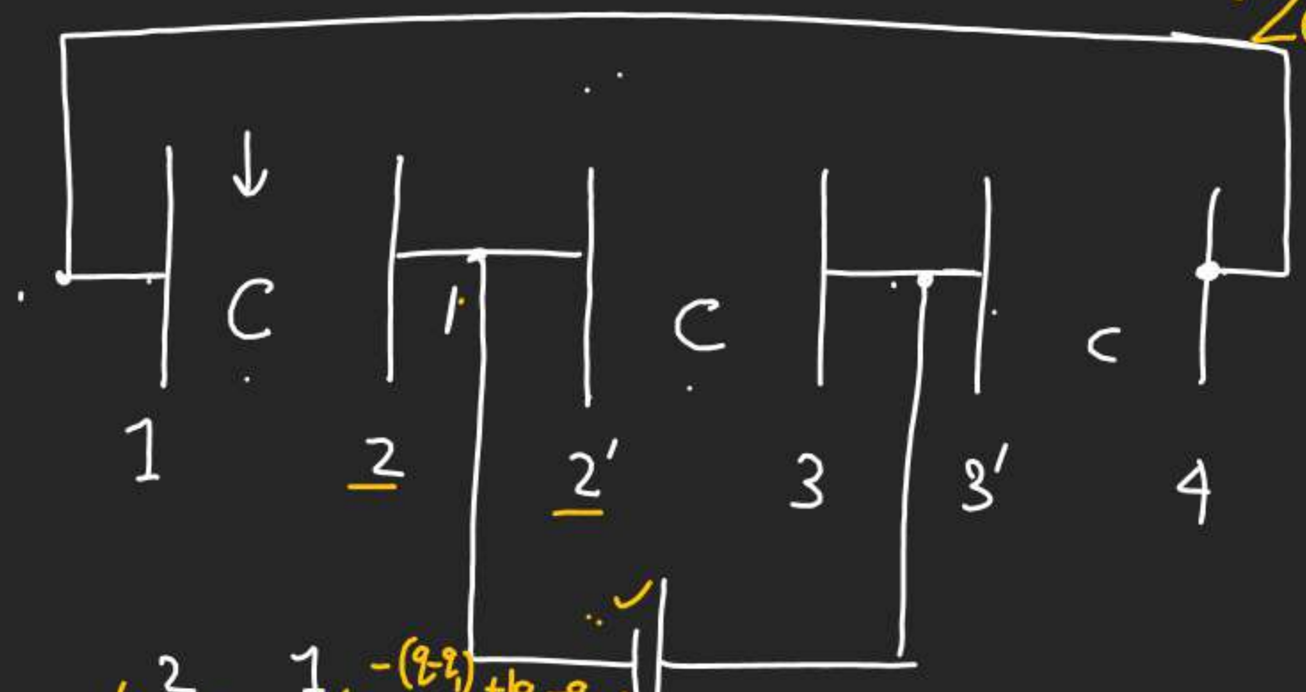
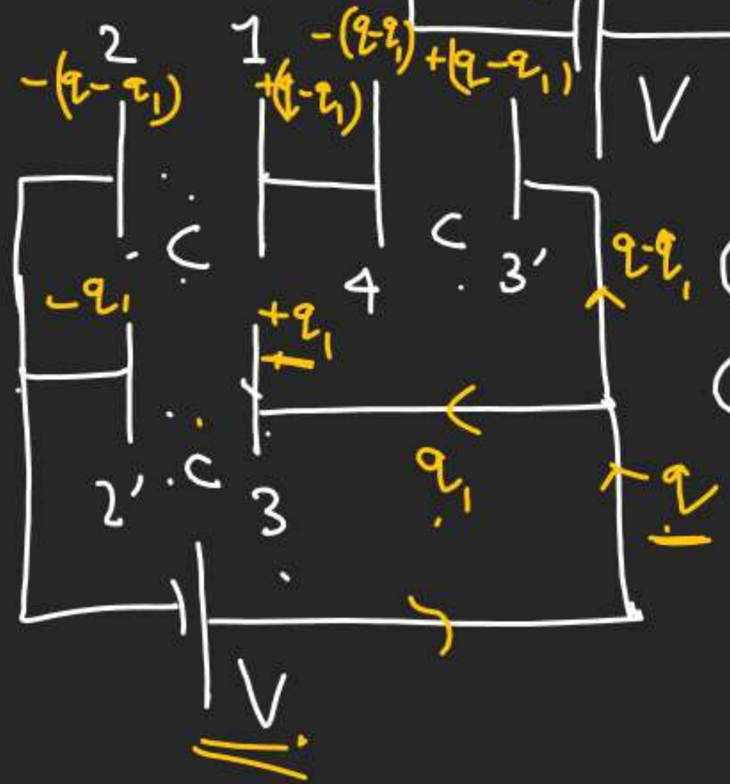
Nishant Jindal

