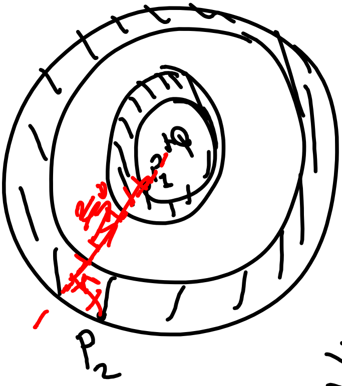
March 17, 2015



$$\Delta V = V(P_1) - V(P_2) = -\int_{P_2}^{P_1} \vec{E}\cdot d\vec{l}$$

$\vec{E}$

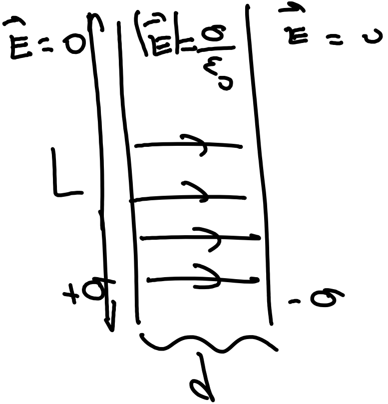
$$\vec{E}\cdot d\vec{l} \leq 0$$

$$\Rightarrow \int_{P_2}^{P_1} \vec{E}\cdot d\vec{l} < 0$$

$$\Rightarrow V(P_1) - V(P_2) > 0$$

$$\Rightarrow V(P_1) > V(P_2)$$

Example



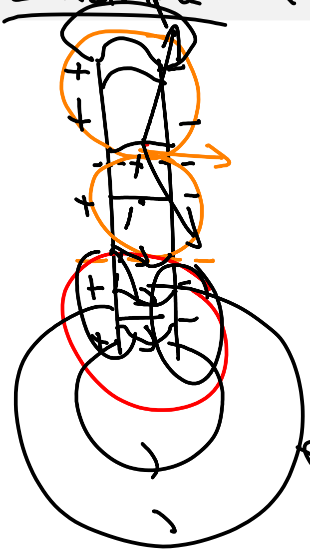
$$\Delta V \equiv V \equiv V_+ - V_- = Ed$$

$$\boxed{V = d\,\frac{\sigma}{\varepsilon_0}}$$

infinite plate

$$\frac{d}{L} \ll 1$$

Example Finite Plate (Parallel Plate Capacitor)



fringing effects

σ: non-uniform

$$\sigma = \sigma_0 + O\left(\frac{d}{L}\right)$$

$$E \simeq \frac{\sigma_0}{\varepsilon_0}$$

$$V \simeq \frac{\sigma_0}{\varepsilon_0} d = \frac{Q}{A}\frac{d}{\varepsilon_0}$$

$$\boxed{V \simeq Q\left(\frac{1}{\varepsilon_0}\frac{d}{A}\right)}$$

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

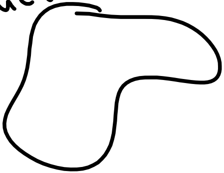
$$\boxed{Q = CV}$$

C : capacitance

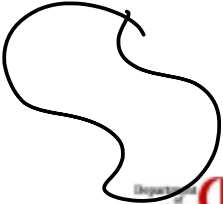
V : voltage across the capacitor.

<u>Example</u>

conductor



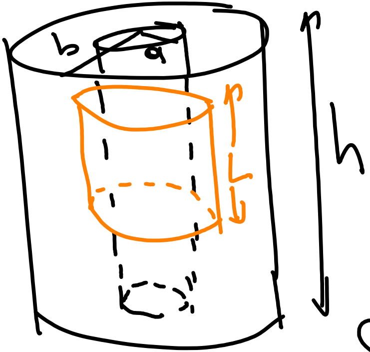
conductor

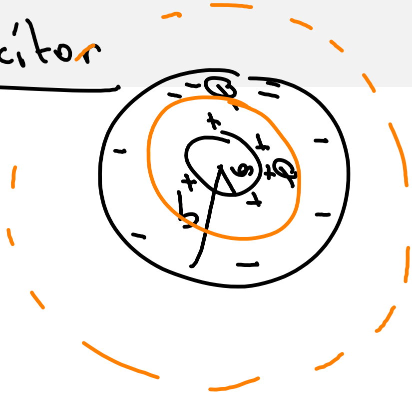


$$V \simeq Q\left(\frac{1}{\varepsilon_0}\frac{d}{A}\right)$$

$$V = \frac{Q}{C} \Rightarrow \boxed{C = \varepsilon_0 \frac{A}{d}}$$

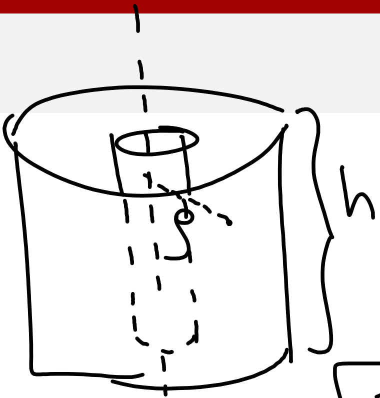
Cylindrical Capacitor

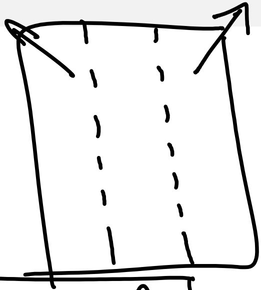




$$V = -\int \vec{E} \cdot d\vec{l}$$

$$Q_{enc} = \frac{Q}{h} L$$



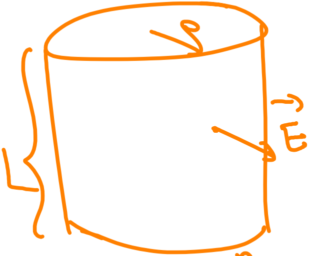


$$\boxed{\vec{E} \simeq E(\rho)\hat{\rho}}$$

ρ = const : points on which $|\vec{E}|$ is const.

