Nishant Jindal

Capacitor

⇒ Capacitance :→

↳ $Q \propto V$

$$\boxed{Q = C V}$$

$$\boxed{C = \frac{Q}{V}}$$

→ Note

↳ C → only depends on medium and geometrical construction where charge is stored.

Capacitance ✓.

Unit → (C/V)

↳ [Energy storage device]

↳ [Energy stored in the form of Electrostatic potential energy]

① Capacitance of a Conductor :→

Neutral

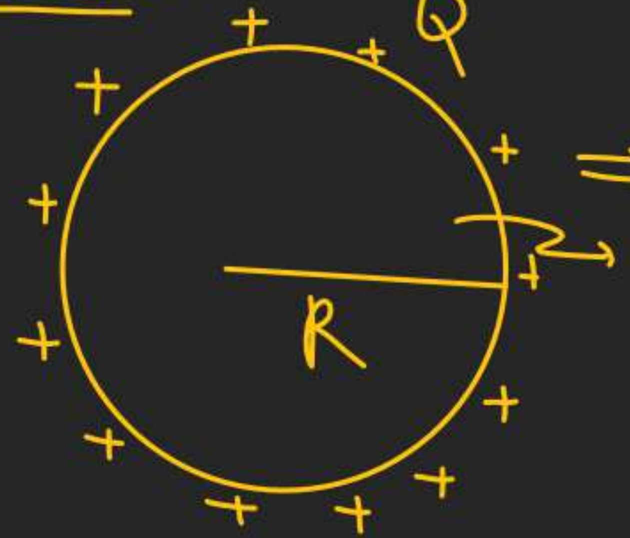
$\Rightarrow$ Charge

q ↙ charge

$q \propto V$

$\boxed{q = CV}$

Spherical Conductor



$\Rightarrow C = ??$

$$V = \frac{KQ}{R} \Rightarrow$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R} \Rightarrow$$

