
समस्त बिहार, भरेगा हुंकार
HUNKAR
2025
में आपका स्वागत हैं

HUNKAR 2025

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PHYSICS

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अध्याय 02

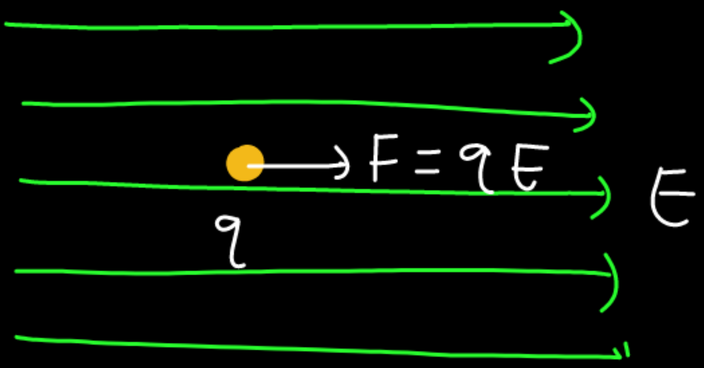
Energy Stored in capacitor
संधारित्र में संचित उर्जा

आज का टॉपिक

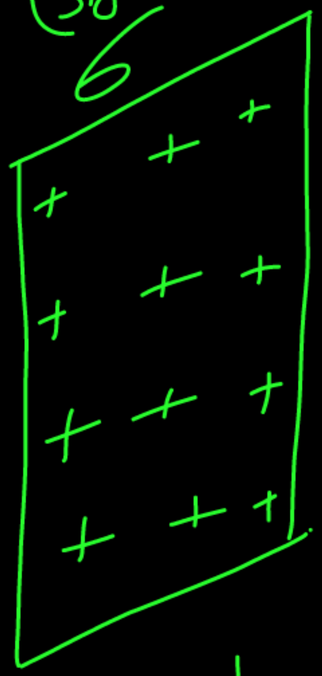
$$dV = -\vec{E} \cdot d\vec{r}$$

$d\vec{r}$

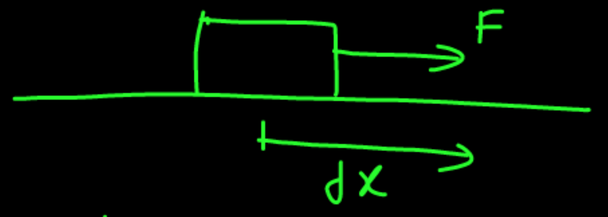
$$\Delta V = EL$$



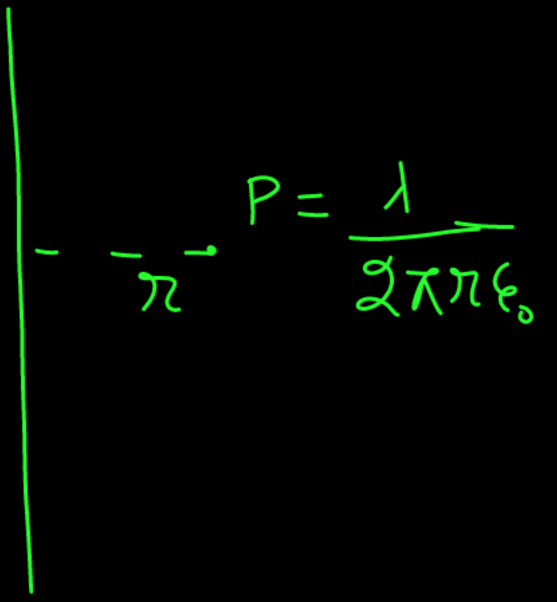
(Sigma) σ



$$E = \frac{\sigma}{2\epsilon_0}$$



$$dW = F \cdot dx$$



$$P = \frac{\lambda}{2\pi r \epsilon_0}$$

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

* Single sphere

$$C = 4\pi\varepsilon_0 R$$

* Double Sphere

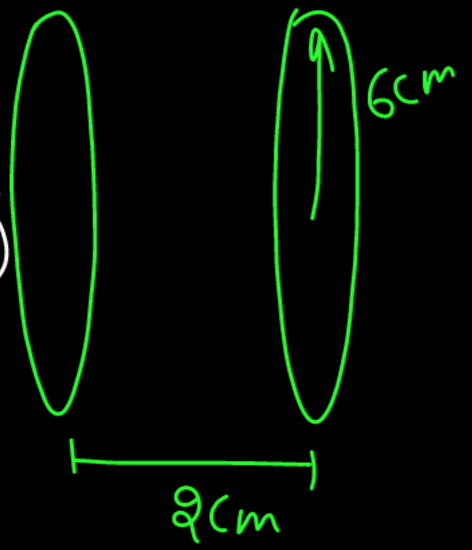
$$C = \frac{4\pi\varepsilon_0 R_1 R_2}{R_2 - R_1}$$

* Parallel Plate capacitor

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

Example 1: If distance between two Circular plates is 2 cm and radius of plates is 6 cm then find the capacitance of capacitor.

