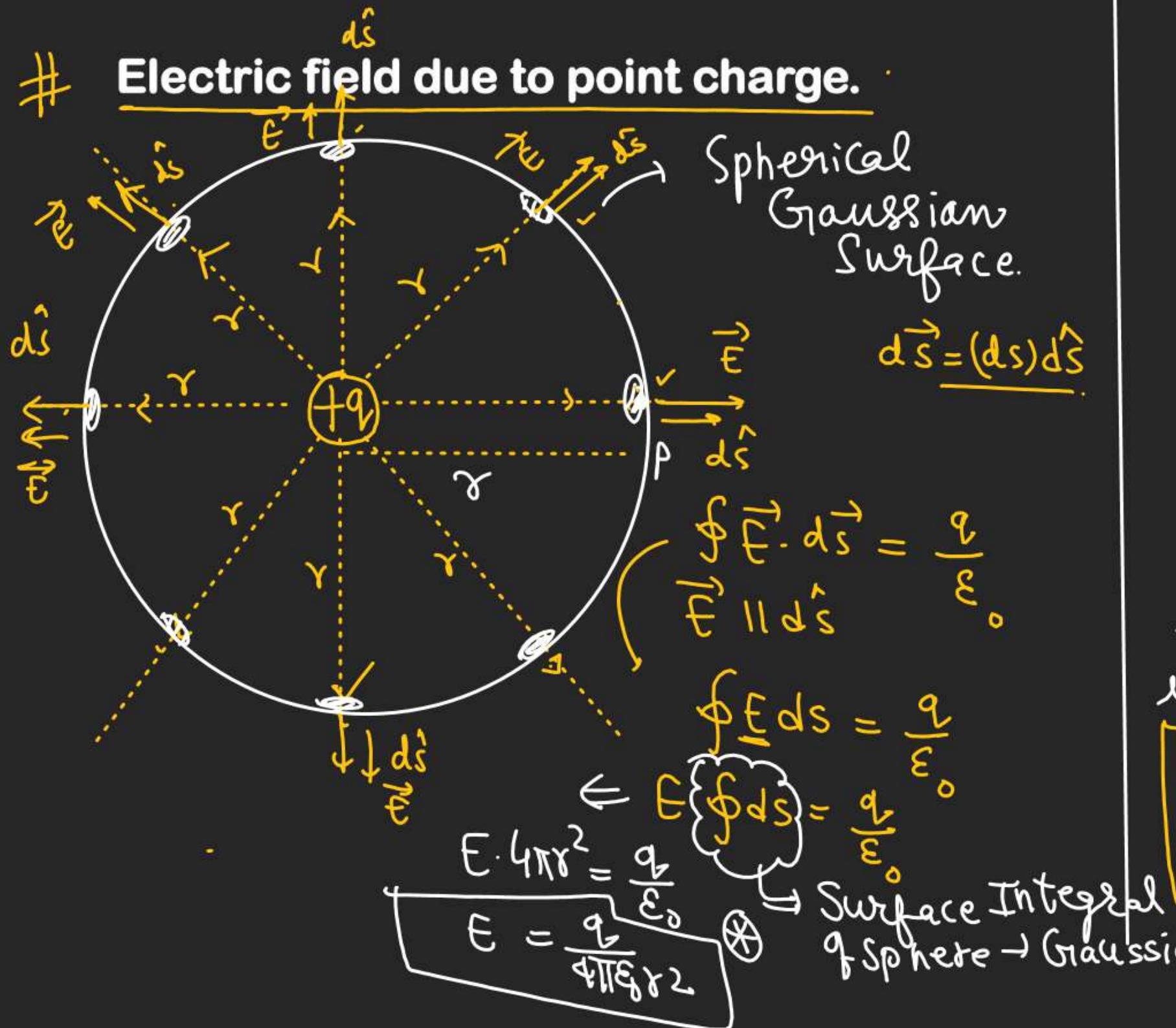


APPLICATION OF GAUSS'S LAW



$$\phi = \frac{q_{enc}}{\epsilon_0}$$

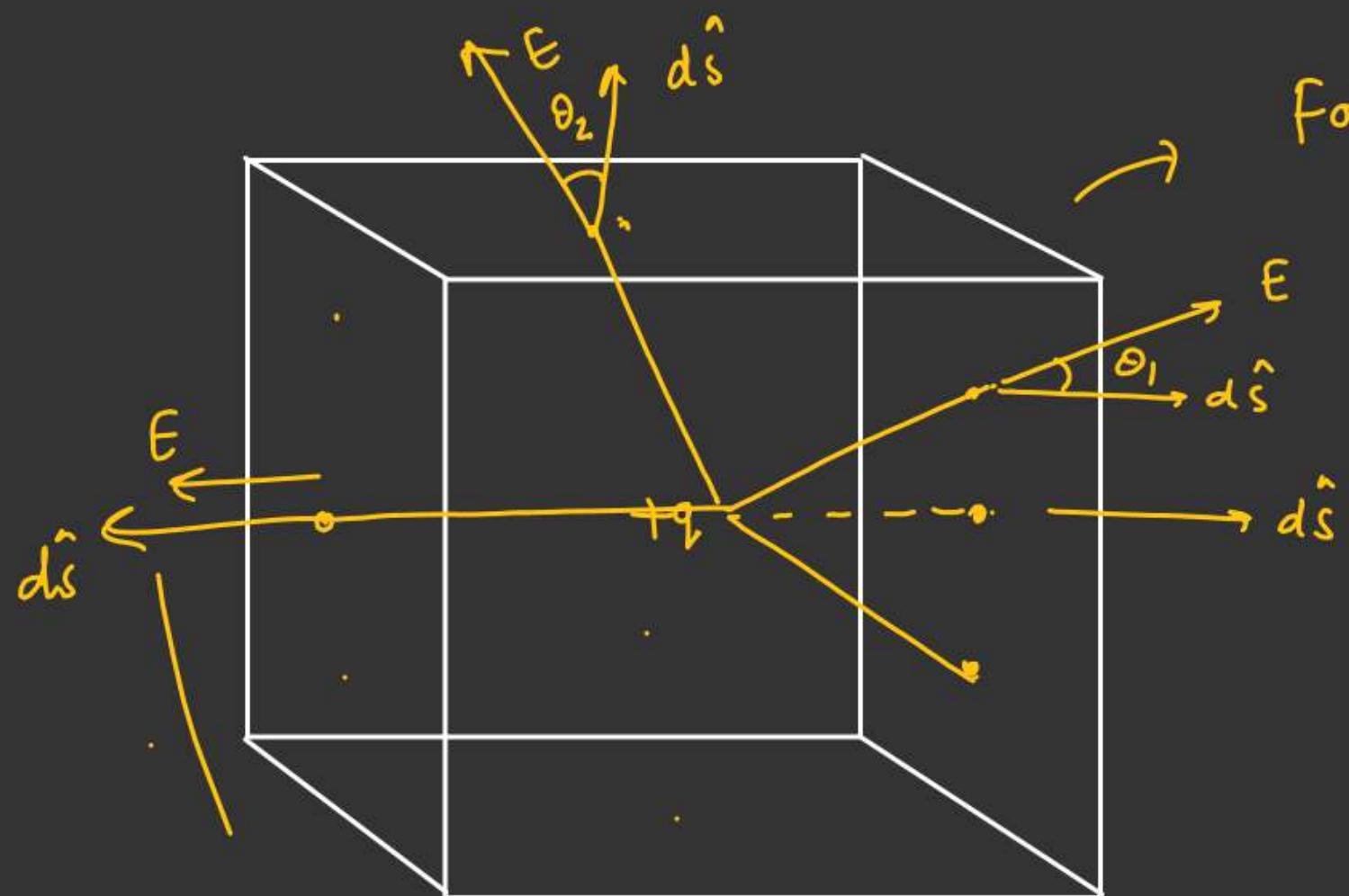
$$\oint \vec{E} \cdot d\vec{s} = \frac{q_{enc}}{\epsilon_0}$$

$$\oint (E ds \cos \theta) = \frac{q_{enc}}{\epsilon_0}$$

For Symmetrical charge distribution
if we can choose a Gaussian Surface
Where $\vec{E} \perp d\hat{s}$ or $\vec{E} \parallel d\hat{s}$ then

$$\vec{E} \cdot d\vec{s} = 0 \quad \vec{E} \perp d\vec{s}$$

$$\vec{E} \cdot d\vec{s} = Eds \quad \vec{E} \parallel d\vec{s}$$



For point Charge
Gaussian Surface as a Cube
not possible for Calculating
 E .

