LAKSHYA JEE

LAKSHYA KO HAR HAAL ME PAANA HAI

Electric Potential & Capacitance

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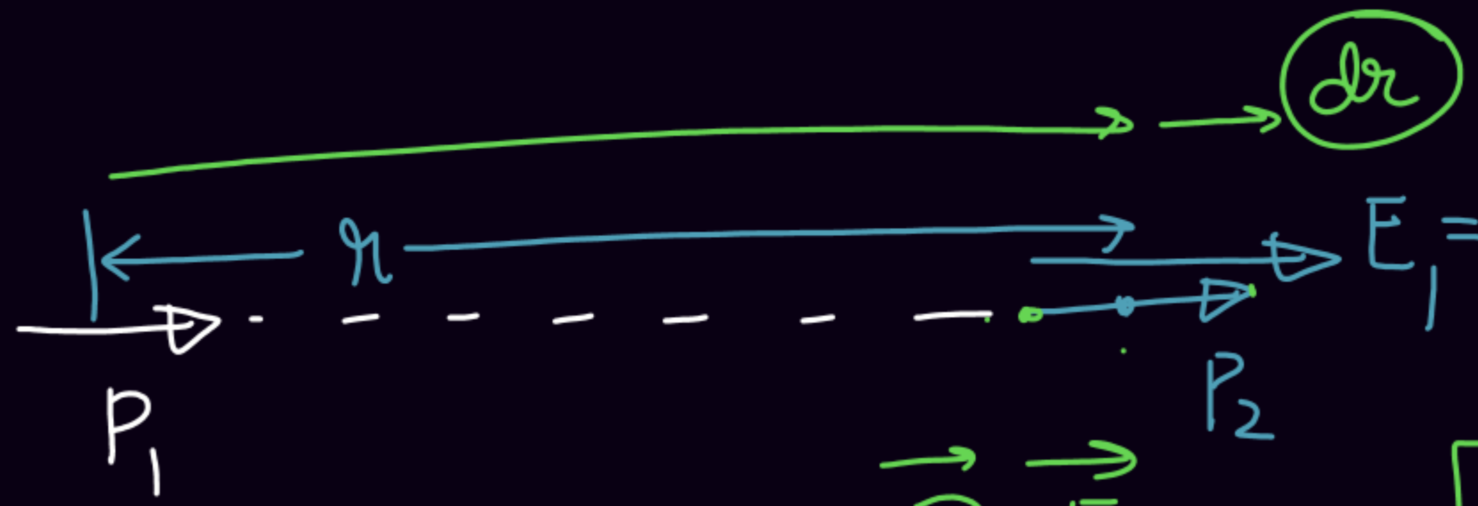
Today's GOALS!

- Properties of conductors in electrostatics.

