

# LAKSHYA JEE

LAKSHYA KO HAR HAAL ME PAANA HAI



## Electric Potential & Capacitance

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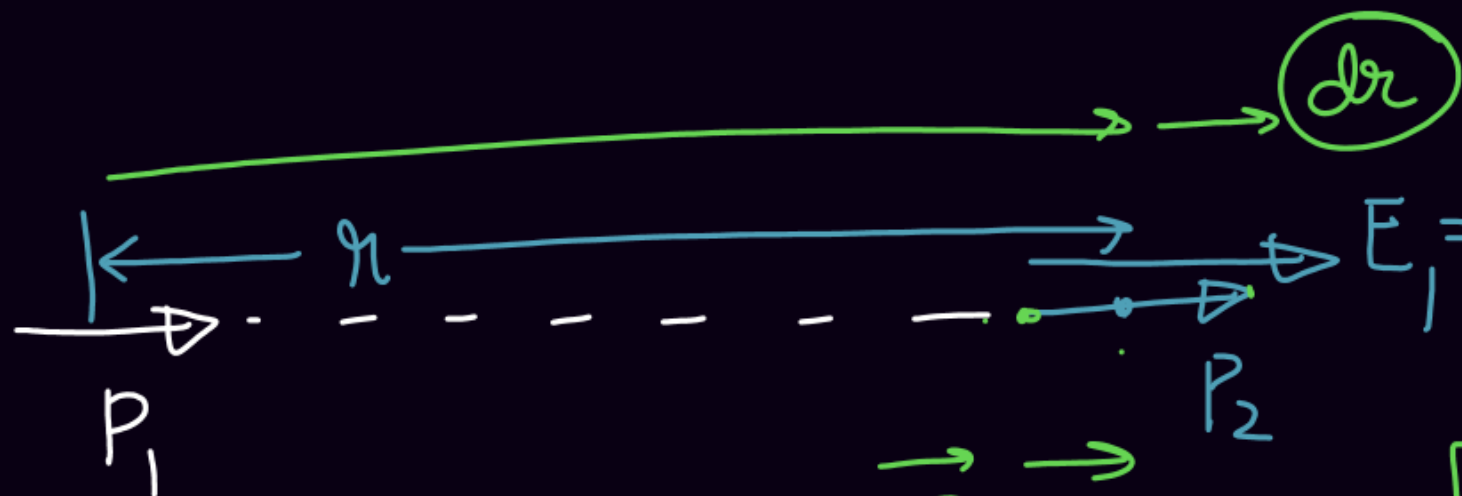


# Today's GOALS!

- Properties of conductors in electrostatics.



