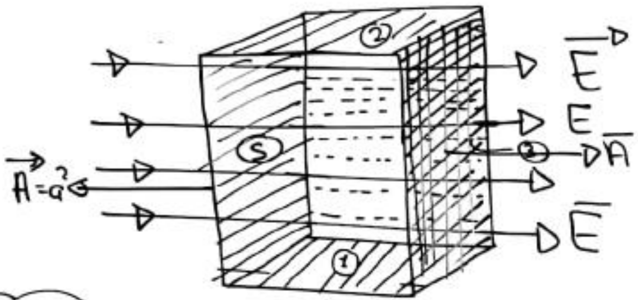
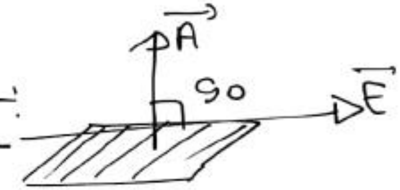
Example:- $A = a^2$, Side a

$$\phi_T = \frac{q_{in}}{\varepsilon_0} = 0$$

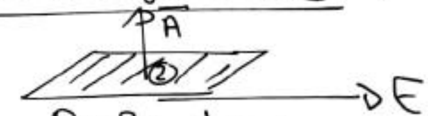


(a) flux through (1) :-



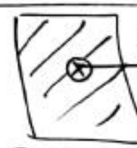
$\phi = EA\cos 90$
$= E \cdot a^2 \, 0 = 0$

(b) flux through area (2) :-



$\theta = 90$ $\quad \phi = 0$

(c) flux through back area (3)



$\theta = 90$
$\phi = 0$

$\phi = \vec{E} \cdot \vec{A}$
$= EA\cos\theta$

(d) from front area.

$\longrightarrow \vec{E}$

$\odot \vec{A} = a^2 (\hat{k})$

$\phi = 0$

(e) flux through area (5)

$\theta = 180$

$\phi = E a^2 \cos 180 = -E a^2$

(f) flux through area (6)

$\phi = E \cdot a^2$

$(\phi_{Total})_{cube} = 0 + 0 + 0 + 0 + E a^2 + (-E a^2)$
$= 0$

JEE(M)
NEET-2007

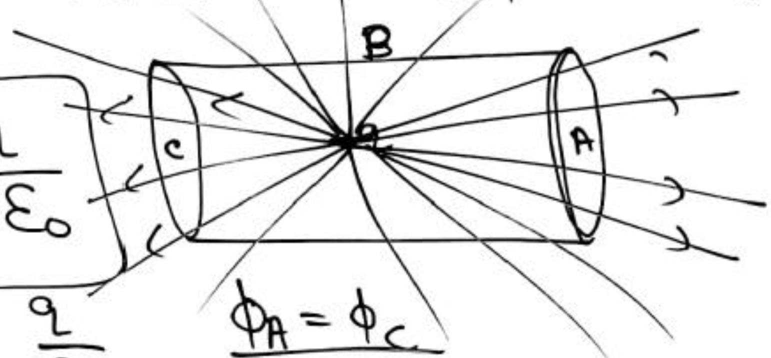
Q) A Hollow cylinder has a charge q Coulomb within it. If ϕ is the electric flux in units of Volt-meter associated with the curved surface B. the flux linked with the plane surface A in units V-m will be.

(a) $q/2\varepsilon_0$

(b) $\phi/3$

(c) $\frac{q}{3}-\phi$

(d) $\frac{1}{2}\left(\frac{q}{\varepsilon_0}-\phi\right)$



$$\boxed{\phi_{Total}=\frac{q}{\varepsilon_0}}$$

$$\phi_A+\phi_B+\phi_C=\frac{q}{\varepsilon_0}$$

$$\phi_A+\phi_C+\phi=\frac{q}{\varepsilon_0}$$

$$\phi_A+\phi_C=\left(\frac{q}{\varepsilon_0}-\phi\right)$$

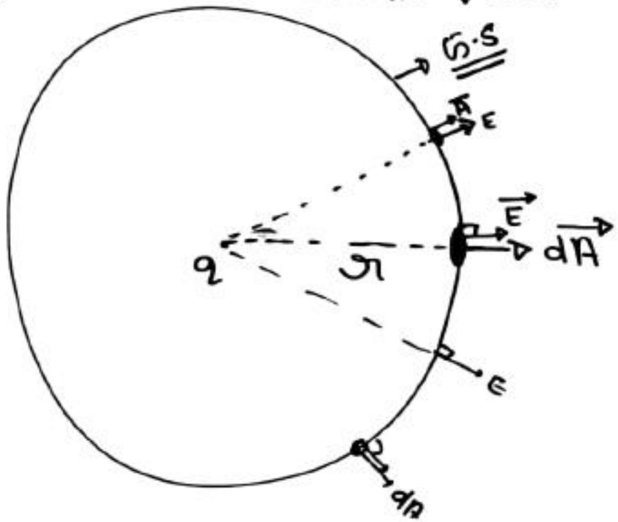
$$2\phi_A=\left(\frac{q}{\varepsilon_0}-\phi\right)$$

$$\phi_A=\phi_C$$

$$\boxed{\phi_A=\frac{1}{2}\left(\frac{q}{\varepsilon_0}-\phi\right)}$$

Application of Gauss Law-:

(a) find Electric field due to point charge at r distance-:



Step1) Symmetric Gaussian Surface

Step2) let small area dA.