Dipole-dipole interaction



$$E_1 = \frac{2KP_1}{r^3}$$

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

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

$$U = -P_2 \frac{2KP_1}{r^3}$$

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

$$F_r = -\frac{d}{dr}\left(-\frac{2KP_1P_2}{r^3}\right)$$

$$F_{dr} = 2KP_1P_2\left(\frac{-3}{r^4}\right)$$

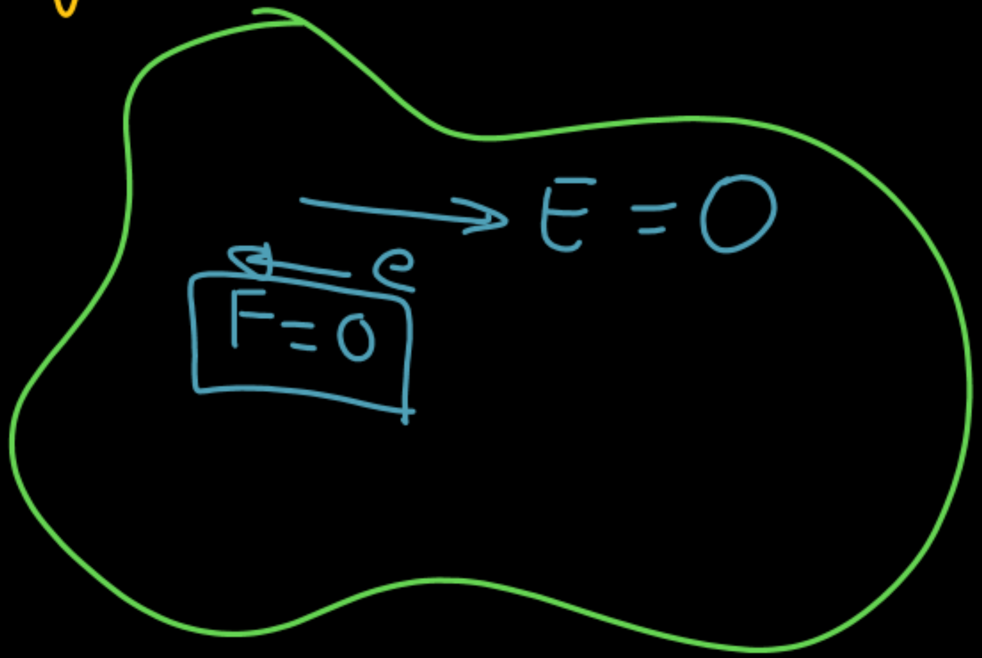
$$F_{dr} = -\frac{6KP_1P_2}{r^4}$$

Attractive

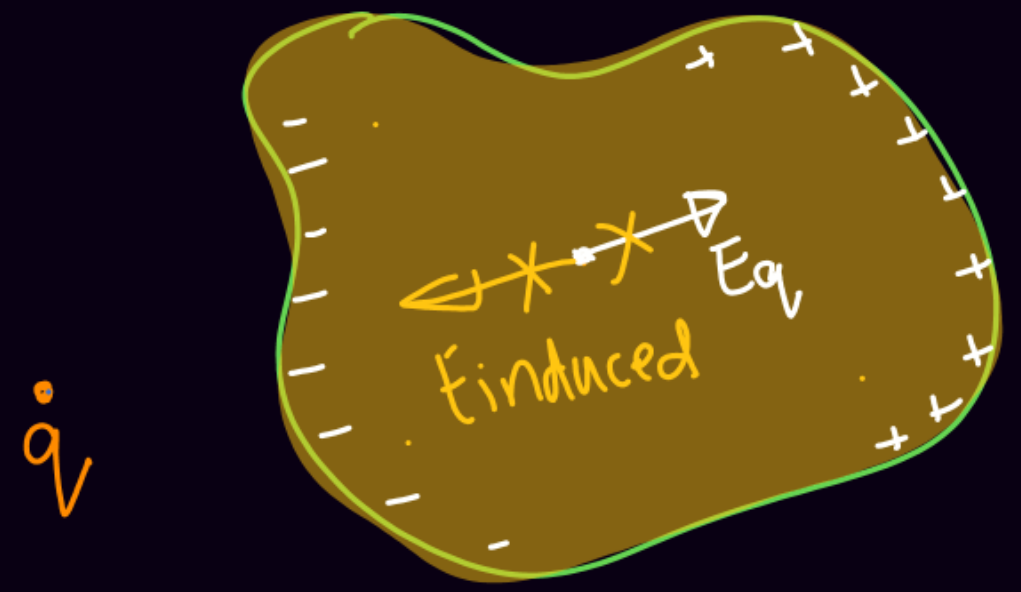
Properties of conductors in Electrostatics