# Dipole-dipole interaction



$$U = -\vec{P} \cdot \vec{E}$$

$$U = -P_2 E_1 \cos 0$$

$$U = -P_2 \frac{2K P_1}{r^3}$$

$$F_{dr} = -\frac{du}{dr}$$

$$F_r = r \frac{d}{dr} \left( -\frac{2K P_1 P_2}{r^3} \right)$$

$$F_{dr} = 2K P_1 P_2 \left( \frac{-3}{r^4} \right)$$

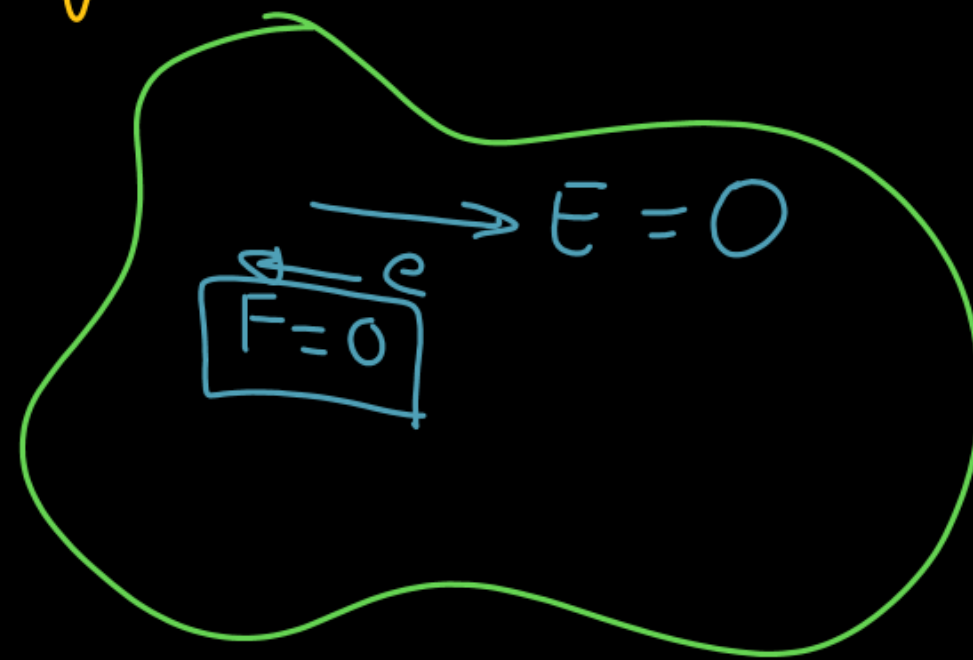
$$F_{dr} = -\frac{6K P_1 P_2}{r^4}$$

Attractive

# Properties of conductors in Electrostatics

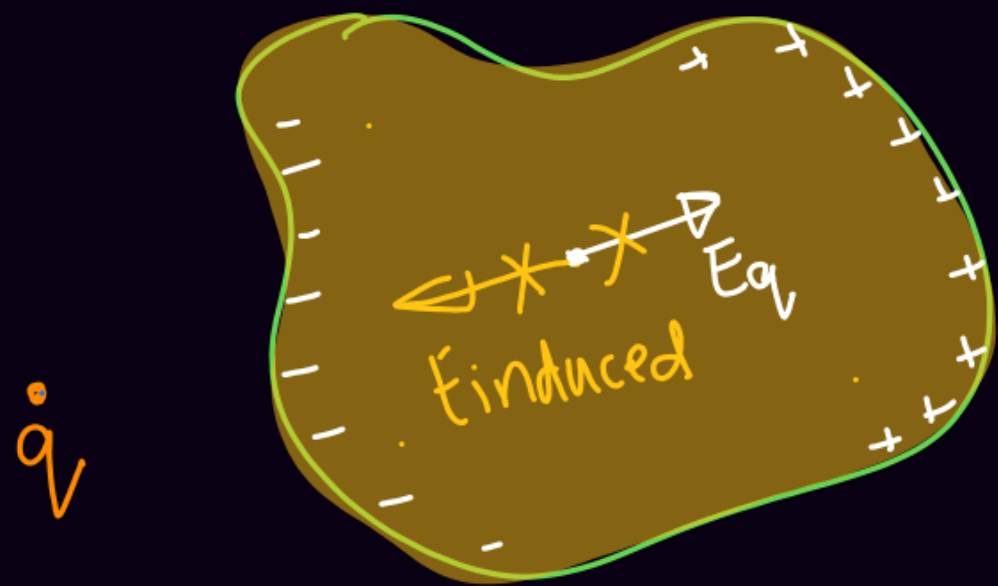
Conductors are those which have very large no. of free electrons.

① Net electric field inside the bulk of a conductor is zero.



