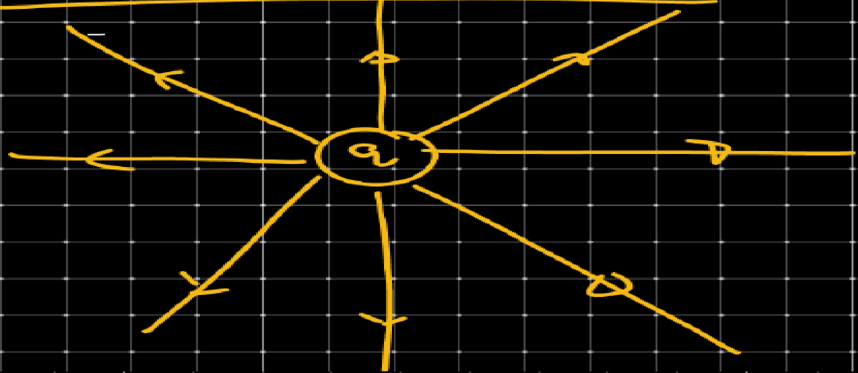
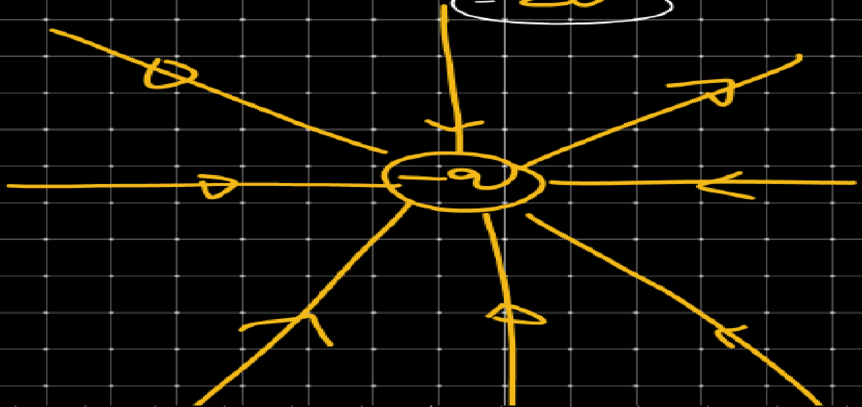
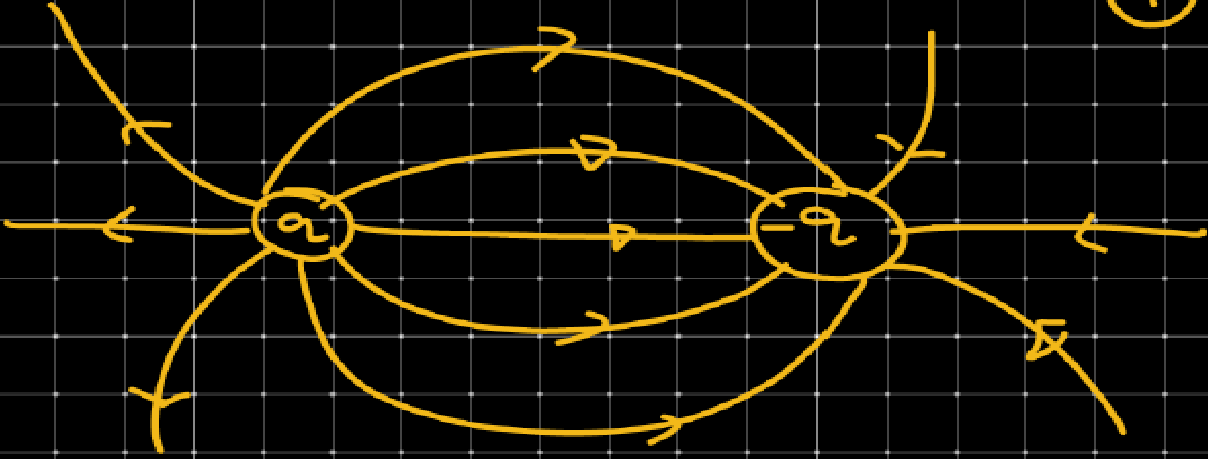
Electric field lines:- (q)



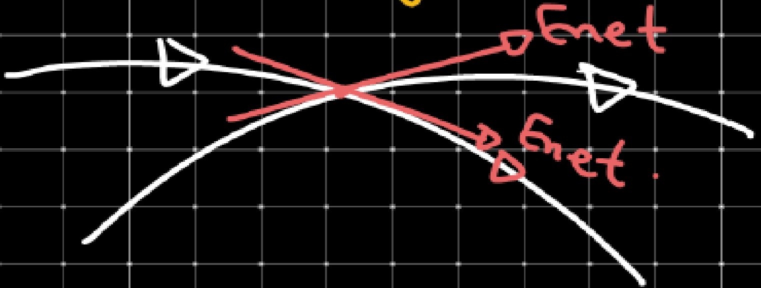
(-q)





(1) E.F.L. originate from +ive charge. or Infinite & terminate on negative charge OR Infinite.

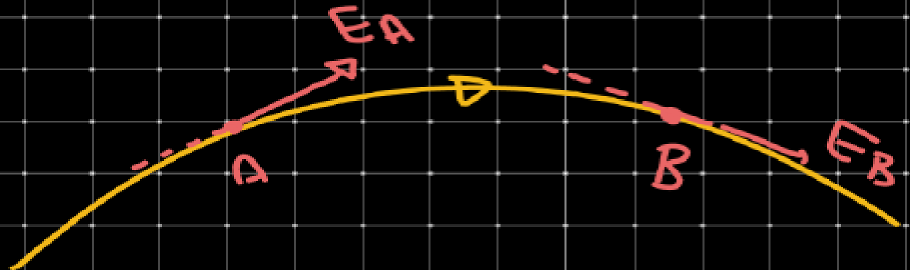
② Electric field lines never cut each other.



