Nishant Jindal

CURRENT ELECTRICITY

(*) Find resistance → ??

$L = x\theta$

$L = \left(x\frac{\pi}{6}\right)$

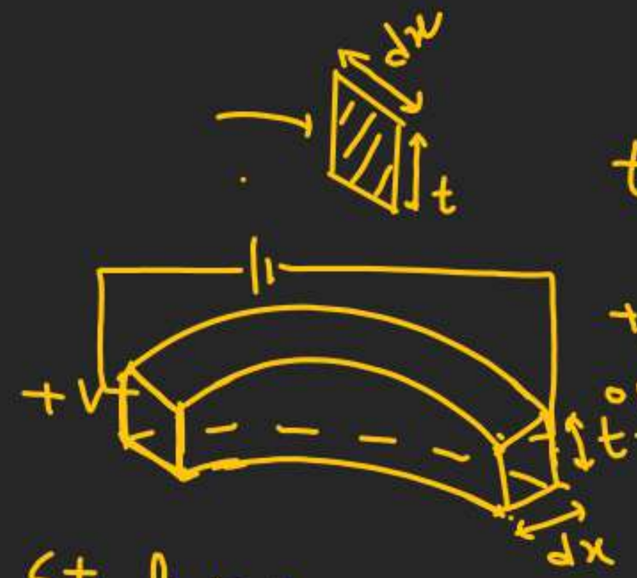
$dR = \left[\frac{\rho(x\,\pi/6)}{t\,dx}\right]$