APPLICATION OF GAUSS'S LAW

Electric field due to infinite line charge

λ = linear charge density

l = length of the Cylindrical Gaussian Surface.

r = radius of the Gaussian Surface.

$$\oint \vec{E} \cdot d\vec{s} = \frac{q_{enc}}{\epsilon_0}$$

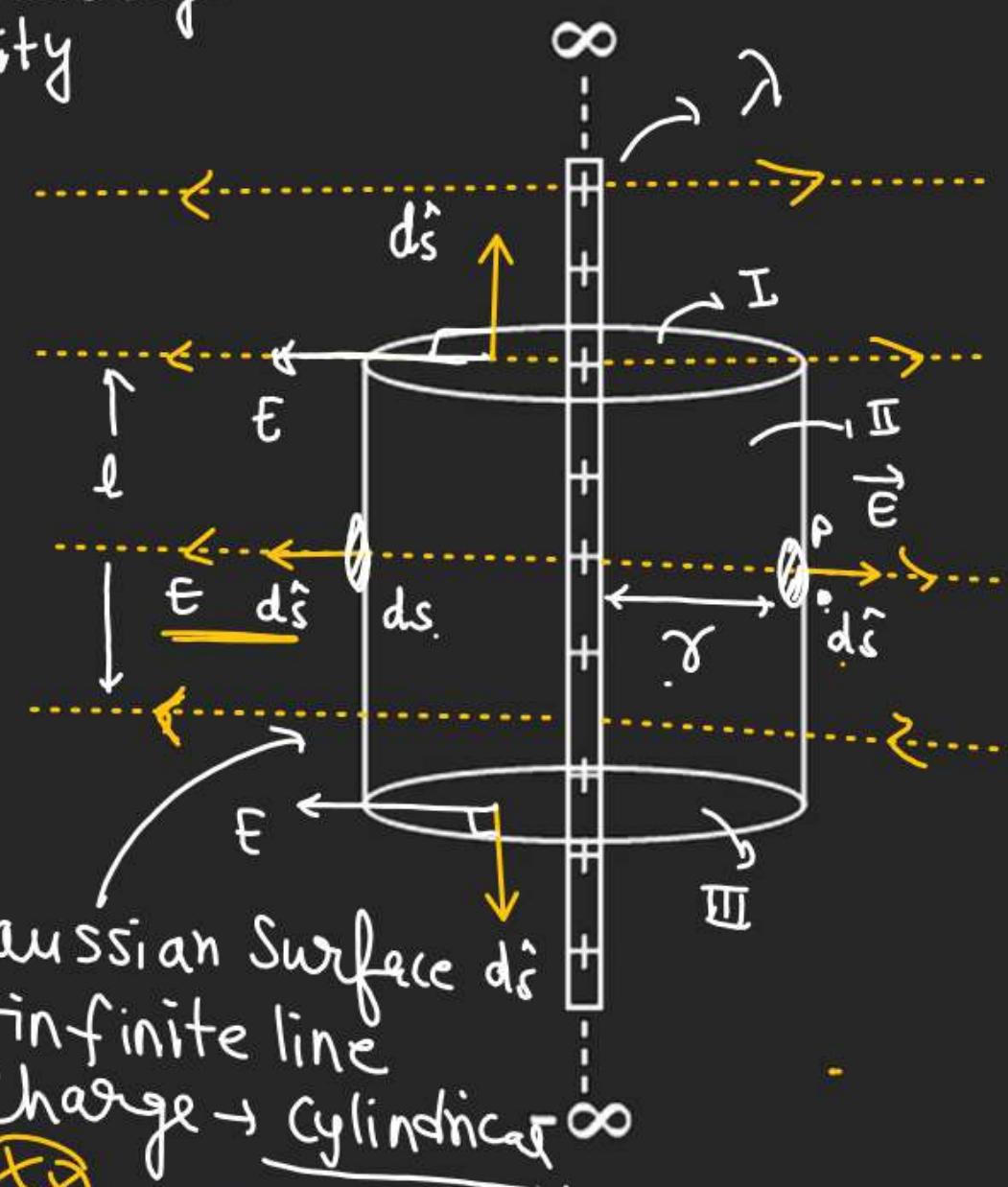
$$q_{enc} = \lambda L$$

$$\int_I \vec{E} \cdot d\vec{s} + \int_{II} \vec{E} \cdot d\vec{s} + \int_{III} \vec{E} \cdot d\vec{s} = \frac{\lambda L}{\epsilon_0}$$

