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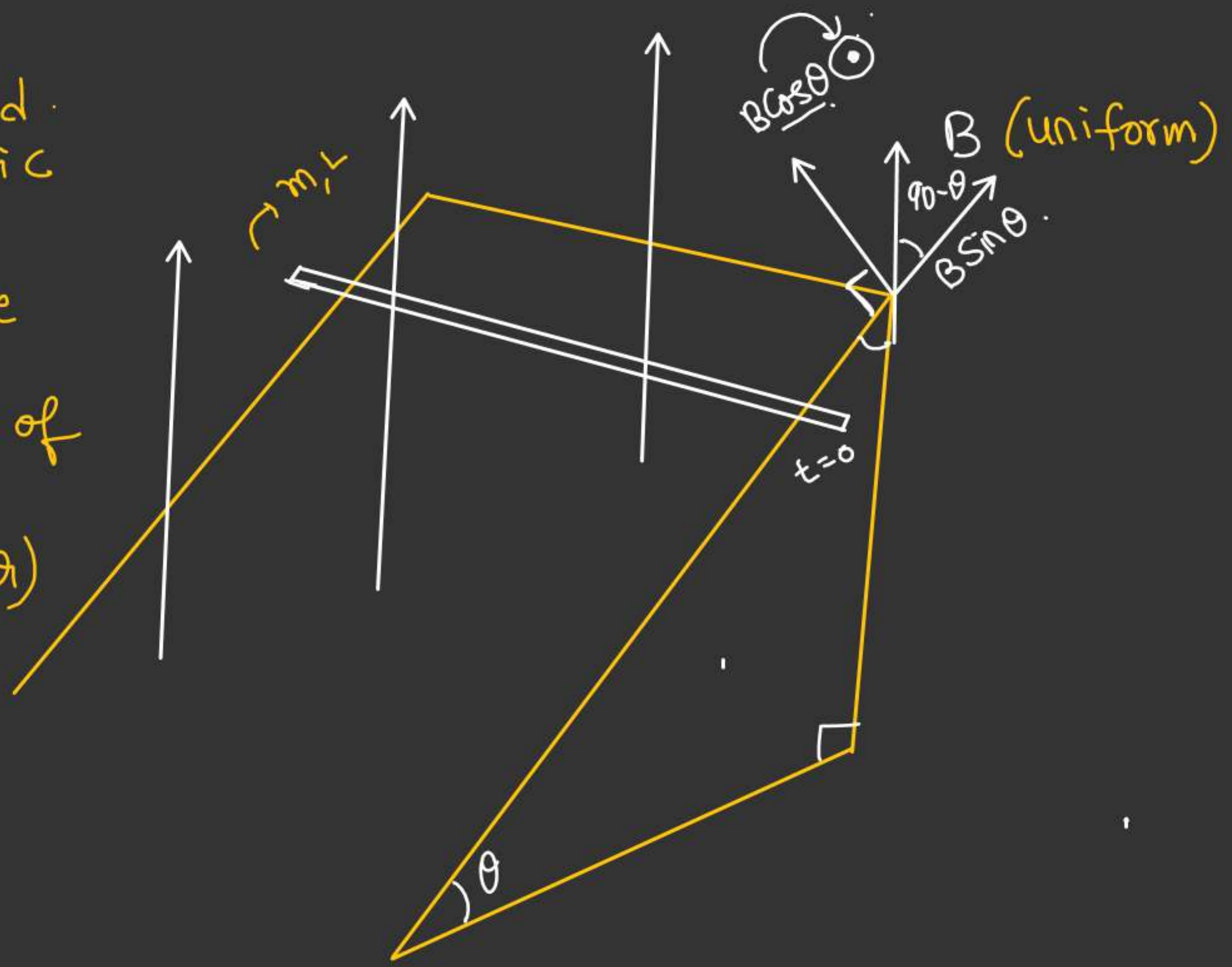
#. Slider is released from rest on a smooth inclined parallel rails where magnetic field is vertical.

a) Find terminal velocity of the Slider

b) Induced Current at the time of terminal velocity.

(R = Resitance of the Slider)



At the time of termal velocity.

$$mg\sin\theta = F_B$$

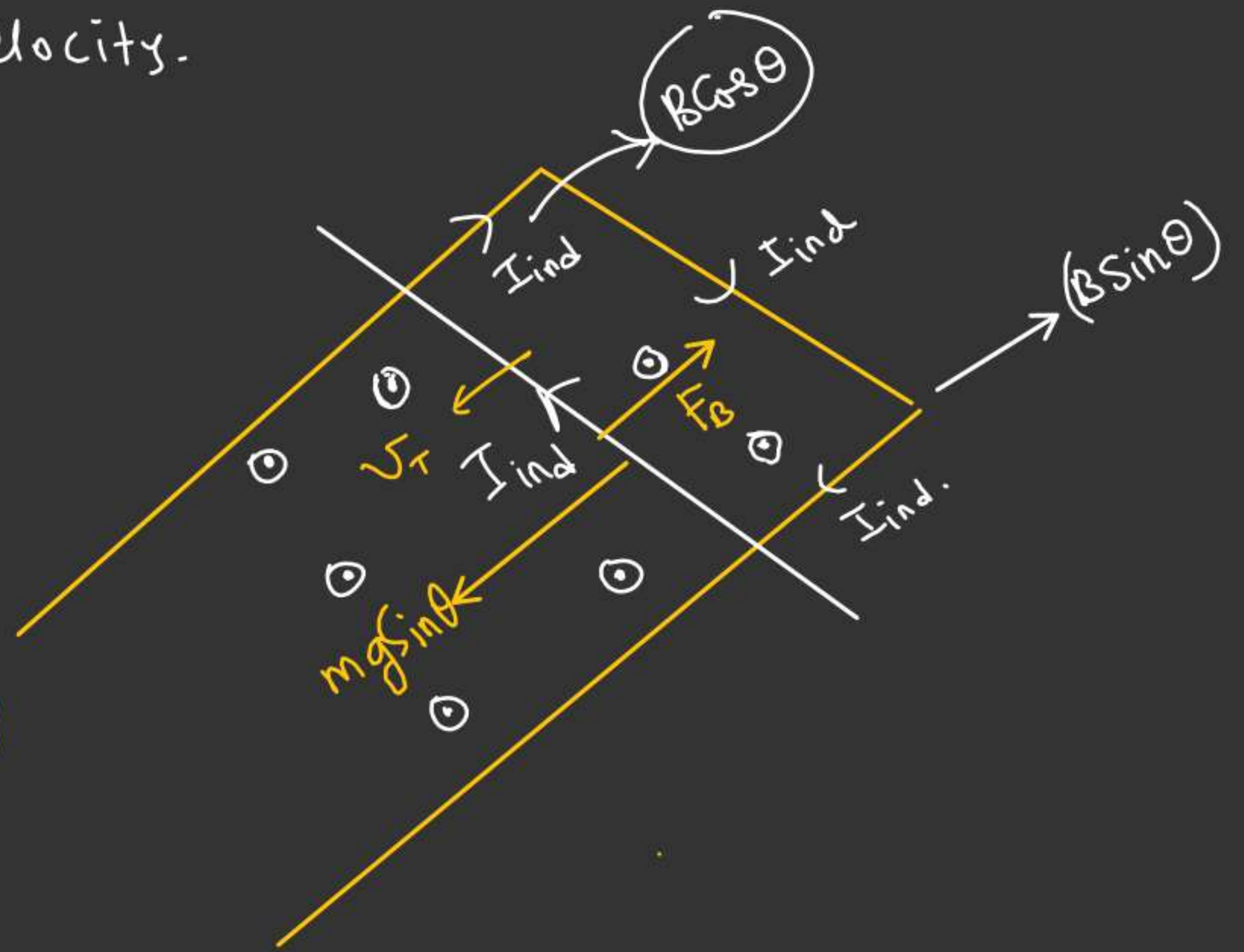
$$mg\sin\theta = I_{ind}\, l(B\cos\theta)$$