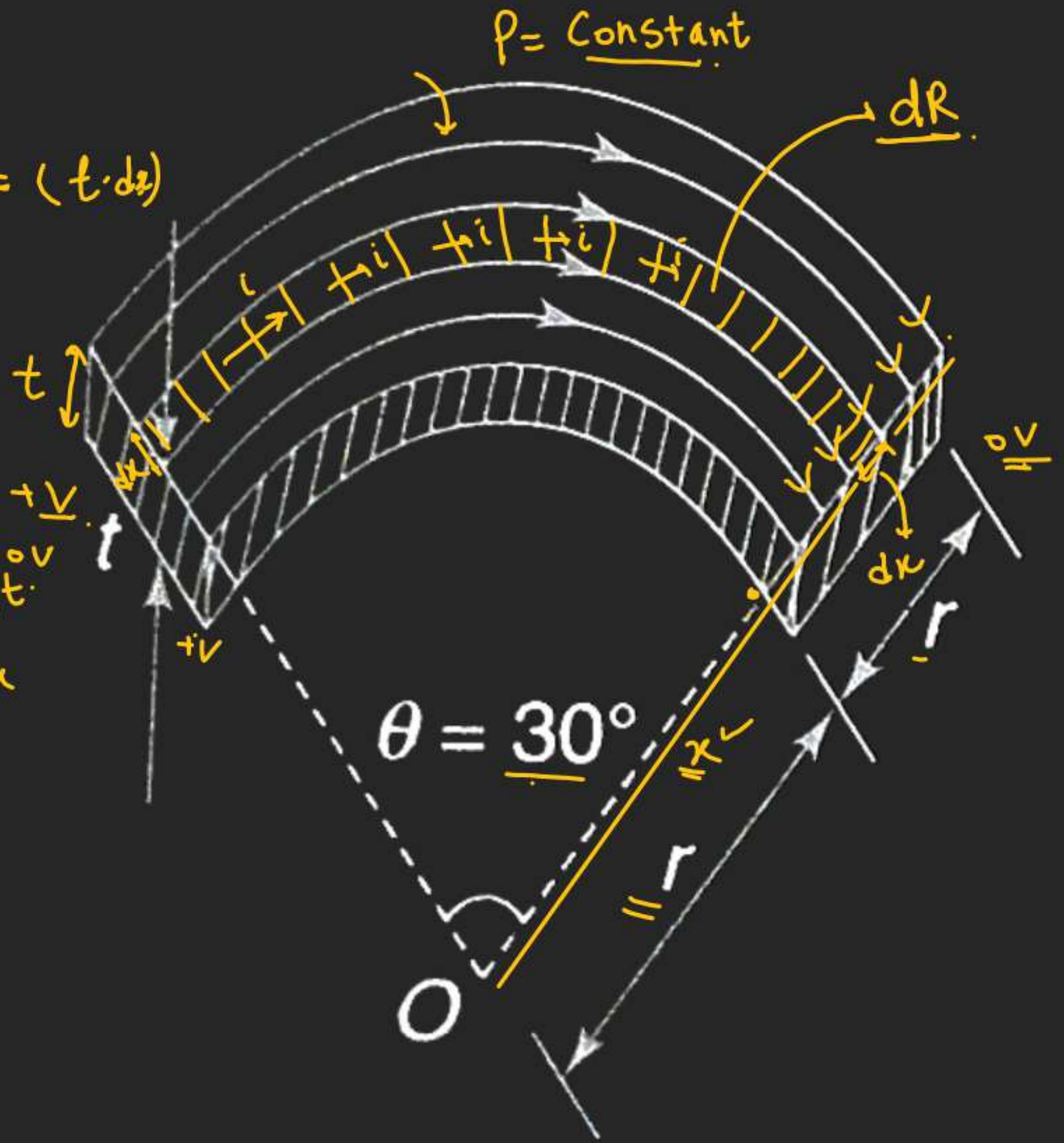
Crossectional area = $(t \cdot dx)$

$\frac{1}{R_{eq}} = \int_{r}^{2r} \frac{1}{dR}$

$\frac{1}{R_{eq}} = \frac{6t}{\rho\pi}\int_{r}^{2r}\frac{dx}{x} \Rightarrow \frac{1}{R_{eq}} = \frac{6t}{\rho\pi}\ln(2)$

$\Rightarrow R_{eq} = \left[\frac{\rho\pi}{6t\ln(2)}\right]$ ✓





CURRENT ELECTRICITY

Find Resitance = ??

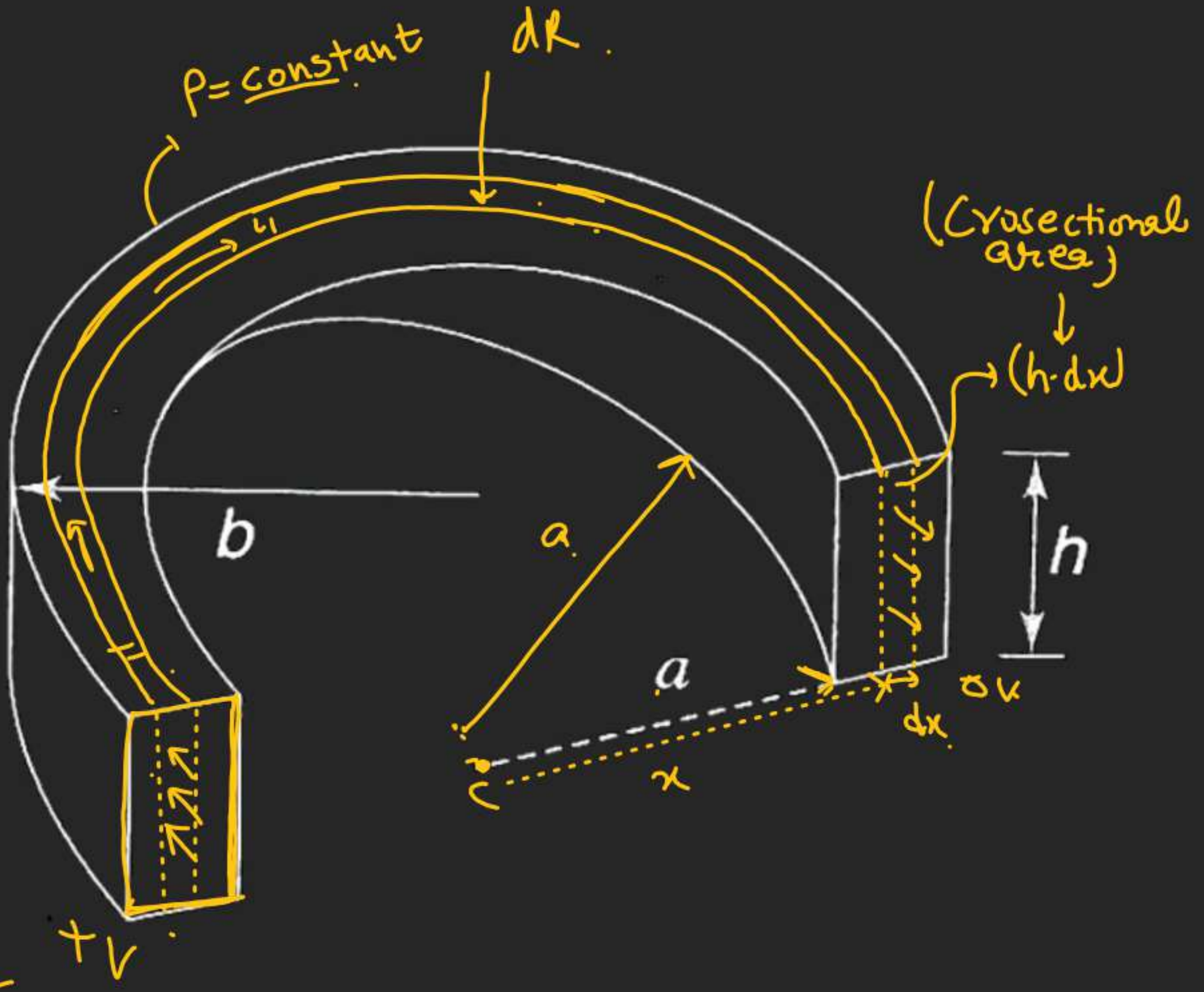
[J = (Current per unit width)]