$\boxed{Q \propto V} = \boxed{Q = CV}$

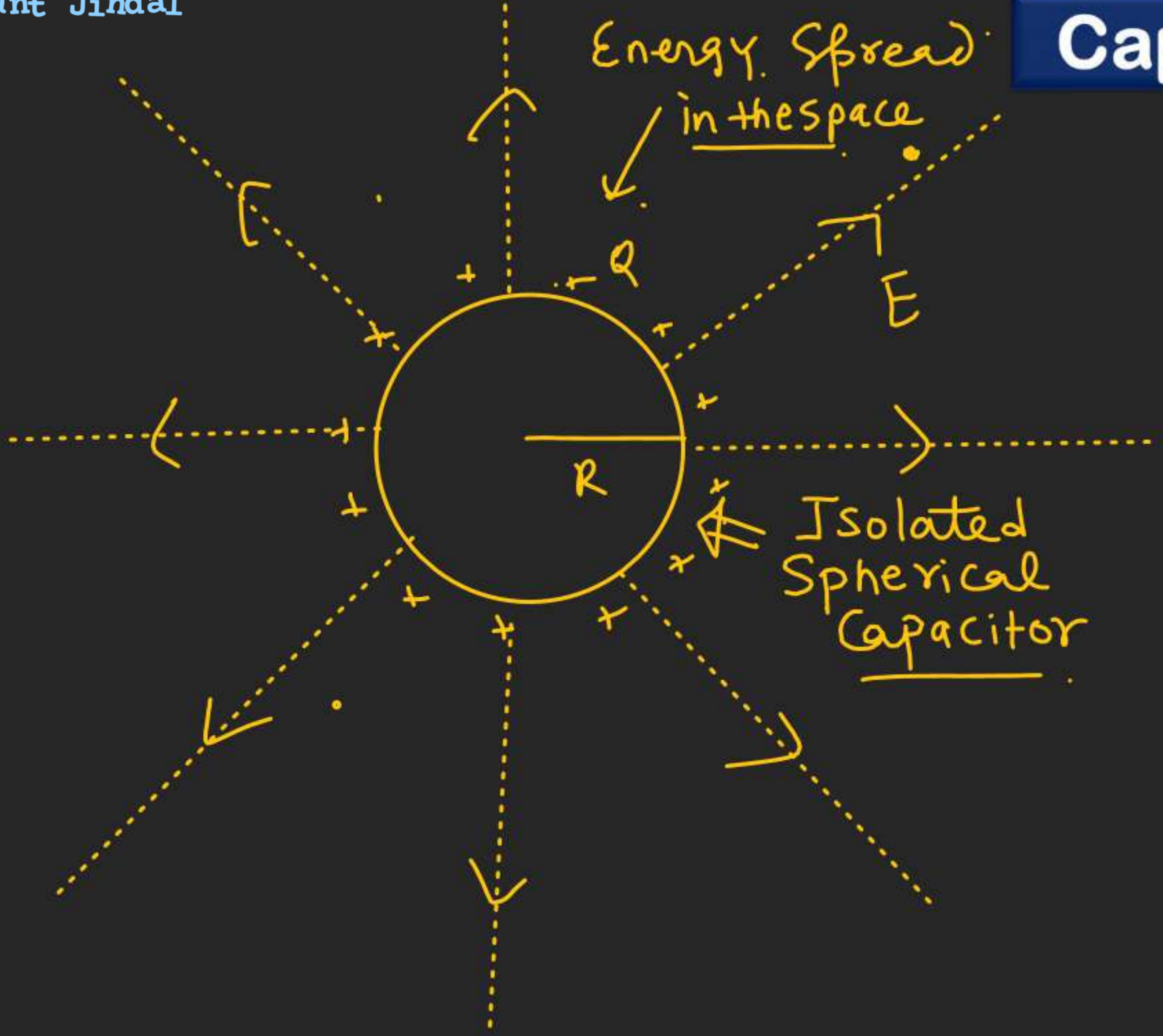
$\Downarrow$

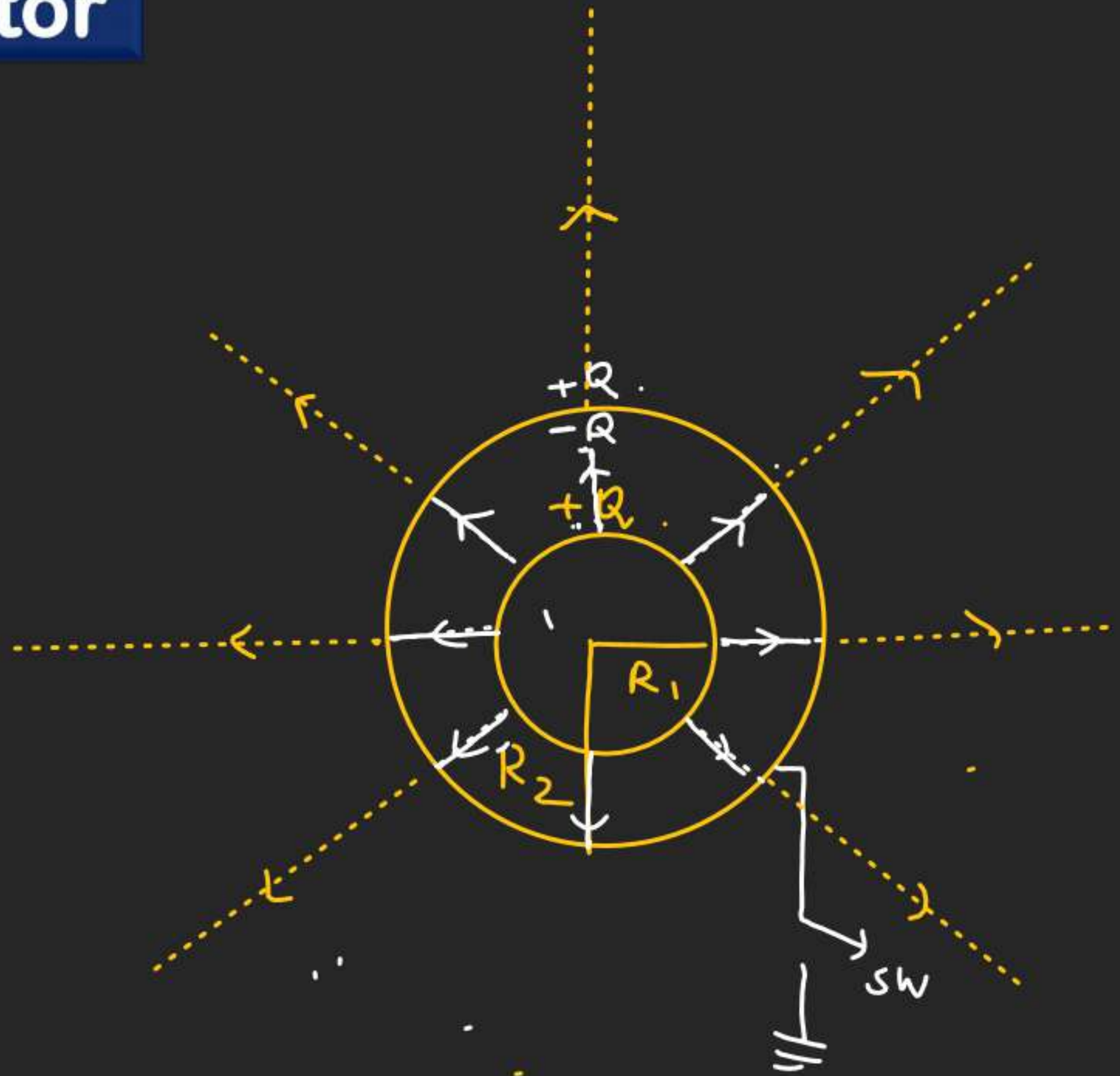
$$\boxed{Q = (4\pi\varepsilon_0 R)V} \Rightarrow \boxed{C = 4\pi\varepsilon_0 R}$$