③ No of Electric field lines $N \propto q$. $\left[N = \frac{|q|}{\varepsilon_0}\right]$

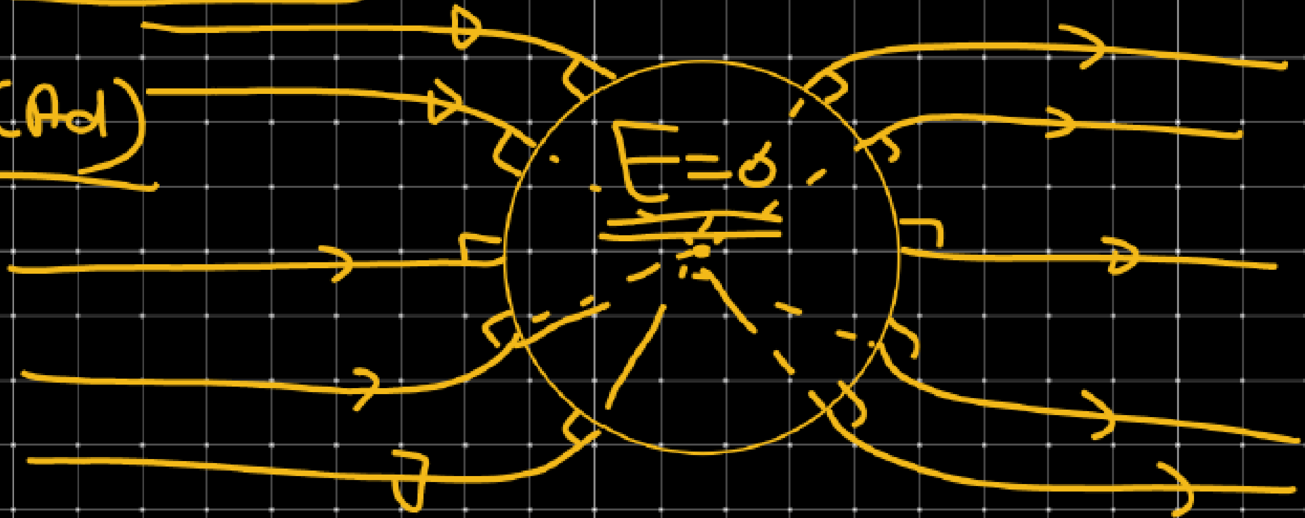
Let q — 10 lines , $2q \to 20$ lines)

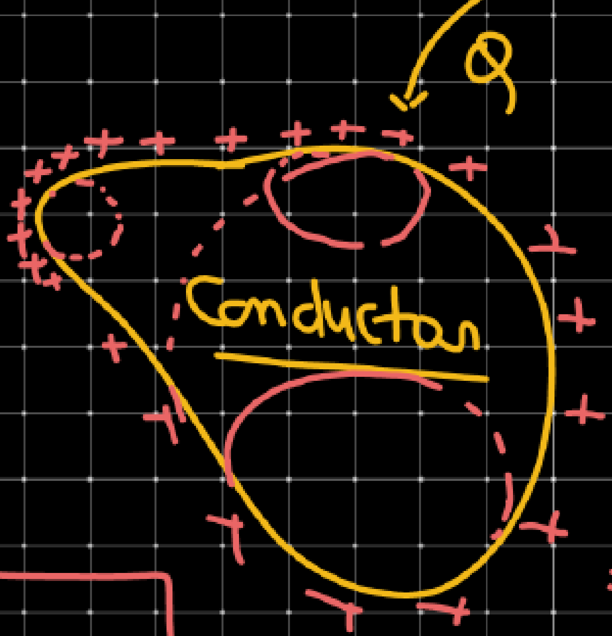
⑤ Tangent on Electric field lines gives net dirn of electric field lines



Electric field inside a conductor [solid, Hollow] is zero.

JEE (Adv)