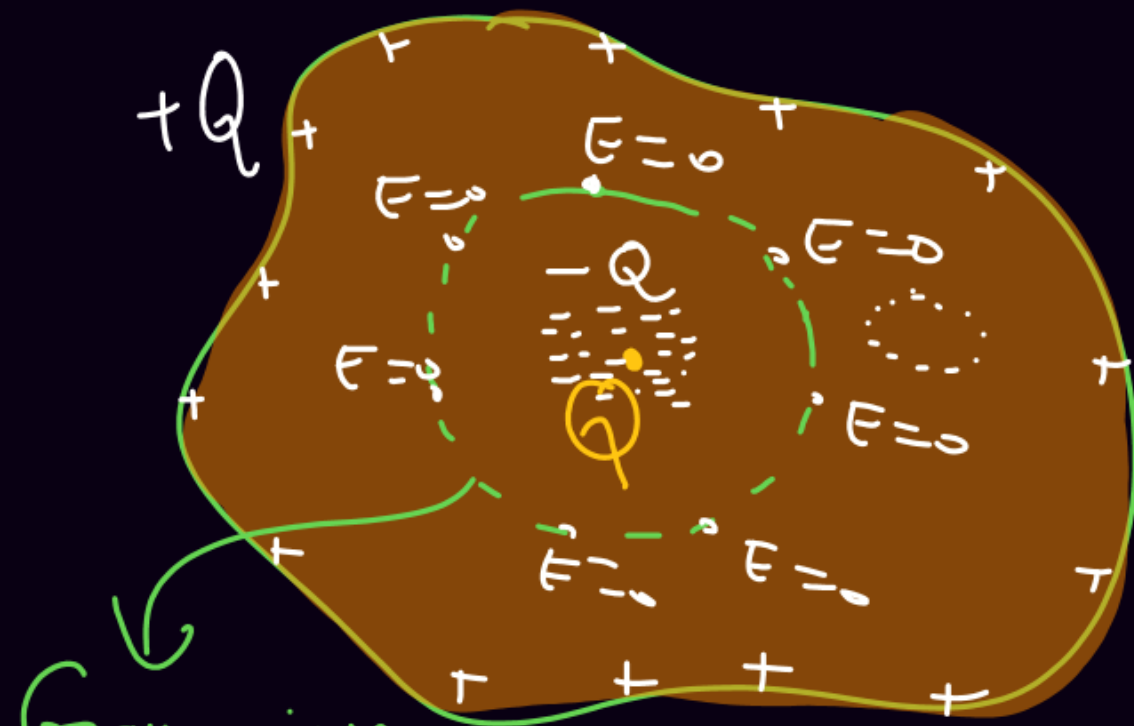
Conductor





Induction

② No excess charge can reside inside the bulk of a conductor.