$$\mathcal{E}_{mf} = (B\cos\theta)\, l\, v_T$$

$$I_{ind} = \frac{\mathcal{E}_{mf}}{R} = \left(\frac{(B\cos\theta)\, l\, v_T}{R}\right)$$

$$mg\sin\theta = \left(\frac{B^2 \cdot l^2 \cos^2\theta}{R}\right) v_T$$

$$v_T = \left(\frac{mgR\sin\theta}{B^2 l^2 \cos^2\theta}\right)$$



$$I_{ind} = \frac{\cancel{(B\cos\theta)}\,\cancel{l}}{\cancel{R}} \times \frac{mg\cancel{R}\sin\theta}{\cancel{B^2}\cancel{l^2}\cos^{\cancel{2}}\theta}$$

$$I_{ind} = \left(\frac{mg}{Bl}\tan\theta\right)$$

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$\underline{\mathcal{E}_{ind}}$:- $\left[(\vec{v}\times\vec{B})\cdot\vec{dl}\right]$

$\left(\vec{E} = \text{Electric field}\right)$

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

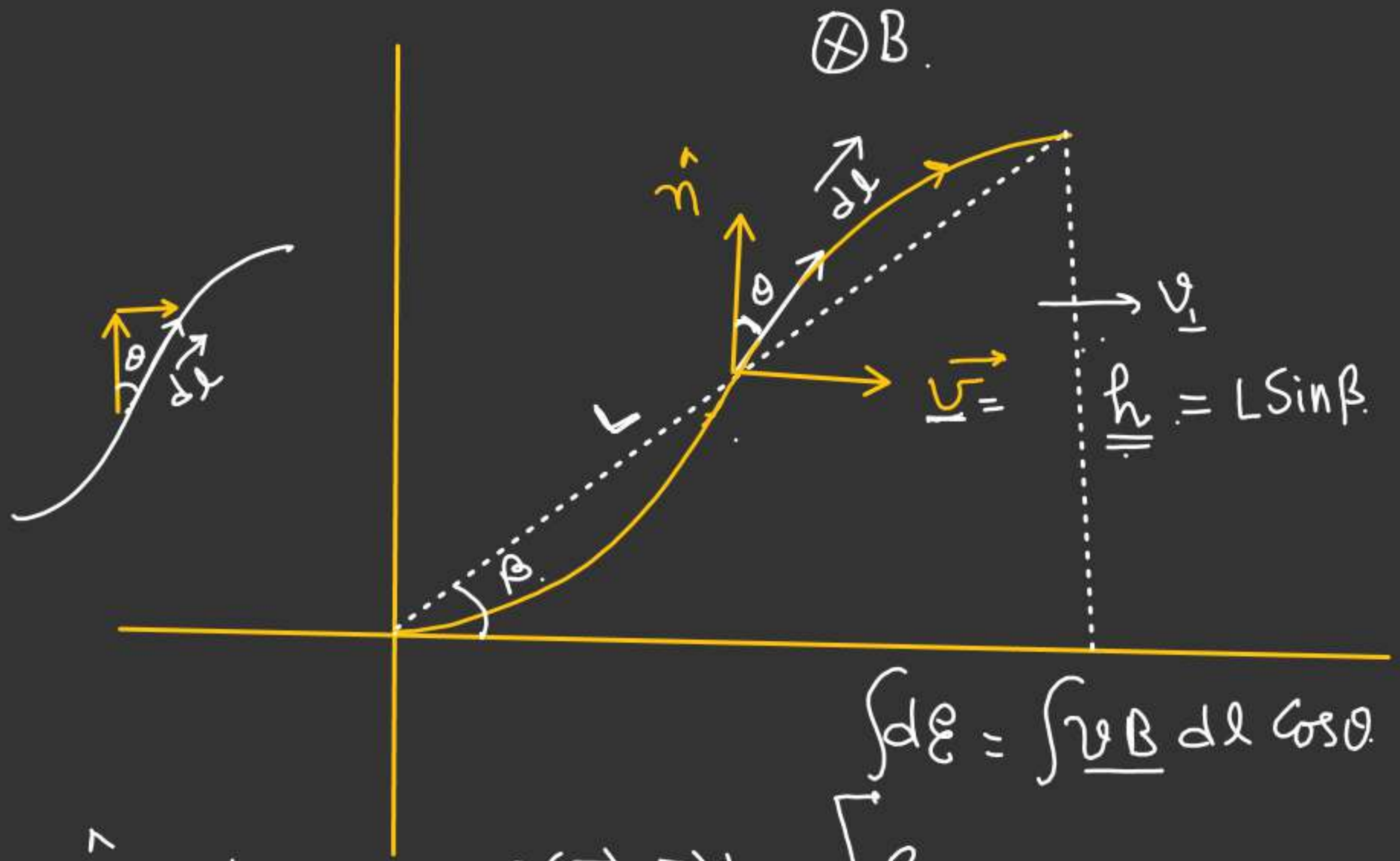
$\vec{F_E} = q\vec{E}$.

$\vec{F_B} = \vec{F_E}$.

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

$$\text{E.M.f} = (\vec{E}\cdot\vec{dl})$$

$$= ((\underline{\vec{v}\times\vec{B}})\cdot\vec{dl})$$



$\underline{\underline{h}} = L\sin\beta$

$\int d\mathcal{E} = \int \underline{vB}\, dl\cos\theta$

$\hat{n} \rightarrow$ direction of $(\vec{v}\times\vec{B})$

$\vec{v}\times\vec{B} = (vB\sin 90)\hat{n}$

$= (vB)\hat{n}$

$d\mathcal{E} = (vB)(\hat{n}\cdot\vec{dl})$

$\mathcal{E}_{ind} = vB\int \underline{dl\cos\theta}$ $\perp$

$= \underline{vBh}$.