$$\int_I \vec{E} \cdot d\vec{s} = \int_{III} \vec{E} \cdot d\vec{s} = 0 \quad [\vec{E} \perp d\vec{s}]$$

$$\epsilon \int_{II} \vec{E} \cdot d\vec{s} = \int_{II} \epsilon d\vec{s} \quad (\vec{E} \parallel d\vec{s})$$

$$E \cdot 2\pi r l = \frac{\lambda L}{\epsilon_0} \Rightarrow E = \frac{\lambda}{2\pi \epsilon_0 r}$$



APPLICATION OF GAUSS'S LAW

Electric field due to a long uniformly charged Conducting Cylinder

① $r < R$ (Inside the Cylinder)

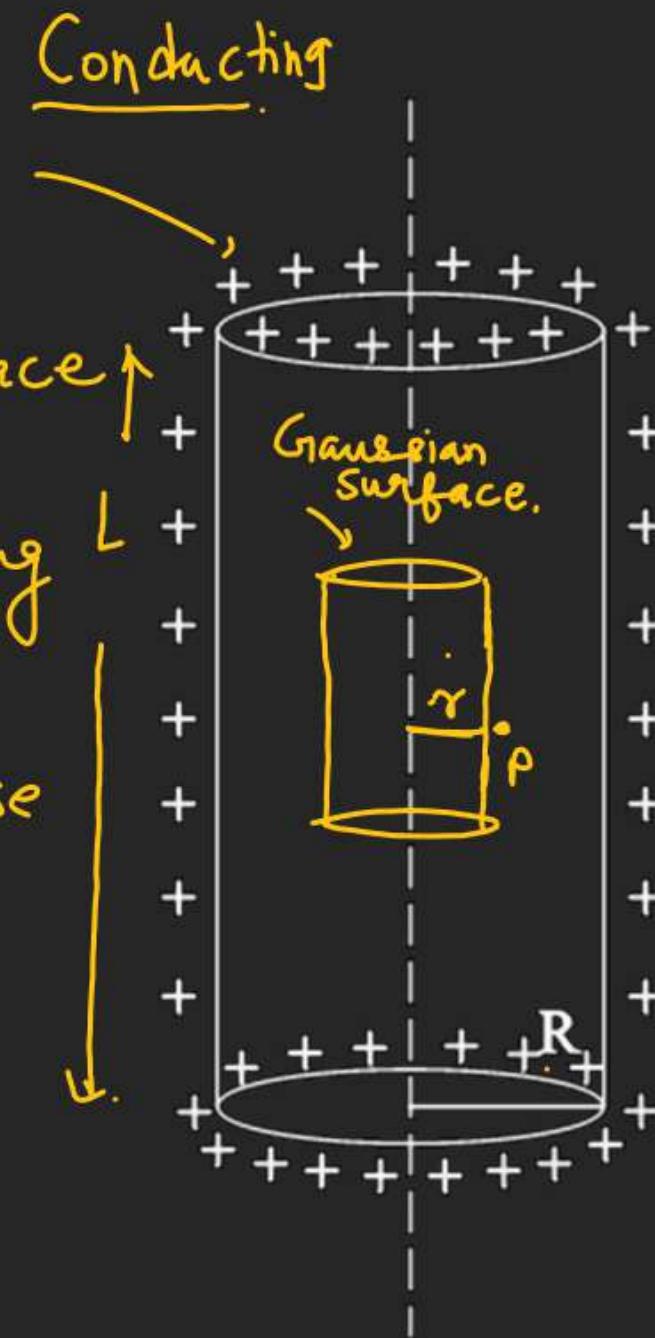
$$\oint \vec{E} \cdot d\vec{s} = \frac{q_{enc}}{\epsilon_0}$$