Capacitance of very large identical parallel plates:—



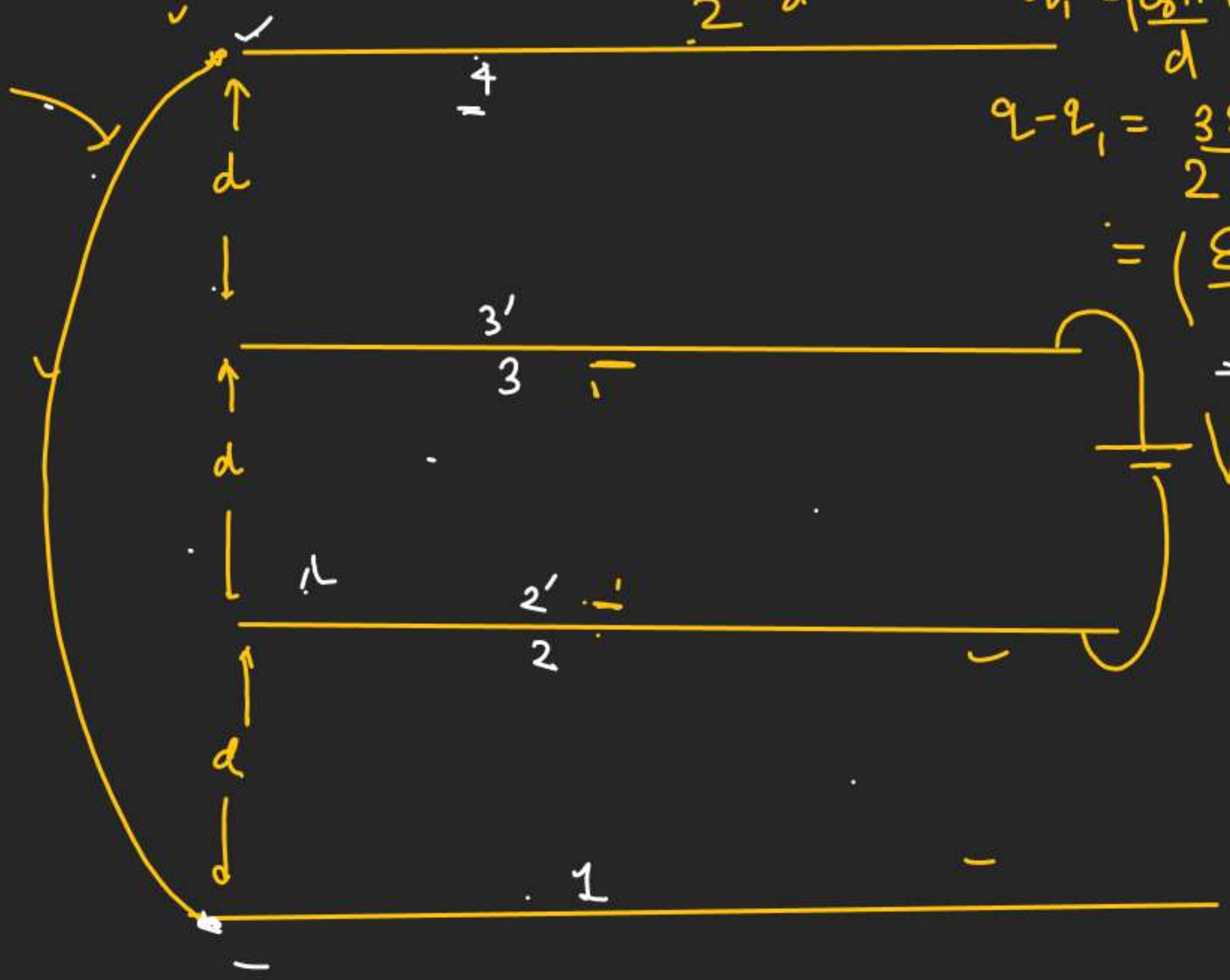


$$C_{eq} = C + \left(\frac{C\cdot C}{C+C}\right)$$

$$C_{eq} = C + \frac{C}{2}$$

$$C_{eq} = \left(\frac{3C}{2}\right)$$

Zero resistance wire



$$q = C_{eq} \cdot V$$

$$q = \frac{3\times \varepsilon_0 A V}{2\,d}$$

