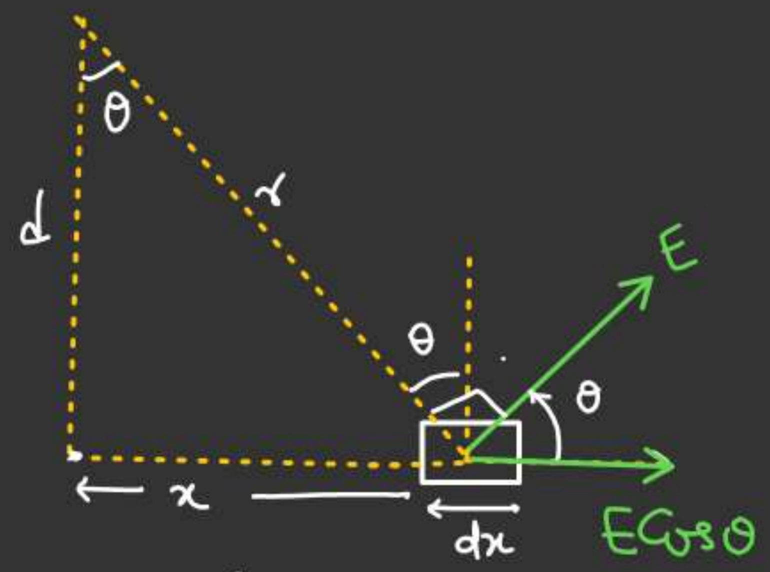
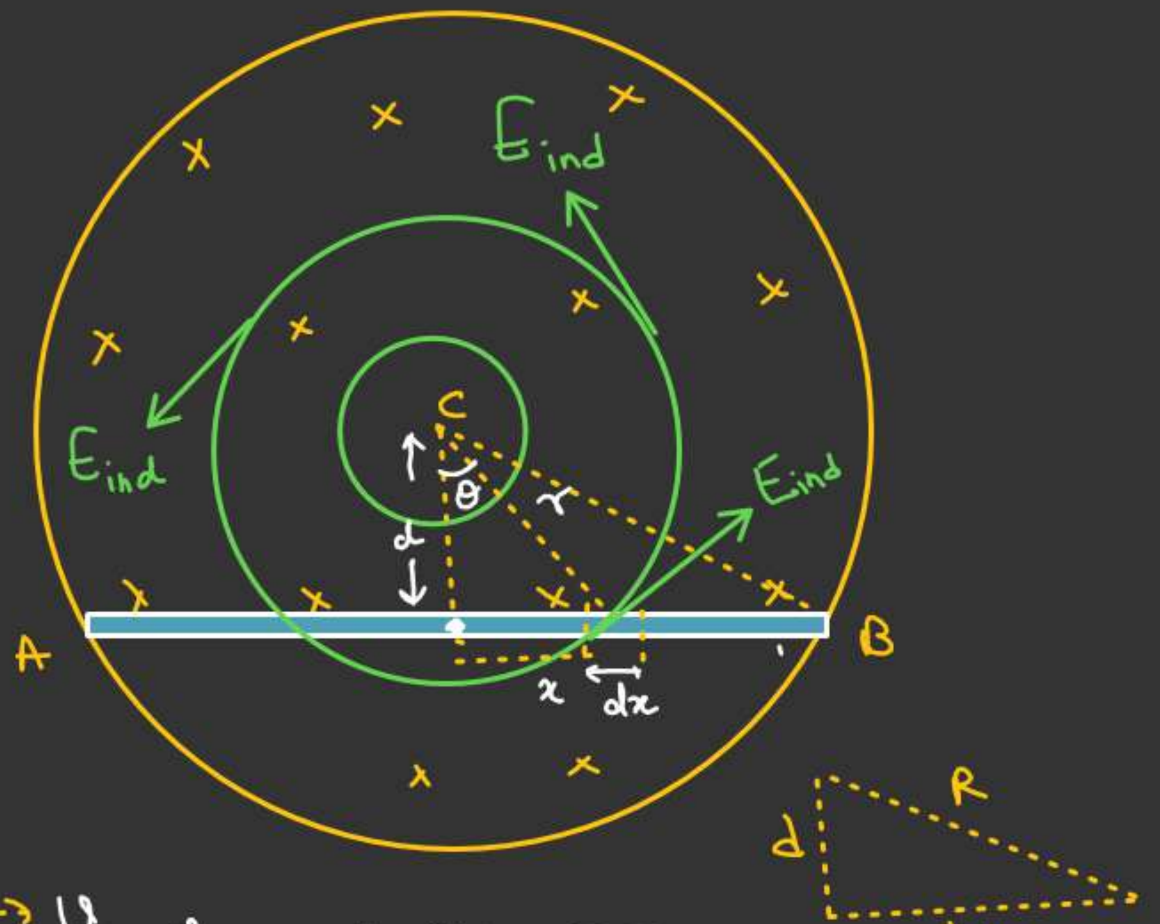
Nishant Jindal