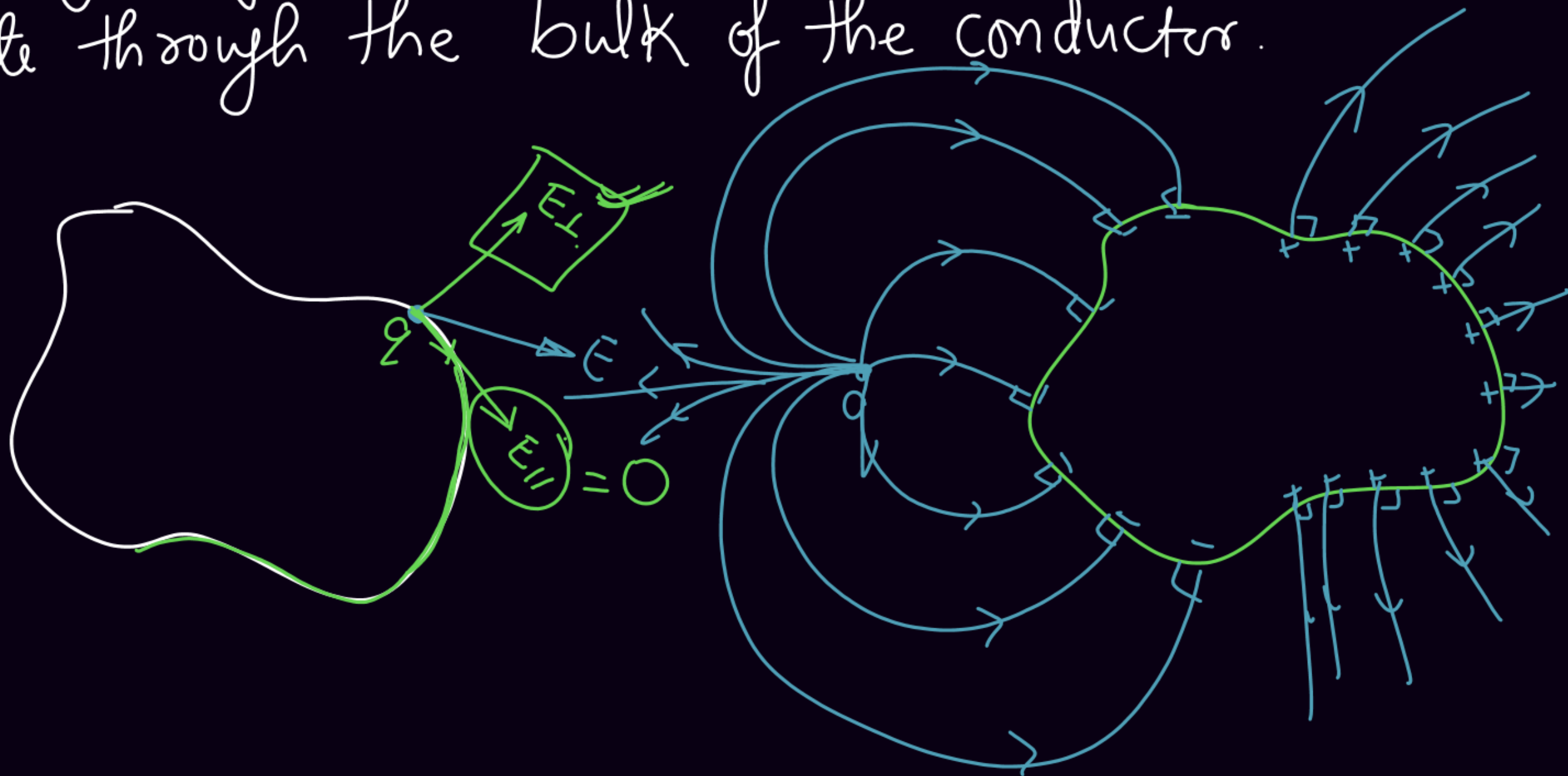


Gaussian surface.