$$q_1 = CV$$

$$q_1 = \left(\frac{\varepsilon_0 A V}{d}\right)$$

$$q - q_1 = \frac{3\varepsilon_0 AV}{2d} - \frac{\varepsilon_0 AV}{d}$$

$$= \left(\frac{\varepsilon_0 AV}{d}\right)$$

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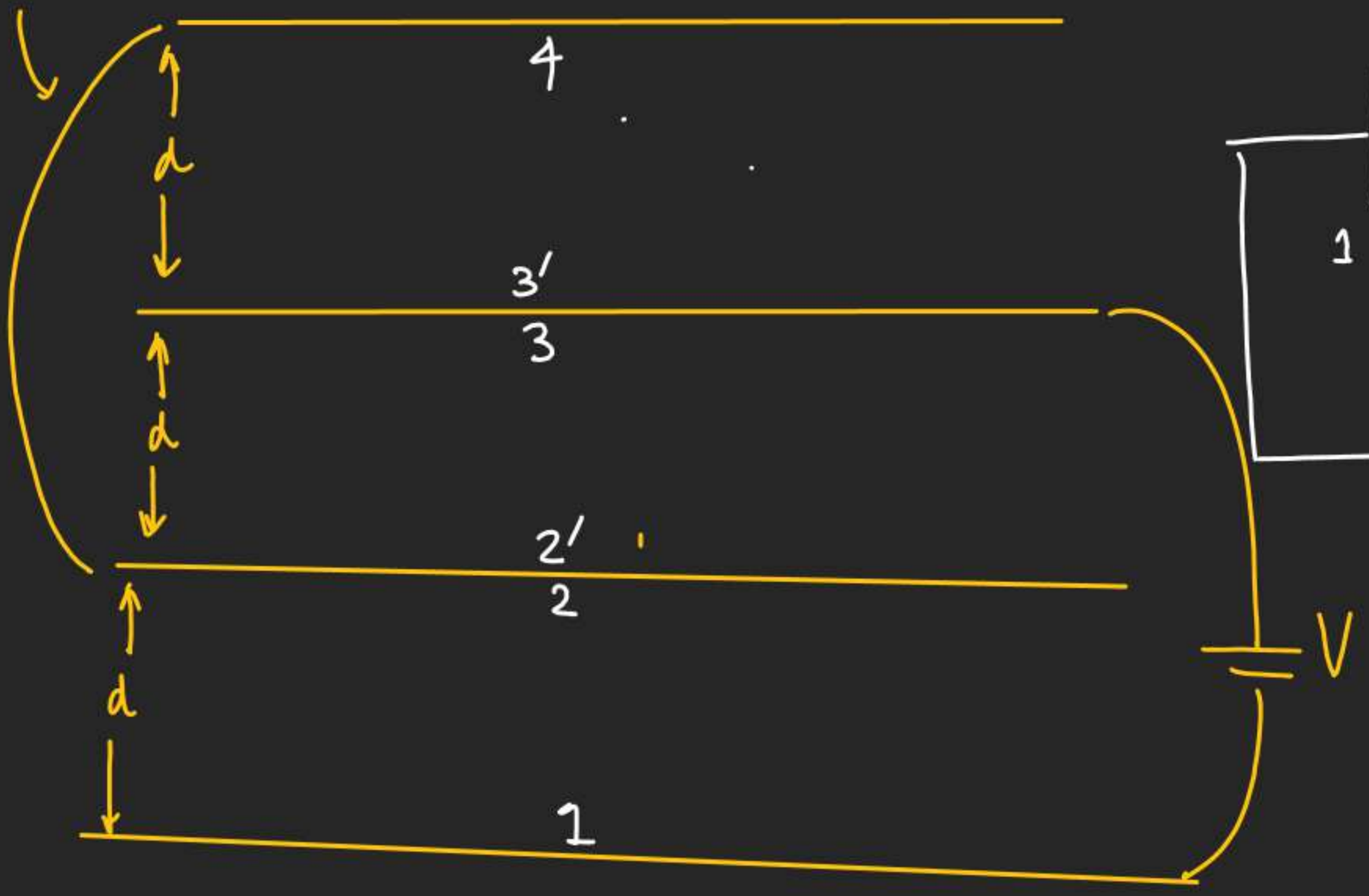
Capacitor