Magnetic field in the Circular zone of radius R Changing at a Constant rate $\left(\frac{dB}{dt}\right)$. Find induced emf across the rod.



$r\cos\theta = d$



$$E_{ind} \cdot \oint dl = -\pi r^2 \frac{dB}{dt}$$

$$E_{ind}(2\pi r) = -\pi r^2 \frac{dB}{dt}$$

$$|E_{ind}| = \frac{r}{2}\left(\frac{dB}{dt}\right).$$

$$d\mathcal{E}_{ind} = (E\cos\theta)\,dx$$

$$= \frac{r}{2}\left(\frac{dB}{dt}\right)\cos\theta \cdot dx$$

$$\int_{V_A}^{V_B} d\mathcal{E}_{ind} = \frac{1}{2}\left(\frac{dB}{dt}\right)\cdot(r\cos\theta)\cdot dx = \frac{d}{2}\left(\frac{dB}{dt}\right)\cdot\int_{-l/2}^{+l/2} dx$$

$$V_B - V_A = \frac{d}{2}\left(\frac{dB}{dt}\right)L.$$

$$d = \sqrt{R^2 - \frac{L^2}{4}}$$

$$V_B - V_A = \frac{L}{2}\left(\frac{dB}{dt}\right)\sqrt{R^2 - \frac{L^2}{4}}$$

$$V_B - V_A = \frac{L}{4}\frac{dB}{dt}\sqrt{4R^2 - L^2}$$

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M-2.