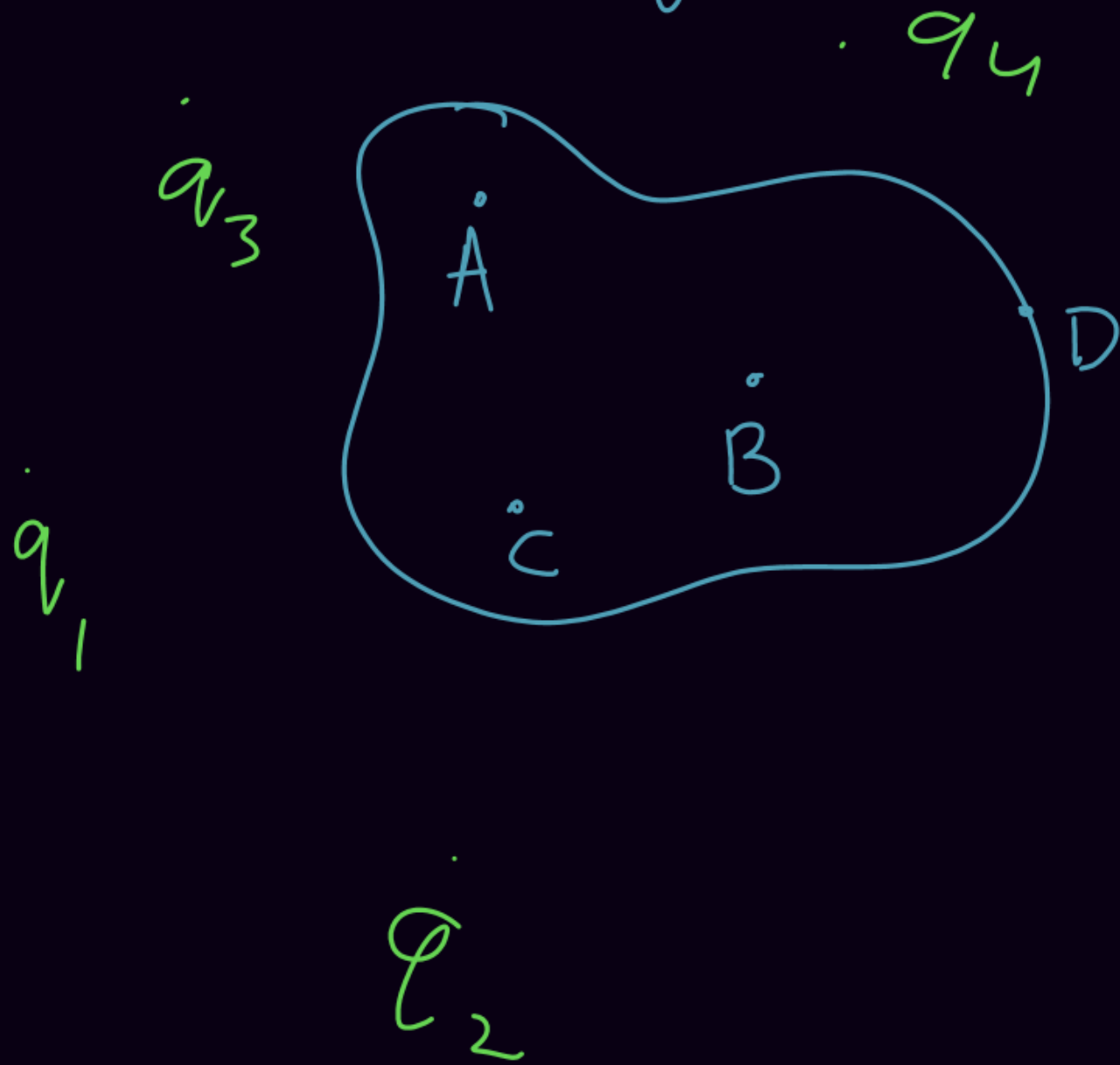
$$\oint \vec{E} \cdot d\vec{S} = \frac{q_{in}}{\epsilon_0}$$

$q_{in} = 0$

③ Electric field lines terminate or originate perpendicularly from the surface of the conductors. E-F-L will not penetrate through the bulk of the conductor.