Medium depend.

geometrical Construction

Capacitor


Energy Spread
in the space
Q
E
R
Isolated
Spherical
Capacitor


+Q
-Q
+Q
R_1
R_2
SW

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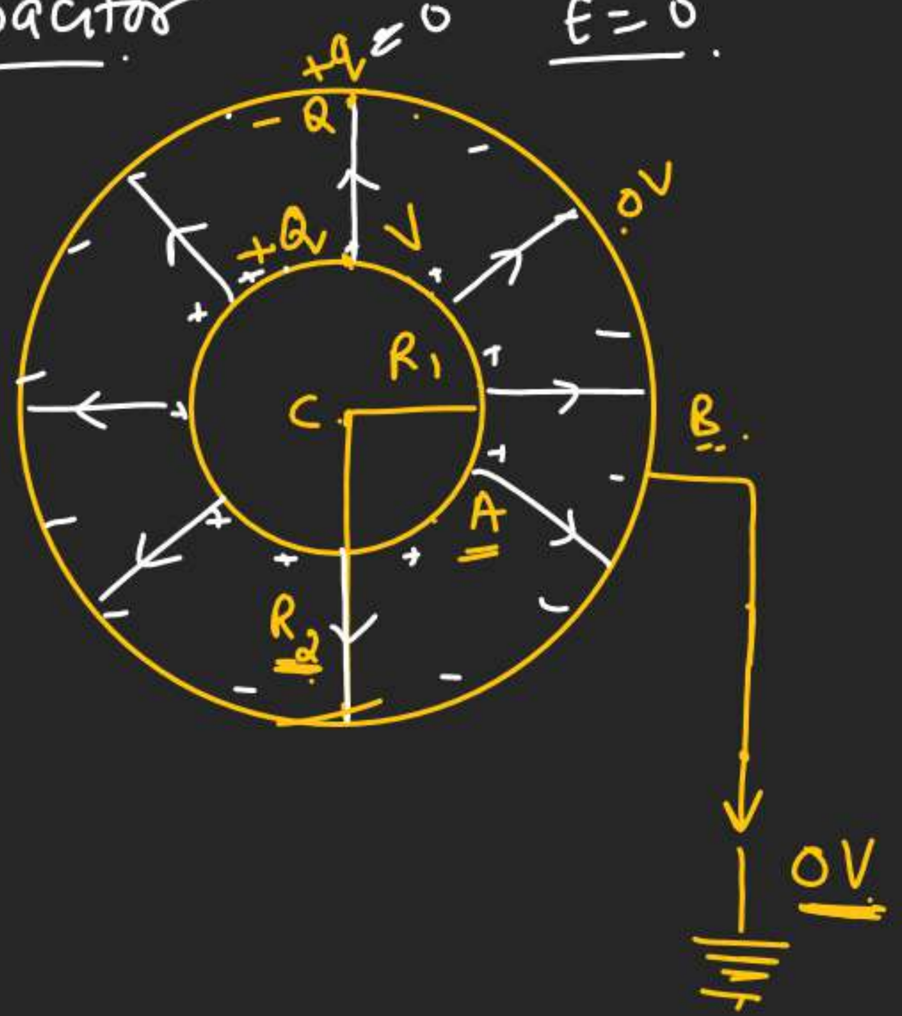
Spherical Capacitor