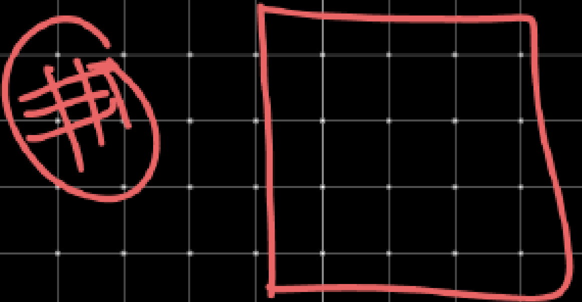


$$\sigma \propto \frac{1}{r^2}$$

$r \rightarrow$ local radius

$r = 0$

$\sigma = \infty$

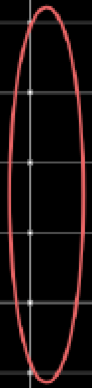


#1 flux → (Electric flux):-

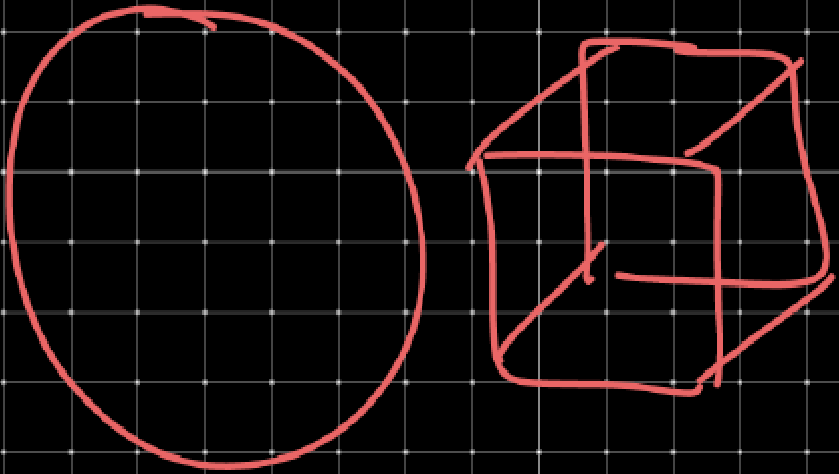
Electric flux basically Number of electric field lines passing through a particular area.

Imp) Calculation of Electric flux:

[Area vector:

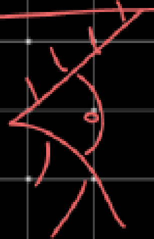


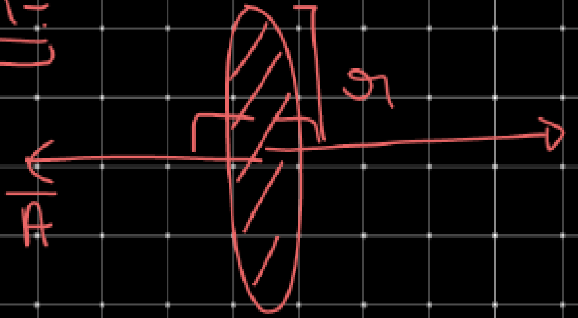
open surface



Closed Surface.

↳ Area Vector :-





$\bar{A} = \pi r^2$ (dir)

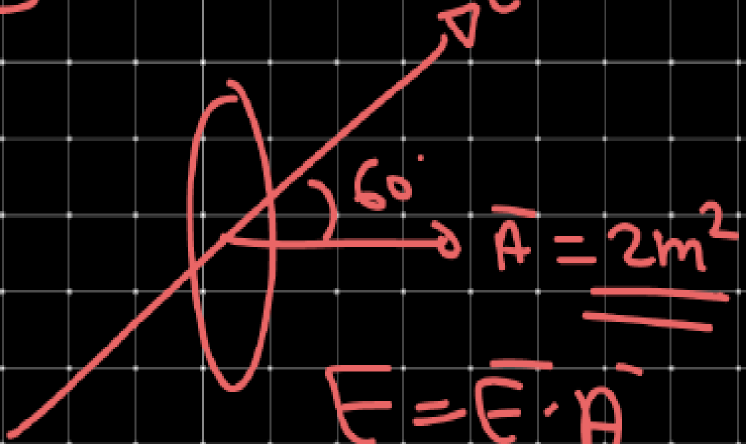
Open Surface → [two area vector]

Calculation of Electric flux (ϕ)

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

$$\phi = E \cdot A\cos\theta$$

Q1)



Calculate electric flux = ?

$E = \vec{E} \cdot \vec{A}$

$\phi = E \cdot A \cos\theta$

$= 10 \times 2 \times \cos 60$

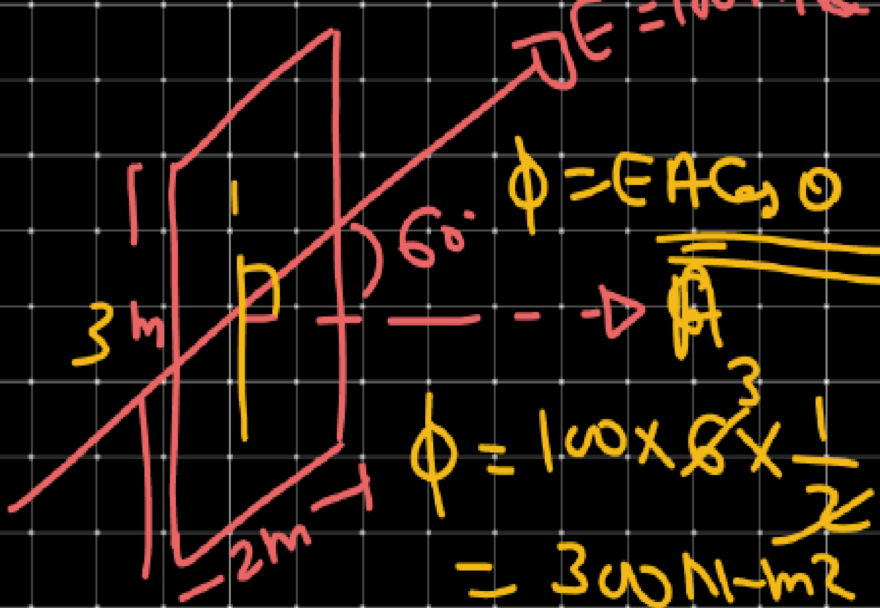
$= 10 \frac{N\text{-}m^2}{C}$

SI unit of flux $= \frac{N\text{-}m^2}{C}$

$[\phi] = \frac{[MLT^{-2}][L^2]}{[AT]}$

$[\phi] = [ML^3T^{-3}A^{-1}]$

Q2) $\phi = E \cdot A \cos\theta$.



$\phi = EA\cos\theta$

$\phi = 100 \times 6 \times \frac{1}{2}$

$= 300 \frac{N\text{-}m^2}{C}$

(Q3) $\phi = \bar{E} \cdot \bar{A}$.