For loop ACB

$$\oint \vec{E}\cdot\vec{dl}$$

$$\oint \vec{E}\cdot\vec{dl} = A\left(\frac{dB}{dt}\right)$$

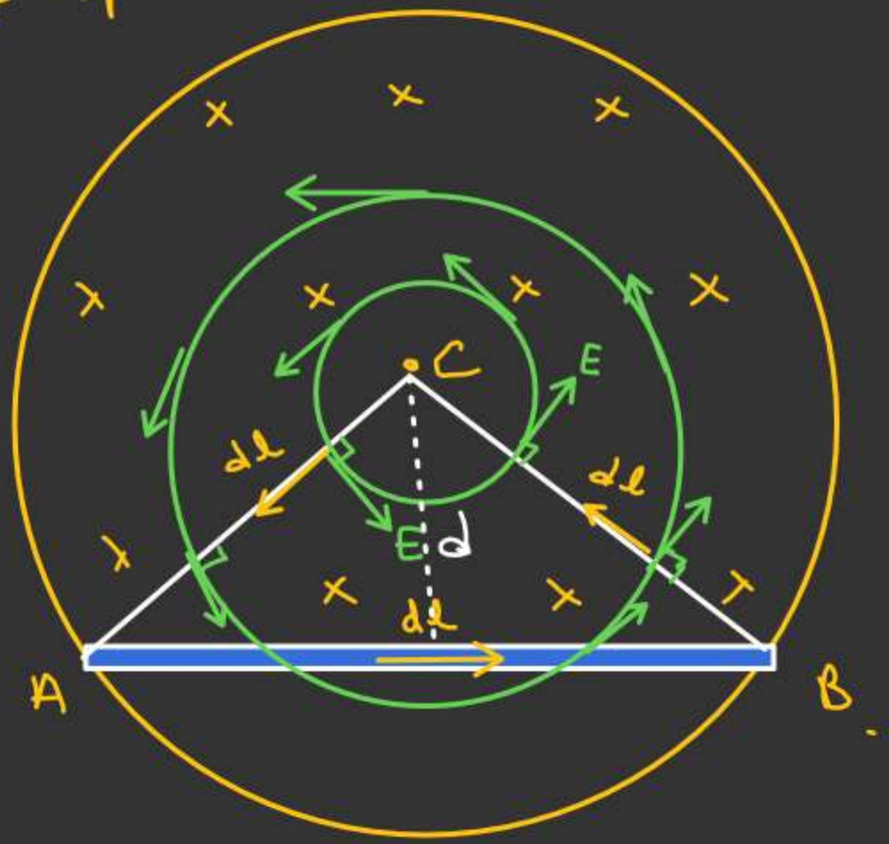
$$\Downarrow$$

$$\int_{AC} \vec{E}\cdot\vec{dl} + \left[\int_{AB} \vec{E}\cdot\vec{dl}\right] + \int_{CB} \vec{E}\cdot\vec{dl} = A\left(\frac{dB}{dt}\right)$$

Area of loop ACB

$\int_{AC}$: $\Downarrow$ 0, $\vec{E} \perp \vec{dl}$

$\int_{CB}$: $\Downarrow$ 0, $\vec{E} \perp \vec{dl}$.



$$|\mathcal{E}_{ind}| = \left(\frac{1}{2} \times L \times d\right)\left(\frac{dB}{dt}\right)$$

$$= \left(\frac{1}{2} \times L \times \sqrt{R^2 - L^2/4}\right)\cdot\frac{dB}{dt}$$

$$= \left(\frac{L}{4}\sqrt{4R^2 - L^2}\right)\left(\frac{dB}{dt}\right)$$

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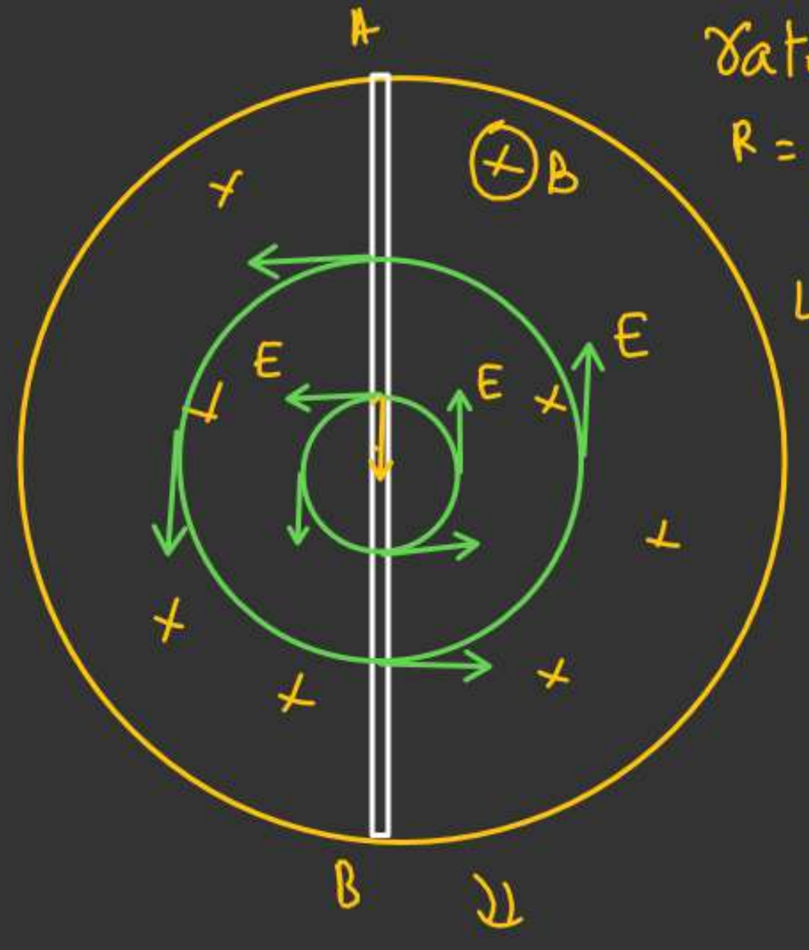
B Changing with constant rate $\left(\frac{dB}{dt}\right)$