$$dR = \frac{\rho(\pi x)}{h(dx)}$$

$$\frac{1}{R_{eq}} = \int_a^b \frac{1}{dR}$$

$$\frac{1}{R_{eq}} = \frac{h}{\rho\pi}\int_a^b \frac{dx}{x}$$

$$\frac{1}{R_{eq}} = \frac{h}{\rho\pi}\ln(b/a) \Rightarrow R_{eq} = \frac{\rho\pi}{h\ln(b/a)}$$



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CURRENT ELECTRICITY

Q. Two cylindrical rods, of different material, are joined as shown. The rods have same cross section (A) and their electrical resistivities are ρ_1 and ρ_2. When a current I is passed through the rods, a charge (Q) gets piled up at the junction boundary. Assuming the current density to be uniform throughout the cross section, calculate Q. Under what condition the charge Q is negative?

$I = \left(dq/dt\right)$

$E_1 = \left(\frac{\rho_1 I}{A}\right)$

$E_2 = \left(\rho_2 I/A\right)$

$J = \sigma E$

$J = \left(\frac{E}{\rho}\right)$

J = Constant

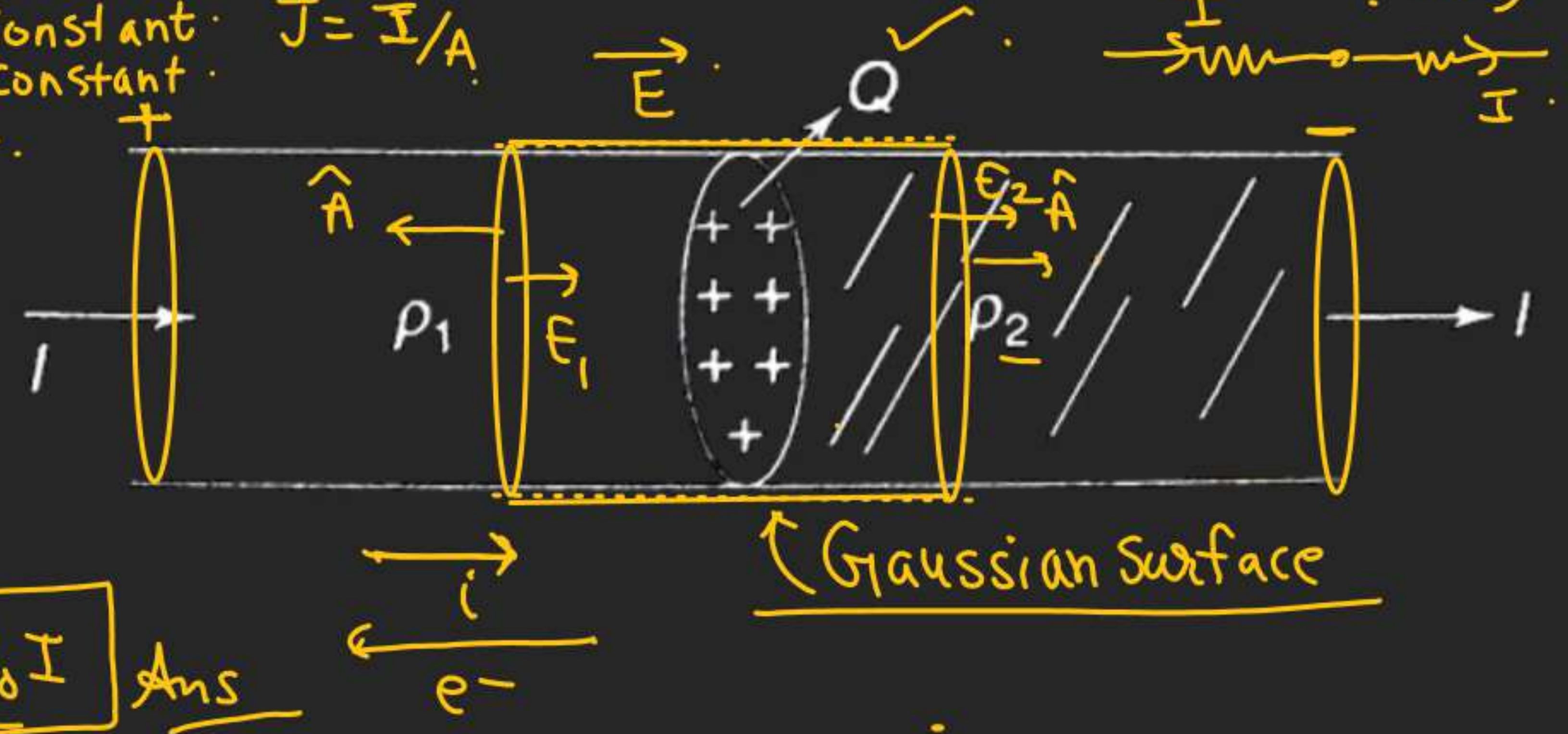
I = Constant

$J = I/A$

$E = \rho J$

$E_1 = \rho_1 J$

$= \rho_2 J$



$-E_1 + E_2 = \frac{Q}{\varepsilon_0 A}$

$-E_1 A + E_2 A = \left(\frac{Q}{\varepsilon_0}\right)$

$-\rho_1 I/\cancel{A} + \rho_2 I/\cancel{A} = \frac{Q}{\varepsilon_0 \cancel{A}} \Rightarrow \boxed{Q = (\rho_2 - \rho_1)\varepsilon_0 I}$ Ans

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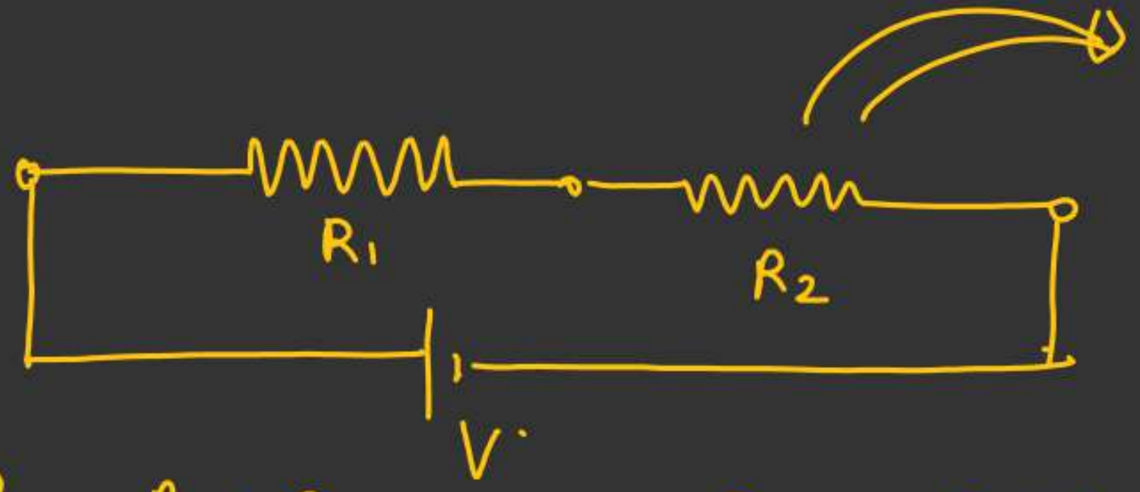
Equivalent Coff^n of resitance in Series Combination :→ (α_{eq})

$$R = R_0(1+\alpha\Delta T)$$

α_1 and α_2 be the coff^n of resistance of R_1 and R_2.