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$$\mathcal{E}_{ind} = \int (\vec{v} \times \vec{B}) \cdot \vec{dl}$$

$$\vec{v} = (\vec{\omega} \times \vec{r})$$

$$\vec{\omega} = \omega(-\hat{k})$$
$$\vec{r} = (x\hat{i} + y\hat{j})$$

$$\vec{v} = [\omega(-\hat{k}) \times (x\hat{i} + y\hat{j})]$$
$$= [-\omega x \hat{j} + \omega y \hat{i}]$$

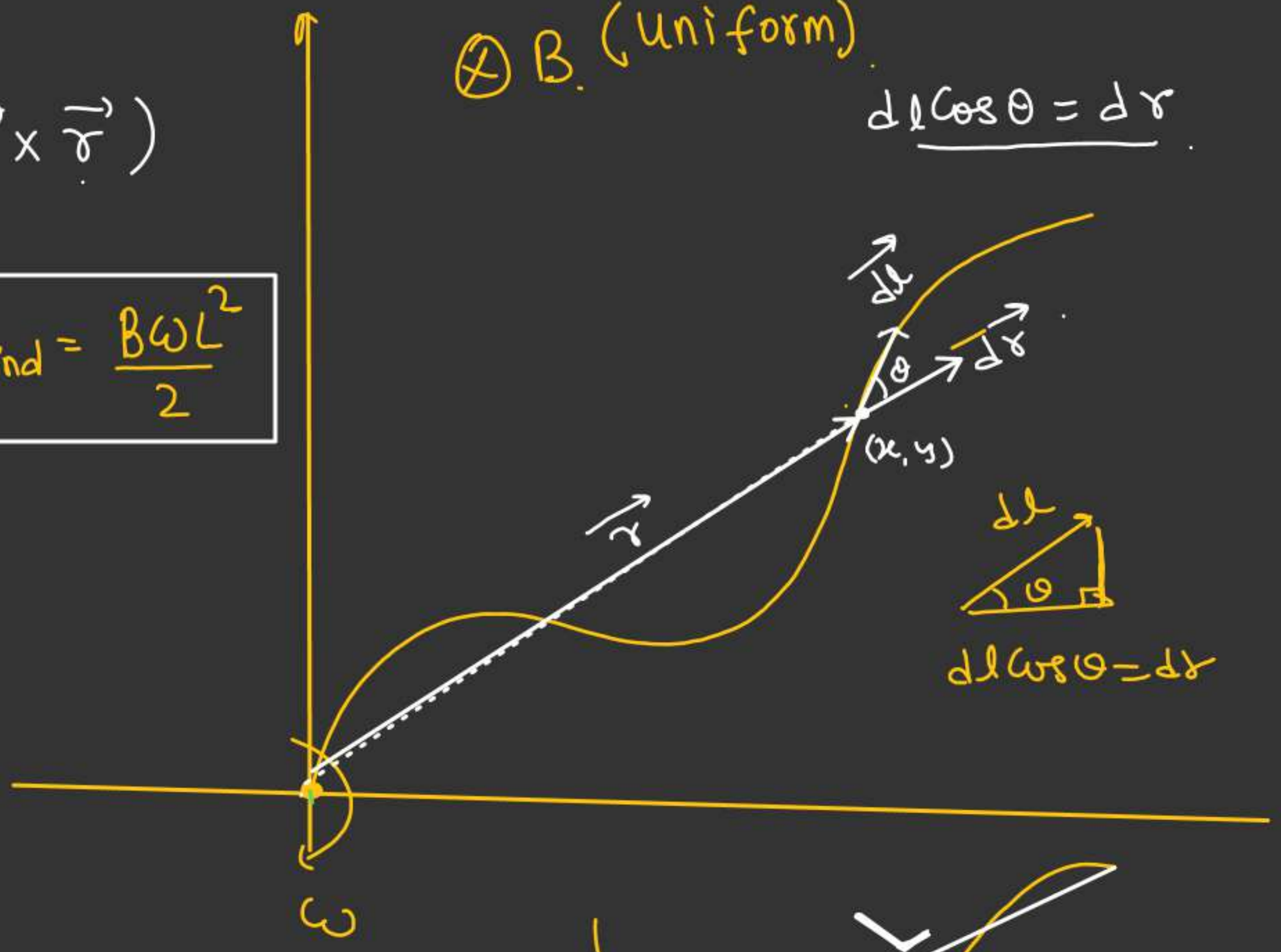
$$\boxed{\mathcal{E}_{ind} = \frac{B\omega L^2}{2}}$$

$$(\vec{v} \times \vec{B}) = [-\omega x \hat{j} + \omega y \hat{i}] \times B(-\hat{k})$$
$$= \omega x B \hat{i} + \omega B y \hat{j}$$
$$= \omega B (x\hat{i} + y\hat{j})$$

$$\mathcal{E}_{ind} = \int \omega B (x\hat{i} + y\hat{j}) \cdot \vec{dl}$$
$$= \omega B \int \vec{r} \cdot \vec{dl} = \omega B \int r(dl\cos\theta) = \omega B \int_0^L r\,dr$$
$$= \left(\frac{\omega B L^2}{2}\right)$$

⊗ B (uniform)

$dl \cos\theta = dr$



$dl \cos\theta = dr$

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(A) Induced E.M.f due to Rotation of Conducting Rod with Constant velocity

