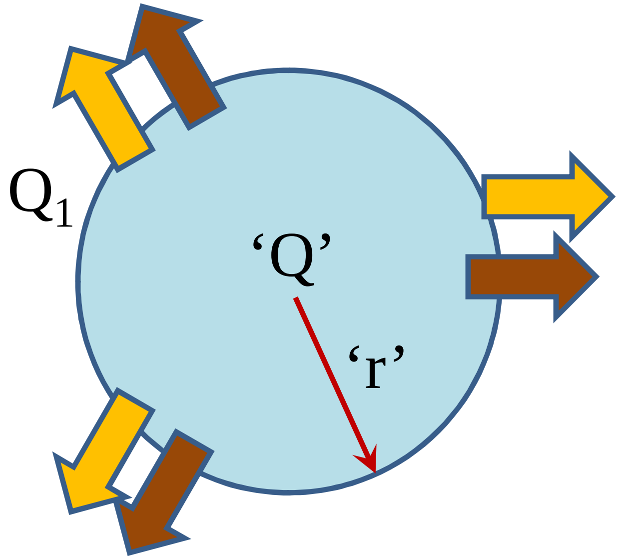
GAUSS THEOREM

Electric field due to a point charge 'Q'

By symmetry we take Gaussian surface as SPHERE, with charge at CENTER

At all places E and A are parallel; θ = 0



$$\phi = \oint_S \vec{E}.d\vec{S} = \oint_S E.dS\cos\theta$$

$$\phi = \oint_S E.dS = E\oint_S dS = E.4\pi r^2$$

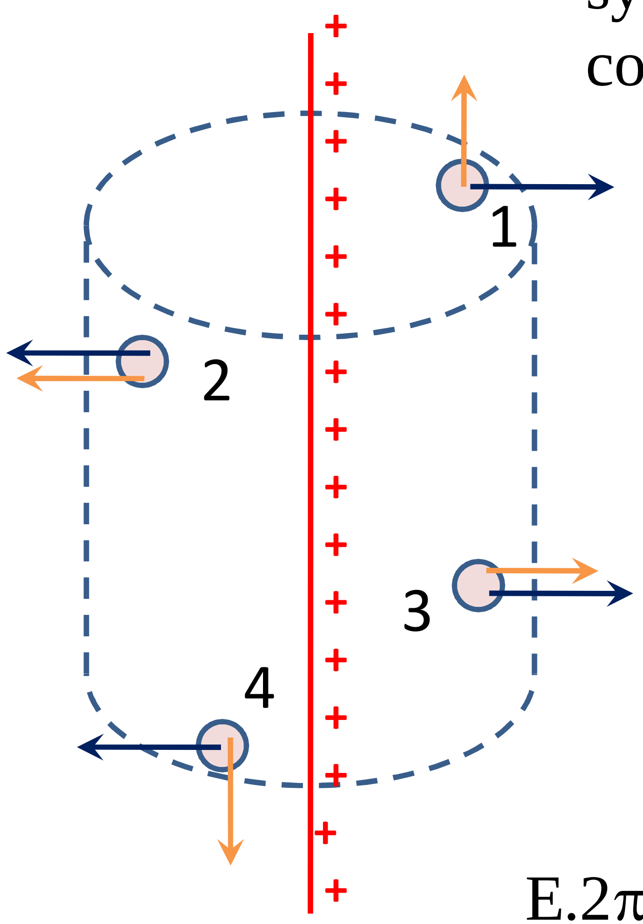
$$\phi = \frac{Q}{\varepsilon_0} \quad \text{(As per Guass Law)}$$

$$\Rightarrow E.4\pi r^2 = \frac{Q}{\varepsilon_0} \Rightarrow E = \frac{1}{4\pi\varepsilon_0}.\frac{Q}{r^2}$$

$$F = Q_1E = Q_1\frac{1}{4\pi\varepsilon_0}.\frac{Q}{r^2} = \frac{1}{4\pi\varepsilon_0}.\frac{QQ_1}{r^2}$$