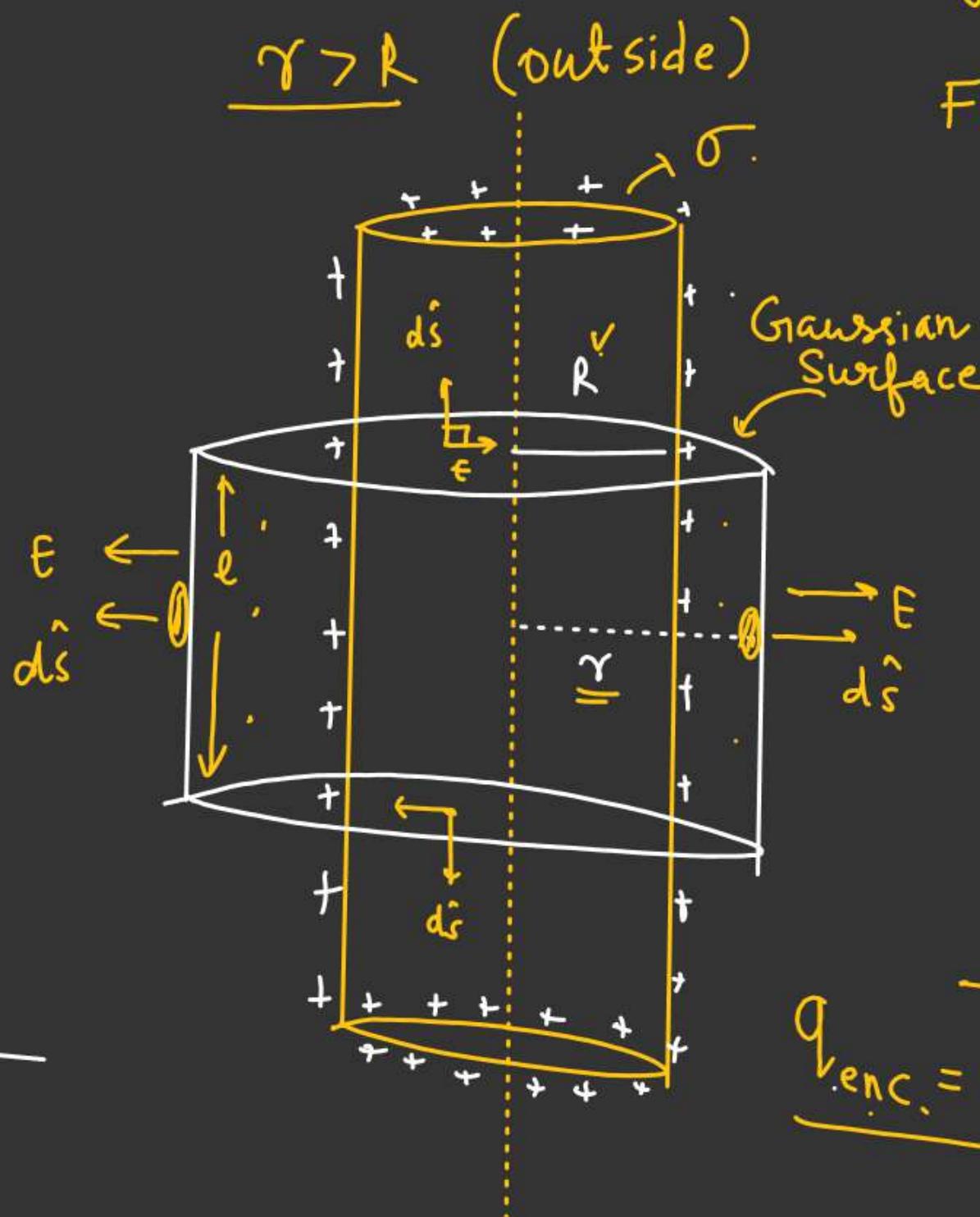
Here, $q_{enc} = 0$.

$$\oint \vec{E} \cdot d\vec{s} = 0$$

$\vec{E} = 0$

↳ Always Charge
 resides at the Surface
 of the Cylinder
 Since Cylinder is very long
 So its field lines
 is perpendicular to
 the cylinder So, we choose
 cylindrical Gaussian
 Surface





σ = Surface Charge density.