$\bar{E} = (2\hat{i} + 3\hat{j} - \hat{k})\ N/C$

$\bar{A} = (2\hat{i} + 3\hat{j})\ m^2$

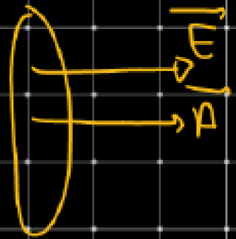
$\phi = ?$

$\phi = (2\hat{i} + 3\hat{j} - \hat{k}) \cdot (2\hat{i} + 3\hat{j})$

$= 2 \times 2\, \hat{i}\cdot\hat{i} + 3 \times 3\, \hat{j}\cdot\hat{j}$

$= 4 + 9 = 13 \frac{N\text{-}m^2}{C}$.

(i) $\theta = 0$

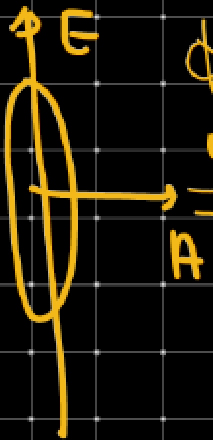


$\phi = EA\cos 0$

$\phi = EA$

maximum

(ii) $\theta = 90^\circ$



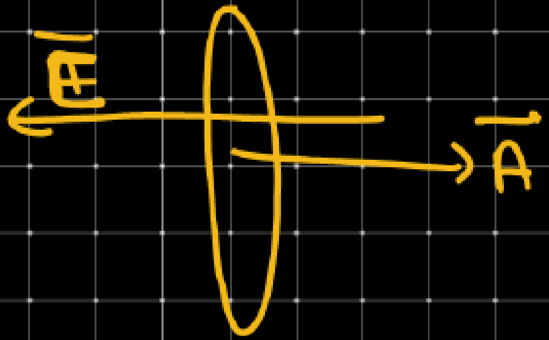
$\phi = EA\cos 90$

$\phi = 0$

(iii) $\theta = 180^\circ$

$\phi = EA\cos 180$

$\phi = -EA$



$\phi = -EA$

#1

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

Q1)