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

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



Conductor



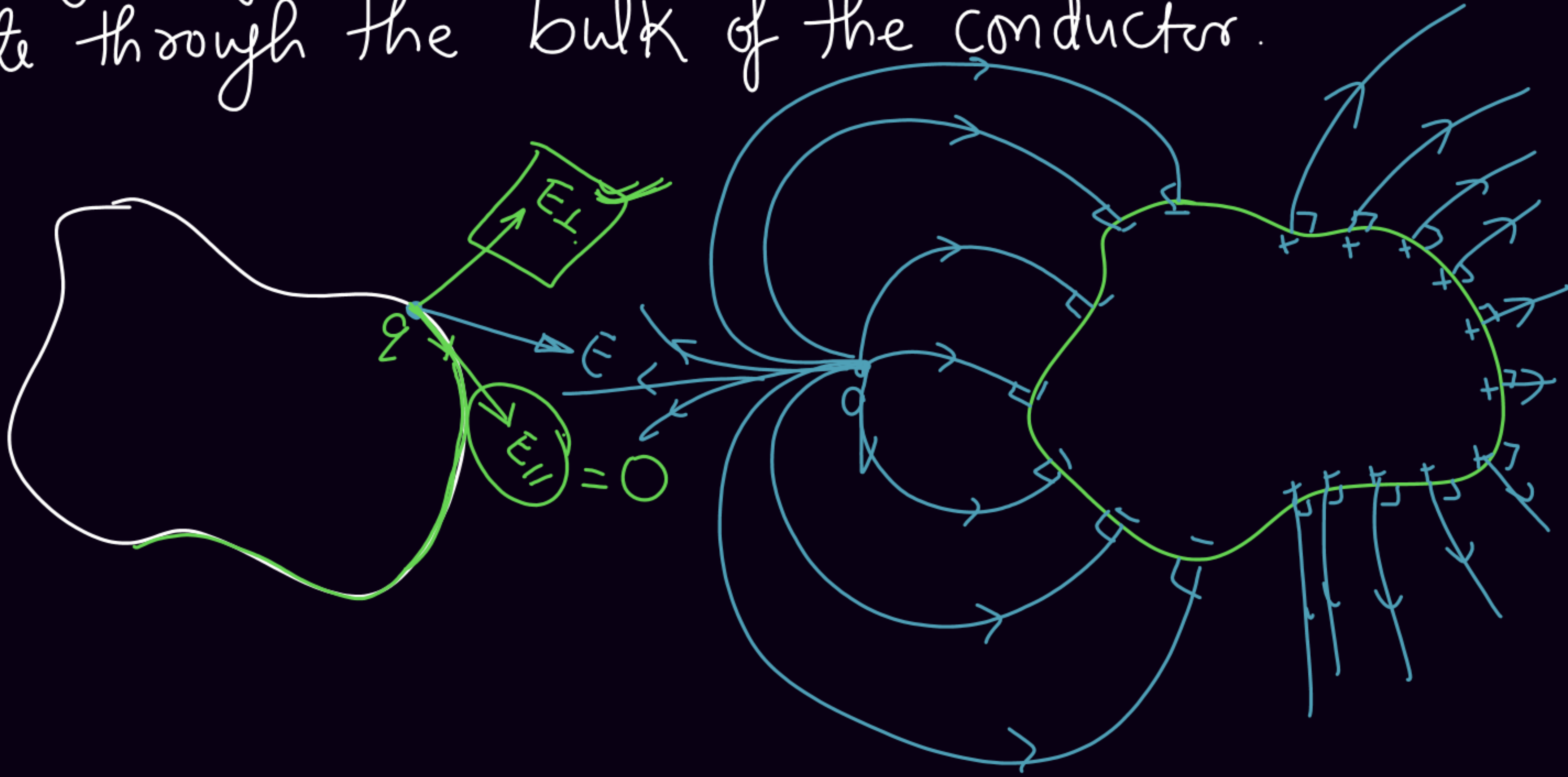
Induction

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

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

$q_{in} = 0$

(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.