$\phi = B \cdot A$

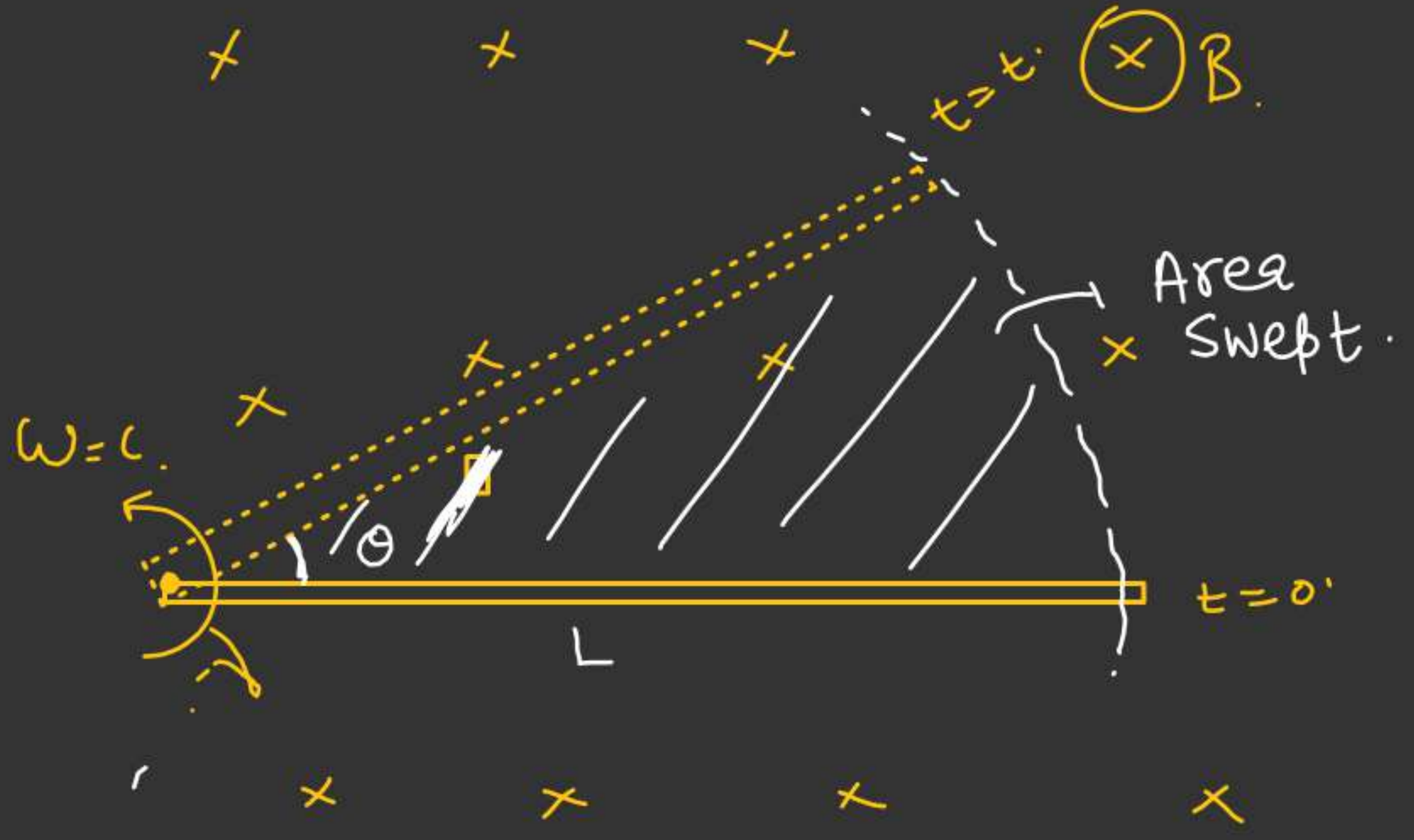
A = Area of the sector

= Area swept by the slider

$= \left(\frac{L^2 \theta}{2}\right)$

$$\phi = \frac{BL^2}{2}\theta$$

$$|\mathcal{E}_{ind}| = \frac{d\phi}{dt} = \frac{BL^2}{2}\overbrace{\left(\frac{d\theta}{dt}\right)}^{\omega}$$



$$\boxed{\mathcal{E}_{ind} = \frac{B\omega L^2}{2}}$$

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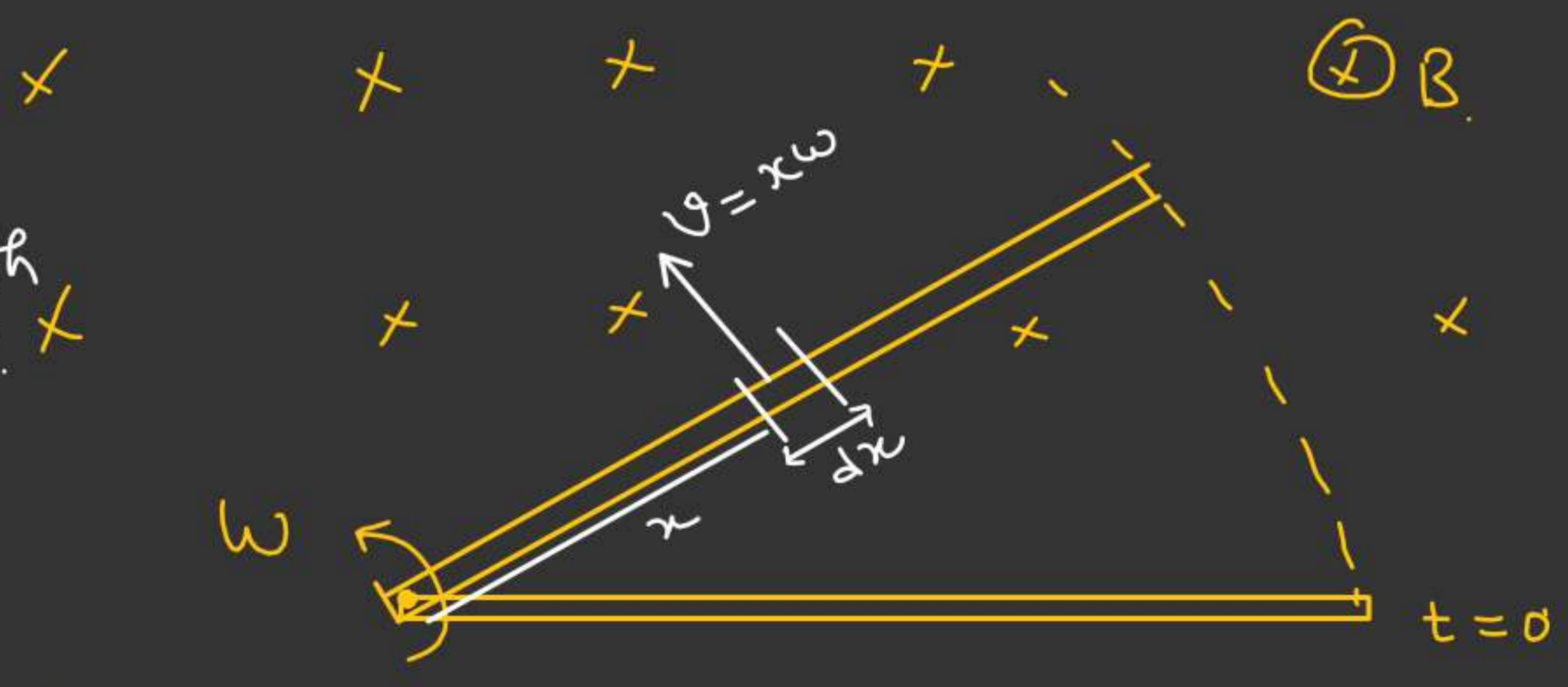
S.Q.

$d\mathcal{E} \rightarrow$ be the induced e.m.f in dx length of the conductor.

