⇒ Now

$$\left(\frac{\Delta I}{\Delta S}\right) = \rho_v \, v_x$$

$$\boxed{J = \rho_v \, v_x}$$

$\perp$er to ref. plane

ie $\perp$er ~~xz~~ plane

ie $\hat{a_x}$.

In general

~~$\rho_v \bar{v}$~~

$$\boxed{\bar{J} = \rho_v \bar{V}}$$

$v_x\hat{a_x} + v_y\hat{a_y} + v_z\hat{a_z}$

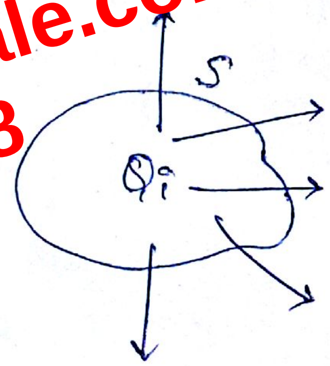
$J_x\hat{a_x} + J_y\hat{a_y} + J_z\hat{a_z}$

So $\boxed{J_x = \rho_v v_x}$ $\quad$ |ly $\boxed{J_y = \rho_v v_y}$ $\quad$ |ly $\boxed{J_z = \rho_v v_z}$

Equation of continuity:-

consider a closed surface that encloses Q_i amount of charge.

Let the charge be coming out of S



The total current out of S

$$I = \oint_{surf} J \cdot ds = (-)\frac{dQ_i}{dt}$$

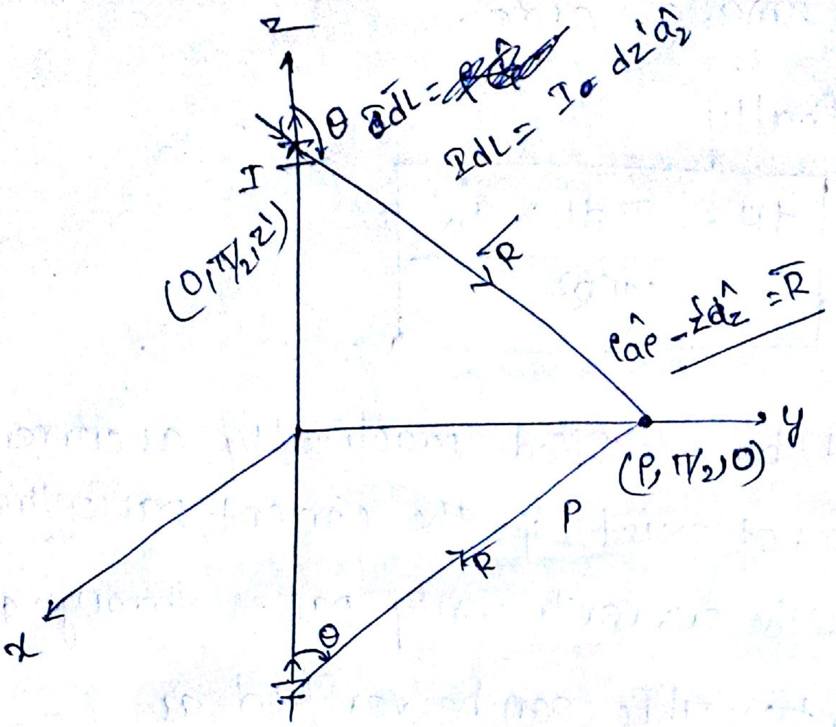
charge still available in surface.

rate at which charge inside is decreasing.

The amount of charge leaving surface is equal to rate at which charge is decreasing inside

Field due to infinite line of current:-

consider a filamental current along z axis



Symmetry analysis:-

1. Field is a function of 'ρ' only. General point to calculate field is $(\rho, \pi/2, 0)$
2. H is along $\hat{a}_\phi$

At P

$$dH = \frac{I(dl \times a_R)}{4\pi R^2}$$

$$dH = \frac{I\left(dz'\hat{a}_z \times \frac{(\rho\hat{a}_\rho - z'\hat{a}_z)}{\sqrt{\rho^2+z'^2}}\right)}{4\pi(\rho^2+z'^2)}$$

$$dH = \frac{I\,dz'\,\hat{a}_\phi\,\rho - 0}{4\pi(\rho^2+z'^2)^{3/2}}$$

$$\oint H_\phi \hat{a}_\phi \cdot (\rho\, d\phi)\hat{a}_\phi = I_{enclosed}$$

$$\int_0^{2\pi} H_\phi\, \rho\, d\phi = I_{enclosed}$$

$$H_\phi \cdot \rho \int_0^{2\pi} d\phi = I_{enclosed}$$

$$H_\phi\, \rho\, (2\pi) = I_{enclosed}$$

$$\boxed{H_\phi = \frac{I_{enclosed}}{2\pi\rho}}$$

$$\underline{H = H_\phi\, \hat{a}_\phi}$$

$$\boxed{\bar{H} = \frac{I_{encl}}{2\pi\rho}\hat{a}_\phi}$$

Alternate method

∴ ~~For~~ the ~~amp~~ Amperian path

$$H \int dL = I$$

$$\bar{H}_\phi = \frac{I}{\int_{H \parallel dL} dL}$$

$$H_\phi = \frac{I}{\int_{H \parallel dL} \rho\, d\phi}$$

$$H_\phi = \frac{I}{\rho \int_{H \parallel dL} d\phi}$$

$$H_\phi = \frac{I}{\rho\,(2\pi)}$$

$$\boxed{H = \frac{I}{2\pi\rho}}$$

$$H_\phi \cdot \hat{a}_\phi = H$$

$$\boxed{H = \frac{I}{2\pi\rho}\hat{a}_\phi}$$