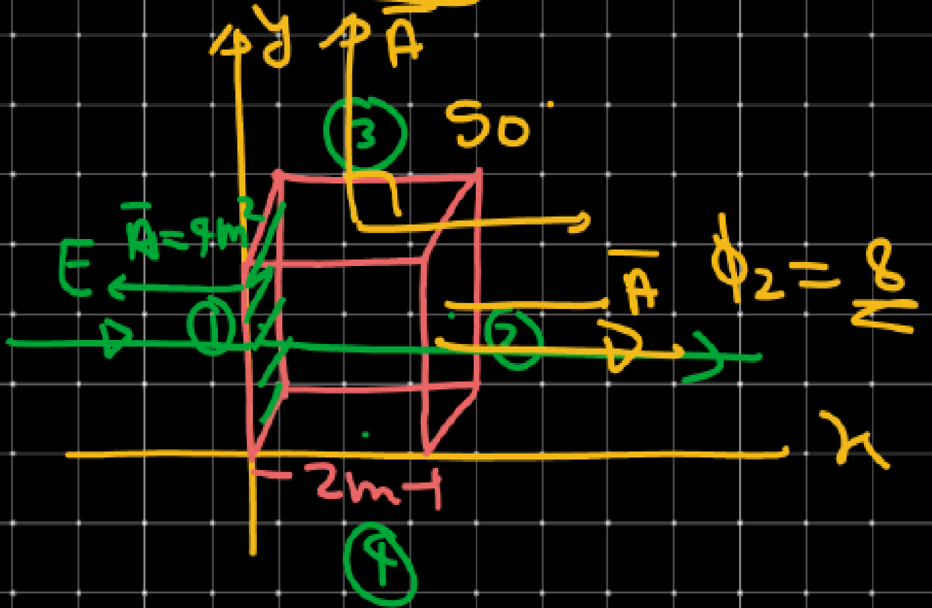
$$E = 2\hat{i}\ N/C$$

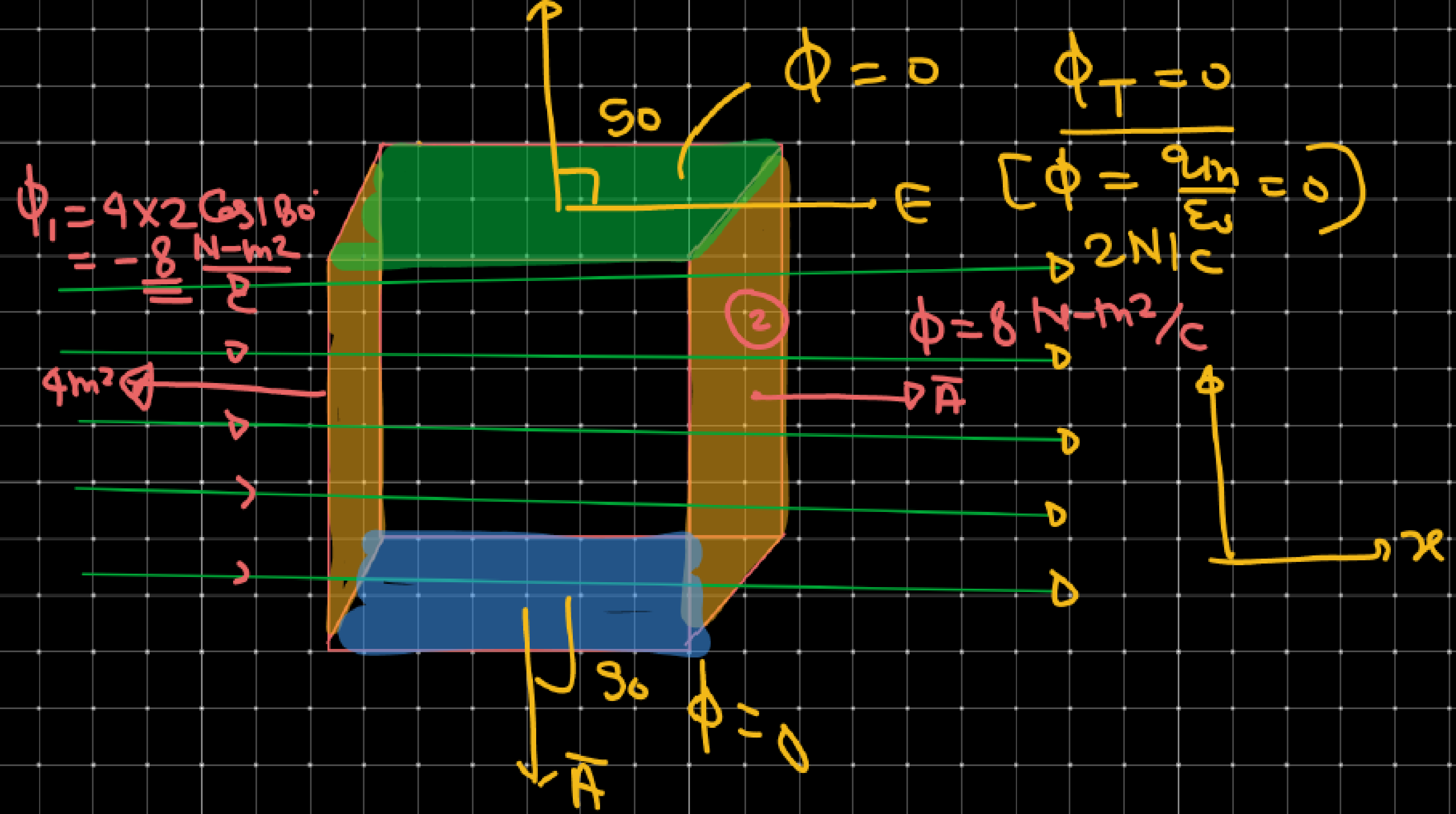
$\phi_1 = ?$ $2 \times 4(\cos 180) = -8$

$\phi_2 = ?$

$\phi_3 = ?$ 0

$\phi_4 = ?$ 0

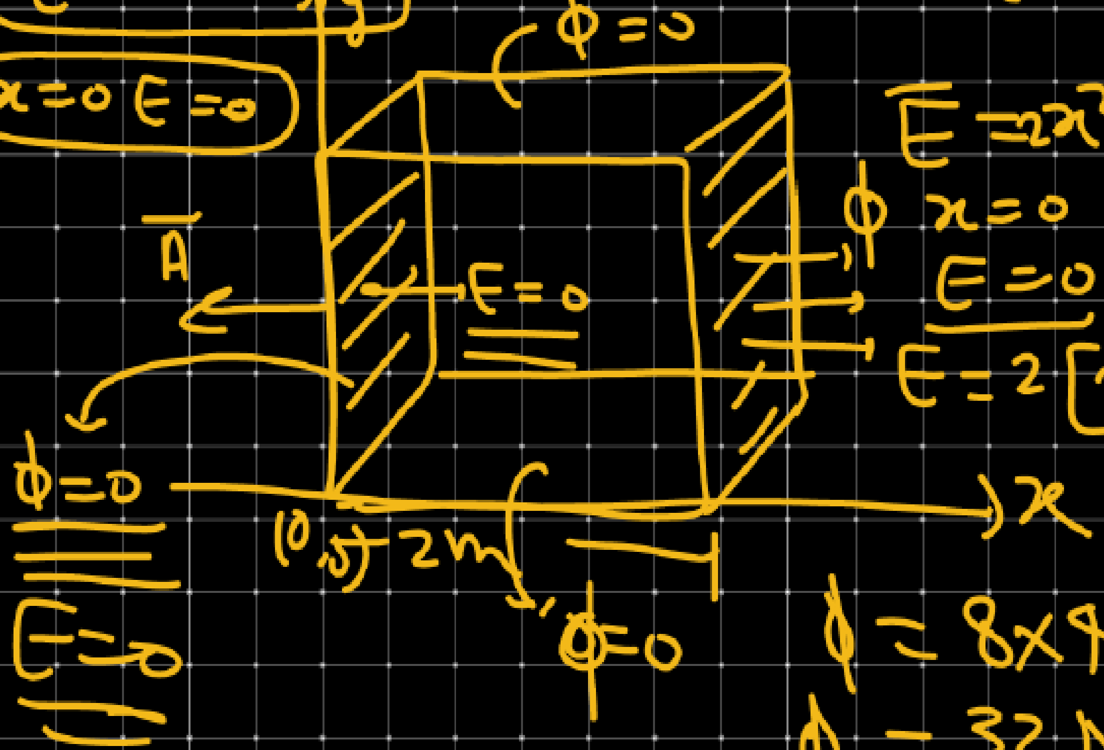




φ = 0
φ_T = 0
[φ = q_in/ε₀ = 0]
90
E
φ₁ = 4×2 Cos180°
= −8 N-m²/C
2N/C
φ = 8 N-m²/C
4m²
A
x
90
φ = 0
A

$E = 2x^2 \hat{i}$ → Variable electric field

$x=0 \quad E=0$



$\vec{E} = 2x^2 \hat{i}$

ϕ $x=0$

$E=0$

$E = 2[2^2]\hat{i}$

$\vec{E} = 8\ N/C$

$\phi = 8 \times 4$

$\phi = 32\ N\cdot m^2/C$

Gauss Statement: flux through any closed surface is equal to $\frac{q_{in}}{\varepsilon_0}$.