$$\oint \vec{E}\cdot d\vec{S} = \frac{Q_{enc}}{\varepsilon_0}$$

$$\oint \vec{E}\cdot d\vec{S} = \overbrace{\cancel{\int_{top} \vec{E}\cdot d\vec{S}}}^{0} + \overbrace{\cancel{\int_{bottom} \vec{E}\cdot d\vec{S}}}^{0} + \int_{side} \vec{E}\cdot d\vec{S}$$



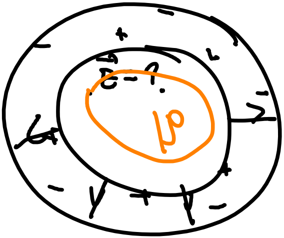
$$\vec{E} = E(\rho)\hat{\rho}$$

$$\left.\begin{array}{l} d\vec{S} = dS\,\hat{\rho} \\ \vec{E} = E(\rho)\,\hat{\rho} \end{array}\right\} \quad \vec{E}\cdot d\vec{S} = E(\rho)\,dS$$

$$\oint \vec{E}\cdot d\vec{S} = \int_{sides} E(\rho)\,dS = E(\rho)\,2\pi\rho L$$

$$E(\rho)\, 2\pi\rho L = \frac{Q}{h} L \frac{1}{\varepsilon_0}$$

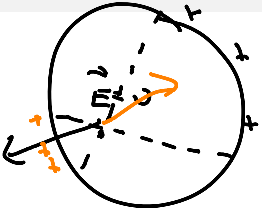
$$\boxed{E(\rho) = \frac{1}{2\pi\varepsilon_0} \frac{Q}{h} \frac{1}{\rho}}$$

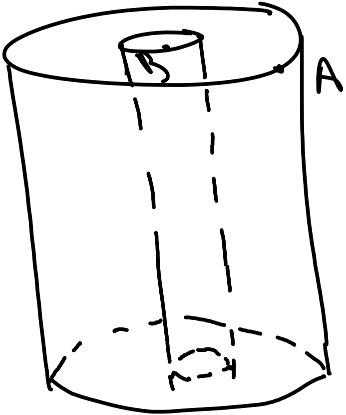


$$\vec{E} = E(\rho)\,\hat{\rho}$$

$$Q_{enc} = 0$$

$$\int \vec{E}\cdot d\vec{S} = E(\rho)\, 2\pi\rho L = \frac{Q}{\varepsilon_0}$$

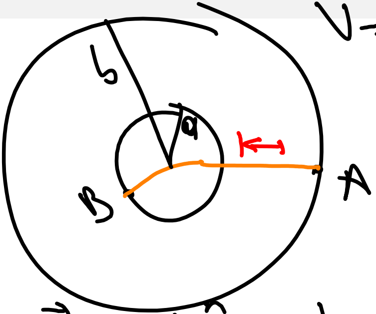




$$\vec{E} = \frac{1}{2\pi\epsilon_0}\frac{Q}{h}\frac{1}{\rho}\hat{\rho}$$

$$V = \left| -\int_A^B \vec{E}\cdot d\vec{l} \right|$$

$$Q = CV$$



$$V = -\int_A^B \vec{E}\cdot d\vec{l} = -\frac{1}{2\pi\varepsilon_0}\frac{Q}{h}\int_b^a \frac{d\rho}{\rho}$$

$$\boxed{V = \frac{1}{2\pi\varepsilon_0}\frac{Q}{h}\ln\frac{b}{a} \equiv \frac{Q}{C}}$$

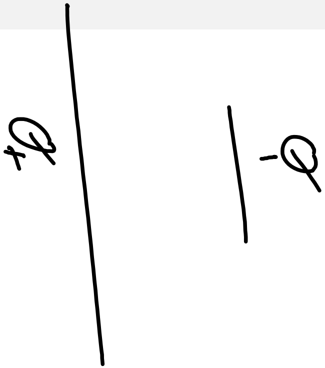
$$\boxed{C = 2\pi\varepsilon_0 \frac{h}{\ln\frac{b}{a}}}$$

$$d\vec{l} = d\rho\,\hat{\rho} \;;\; d\rho < 0$$

$$\vec{E} = \frac{1}{2\pi\varepsilon_0}\frac{Q}{h}\frac{1}{\rho}\hat{\rho}$$

$$\vec{E}\cdot d\vec{l} = \frac{1}{2\pi\varepsilon_0}\frac{Q}{h}\frac{1}{\rho}\,d\rho$$

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



Quiz draw the electric field lines for the following configuration:

$+q \bullet$ $\bullet +q$

One full page!