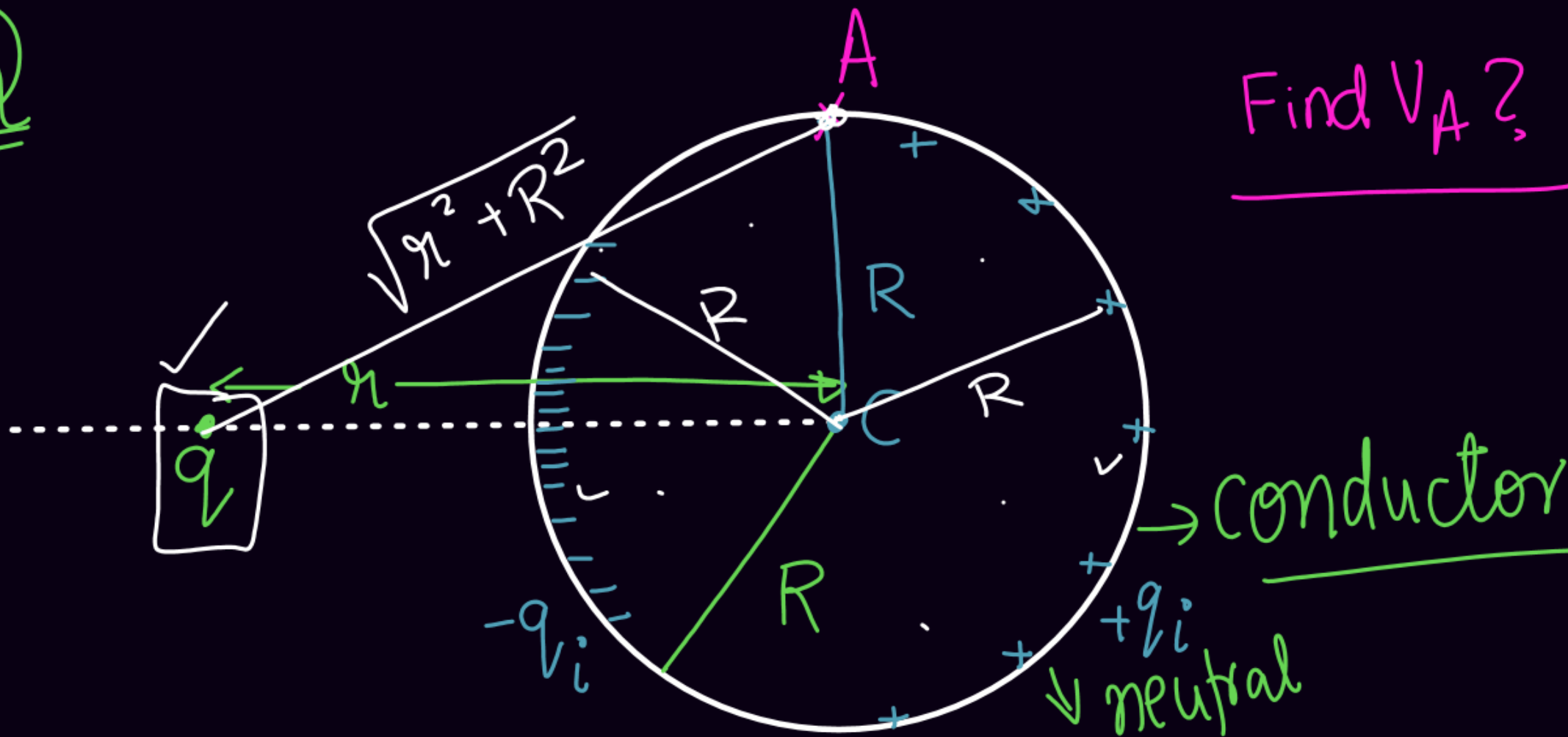


④ Bulk & surface of a conductor is equipotential.



$$V_A = V_B = V_C = V_D.$$

11Q



Find  $V_A$ ?

Find the potential at point A due to induced charges only.

$$V_A = V_C = \frac{kq}{r} - \frac{kq_i}{R} + \frac{kq_i}{R}$$

$$V_A = V_{Aq} + V_{A \text{ induced charges}}$$

$$\frac{kq}{r} = \frac{kq}{\sqrt{R^2 + r^2}} + V_{A \text{ ind. charges}}$$

$$V_{A \text{ induced charges}} = kq \left( \frac{1}{r} - \frac{1}{\sqrt{R^2 + r^2}} \right)$$



5) When a conductor is earthed its potential becomes zero.

Earth is a huge conductor.

After earthing

$$V_C = 0 = \frac{Kq}{r} + \frac{KQ}{R}$$

$$Q = -\frac{qR}{r}$$

Before earthing

$$V = \frac{Kq}{r} \quad \& \quad Q_{\text{sphere}} = 0$$

After earthing

$$V = 0 \quad \& \quad Q_{\text{sphere}} = ?$$

Spherical conductor

The diagram illustrates a spherical conductor of radius  $R$  and center  $C$ . A point charge  $q$  is positioned at a distance  $r$  from the center. The conductor's surface is indicated by a dashed line. A separate circuit diagram shows the conductor connected to ground through a wire and a switch, labeled "Earthing".