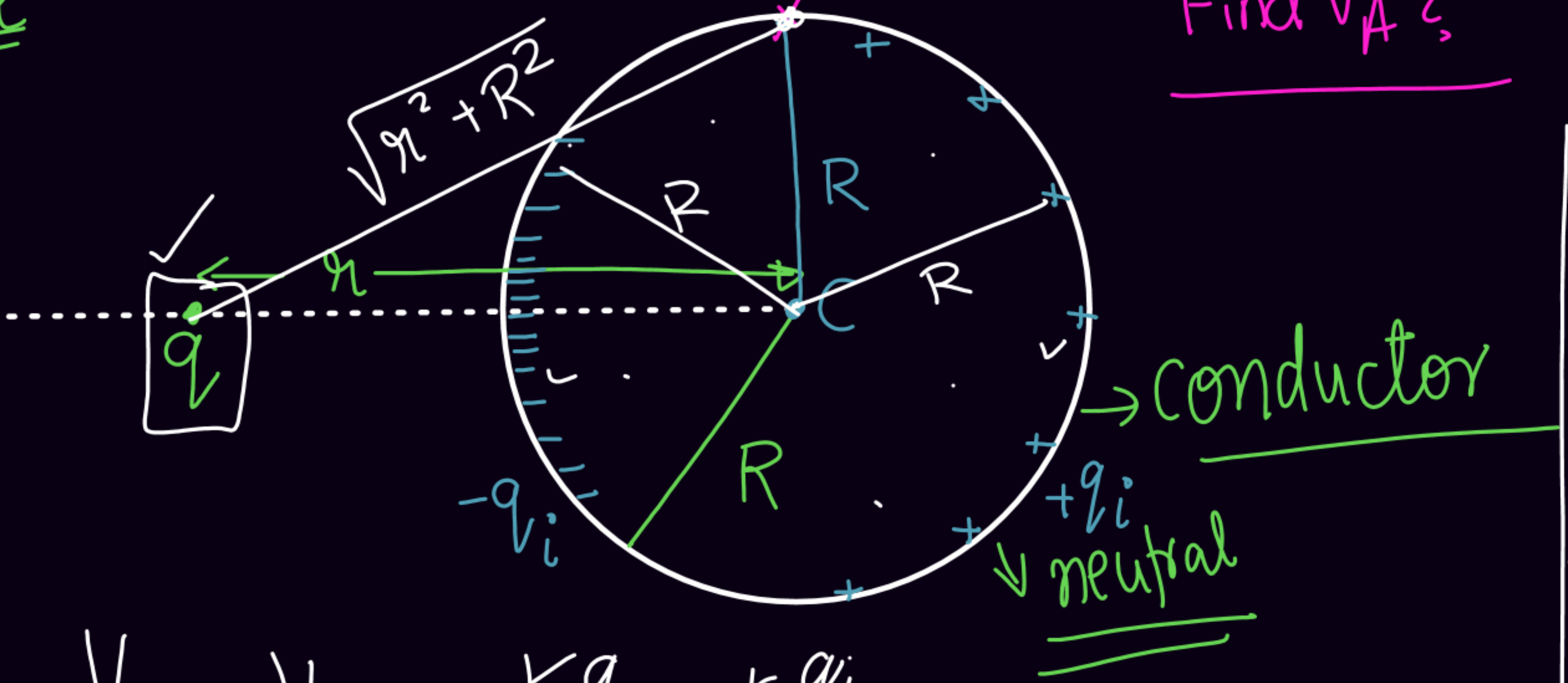


(4) Bulk & surface of a conductor is equipotential.

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

Q

Find V_A?