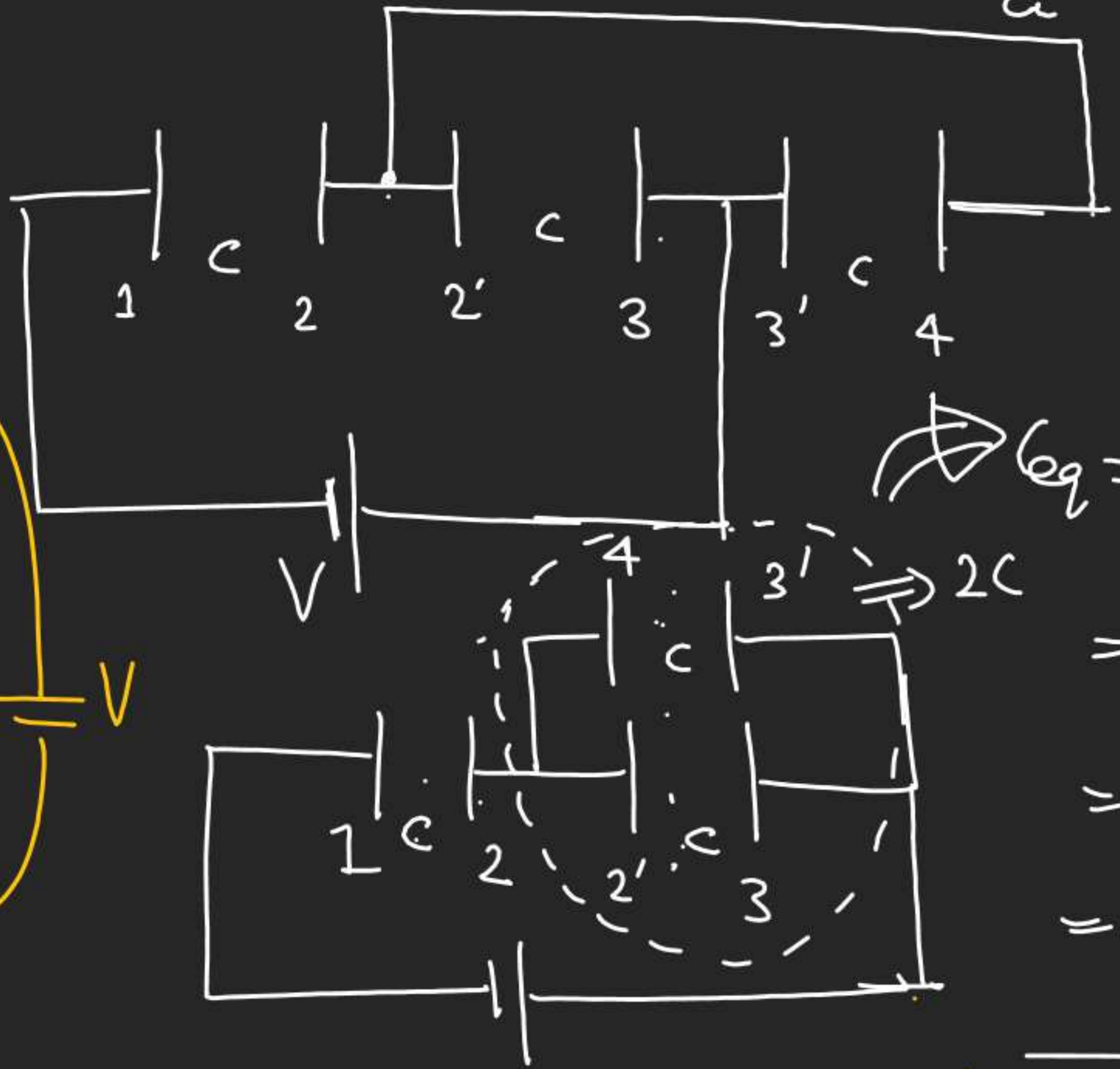
#. All the plates are identical

[Zero resistance wire]



$$\frac{1}{C_{eq}} = \frac{1}{2C} + \frac{1}{C}$$

$$\frac{1}{C_1} = \frac{3}{2C}$$



$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$\Rightarrow 2C$

$$C_{eq} = \left[\frac{2C \cdot C}{2C + C}\right]$$

$$= \frac{2C^2}{3C}$$

$$= \frac{2C}{3}$$

$$= \frac{2}{3}\left(\frac{\varepsilon_0 A}{d}\right)$$

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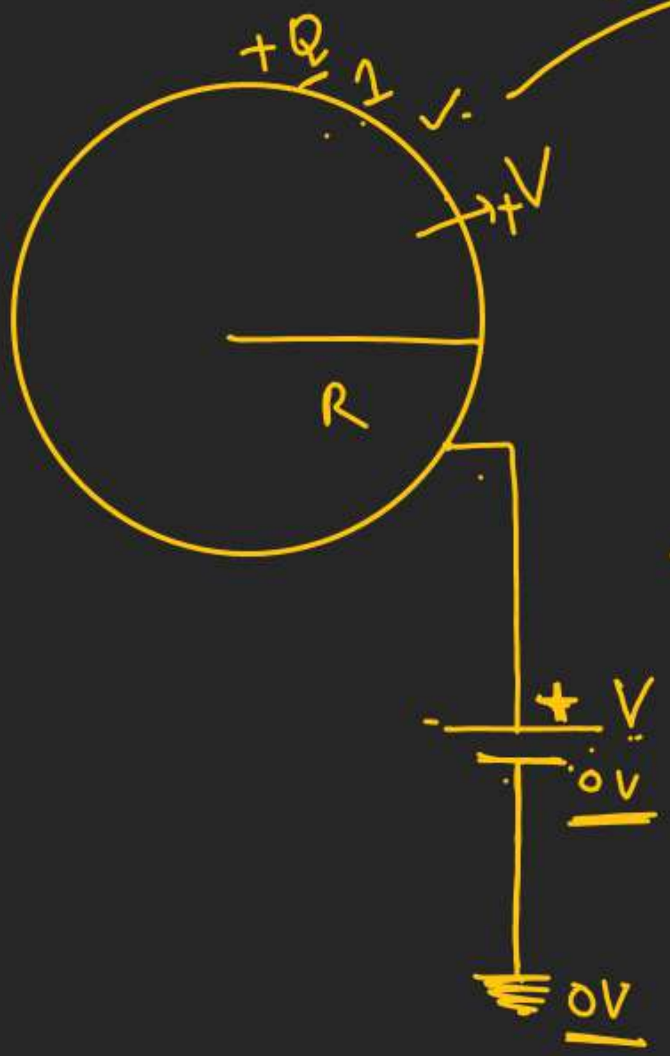
Capacitor