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

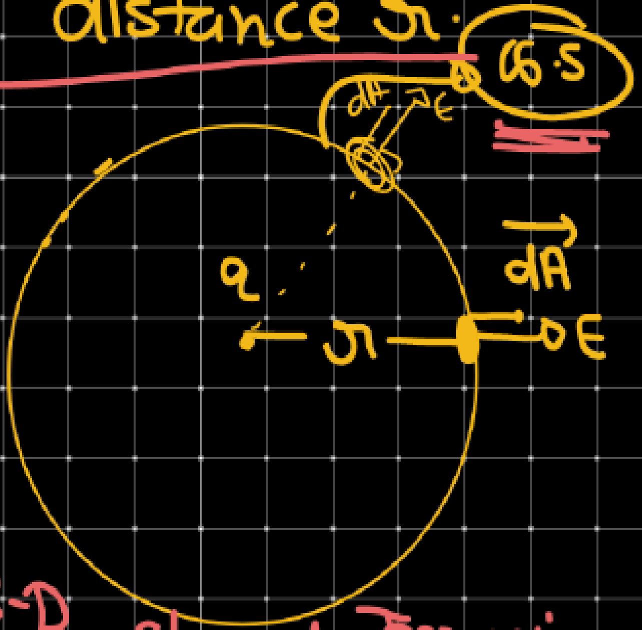
$$\phi = \frac{q_{in}}{\varepsilon_0}$$

G.S

$$\phi = \frac{q_{in}}{\varepsilon_0} = \frac{q_1 + q_2 - q_3}{\varepsilon_0}$$

Application of Gauss' Law:

↳ Find Electric field due to Point charge at distance r.



3-D, closed imaginary surface

↳ flux through small dA element

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

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

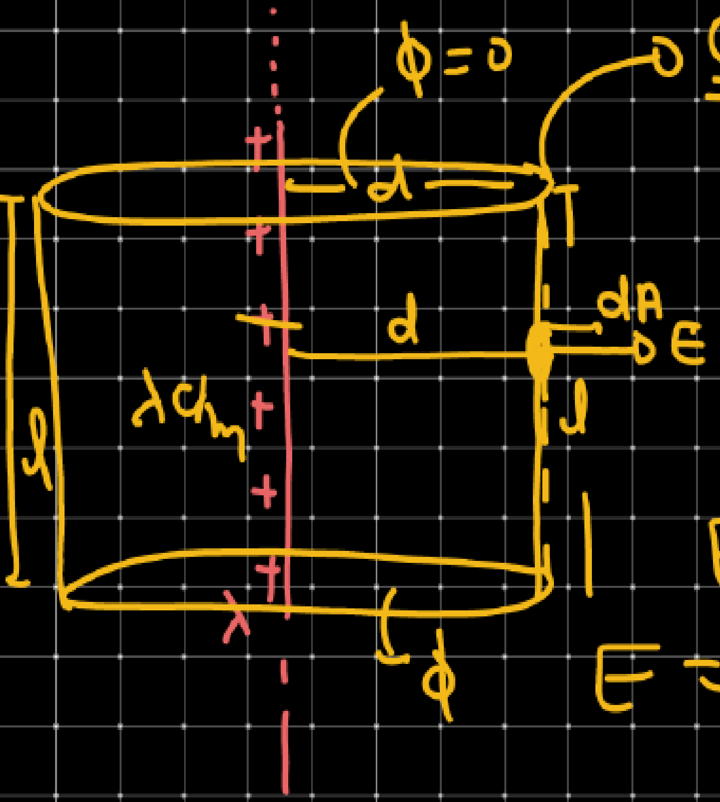
$E \oint dA = \frac{q}{\varepsilon_0}$

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

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

$E = \frac{Kq}{r^2}$

↳ Electric field due to Infinite Charge Carrying rod:



G.S.

$$q = \lambda l$$

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

total flux ⇒ $\phi_T = \oint \bar{E}\cdot d\bar{A} = \frac{q_{in}}{\varepsilon_0}$

$$E\oint d\bar{A} = \frac{\lambda l}{\varepsilon_0}$$

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

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

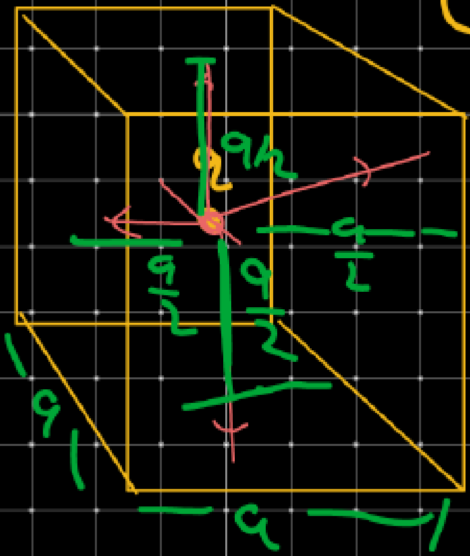
$$E = \frac{2\lambda}{4\pi\varepsilon_0 d}$$

$$E = \frac{2k\lambda}{d}$$

↳ Calculation of Electric flux

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

(a) A. Centre



(q) $\phi_{Total} = \frac{q}{\varepsilon_0}$

(b) find flux through one surface.