For Curve part of Cylinder. E

$$\vec{E} \parallel d\vec{s}$$

$$E \oint dS = \frac{q_{enc}}{\epsilon_0}$$

Curve part
of Cylinder

$$E_{surface} = \frac{\sigma}{\epsilon_0}$$

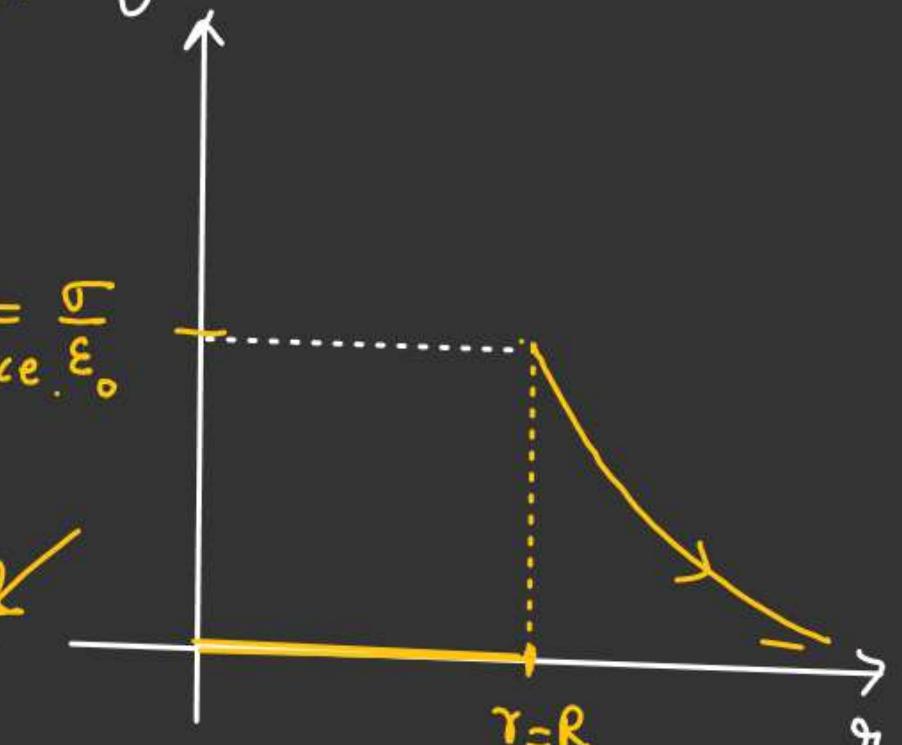
$$E \cdot (2\pi r L) = \frac{\sigma \cdot 2\pi R L}{\epsilon_0}$$

$$E = \left(\frac{\sigma R}{\epsilon_0 \gamma} \right)$$

Outside.

$$E \propto \frac{1}{\gamma}$$

$$q_{enc} = \sigma \cdot 2\pi R L$$



APPLICATION OF GAUSS'S LAW

Electric field due to a long uniformly charged non-conducting cylinder.

"For very long cylinder electric field perpendicular to axis of cylinder."