$$\frac{KQ}{R_2} + K\left(\frac{q-Q}{R_2}\right) = 0$$

$$\frac{KQ}{R_2} - \frac{KQ}{R_2} + \frac{Kq}{R_2} = 0$$

$$\boxed{q = 0}$$

**

$$\boxed{C = \frac{4\pi\varepsilon_0 R_1 R_2}{R_2 - R_1}}$$

Capacitance of Spherical Capacitor:

$V_A = V, \quad V_B = 0$

$V_A - \cancel{V_B}^{0} = V$

$\Downarrow$

$$\frac{KQ}{R_1} - \frac{KQ}{R_2} = V$$

$$KQ\left[\frac{1}{R_1} - \frac{1}{R_2}\right] = V$$

$$Q = \frac{1}{K\left[\frac{1}{R_1} - \frac{1}{R_2}\right]} V$$

$\Rightarrow C$

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Another Method for finding Capacitance :-

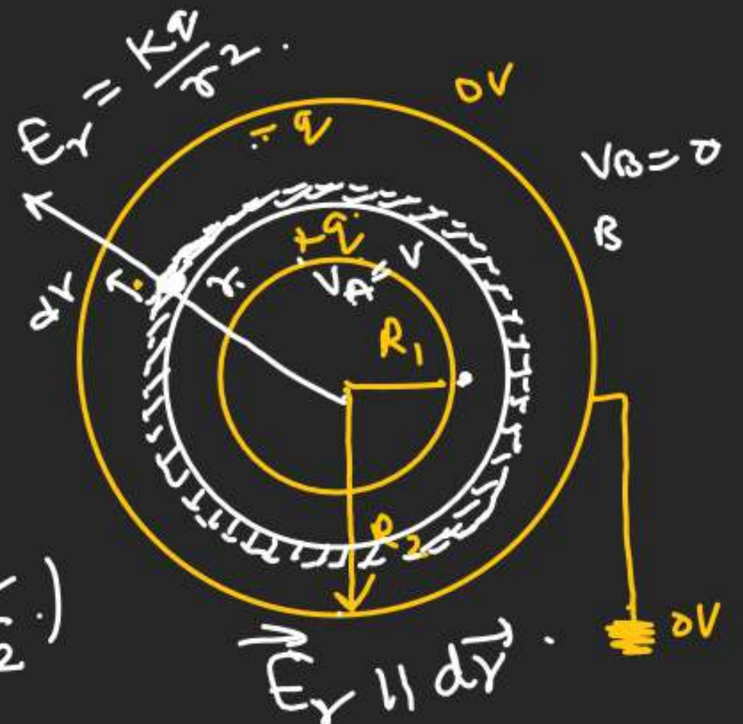
⇒ Step - 1) Assume equal and opposite Charge b/w two plates of the Capacitor.

2) Earth the outer Capacitor.

3) Find potential difference b/w two plates.