$R_{eq} \rightarrow (\alpha_{eq}) = ??$

$$\underset{\substack{\Downarrow \\ R_{eq}\ \text{at } 0^\circ C}}{R_0} = \underset{\substack{\Downarrow \\ \text{at } 0^\circ C}}{R_{01}} + \underset{\substack{\Downarrow \\ \text{at } 0^\circ C}}{R_{02}}$$

$$R_{eq} = R_1 + R_2$$

$$R_0(1+\alpha_{eq}\Delta T) = R_{01}(1+\alpha_1\Delta T) + R_{02}(1+\alpha_2\Delta T)$$

$$\cancel{R_0} + R_0\alpha_{eq}\Delta T = \cancel{(R_{01}+R_{02})} + (R_{01}\alpha_1\Delta T + R_{02}\alpha_2\Delta T)$$

$$\alpha_{eq} = \left[\frac{R_{01}\alpha_1 + R_{02}\alpha_2}{R_0}\right]$$

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CURRENT ELECTRICITY

(*) ρ = Constant.

Find R = ??

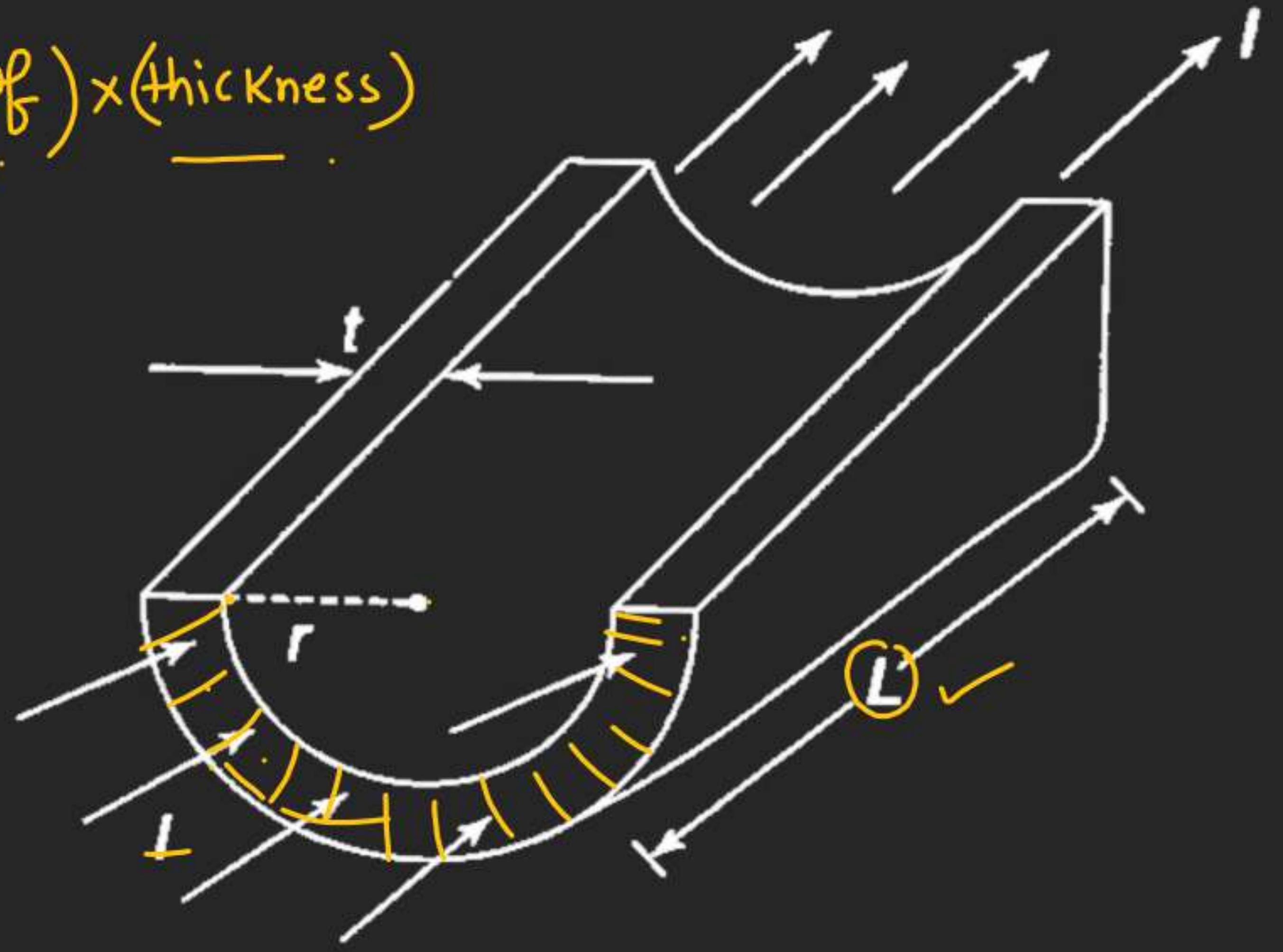
$$\boxed{R = \frac{\rho L}{\pi r t}}$$

$\pi r t = A$

$\Downarrow$

(length of element) × (thickness)

R



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CURRENT ELECTRICITY

(A) $\rho =$ Constant.