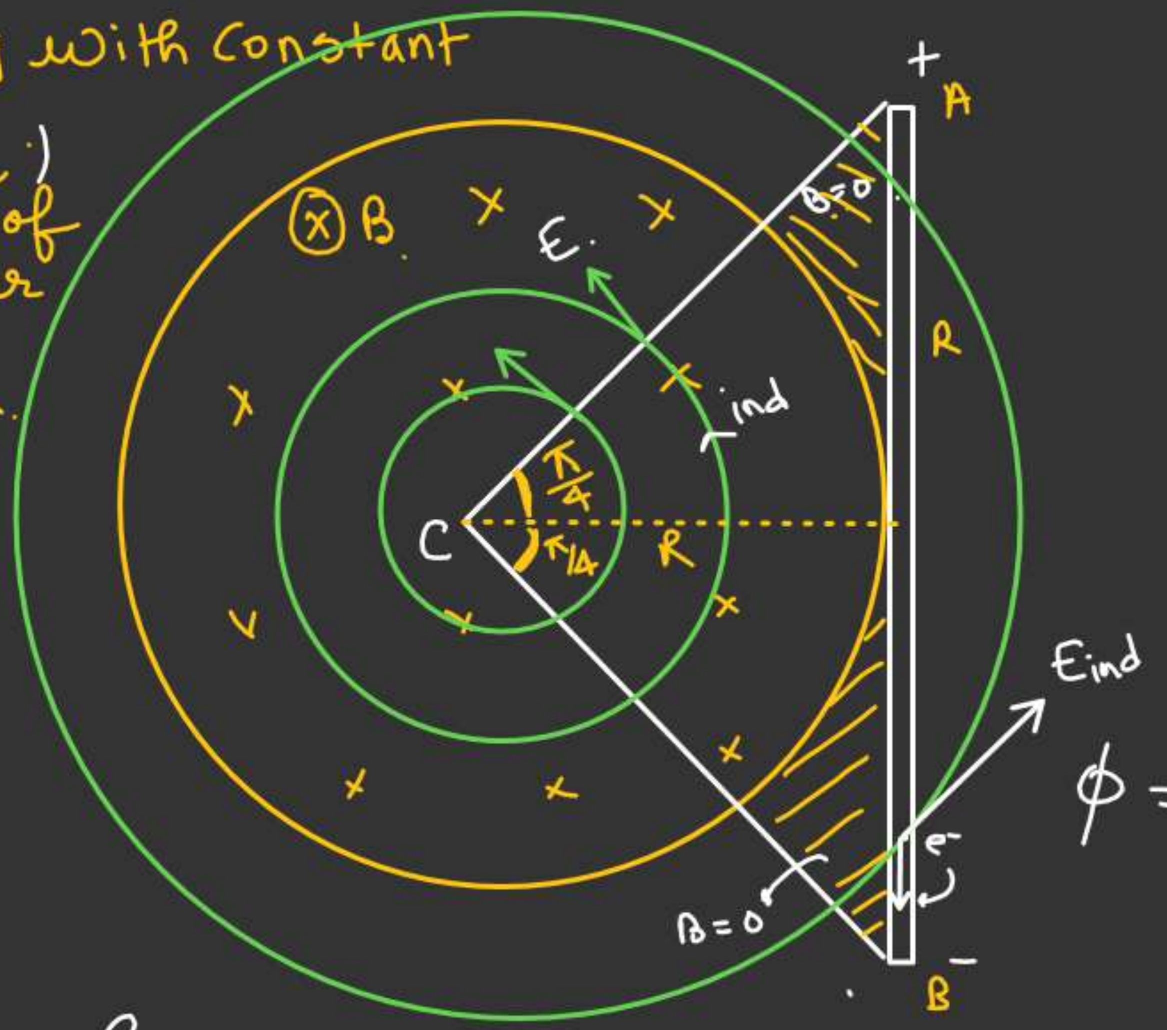
R = Radius of circular zone.

$L_{AB} = 2R$.