$$\int dV = -\int \vec{E}\cdot d\vec{r}$$

4) Compare the result with $\boxed{Q = CV}$ ⇒ find $C = ??$



$$E_r = \left(\frac{Kq}{r^2}\right)$$

$$\int dV = -\int_{R_2} E_r\, dr$$

$$\int_V^0 dV = -Kq\int_{R_1}^{R_2} \frac{dr}{r^2}$$

$$0 - V = -Kq\left[-\frac{1}{r}\right]_{R_1}^{R_2}$$

$$\boxed{V = Kq\left[\frac{1}{R_1} - \frac{1}{R_2}\right]}$$

$$q = \frac{1}{K\left[\frac{1}{R_1} - \frac{1}{R_2}\right]}\cdot V$$

$$q = CV$$

$$\boxed{C = \left(\frac{4\pi\varepsilon_0 R_1 R_2}{R_2 - R_1}\right)}$$

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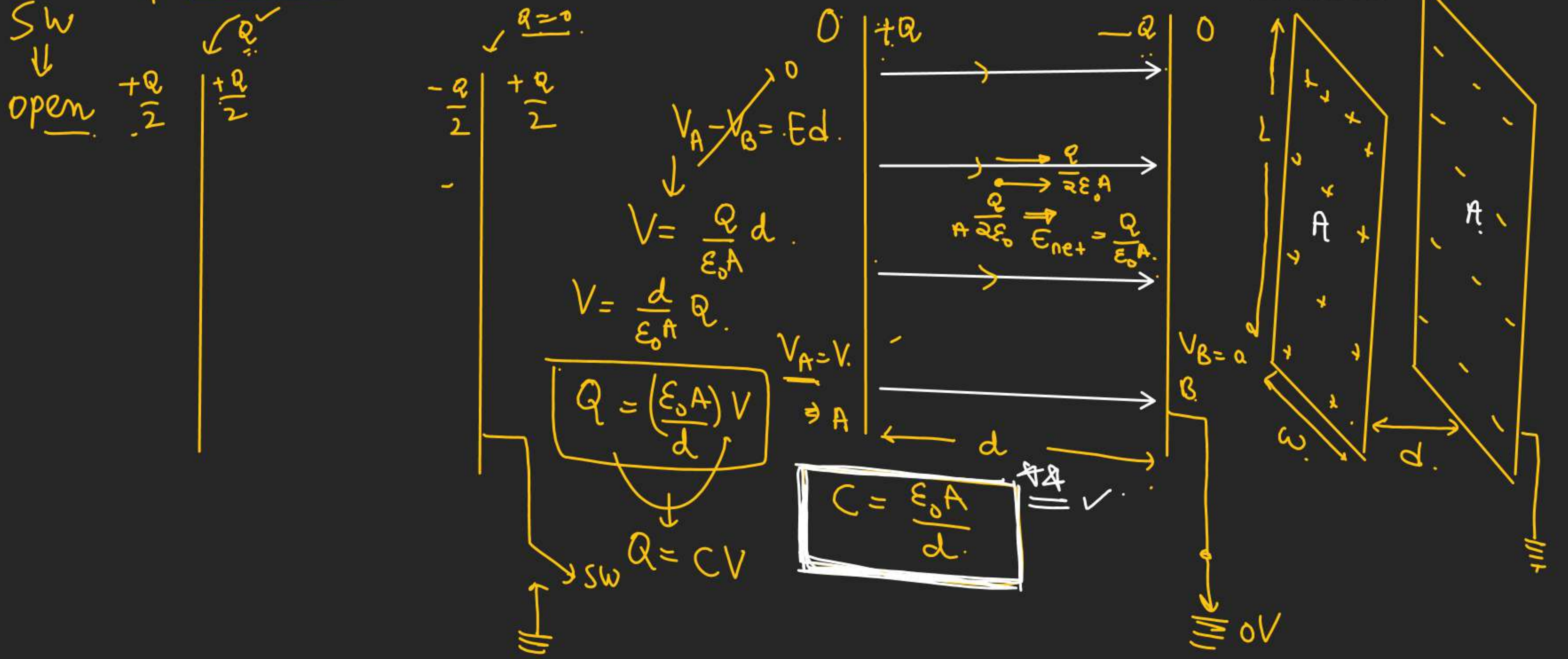
(*) Capacitance of a parallel plate Capacitor :→