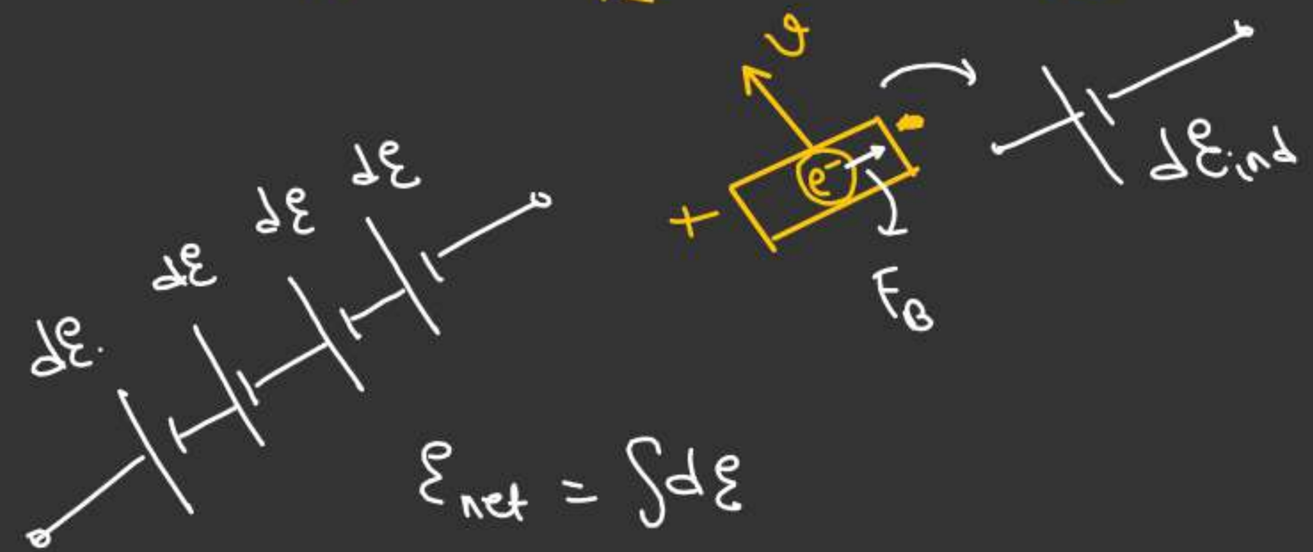


$$d\mathcal{E} = B\,dx\,v$$

$$d\mathcal{E} = B\,dx\,(x\omega)$$

$$\int_0^{\mathcal{E}_{ind}} d\mathcal{E} = B\omega \int_0^{L} x\,dx$$

$$\boxed{\mathcal{E}_{ind} = \frac{B\omega L^2}{2}}$$



$$\underline{\mathcal{E}_{net} = \int d\mathcal{E}}$$

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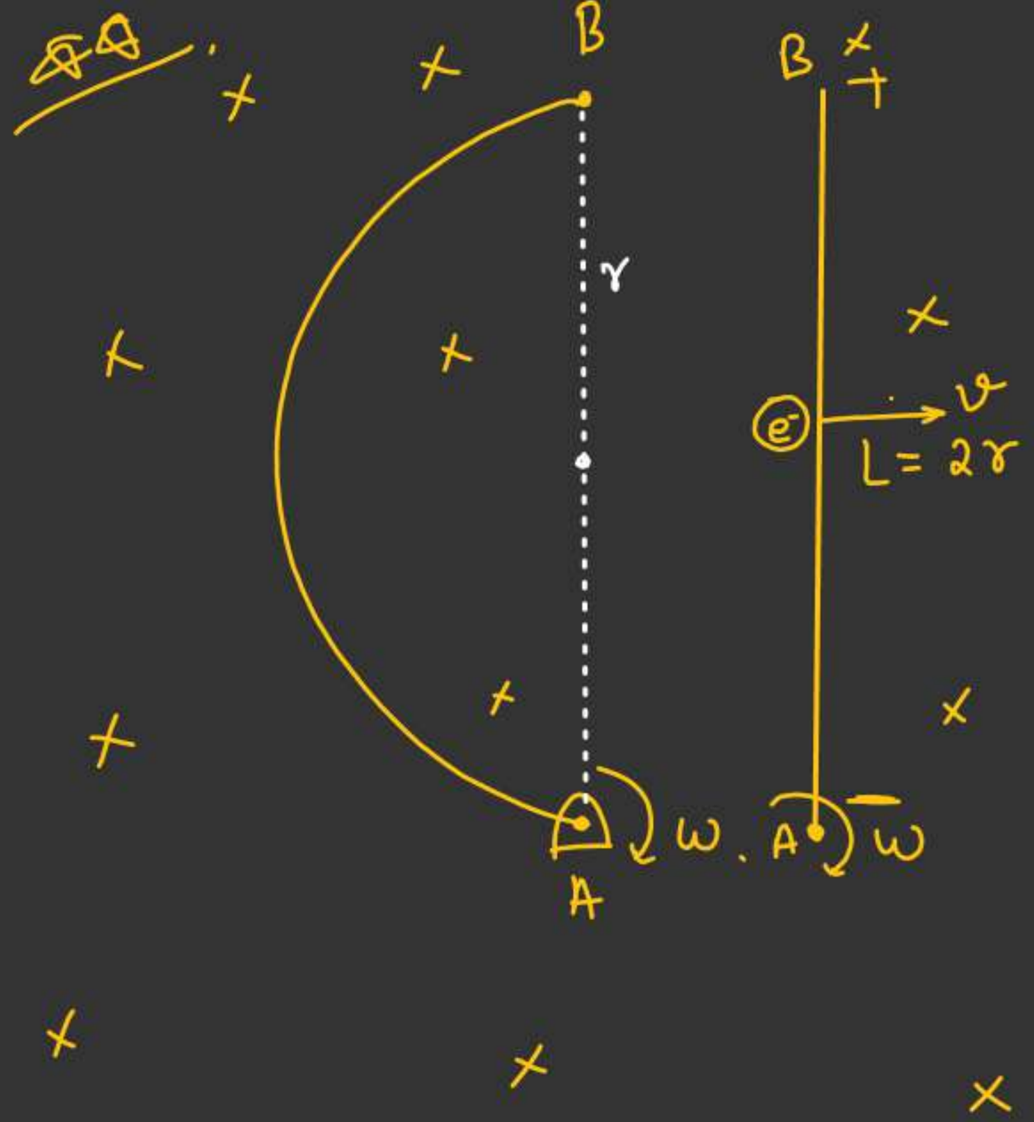