$\Downarrow$

$$|V_A - V_B| = 0$$



$\phi = B.A$

$E \rightarrow$ field

$\mathcal{E} \rightarrow$ e.m.f

$$\mathcal{E}_{ind} = A\left(\frac{dB}{dt}\right) = \left(\frac{R^2}{2}\left(\frac{\pi}{4}\right) \times 2\right)\left(\frac{dB}{dt}\right)$$

$\Downarrow$ $\Downarrow$ Area of sector

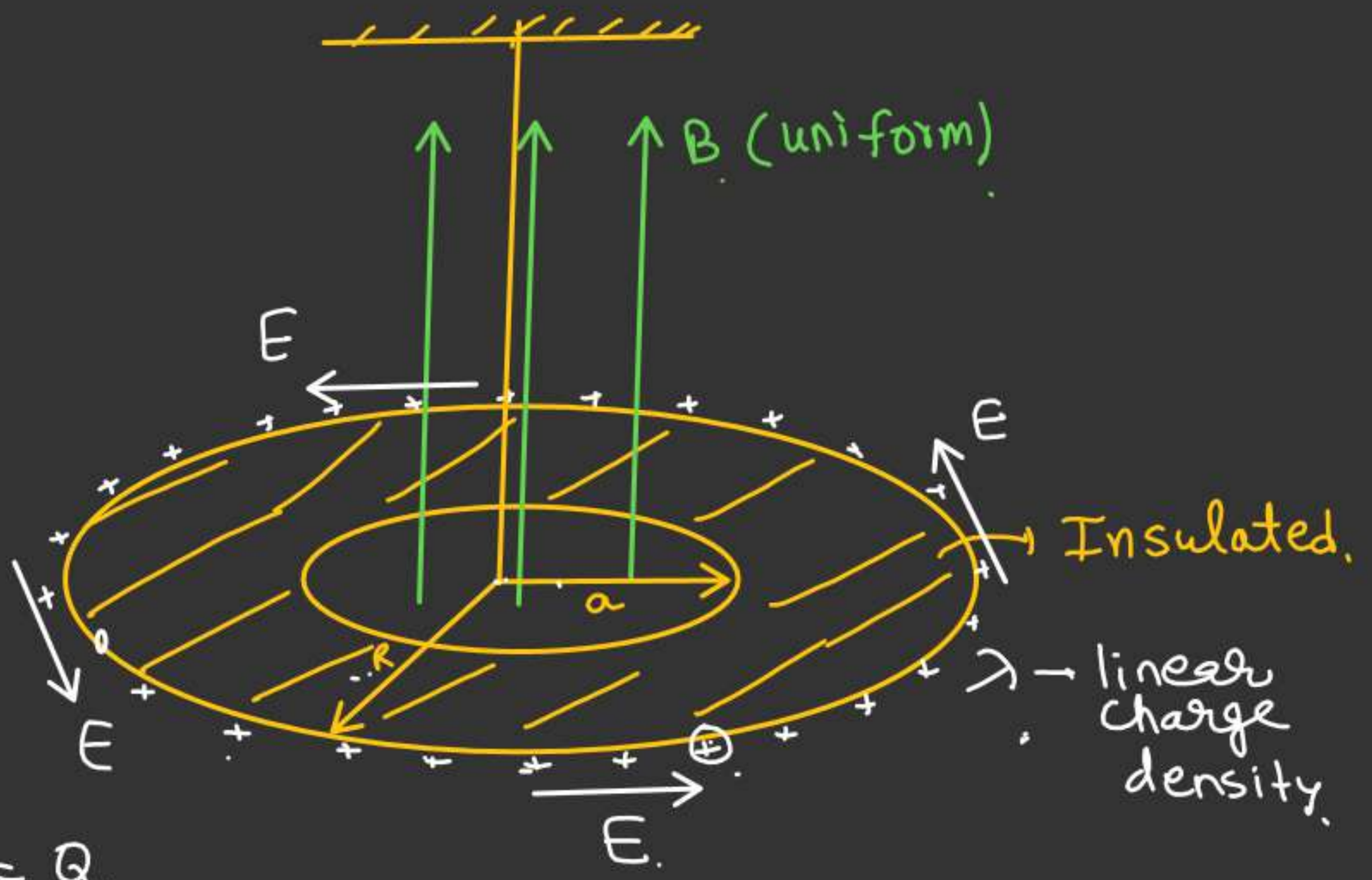
$$(V_A - V_B) = \left(\frac{\pi R^2}{4}\right)\left(\frac{dB}{dt}\right)$$

Nishant Jindal

Find ω of the disc when magnetic field is switch off.

m = mass of disc.