यदि दो वृत्ताकार चालक प्लेट के बीच की दूरी (2 cm) हो और उनकी त्रिज्या (6 सेंटीमीटर) हो तो इस निकाय की विद्युत धारिता ज्ञात करें।



$d = 2 \times 10^{-2}\ m$

$A = \pi (0.06)^2$

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

$$C = \frac{\varepsilon_0 \times \pi \times (0.06)^2}{0.02}$$

$$C = \frac{1}{4\pi \times 9 \times 10^9} \cdot \frac{\pi \times 0.06 \times 0.06}{0.02 \times 100}$$

$$C = \frac{1}{2} \times 10^{-11} = 0.5 \times 10^{-11}$$

$$= 5 \times 10^{12}$$

5 PF

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

$$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$$

$$\frac{1}{4\pi \times 9 \times 10^9} = \varepsilon_0$$

Example 2: If distance between two Circular plates is 8 mm and capacitance of capacitor is 4 μF then find the radius of plates.

यदि दो वृत्ताकार चालक प्लेट के बीच की दूरी 8 mm हो और इस निकाय की विद्युत धारिता 4μF हो तो प्लेटो की त्रिज्या ज्ञात करें।

$$\frac{1}{\varepsilon_0} = 9\times10^9\times4\pi$$

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

$$C = 4\times10^{-6}\ F$$

$$d = 8\ mm = 8\times10^{-3}\ m$$

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

$$A = \frac{Cd}{\varepsilon_0} = \frac{4\times10^{-6}\times8\times10^{-3}}{\varepsilon_0}$$

$$A = 4\times10^{-6}\times8\times10^{-3}\times9\times10^9\times4\pi$$

$$\pi R^2 = 16\times36\times2\times\pi$$

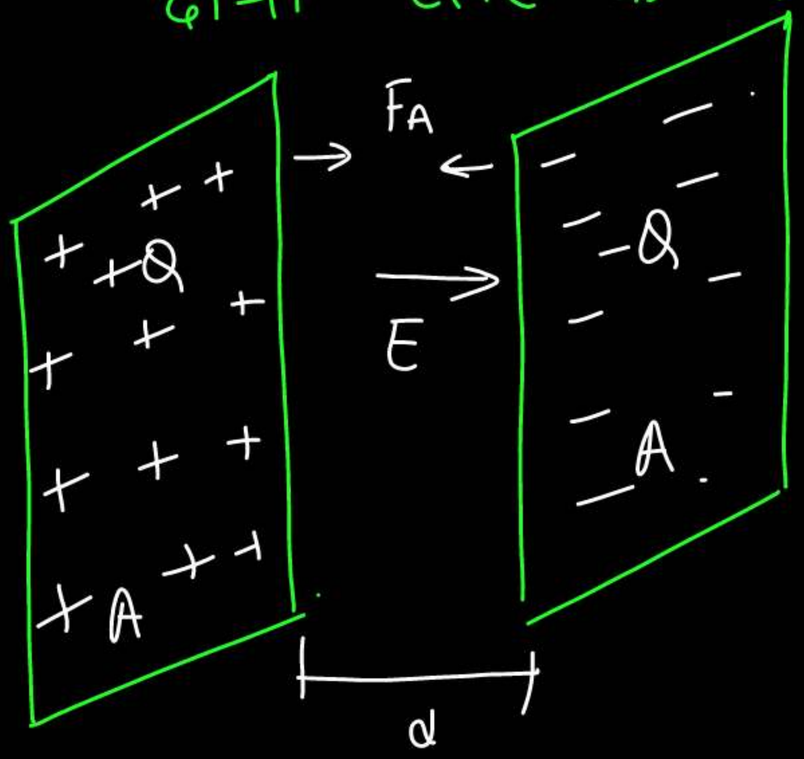
$$R = \sqrt{16\times36\times2}$$

$$R = 4\times6\times\sqrt{2}$$

$$R = 24\sqrt{2}\ m$$

FORCE BETWEEN TWO PLATES

दोनों प्लेट के बीच बल



$$\because \sigma = Q/A$$

$$E = \frac{\sigma}{2\epsilon_0}$$

$$E = \frac{Q}{2A\epsilon_0}$$

$$F = qE$$

$$= Q\frac{Q}{2A\epsilon_0}$$

$$\boxed{F = \frac{Q^2}{2A\epsilon_0}}$$

(*) $\boxed{W = F \cdot d}$

WORK DONE TO SEPARATE THE PLATES

दोनों प्लेटों को दुर करने में किया गया कार्य·

$$W = F \cdot d$$

$$\therefore F = \frac{Q^2}{2A\epsilon_0}$$

$$\boxed{W = \frac{Q^2 \cdot d}{2A\epsilon_0}}$$

ENERGY STORED IN CAPACITOR

संधारित्र में जमा उर्जा

Work done by external agent is stored as Energy of capacitor.

बाहरी कारक द्वारा किया गया कार्य संधारित्र में उर्जा के रूप में जमा होता है।

$$W = \frac{Q^2 \cdot d}{2A\varepsilon_0}$$

$$\text{Energy} \rightarrow U = \frac{Q^2 d}{2A\varepsilon_0}$$

$$U = \frac{1}{2}\frac{Q^2}{\left(\frac{A\varepsilon_0}{d}\right)}$$

$$\boxed{U = \frac{1}{2}\frac{Q^2}{C}}$$

$$U = \frac{1}{2}\frac{C^2V^2}{C}$$

$$\boxed{U = \frac{1}{2}CV^2}$$

$$U = \frac{1}{2}\frac{Q^2}{Q/V}$$

$$\boxed{U = \frac{1}{2}QV}$$

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

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

$$Q = CV$$

$$U = \frac{1}{2}\frac{Q^2}{C}$$

$$U = \frac{1}{2}CV^2$$

$$U = \frac{1}{2}QV$$

Another method:

Energy density