Equivalent Ckt in Case of Spherical Capacitor :→



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

$$Q = 4\pi\varepsilon_0 R \cdot V$$

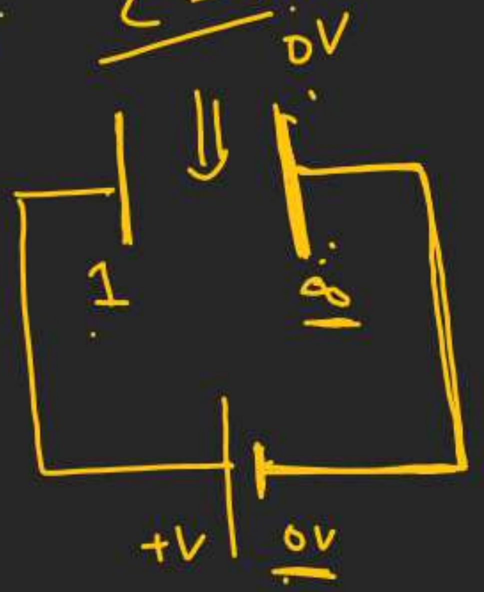
$$Q = C\ V$$

$$\boxed{C = 4\pi\varepsilon_0 R}$$

↳ Isolated Capacitor.

(Assume its Counter -ve plate at ∞.)

$C = 4\pi\varepsilon_0 R$



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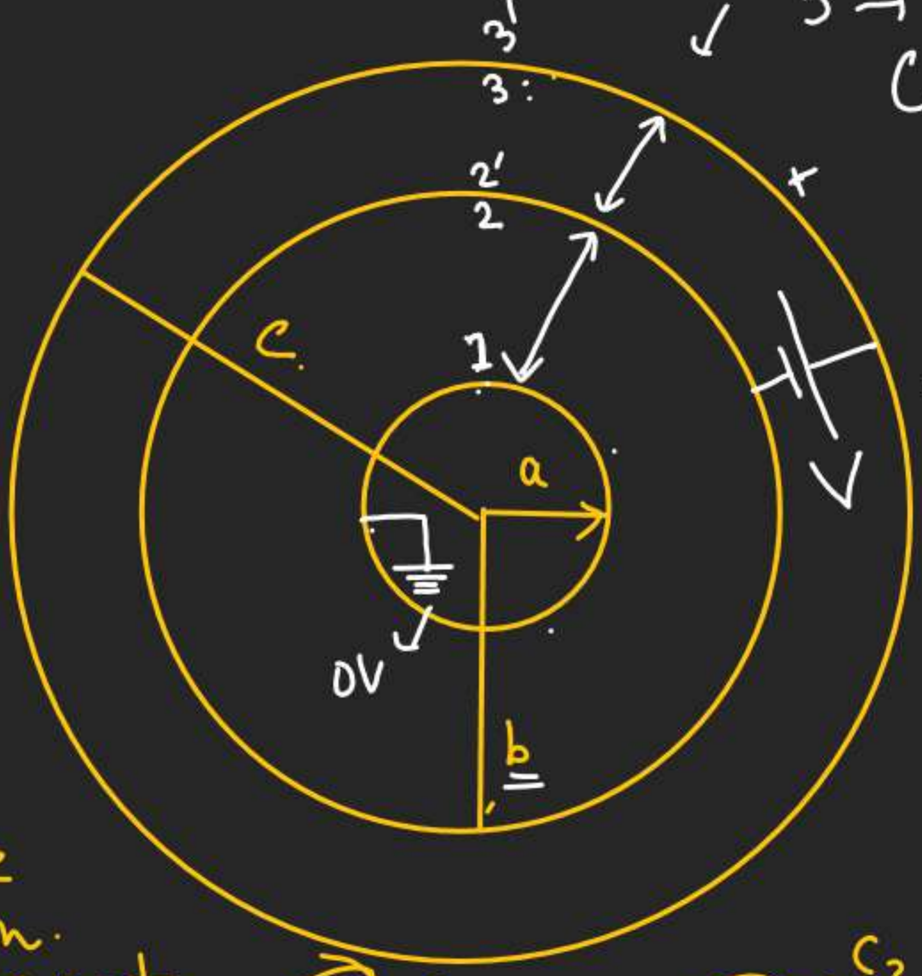
Capacitor

3 → thin Concentric Spheres.