Step3) Let Electric field at that point is:- $\vec{E}$

Step4) find flux through small area dA

$$d\phi = \vec{E}\cdot\vec{dA}$$

$$\int d\phi = \oint E\,dA$$

$$\phi_{Total} = E\oint dA$$

$$\phi_{Total} = E \times 4\pi r^2$$

$$\frac{q}{\varepsilon_0} = E \times 4\pi r^2$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

Application of Gauss Law :-

(2) Using Gauss law find Electric field due to infinite long wire having linear charge density λ :-

$\Rightarrow$ Gaussian Surface :- Cylinder

$$\int d\phi = \int \vec{E} \cdot d\vec{A}$$

$$\phi_{Total} = E\, 2\pi r l$$

$$\frac{q_{in}}{\varepsilon_0} = E \times 2\pi r l$$

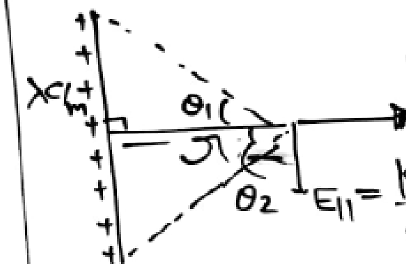
$$\frac{\lambda \cancel{l}}{\varepsilon_0} = E \times 2\pi r \cancel{l}$$

$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

$$E = \frac{2\lambda}{4\pi\varepsilon_0 r} = \frac{2K\lambda}{r}$$

$$\lambda = \frac{q}{l} \qquad q_{in} = \lambda l$$

$\Rightarrow$ Electric field due to finite wire having linear charge density is λ

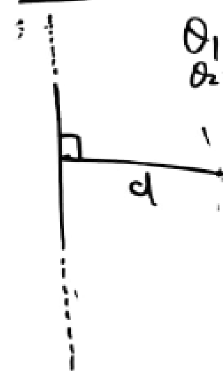


$$E_{\perp} = \frac{K\lambda}{r}\left[\sin\theta_1 + \sin\theta_2\right]$$

$$E_{\parallel} = \frac{K\lambda}{r}\left[\cos\theta_2 - \cos\theta_1\right]$$

If wire is infinite

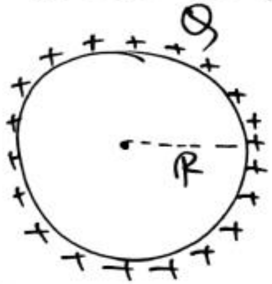
$\theta_1 = 90°$
$\theta_2 = 90°$



$$\boxed{E_{\perp} = \frac{2K\lambda}{r} = \frac{\lambda}{2\pi\varepsilon_0 d}}$$

Gauss Law application :-

(3) Electric field due to charged sphere :-



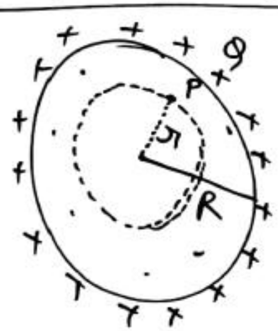
Surface charge density $\sigma = \frac{Q}{A}$

$\sigma = \frac{Q}{4\pi R^2}$

(1) draw gaussian surface.

$\phi = \oint \bar{E} \cdot d\bar{A} =$

(a) Inside the sphere :- $[r < R]$



$\phi = \bar{E} \cdot \bar{A}$

$\phi = EA\cos\theta$

$\phi = \frac{q_{in}}{\varepsilon_0}$

$\boxed{\phi = \oint \bar{E}\, d\bar{A}}$

$\oint \bar{E} \cdot d\bar{A} = \frac{q_{in}}{\varepsilon_0}$

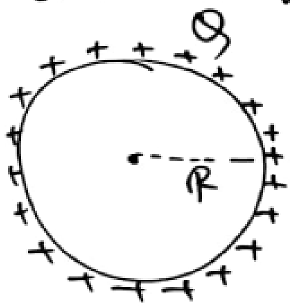
$\bar{E} \cdot \oint dA = \frac{0}{\varepsilon_0}$

$E = 0$

Electric field inside a charge hollow conducting sphere is zero.