$R = ??$

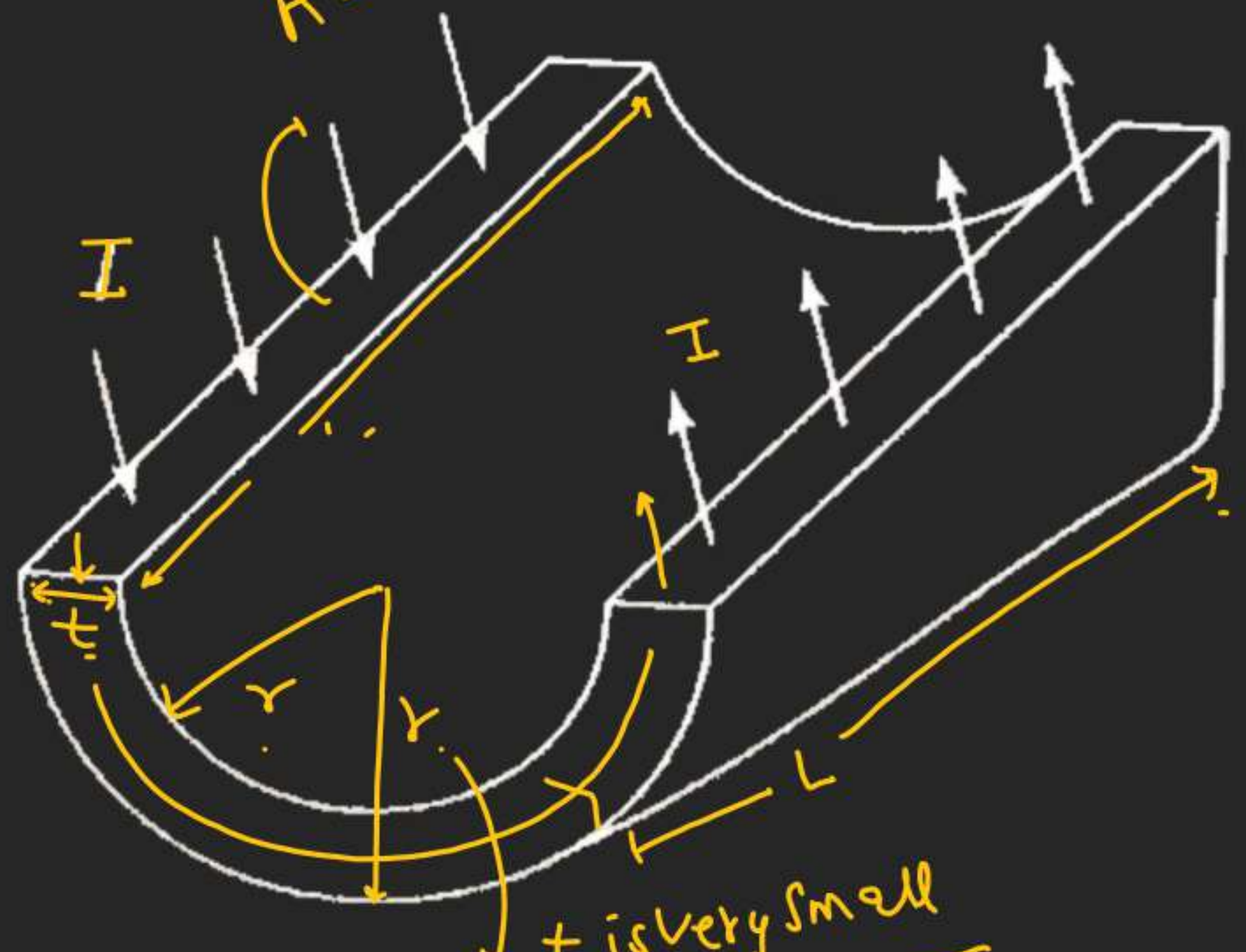
$[r >> t]$ ✓

$$\boxed{R = \frac{\rho(\pi r)}{Lt}}$$

Ans ✓

$L = (\pi r)$

$A = Lt$



t is very small

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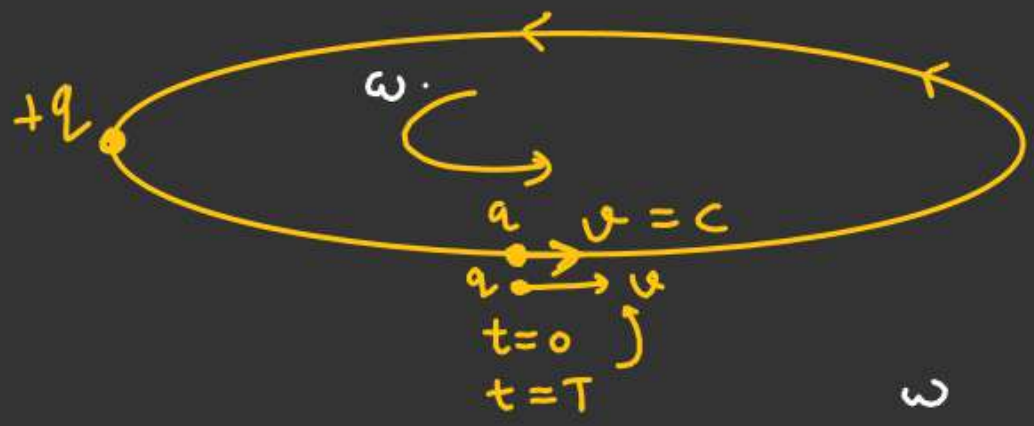
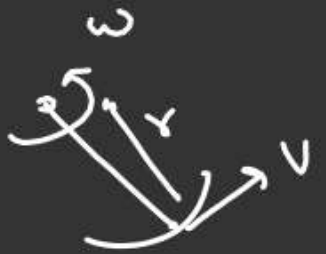
Current due to moving Charge :-





$(v = r\omega)$

$\omega = \frac{2\pi}{T} = 2\pi f$