ρ = Volume Charge density.

$$\boxed{\rho = \text{constant}}$$

$$\frac{Q}{\pi R^2 h} = \rho$$

$$\begin{aligned} &\text{For } r > R \\ &E \cdot 2\pi r l = \rho \pi R^2 l \\ &E = \frac{\rho R^2}{2\epsilon_0 r} \end{aligned}$$

$$\boxed{E_{\text{inside}} = \frac{\rho r}{2\epsilon_0}}$$

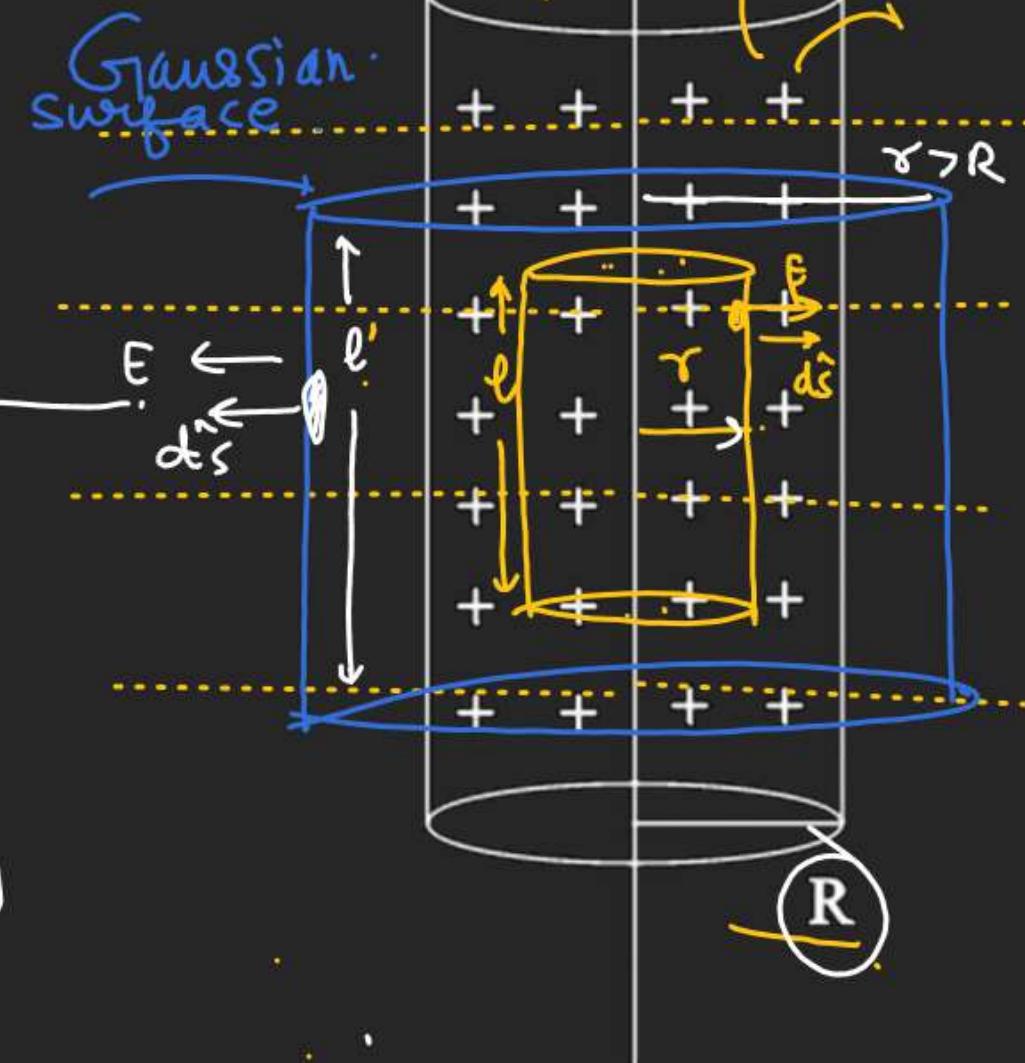
$$\boxed{E_{\text{inside}} = \frac{\rho r}{2\epsilon_0}}$$

$$\boxed{E_{\text{surface}} = \frac{\rho R}{2\epsilon_0}}$$

$$1) \quad r < R \quad \vec{E} \parallel d\vec{s} \quad (\text{For Curve part})$$