↳ 6 side → $\frac{q}{\varepsilon_0}$

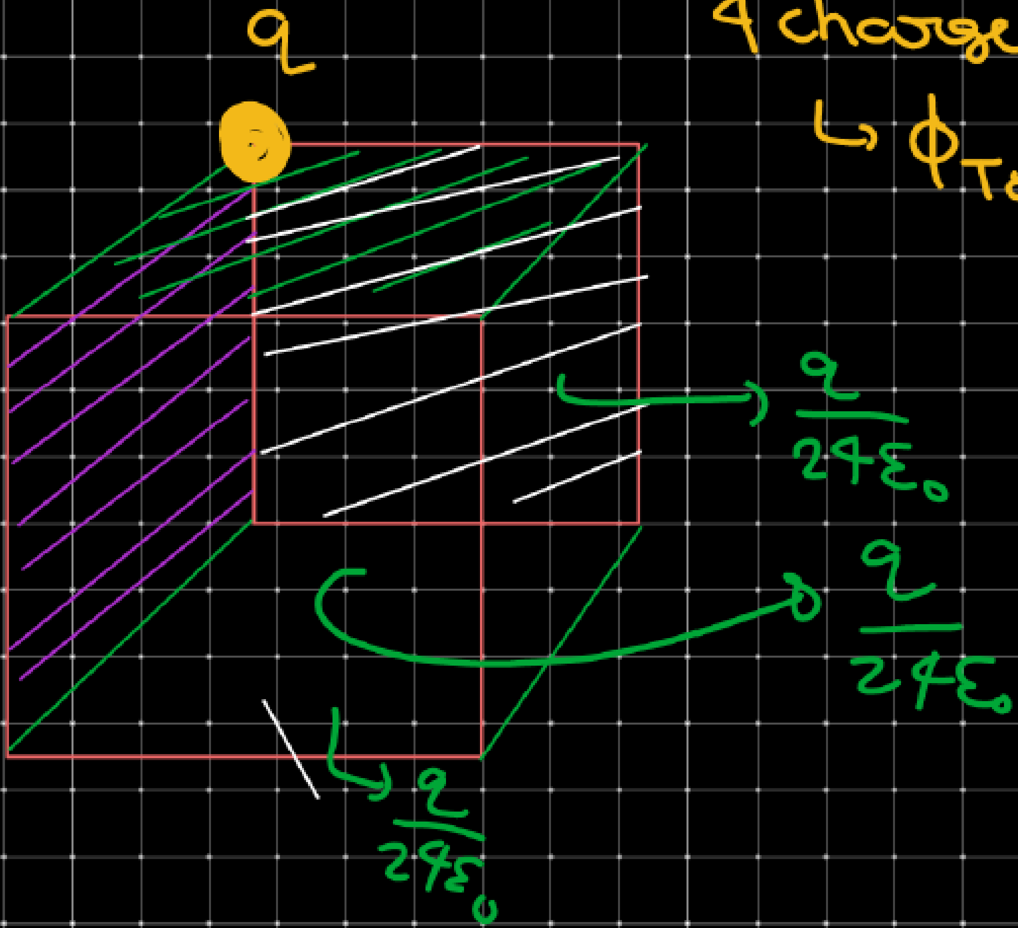
1 side $= \frac{q}{6\varepsilon_0}$

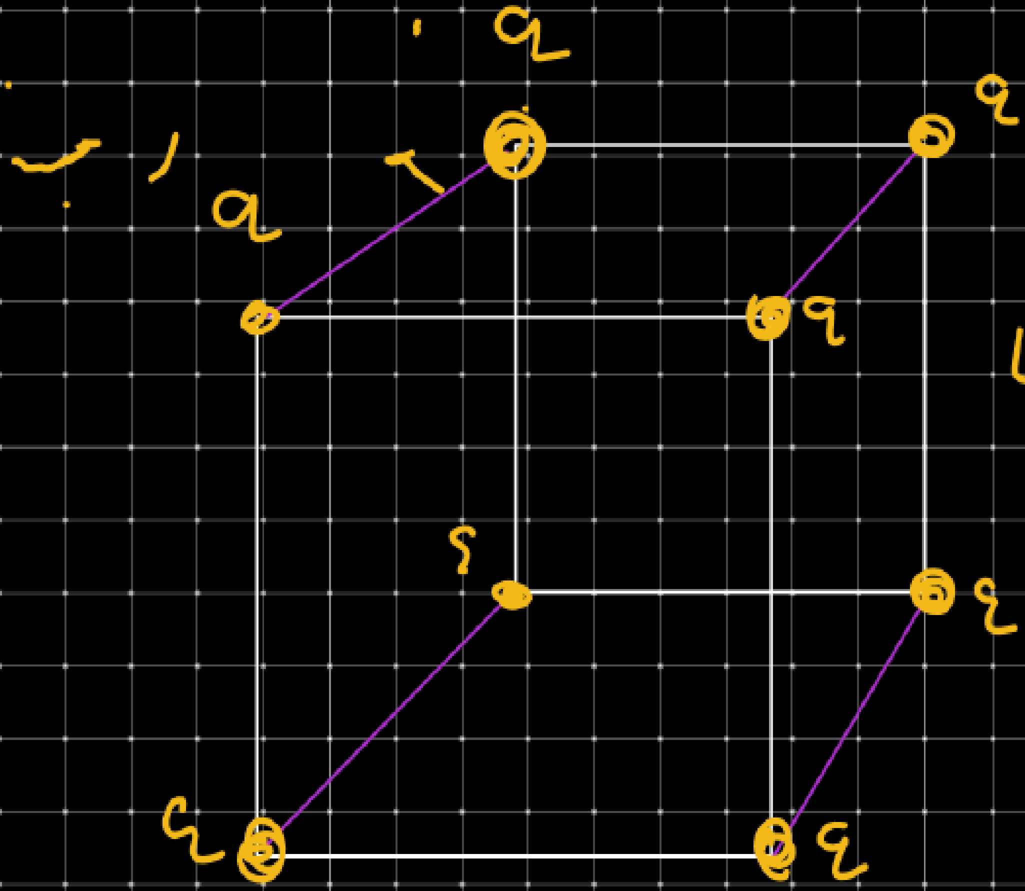
↳ each side a.