$T = \frac{2\pi}{\omega}$

Current associated with this moving charge.

$$I = \frac{q}{T}.$$

$$I = \frac{q}{\left(\frac{2\pi}{\omega}\right)} = \left(\frac{q\omega}{2\pi}\right) \checkmark$$

$$\boxed{I = \left(\frac{q}{2\pi} \times \frac{v}{r}\right)}$$

$$I = \frac{qv}{2\pi r} \checkmark$$

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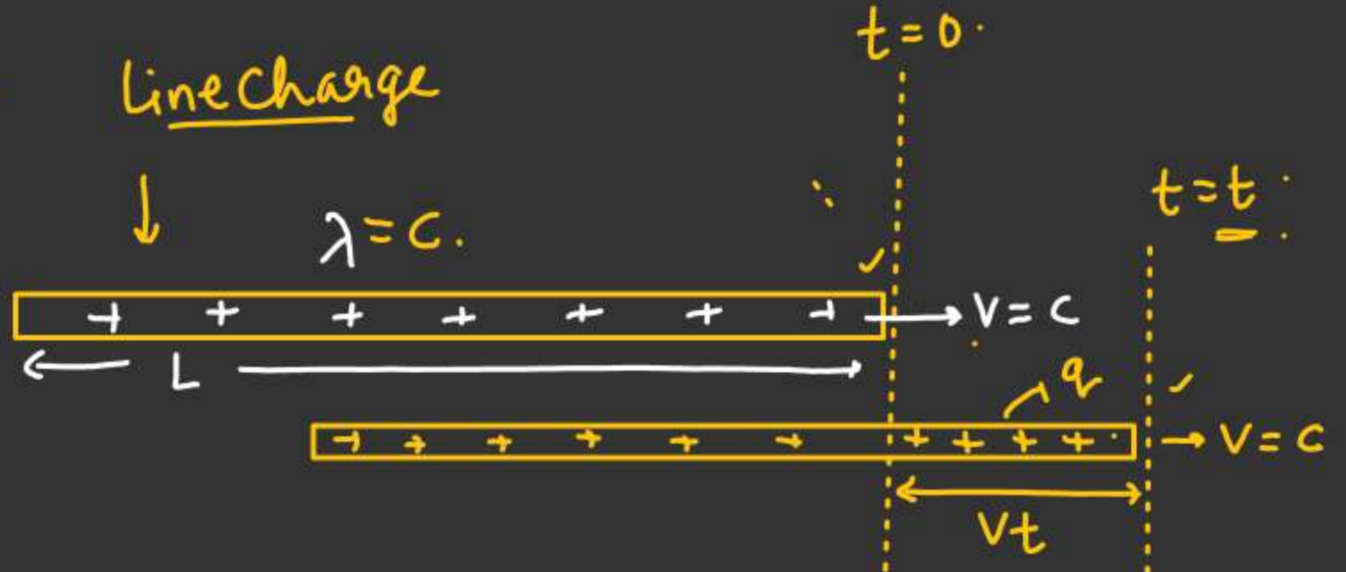
Line Charge