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On conductor  $\sigma R = \text{Const.}$

$\downarrow$   $\hookrightarrow$  Radius of curvature.

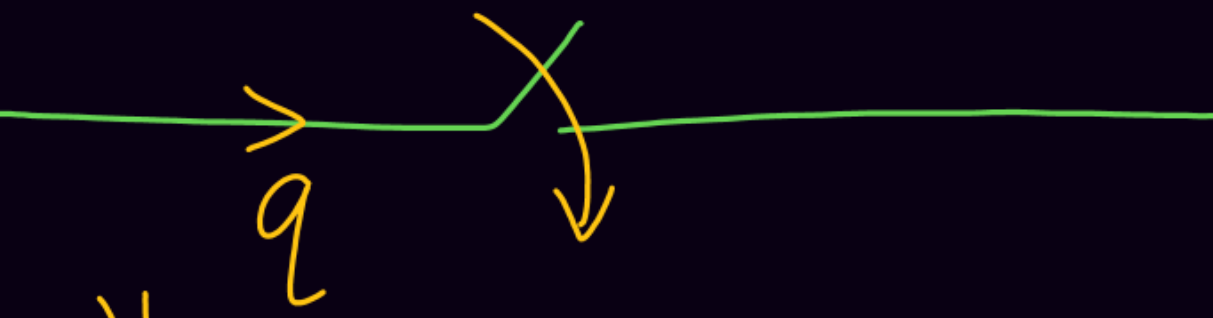
Surface charge density

$$Q - q = q_1$$

$$\sigma_1 = \frac{q_1}{4\pi R_1^2}$$

$$\sigma_2 = \frac{q_2}{4\pi R_2^2}$$

$$q_1 = q_2$$



$$\frac{V_1}{\frac{Kq_1}{R_1}} = \frac{V_2}{\frac{Kq_2}{R_2}}$$

$$\Rightarrow \frac{q_1}{R_1} = \frac{q_2}{R_2} \Rightarrow \frac{q_1}{q_2} = \frac{R_1}{R_2}$$

$$\frac{\sigma_1}{\sigma_2} = \frac{q_1 \sqrt{R_2^2}}{\sqrt{R_1^2} q_2}$$

$$\frac{\sigma_1}{\sigma_2} = \frac{q_1}{q_2} \times \frac{R_2^2}{R_1^2}$$

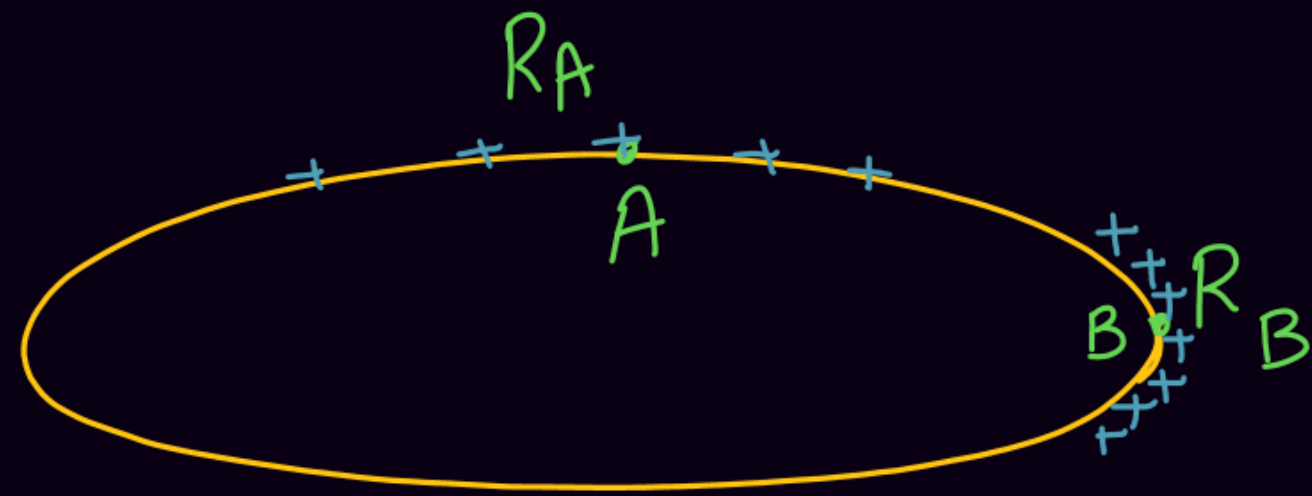
$$= \frac{R_1}{R_2} \times \left( \frac{R_2}{R_1} \right)^2$$