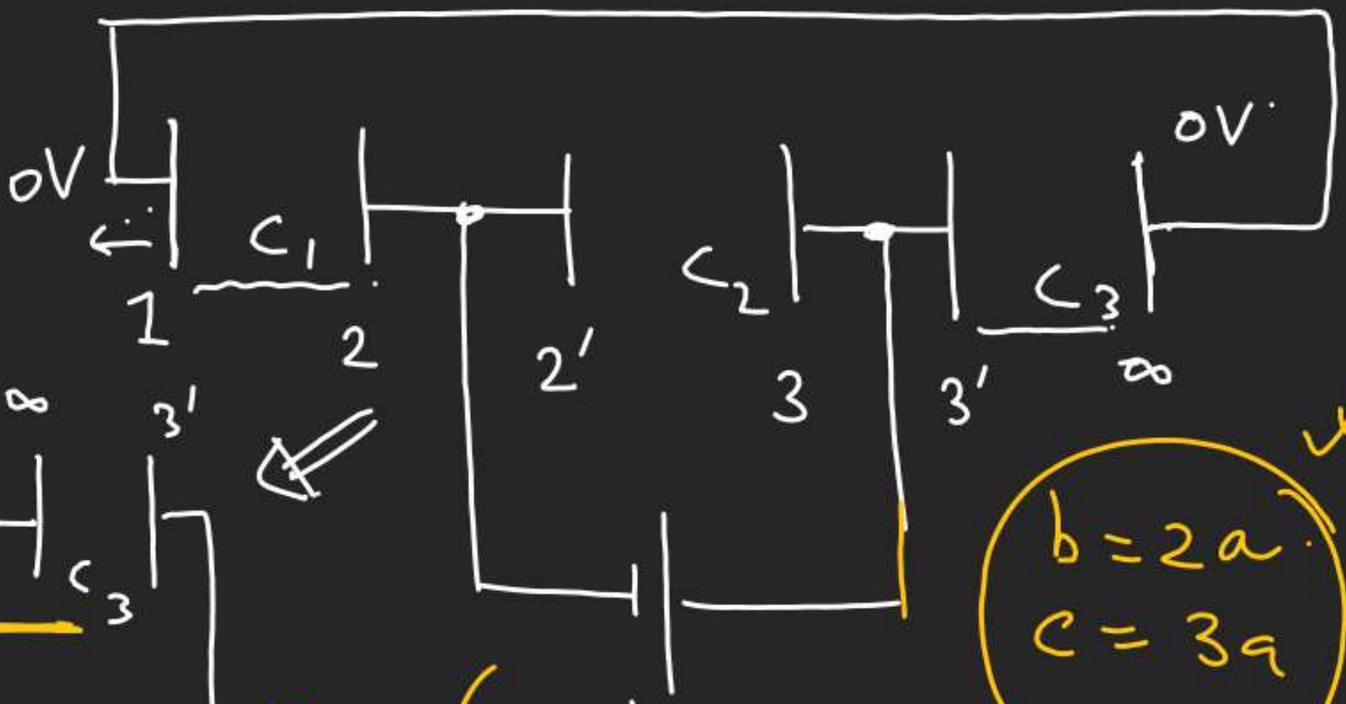
Find Capacitance Capacitor

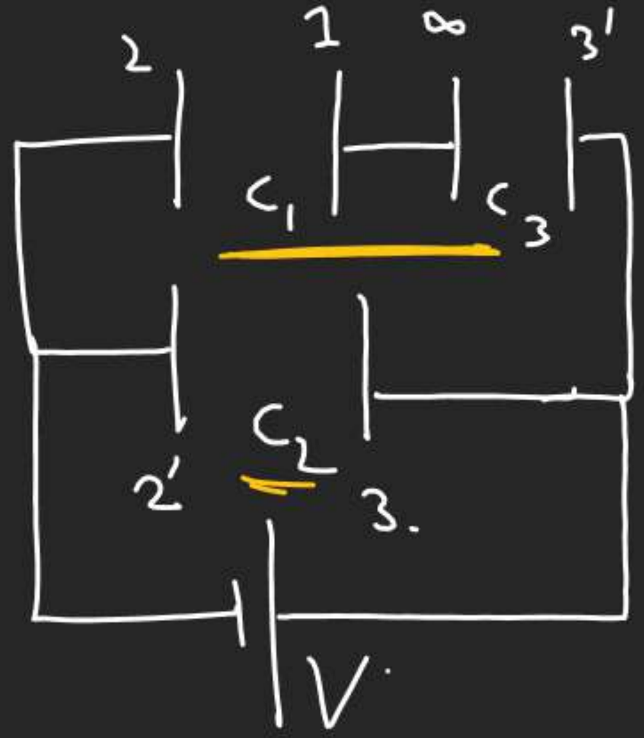
$C_2 = \left(\dfrac{4\pi\varepsilon_0 bc}{c-b}\right)$, $C_3 = (4\pi\varepsilon_0 c)$

$C_1 = \left(\dfrac{4\pi\varepsilon_0 ab}{b-a}\right)$



outermost −ve plate Considered at ∞

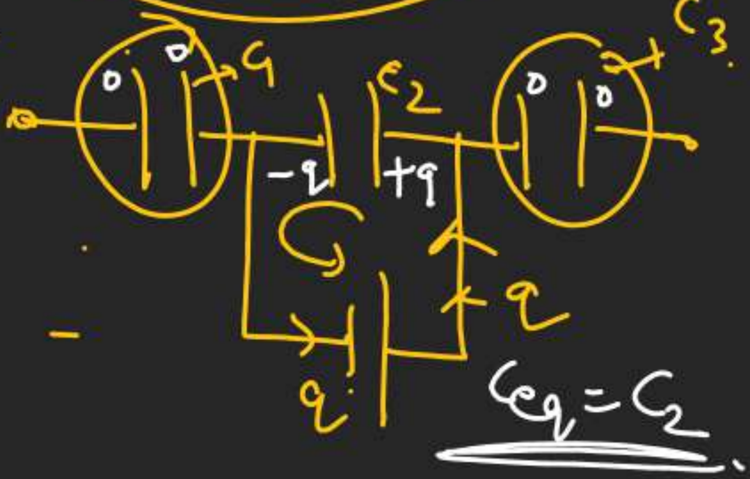




$C_{eq} = \left(\dfrac{C_1C_3}{C_1+C_3} + C_2\right)$

$b = 2a$
$c = 3a$

Case when 1 is not earthed.