Gauss Law application :-

(3) Electric field due to charged sphere :-

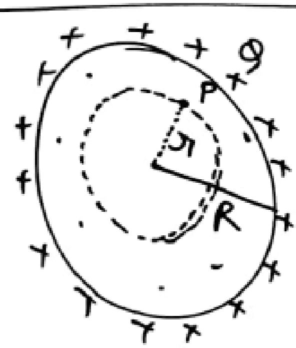


[Surface charge density $\sigma = \frac{Q}{A}$

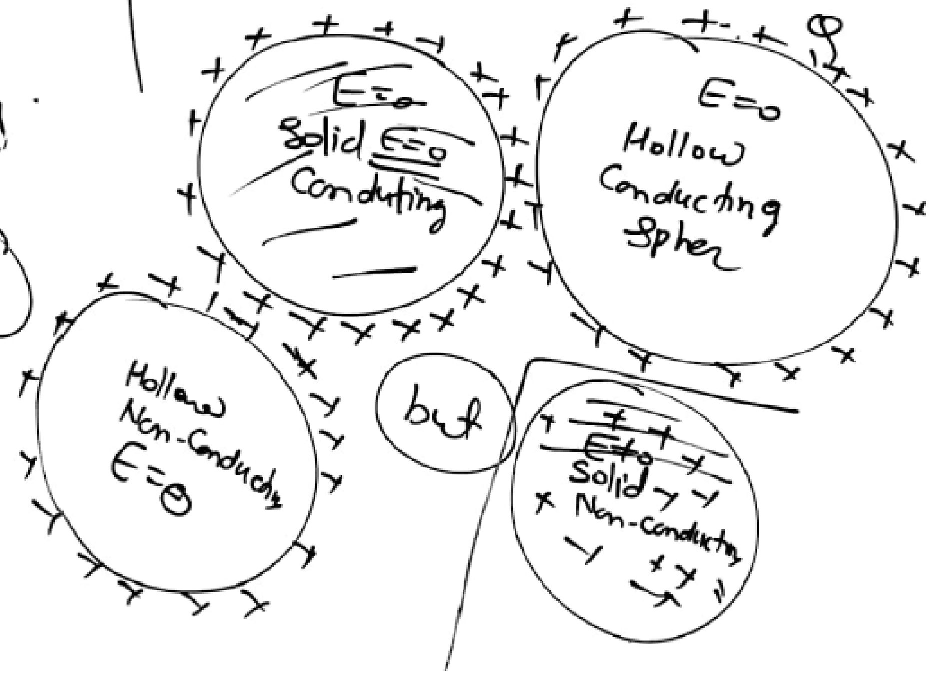
$\sigma = \frac{Q}{4\pi R^2}$]

Hollow non conducting sphere / Hollow Conducting sphere / Solid Conducting sphe

(a) Inside the sphere :- $[r < R]$

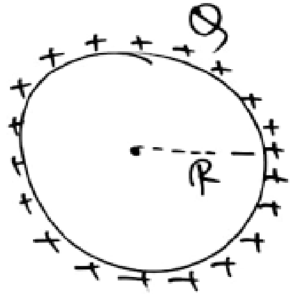


$E_{inside} = 0$



Gauss Law application :-

(3) Electric field due to charged sphere :-



Surface charge density $\sigma = \frac{Q}{A}$

$\sigma = \frac{Q}{4\pi R^2}$

↳ r → radius का Gaussian surface बनायेंगे।

$\phi = \oint \vec{E} \cdot d\vec{A}$

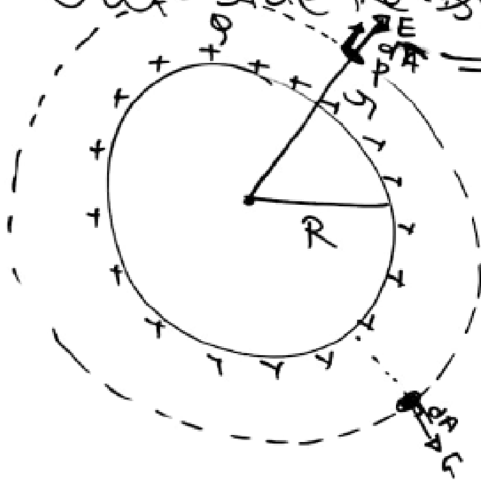
$\frac{q_{in}}{\varepsilon_0} = E \oint dA$

$\frac{Q}{\varepsilon_0} = E \times 4\pi r^2$

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

$\boxed{E \propto \frac{1}{r^2}}$

(b) Out-side the sphere $(r > R)$



⟹ For outside point charge sphere behave like point charge & placed at centre of the sphere.