$$V_B - V_A = \frac{B\omega(2r)^2}{2}$$

$$= \underline{2B\omega r^2}$$

$$V_A - V_B = -2B\omega r^2$$

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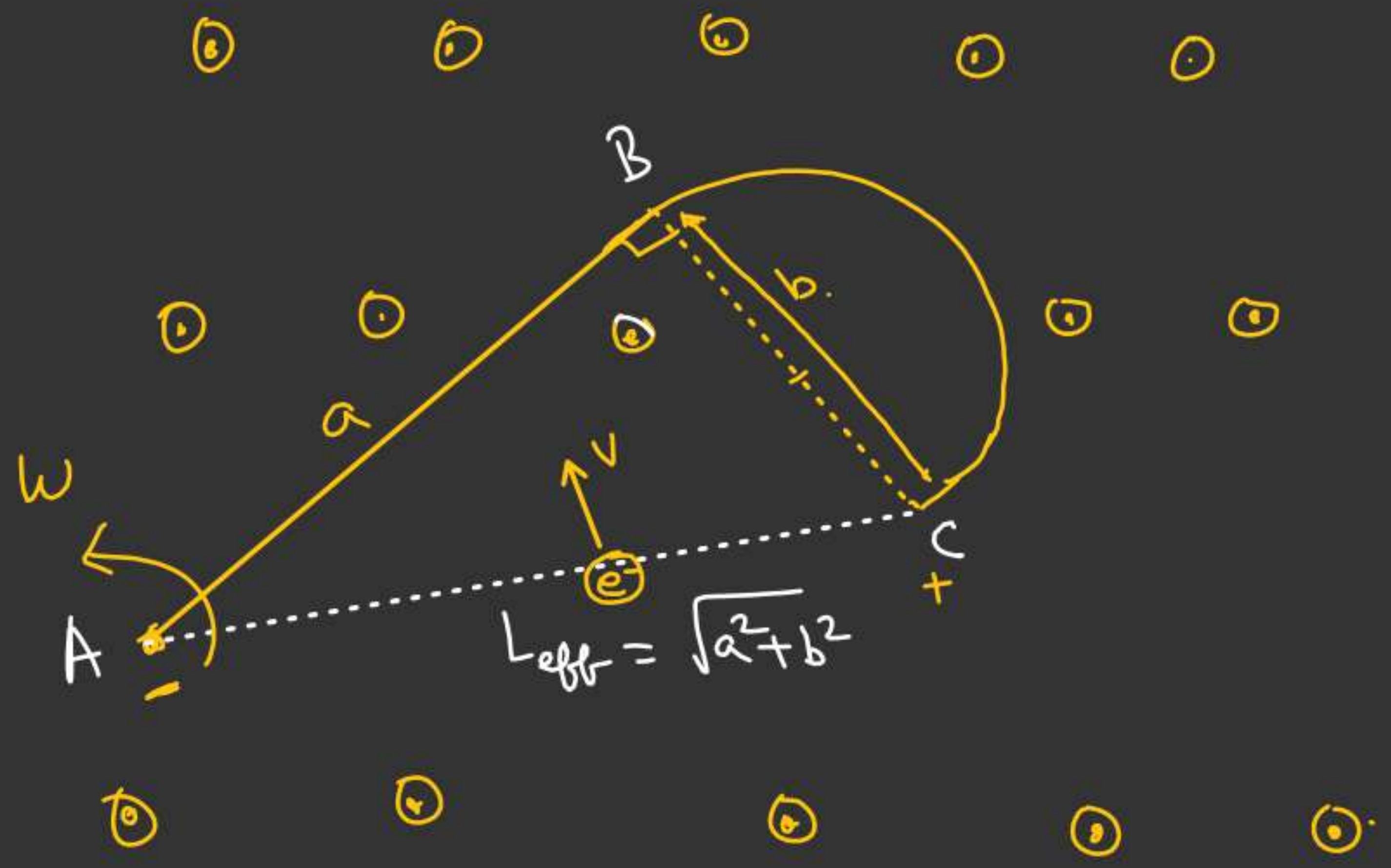
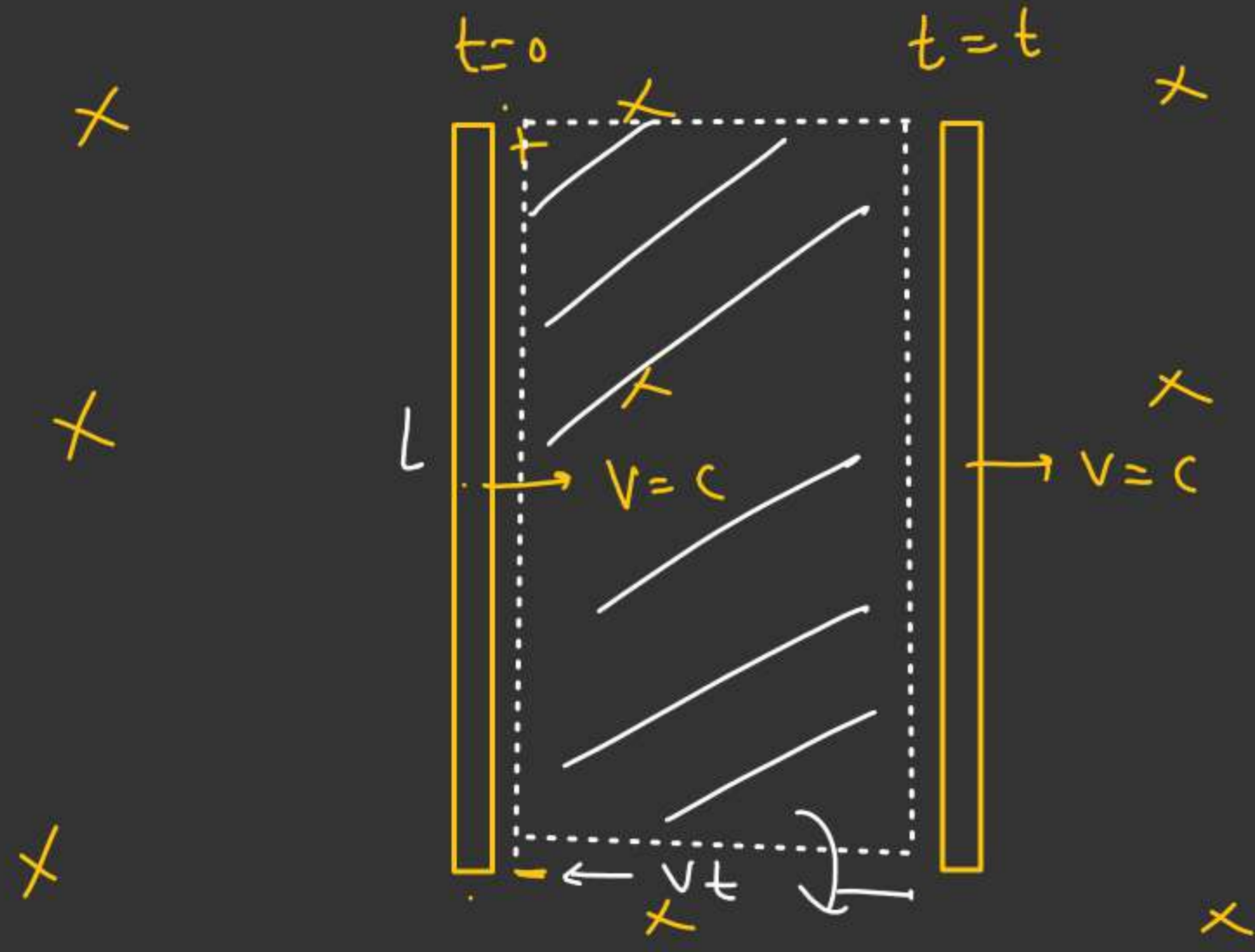
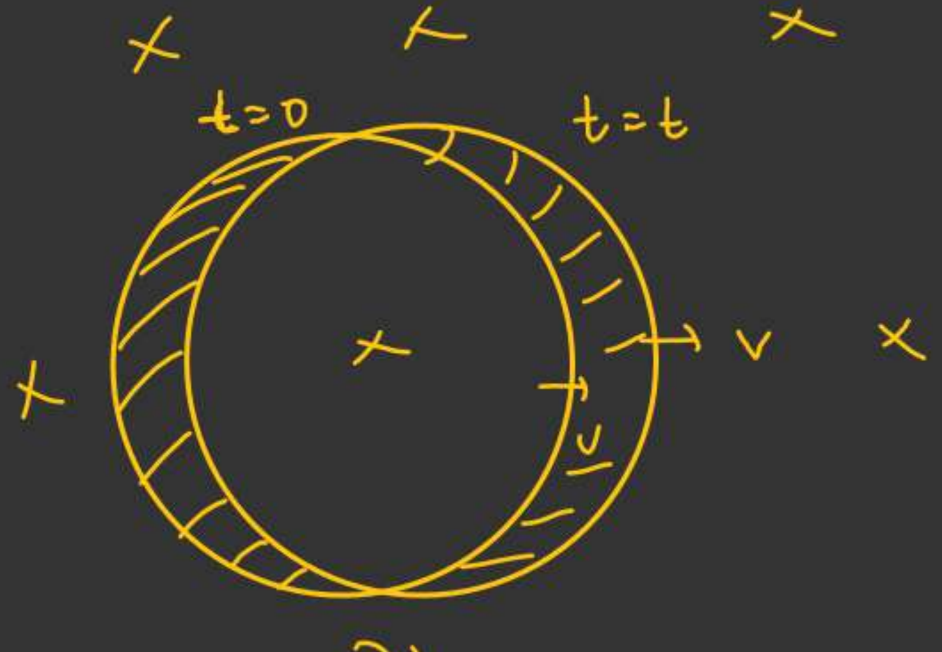