GAUSS THEOREM

Electric field due to infinitely long conductor λ linear charge density



symmetrical cylinder as Gaussian with the linear conductor with length 'L' and radius 'r'

Top and bottom will not contribute to flux

$$\phi = \oint_S \vec{E}.d\vec{S} = \int_1 \vec{E}.d\vec{S} + \int_2 \vec{E}.d\vec{S} + \int_3 \vec{E}.d\vec{S} + \int_4 \vec{E}.d\vec{S}$$

$$\phi = \int_{2,3} \vec{E}.d\vec{S} = \int_{2,3} E.dS \quad = E.2\pi rL$$

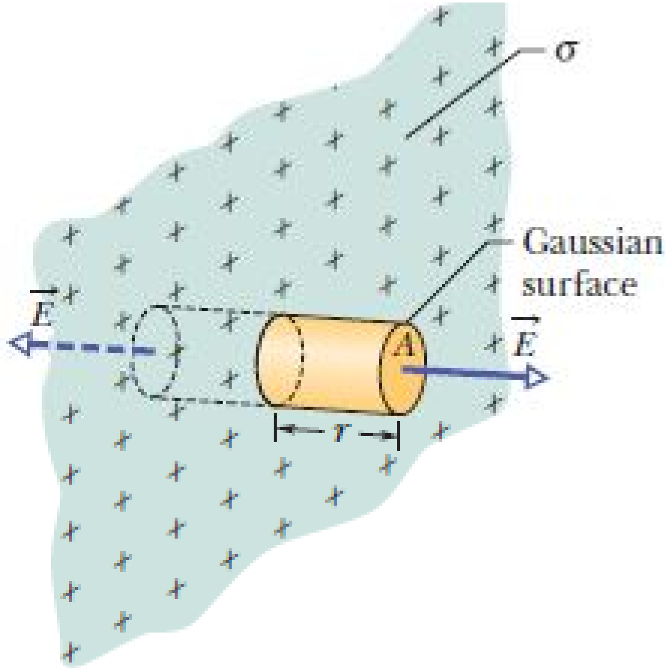
$$\phi = \frac{Q}{\varepsilon_0} \text{ (As per Guass Law)}$$

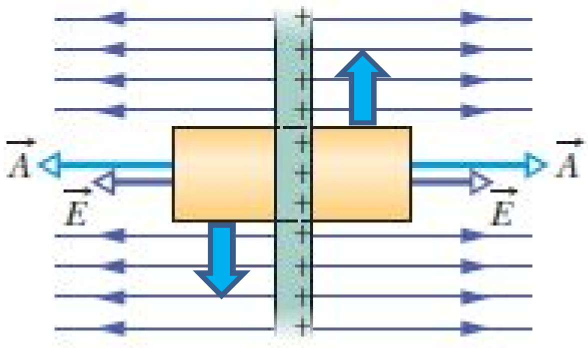
$$\lambda = \frac{Q}{L} \Rightarrow Q = \lambda L$$

$$E.2\pi rL = \frac{Q}{\varepsilon_0} = \frac{\lambda L}{\varepsilon_0} \Rightarrow E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

GAUSS THEOREM

Electric field due to infinitely large charged sheet , density = σ





Symmetrical cylinder having area A

Curved surface will not contribute to flux

$$\phi = \oint_S \vec{E}.d\vec{A} \qquad \phi = \int \vec{E}.d\vec{A} = \int E.dA\cos 0$$

$$\phi = E.\int dA = E.2A$$

$$\phi = \frac{Q}{\varepsilon_0} \quad \text{(As per Gauss Law)}$$

$$\sigma = \frac{Q}{A} \Rightarrow Q = \sigma A$$

$$E.2A = \frac{\sigma A}{\varepsilon_0} \Rightarrow E = \frac{\sigma}{2\varepsilon_0}$$