$C_{eq} = C_2$

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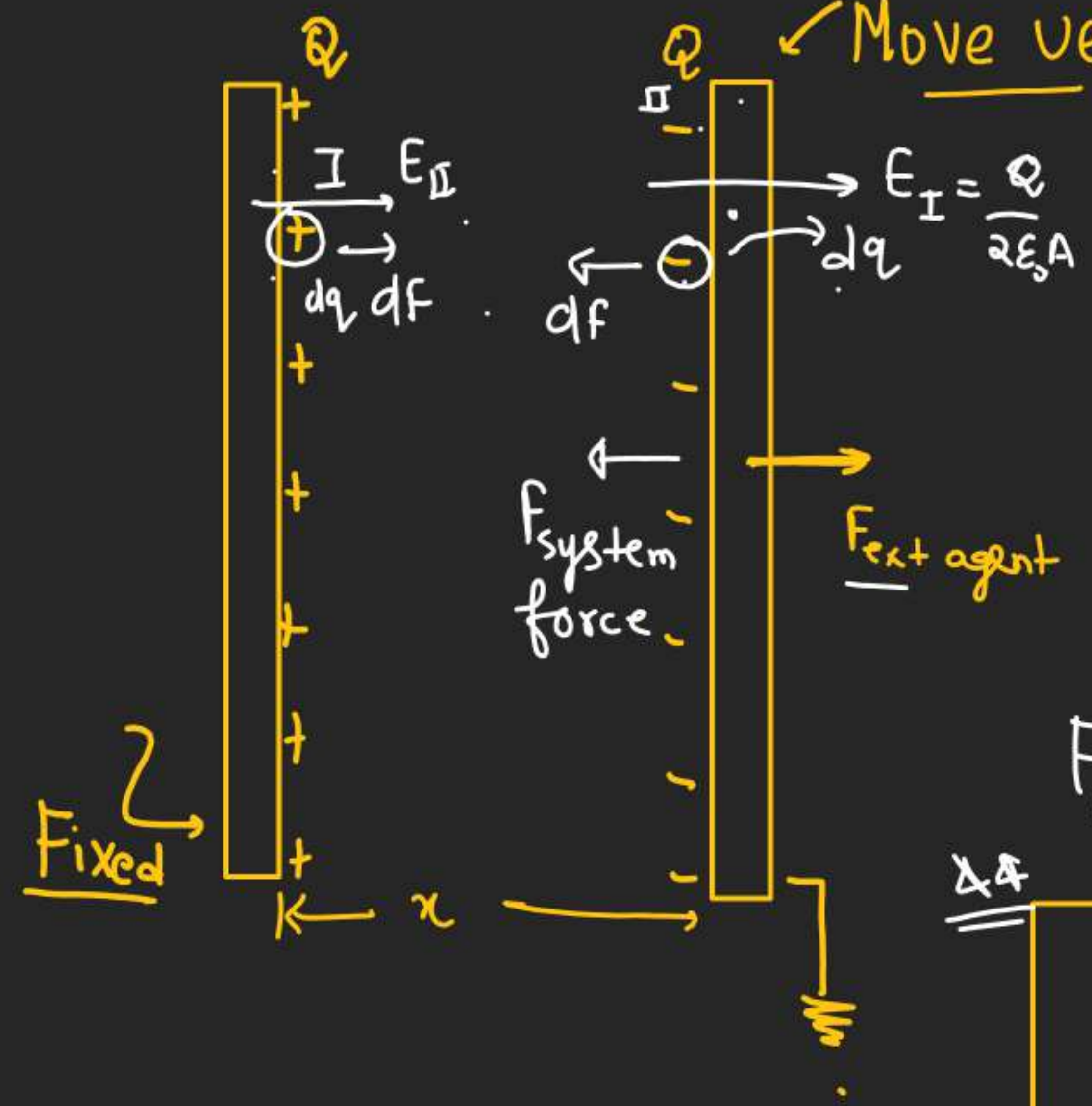
Capacitor

(*) Force acting b/w two parallel plate Capacitor :→



P.E when plate Seperation is x

$$U = \frac{Q^2}{2C} = \frac{Q^2}{\left(\frac{2\varepsilon_0 A}{x}\right)}$$

$$U = \frac{Q^2}{2\varepsilon_0 A}x$$

$$F_{system} = -\frac{dU}{dx} = -\frac{Q^2}{2\varepsilon_0 A}\frac{d}{dx}(x)$$

$$\boxed{F_{system} = -\frac{Q^2}{2\varepsilon_0 A}}$$

(Attractive force)