$$\frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$$

$$\sigma_1 R_1 = \sigma_2 R_2$$

$$\uparrow \sigma R = \text{const.}$$

↓  
Flatter  $\Rightarrow R \uparrow$   
Sharper  $\Rightarrow R \downarrow$

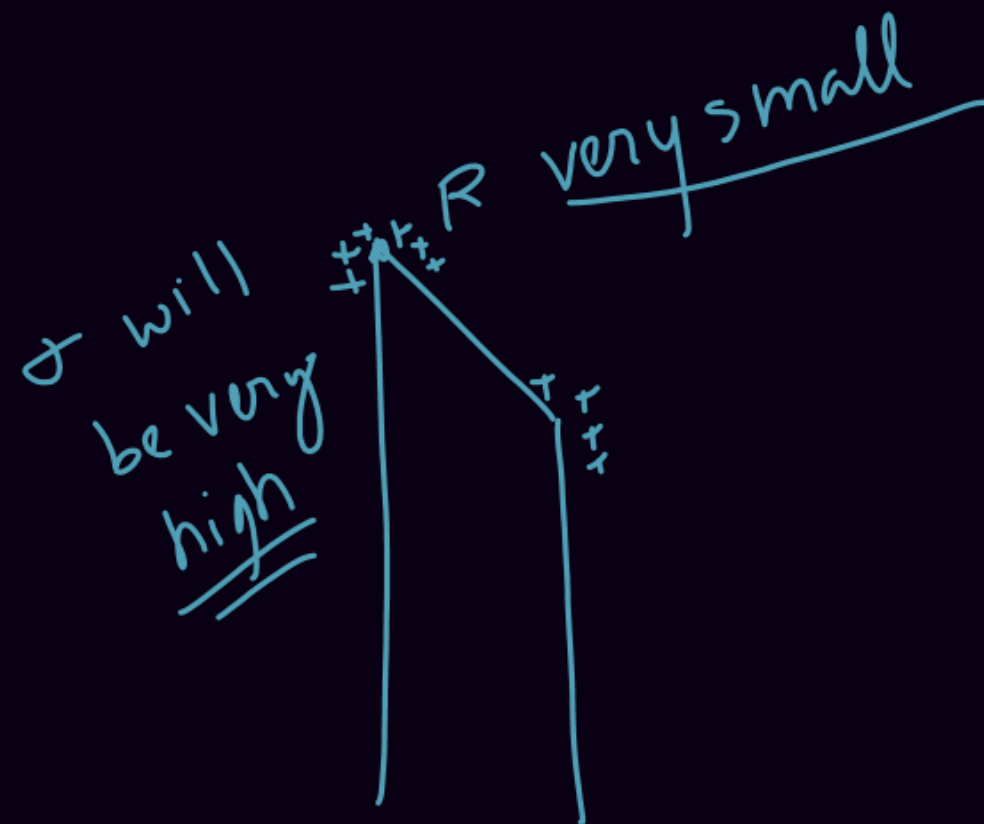


$$R_A > R_B$$

$$R \uparrow \quad \sigma \downarrow$$

$$R \downarrow \quad \sigma \uparrow$$

$$\sigma_B > \sigma_A$$



$\sigma$  will  
be very  
high

$R$  very small

*Thank You Lakshyians*