$$\underline{V_A - V_c = ??}$$

$$V_c - V_A = \frac{B\omega}{2}(a^2+b^2)$$

$$V_A - V_c = -\frac{B\omega(a^2+b^2)}{2}.$$





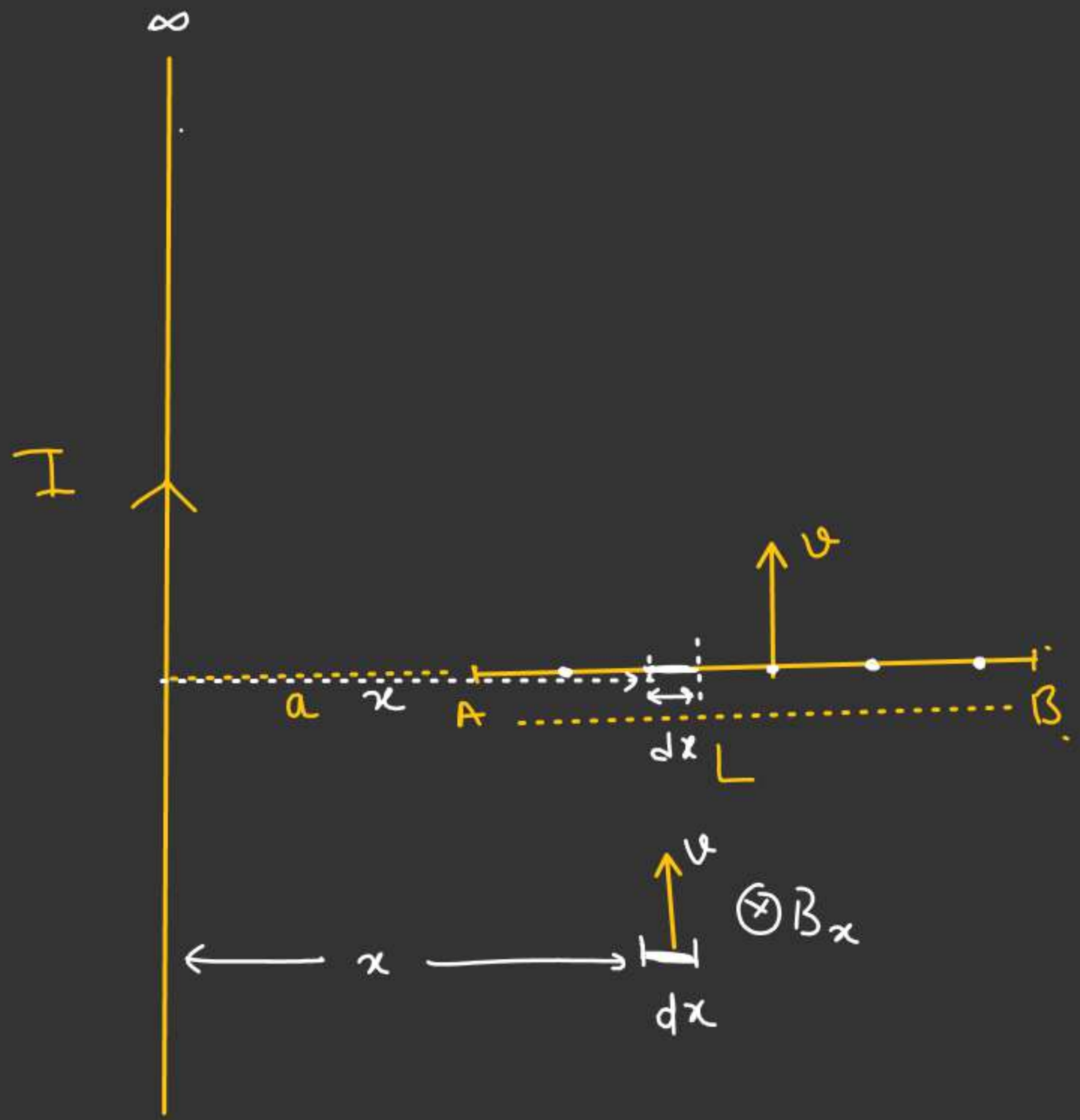
Net Swept Area = 0.
$\varepsilon_{ind} = 0$.

<u>Area Swept</u>

$$\phi = (LVt)B.$$

$$|\varepsilon| = \frac{d\phi}{dt} = \underline{BLV}.$$

(A)



$V_A - V_B = ??$

$$d\mathcal{E}_{ind} = B_x\, dx\, v$$

$$d\mathcal{E}_{ind} = \frac{\mu_0 I v}{2\pi x}\, dx$$

$$\int_{V_A}^{V_B} d\mathcal{E}_{ind} = \frac{\mu_0 I v}{2\pi} \int_{a}^{a+L} \frac{dx}{x}$$