Disc can rotate about the point of suspension.



Sol^n

$$E\, 2\cancel{\pi} R = \cancel{\pi} a^2\left(-\frac{dB}{dt}\right)$$

$$E = \left(\frac{a^2}{2R}\right)\left(-\frac{dB}{dt}\right)$$

$$\lambda \cdot 2\pi R = Q$$

$$F_t = (Q \cdot E) = (\lambda \cdot \cancel{2}\pi \cancel{R})\left(\frac{a^2}{\cancel{2R}}\right)\left(-\frac{dB}{dt}\right)$$

$$F_t = (\lambda \pi a^2)\left(-\frac{dB}{dt}\right)$$

$$\frac{dL}{\cancel{dt}} = \tau = F_t \cdot R = (\lambda \pi a^2 R)\left(-\frac{dB}{\cancel{dt}}\right)$$

$$\tau = \frac{dL}{dt} \Rightarrow \qquad L = I\omega$$

$$L =$$

$$\int_0^L dL = (\lambda \pi a^2 R)\int_B^0 -dB$$

$$L = (\lambda \pi a^2 R B)$$

$$I\omega = \lambda \pi a^2 R B \Rightarrow \left(\omega = \frac{\lambda \pi a^2 R B}{I}\right)$$

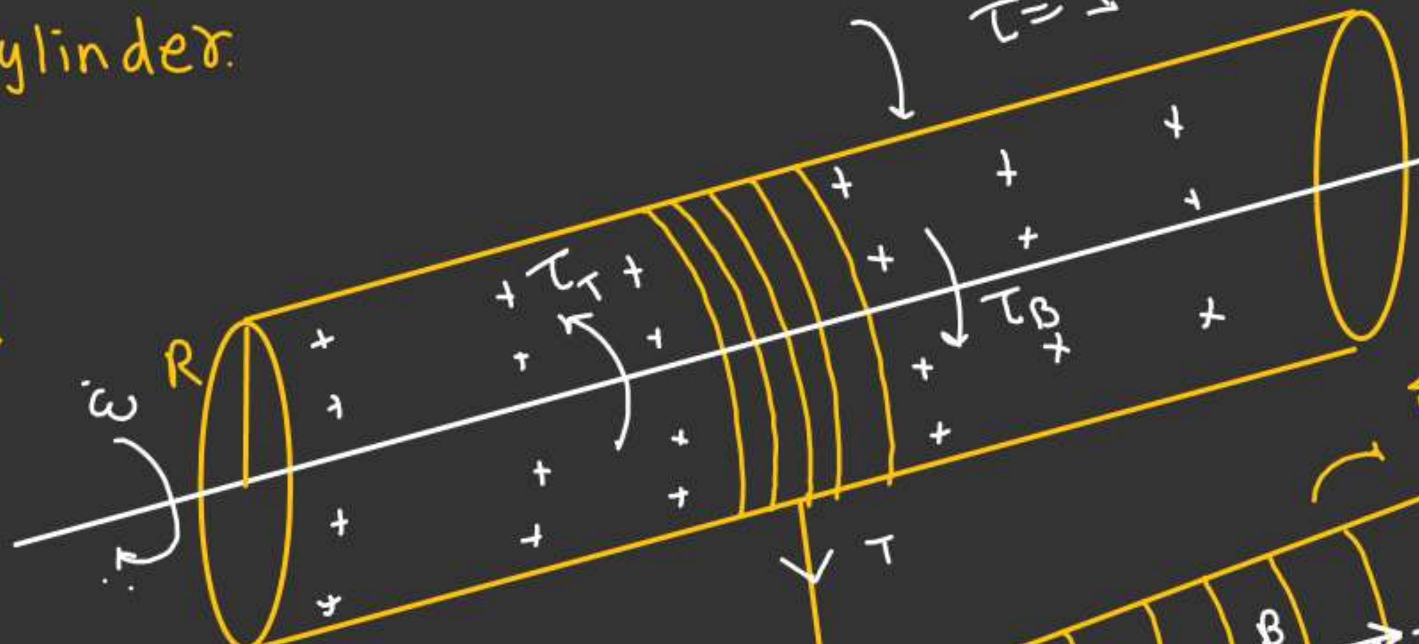
Nishant Jindal

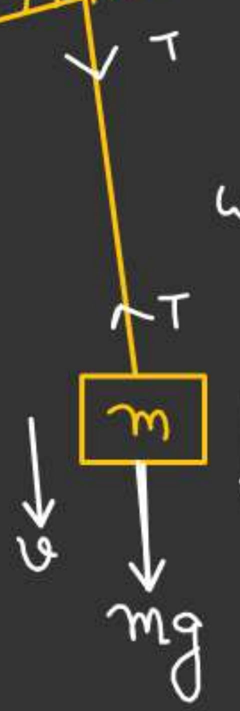
\# Non Conducting light Cylinder having Charge Q uniformly distributed on the Curve Surface of the Cylinder. System is released from rest. Find accleration of block.