Sw ⇓ open

SW → closed

$A = LW$



$V_A - \cancel{V_B} = Ed$

$V = \frac{Q}{\varepsilon_0 A} d$

$V = \frac{d}{\varepsilon_0 A} Q$

$$\boxed{Q = \left(\frac{\varepsilon_0 A}{d}\right) V}$$

$Q = CV$

$V_A = V$

$V_B = 0$

$\frac{Q}{2\varepsilon_0 A}$

$E_{net} = \frac{Q}{\varepsilon_0 A}$

$$\boxed{C = \frac{\varepsilon_0 A}{d}}$$

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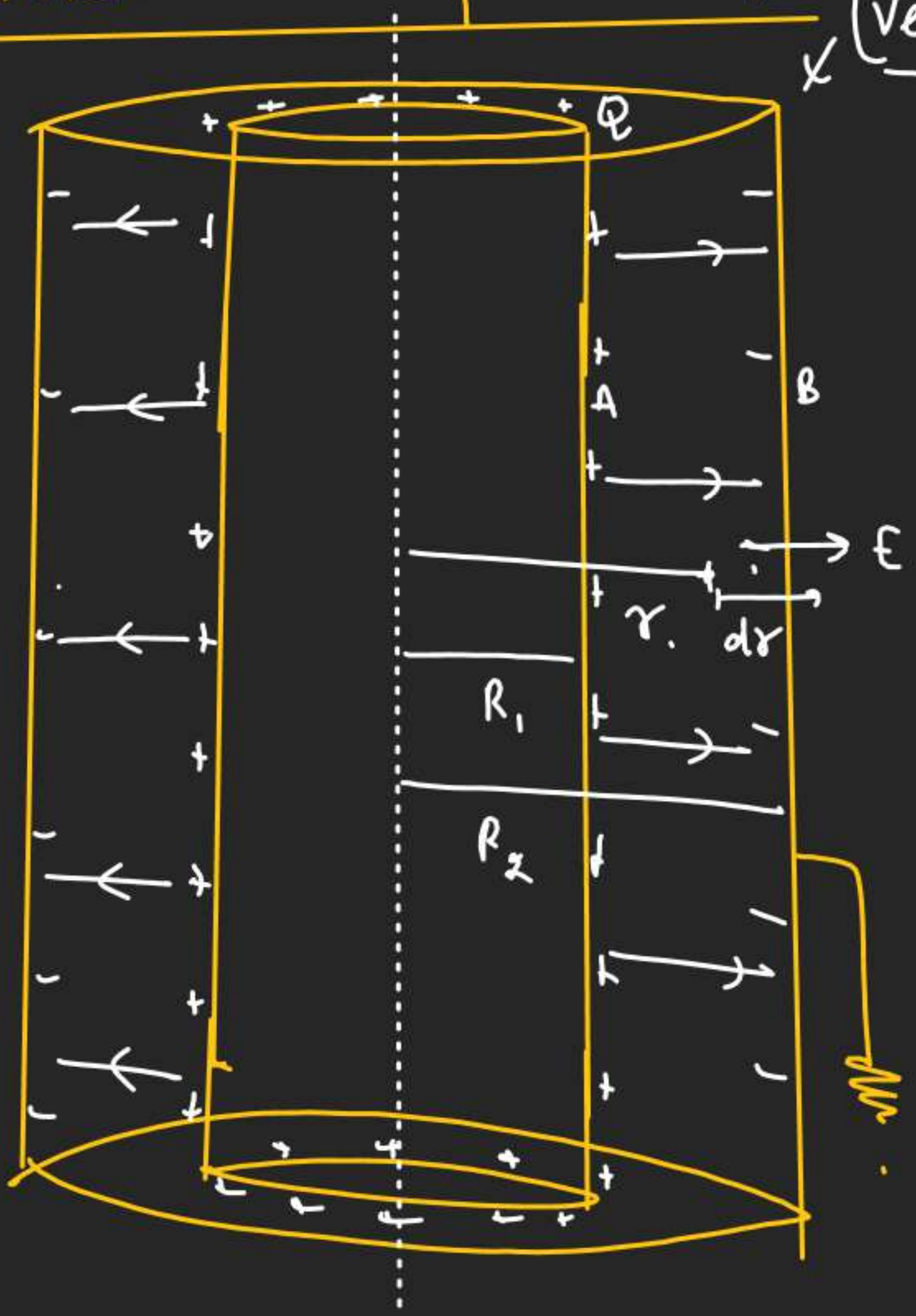
⇒ Capacitance of a Cylindrical Capacitor :→ [Very long]



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

$$\int_V^0 dV = -\frac{Q}{2\pi\varepsilon_0}\int_{R_1}^{R_2}\frac{dr}{r}$$

$$0 + V = +\frac{Q}{2\pi\varepsilon_0}\ln\left(\frac{R_2}{R_1}\right)$$

$$V = \frac{Q}{2\pi\varepsilon_0}\ln\left(\frac{R_2}{R_1}\right)$$

$$\rightarrow Q = \frac{2\pi\varepsilon_0}{\ln\left(\frac{R_2}{R_1}\right)}V$$

$$Q = C\,V \quad (\cancel{x}x)$$

$$\boxed{C = \frac{2\pi\varepsilon_0}{\ln\left(\frac{R_2}{R_1}\right)}}$$

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