In the interval $t = 0$ to $t = t$

Charge flow $= (\lambda v t)$

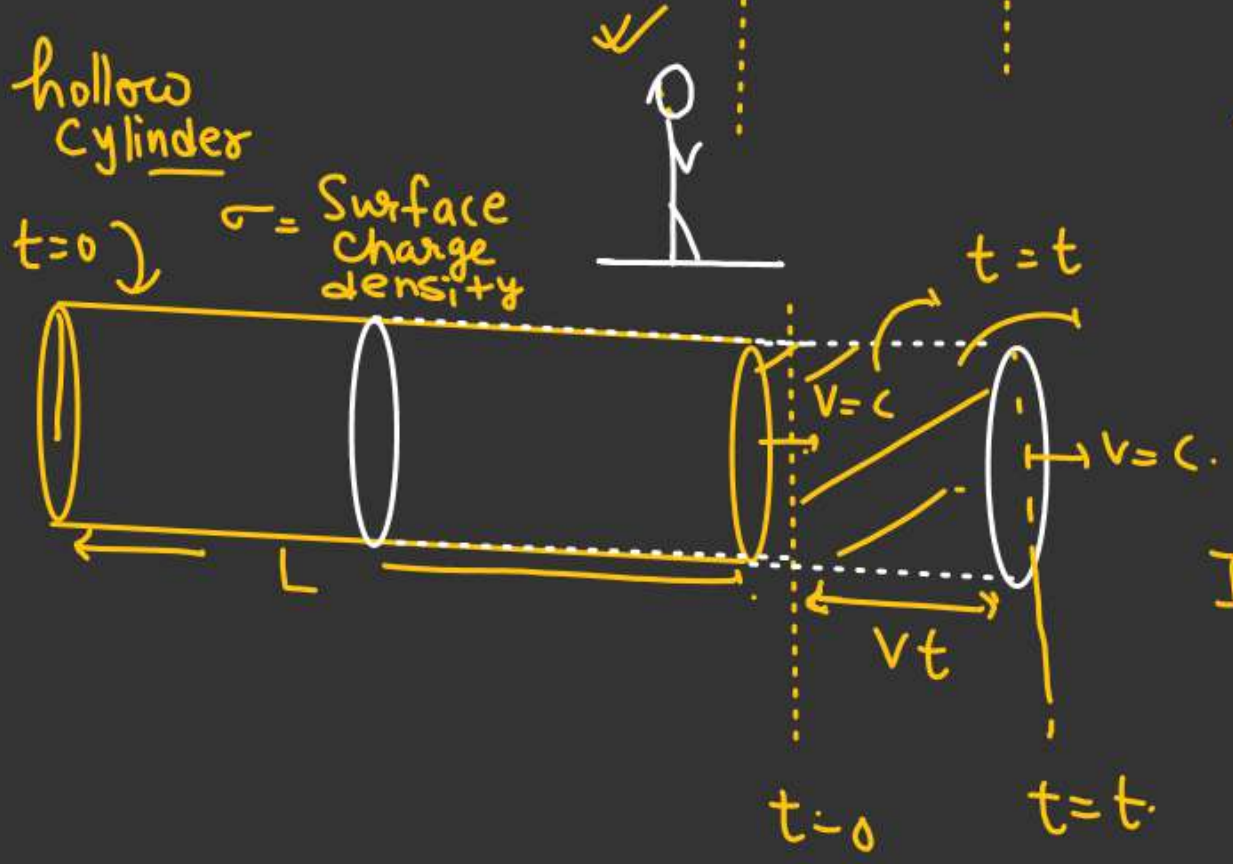
$$q = \lambda v t$$

$$i_{avg} = \frac{q}{t} = (\lambda v)$$

$L >> r$

hollow cylinder

σ = Surface charge density



$$Q = (2\pi r L)\sigma$$

(Total Charge)

$$\lambda = \frac{Q}{L} = (\sigma . 2\pi r)$$

$$q = \lambda v t$$

$$I = \left(\frac{q}{t}\right) = (\lambda v)$$

$$I = \lambda v = (\sigma . 2\pi r) v$$