Block is Connected by insulated thread Which is Wind ~~on~~ the Cylinder.

Massless

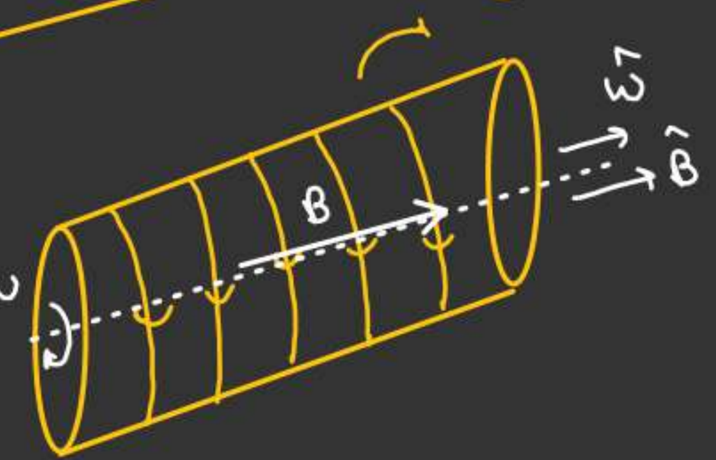
$I = 0$

$\tau = I\alpha = 0$





Solenoid



$$B = \mu_0\left(\frac{N}{L}\right)I \qquad \frac{N}{L} \to 1$$

$$B = \frac{\mu_0}{L} \times \frac{Qa}{2\pi R}t$$

$$B = \left(\frac{\mu_0 Q a}{2\pi R L}\right)t$$

$$v = R\omega$$

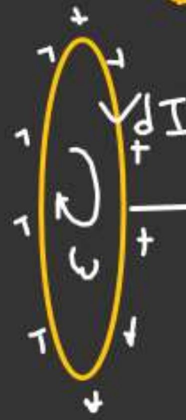
$$v = at$$

$$at = R\omega$$

$$\omega = \left(\frac{at}{R}\right)$$

$$I = \frac{Q}{2\pi} \times \frac{a}{R}t$$

$$I = \left(\frac{Qa}{2\pi R}t\right)$$



$$dI = \frac{dq\,\omega}{2\pi}$$

$\longrightarrow dM$

$$I = \int dI$$

$$I = \frac{\omega Q}{2\pi}$$

$$\int dM = \int dI \cdot \pi R^2$$

$$M = I\pi R^2$$

$$x = R\theta$$

$$\frac{dx}{dt} = R\frac{d\theta}{dt}$$

$$v = R\omega$$

$$a = R\alpha$$

$$\tau_{E_{ind}} = \tau_T$$

$$\Downarrow$$

$$Q \cdot R\, E_{ind} = (T \cdot R)$$

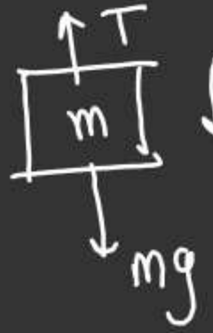
$$QR \cdot \frac{\mu_0 Q a}{4\pi L} = T \cdot R$$

