow \mu = \left( \frac{F_1 - F_2}{2ILB} \right) \text{ --- } A$$

At  $t=0$ , switch is closed, parallel rails are smooth but ground is rough. And  $\mu$  be the coefficient of friction b/w ground and Slider.



(Horizontal)

$$a = \frac{F_B}{m} = \left( \frac{IBb}{m} \right)$$

$$v^2 = 2aL$$

$$v^2 = 2L \left( \frac{IBb}{m} \right)$$

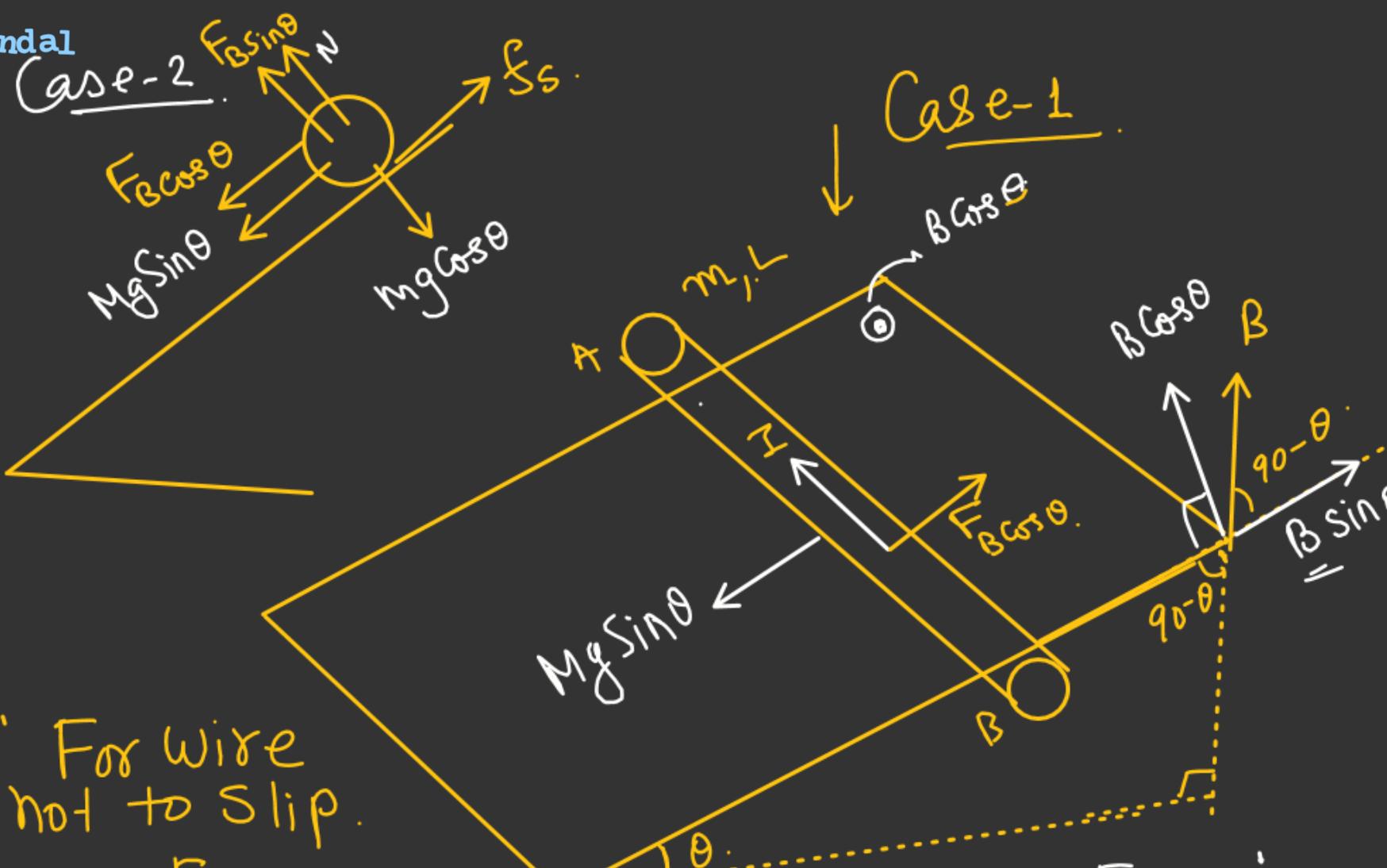
Find maximum distance.  
Slider cover from parallel rails.

$$a_1 = \frac{f_k}{m} = \frac{\mu mg}{m} = \mu g$$

From motion of slider on the ground:

$$0 = v^2 - 2\mu g s_{max}$$

$$s_{max} = \frac{v^2}{2\mu g} = \frac{1}{2\mu g} \times \frac{2ILBb}{m} = \boxed{\frac{ILBb}{\mu mg}}$$



For wire not to slip.

$$F_{B\cos\theta} + Mg\sin\theta = f_s.$$

$$[ILB\cos\theta + Mg\sin\theta = f_s]$$

$$N = [mg\cos\theta - ILB\sin\theta]$$

Case-1

For wire not to slide.

$$Mg\sin\theta = (F_{B\cos\theta}) = ILB\cos\theta.$$

$$I = \frac{Mg\sin\theta}{LB\cos\theta} = \frac{Mg\tan\theta}{BL}$$

① Case-1: if inclined plane is smooth.  
Find magnitude and direction of I so that wire is in equilibrium.

② Case-2.

If incline plane is rough and current in the wire is I from A to B. find M so that wire is in equilibrium.

$$f_s \leq (f_s)_{\max}$$

↓

$$\underbrace{ILB \cos \theta + mg \sin \theta}_{\cdot} \leq \mu \left( \underbrace{mg \cos \theta - ILB \sin \theta}_{\cdot} \right)$$

$$\mu \geq \left[ \frac{ILB \cos \theta + mg \sin \theta}{mg \cos \theta - ILB \sin \theta} \right]$$

$$\mu_{\min} = \left[ \frac{ILB \cos \theta + mg \sin \theta}{mg \cos \theta - ILB \sin \theta} \right] \checkmark$$