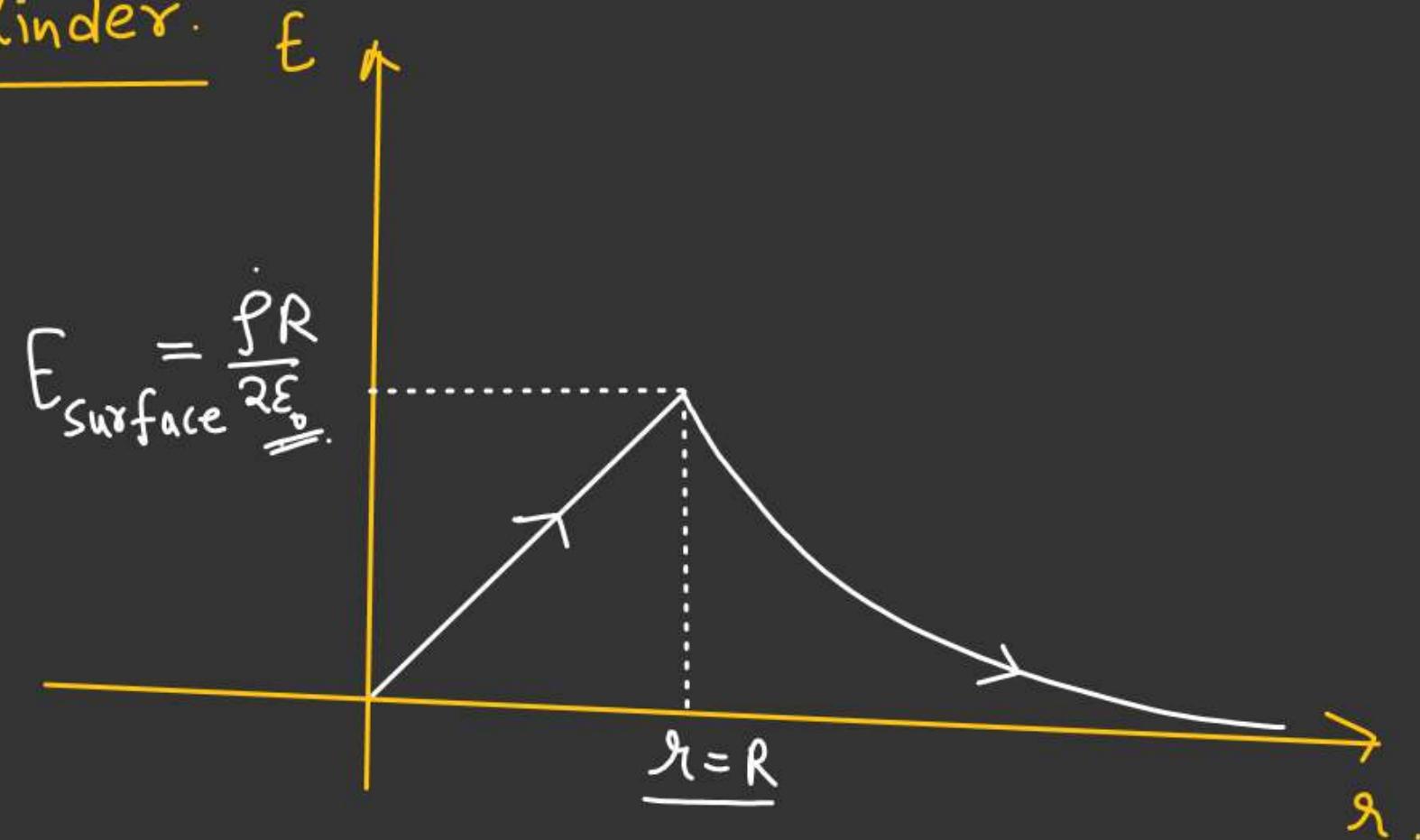
$$\oint \vec{E} \cdot d\vec{s} = \frac{q_{\text{enc}}}{\epsilon_0}$$

$$E \cdot 2\pi r l = \frac{(\rho \pi r^2 l)}{\epsilon_0}$$



E Vs r graph for uniformly Charge non-Conducting long.

Cylinder



$$E_{\text{inside}} = \frac{\rho r}{2\epsilon_0} \quad \checkmark$$

$$E_{\text{outside}} = \frac{\rho R^2}{2\epsilon_0 r} \quad \checkmark$$