$$\left(\frac{Q^2 \mu_0 \cancel{R}}{4\pi L}\right) a = m(g-a)\cancel{R}$$

$$\frac{Q^2 \mu_0}{4\pi L m} a = (g-a)$$

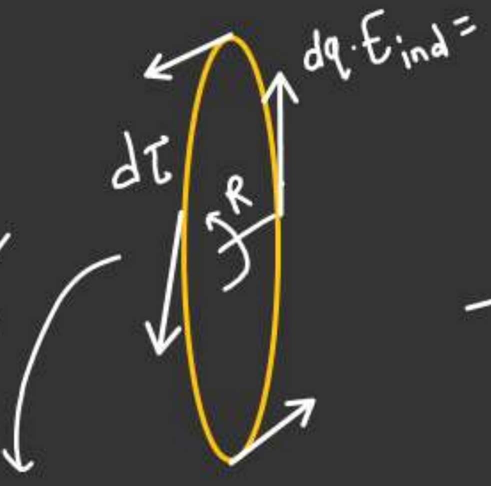
$$a\left(1 + \frac{Q^2 \mu_0}{m 4\pi L}\right) = g$$

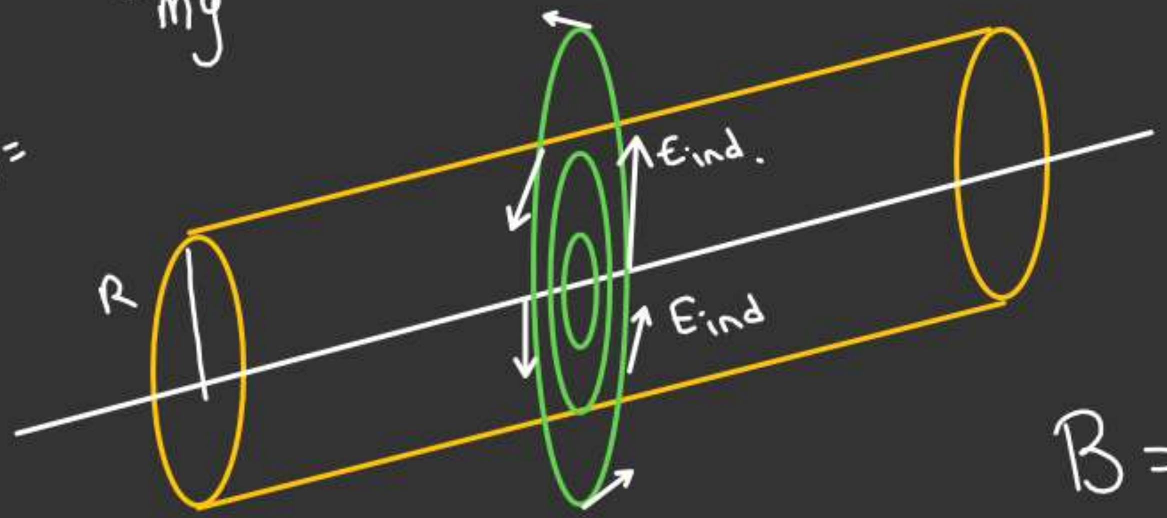
$$a = \left(\frac{g}{1 + \frac{Q^2 \mu_0}{4\pi m L}}\right)$$



$$\Rightarrow mg - T = ma$$

$$T = m(g-a)$$





$$d\tau = (dq \cdot E_{ind}) \cdot R$$

$$\tau_{net} = E_{ind} R \int_0^Q dq$$

$$= (E_{ind} Q) \cdot R$$

$$E_{ind} \cdot 2\cancel{\pi}\cancel{R} = \cancel{\pi} R^{\cancel{2}} \left(\frac{dB}{dt}\right)$$

$$E_{ind} = \frac{R}{2}\left(\frac{dB}{dt}\right)$$

$$E_{ind} = \frac{\cancel{R}}{2} \times \left(\frac{\mu_0 Q a}{2\pi \cancel{R} L}\right) = \left(\frac{\mu_0 Q a}{4\pi L}\right)$$

$$B = \mu_0 n i$$

no of turns per unit length

$$n = \frac{N}{L} \rightarrow 1$$

$$B = \frac{\mu_0 Q a}{2\pi R L} t$$

$$\frac{dB}{dt} = \left(\frac{\mu_0 Q a}{2\pi R L}\right)$$