Another Method

$$dF = dq \cdot E_I$$

$$\int dF = \int dq\left(\frac{Q}{2\varepsilon_0 A}\right)$$

$$F_{net} = \frac{Q}{2\varepsilon_0 A}\int dQ$$

$$F_{net} = \frac{Q^2}{2\varepsilon_0 A}$$

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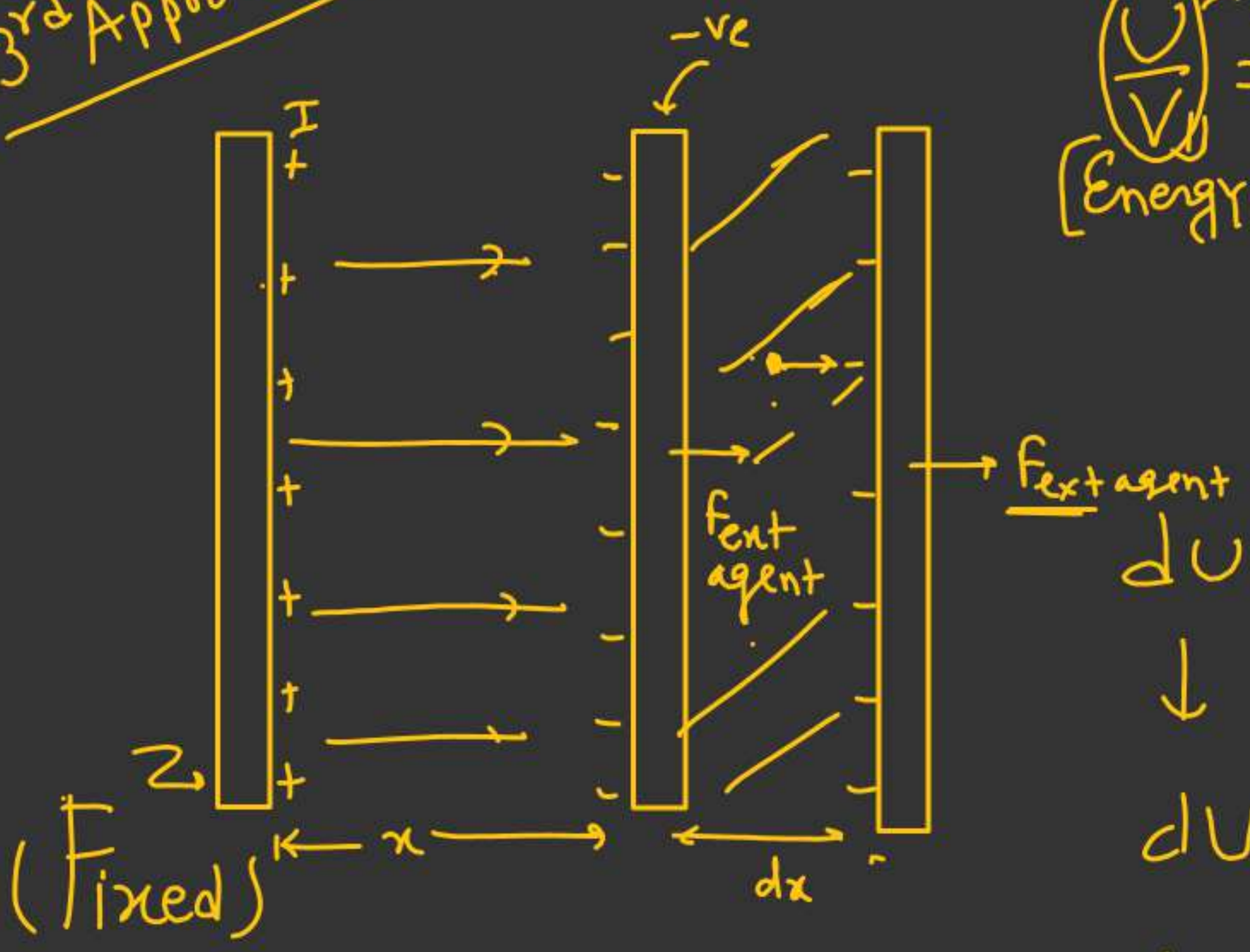
3rd Approach



$$\frac{U}{V} = \frac{1}{2}\varepsilon_0 E^2 \quad \frac{U}{V} \rightarrow u$$

[Energy density] ← net field

$u = \frac{1}{2}\varepsilon_0 E^2$ be the energy when -ve plate is at a seperation x.

$$dU = u \cdot A\,dx$$

$$\downarrow$$

$$dU = \frac{1}{2}\varepsilon_0 E^2 A\,dx$$

$$F_{system} = -\frac{dU}{dx}$$

** $$dU = \frac{1}{2}\varepsilon_0 \left(\frac{Q}{\varepsilon_0 A}\right)^2 A\,dx$$

$$\boxed{F_{ext\ agent} = \frac{dU}{dx} = \frac{Q^2}{2\varepsilon_0 A}}$$