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

$$V_A = V_C = \frac{Kq}{r} - \frac{Kq_i}{R} + \frac{Kq_i}{R}$$

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

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

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

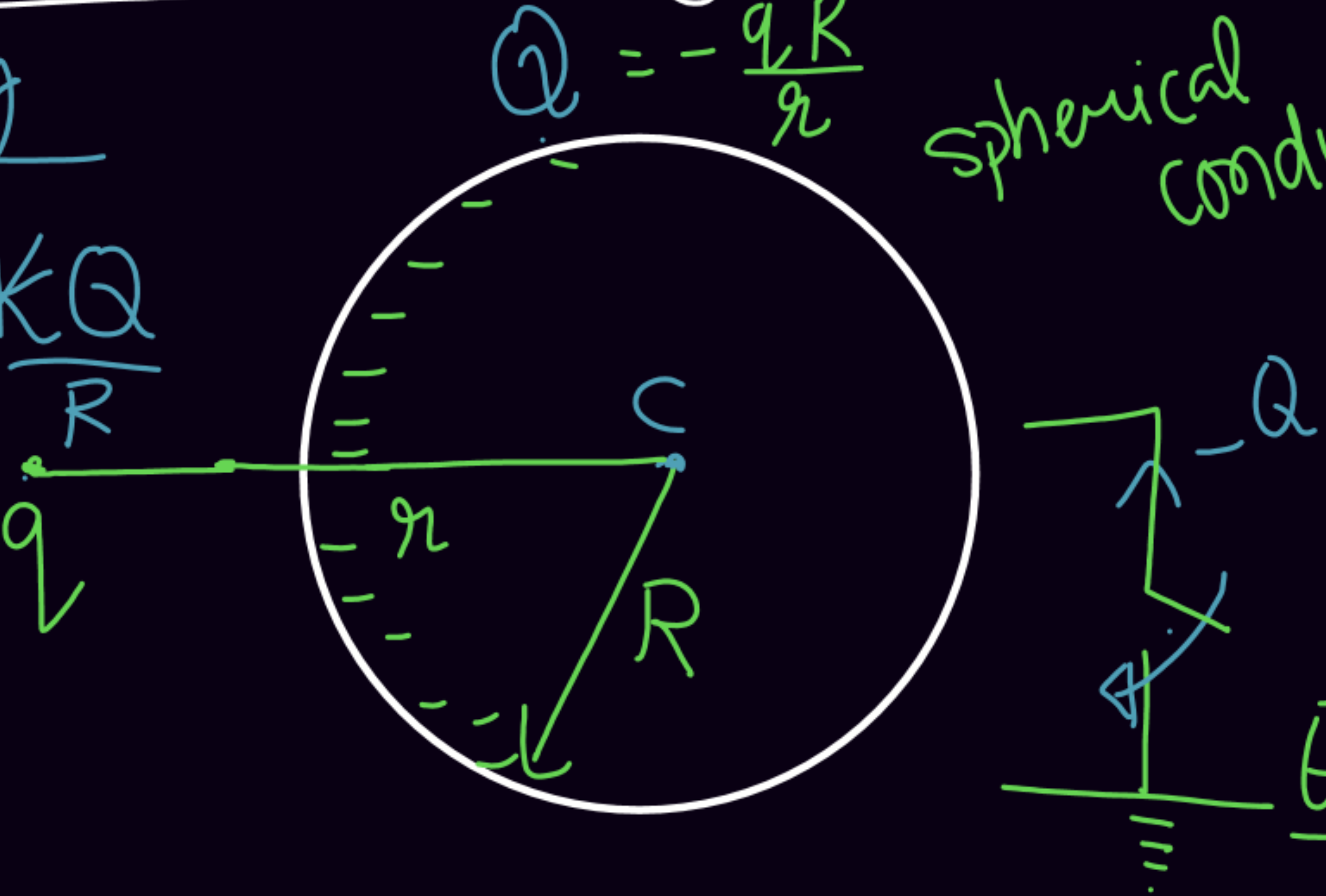
(5) When a conductor is earthed its potential becomes zero.

Earth is a huge conductor.