$$V_B - V_A = \frac{\mu_0 I v}{2\pi} \ln\left(\frac{a+L}{a}\right)$$

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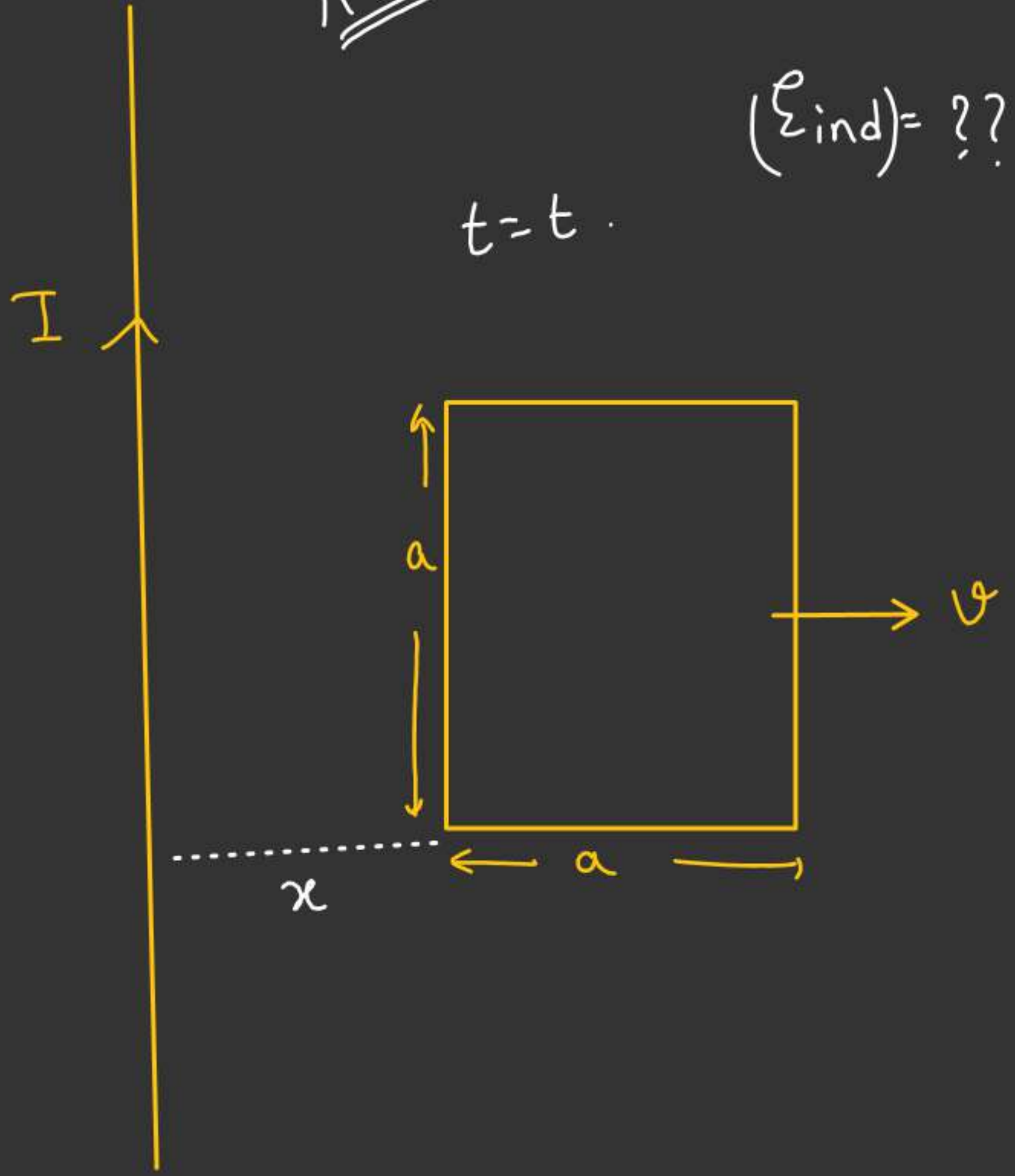
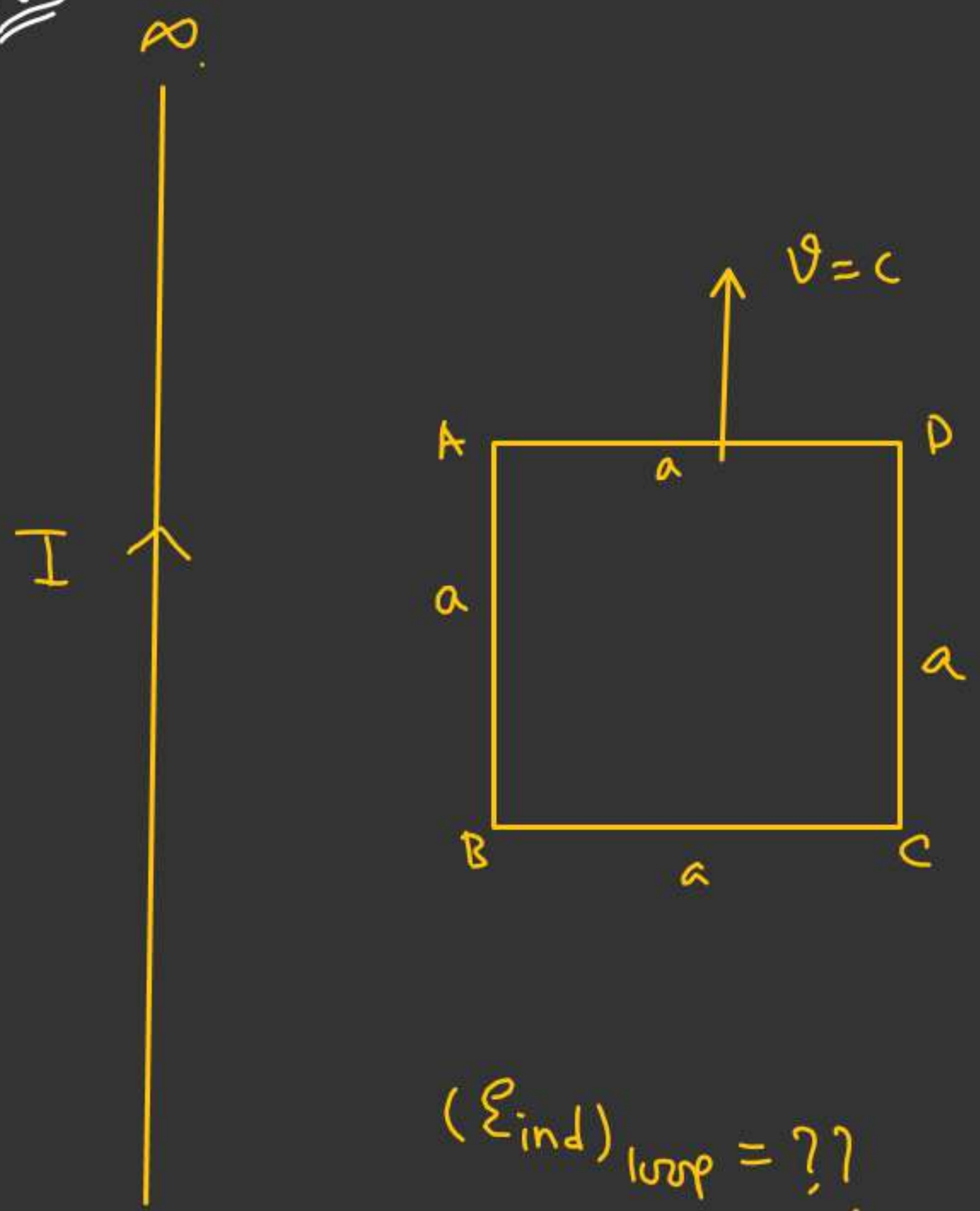
H.W !

$(\mathcal{E}_{ind}) = ??$

$t = t$.



H.W



$(\mathcal{E}_{ind})_{loop} = ??$