∮ charge is placed at Corner.

↳ $\phi_{Total} = \frac{q}{8\varepsilon_0}$.

↳ only pass in 3-side



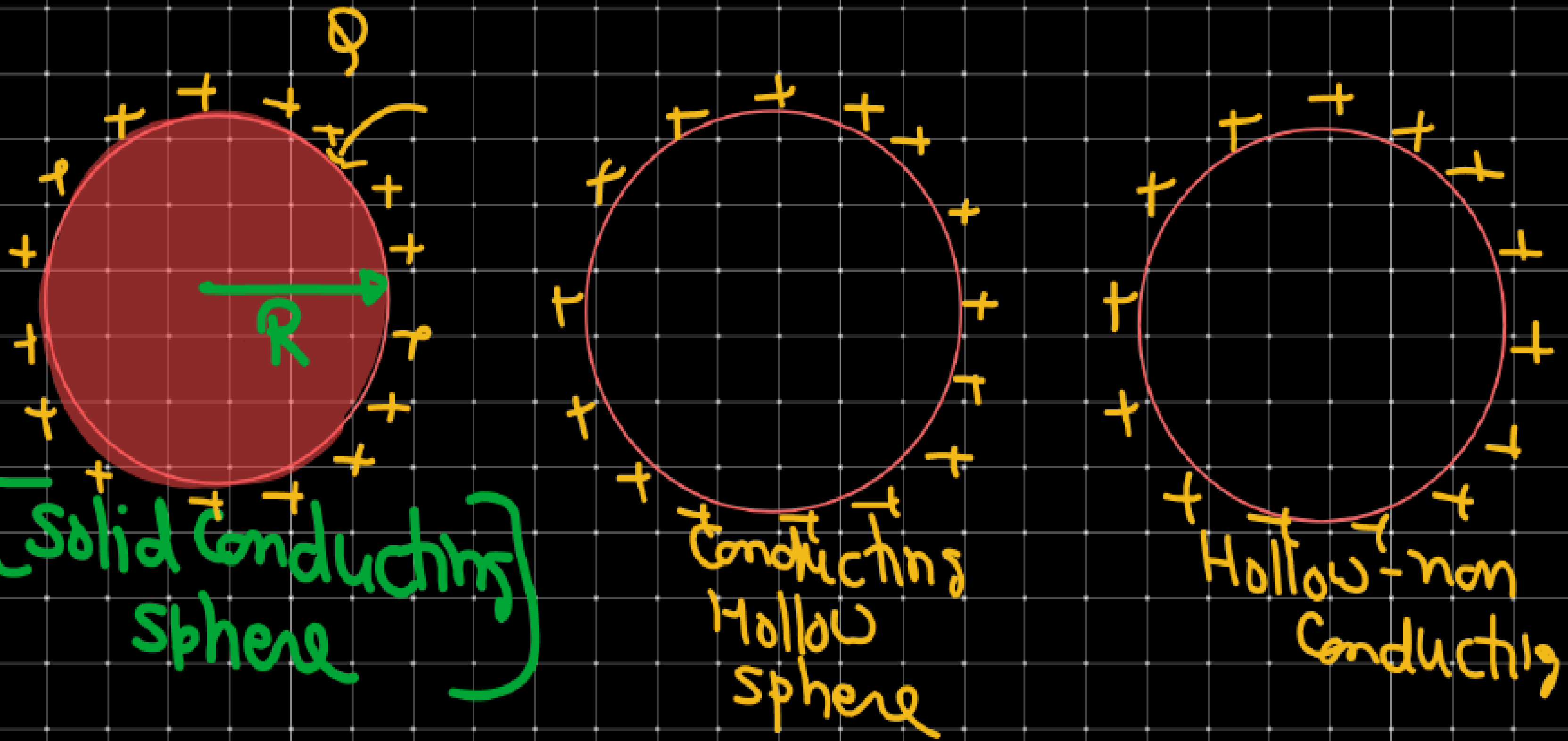


$\phi_{total} = ?$ $\frac{q}{\varepsilon_0}$

↳ For each side.

$\frac{q}{6\varepsilon_0}$

Electric field due to [Solid conducting, Hollow conducting or non conducting uniform sphere.



① Electric field due to charged sphere.

(i) For inside point [r < R]

$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0} = 0$$

$$E = 0$$

(ii) For outside point (r > R)

$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0} \Rightarrow E \times 4\pi r^2 = \frac{Q}{\varepsilon_0}$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2} = \frac{KQ}{r^2} \quad (r > R)$$

$r = R$

$$\frac{KQ}{R^2} = E$$