After earthing

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

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



Earthing

Before earthing

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

After earthing

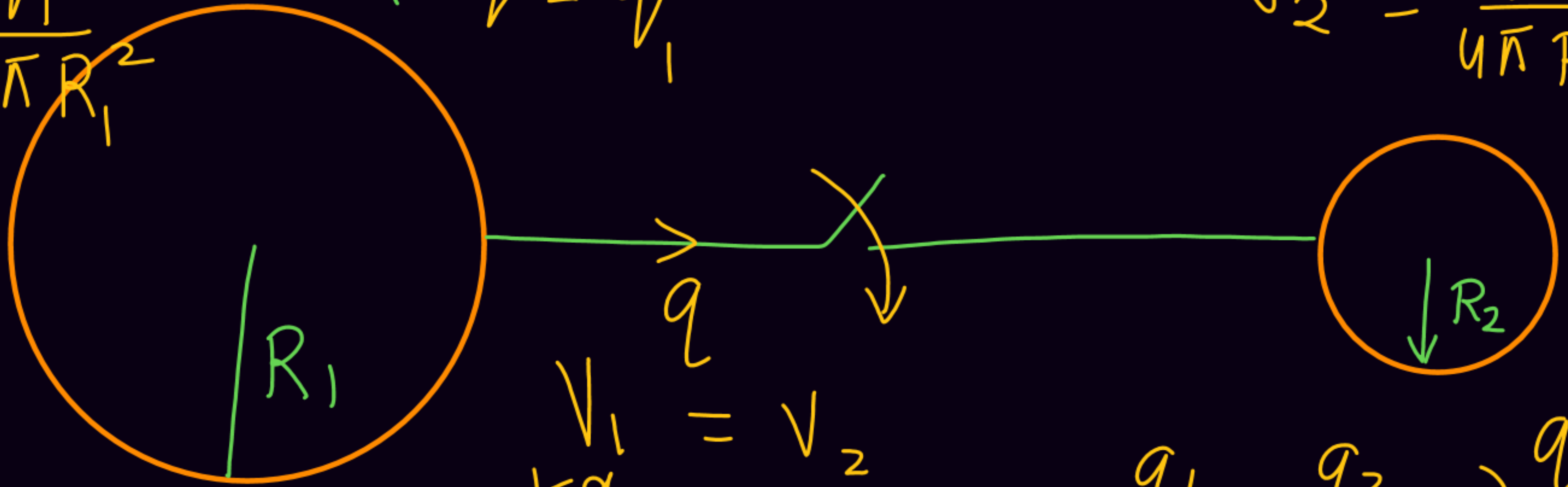
$V = 0$; $Q_{sphere} = ?$

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

$\sigma \downarrow$ Surface Charge density

$R \to$ Radius of curvature.

$$\sigma_1 = \frac{q_1}{4\pi R_1^2} \qquad Q - q = q_1 \qquad \sigma_2 = \frac{q_2}{4\pi R_2^2}$$



$$q = q_2.$$

$$V_1 = V_2$$

$$\frac{Kq_1}{R_1} = \frac{Kq_2}{R_2} \Rightarrow \frac{q_1}{R_1} = \frac{q_2}{R_2} \Rightarrow \frac{q_1}{q_2} = \frac{R_1}{R_2}$$

$$\frac{\sigma_1}{\sigma_2} = \frac{q_1}{4\pi R_1^2} \frac{4\pi R_2^2}{q_2}$$

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

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

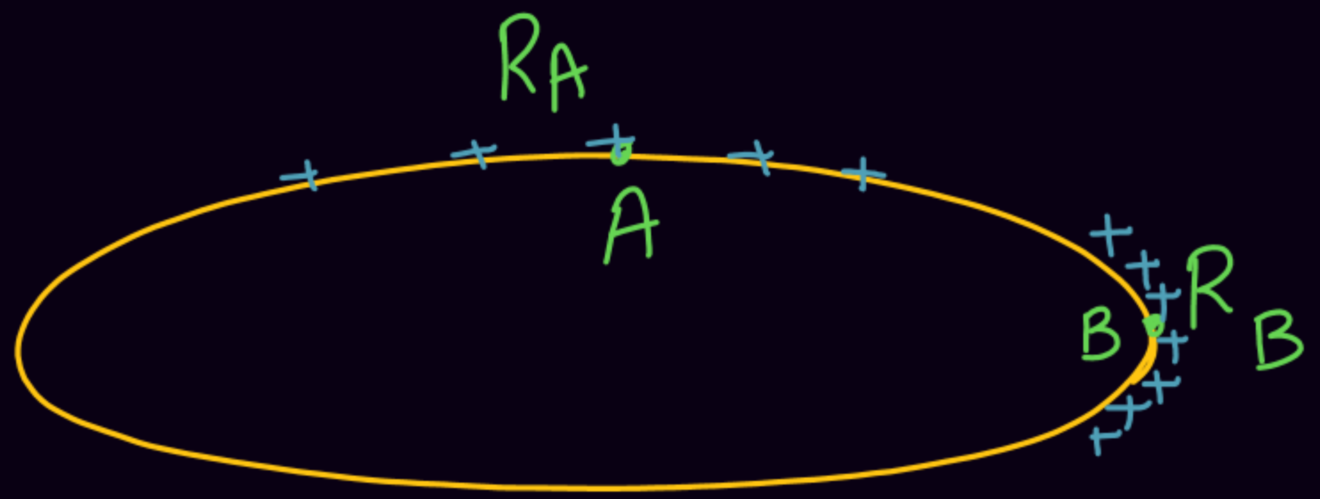
$$\frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$$

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

$$\boxed{\uparrow \sigma R = \text{Const.}}$$

Flatter $\Rightarrow R \uparrow$

Sharp turn $\Rightarrow R \downarrow$

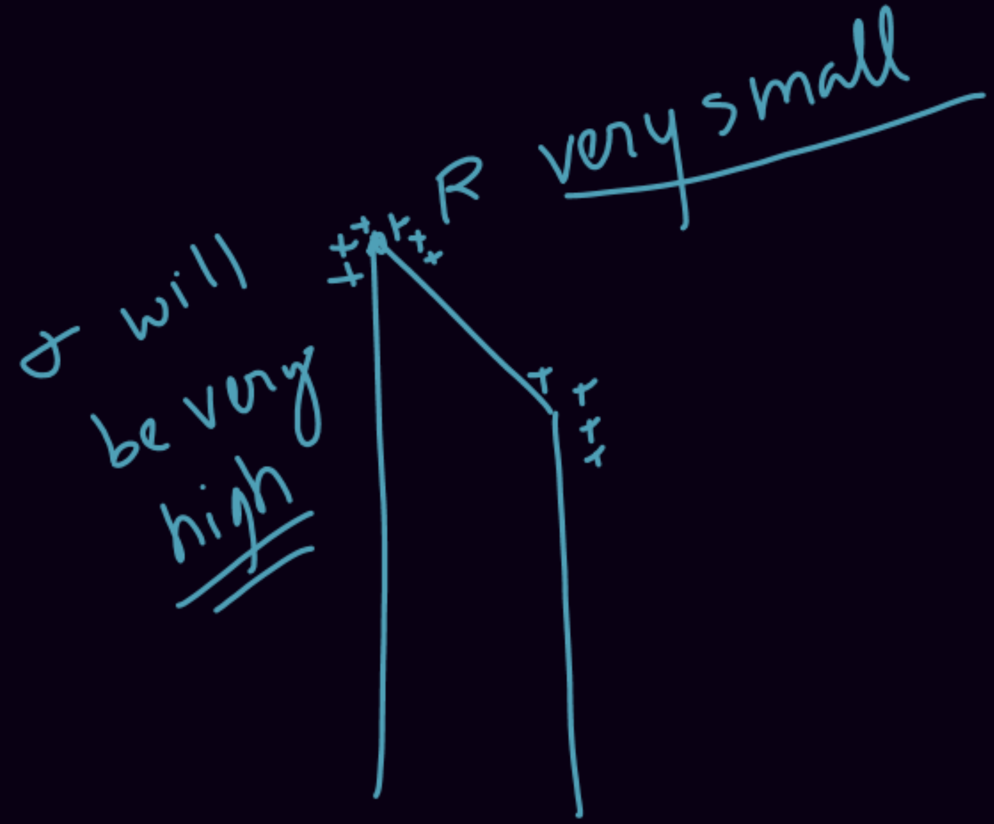


$$\boxed{R_A > R_B}$$

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

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

$$\sigma_B > \sigma_A$$



Thank You Lakshyians