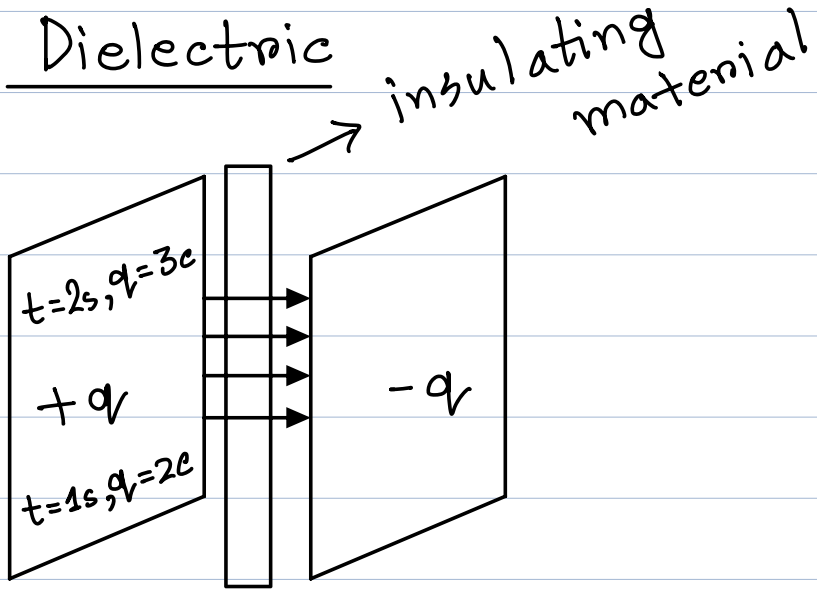
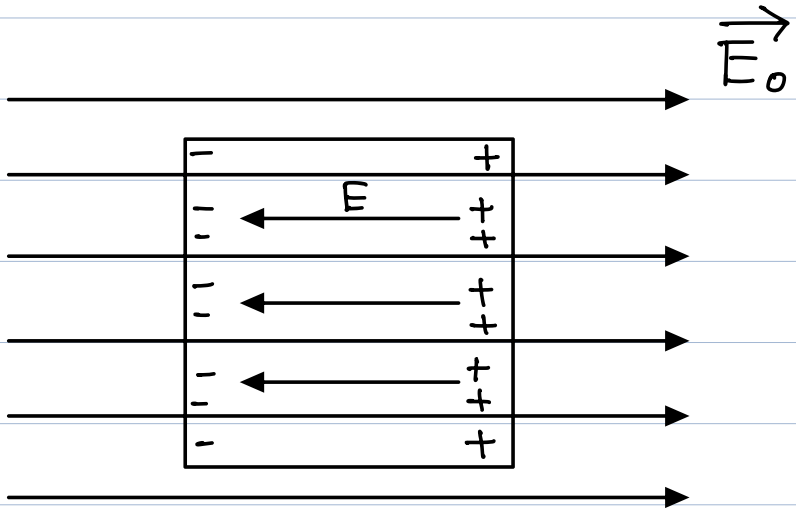
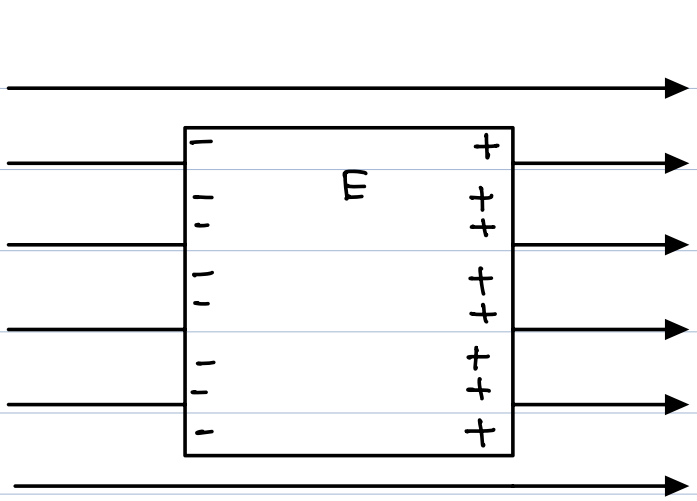
Dielectric



will work like battery for a long time.

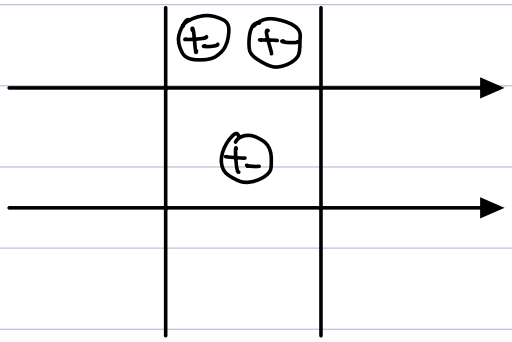


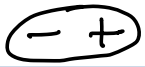
$$\vec{F} = q\vec{E} \qquad q > 0$$

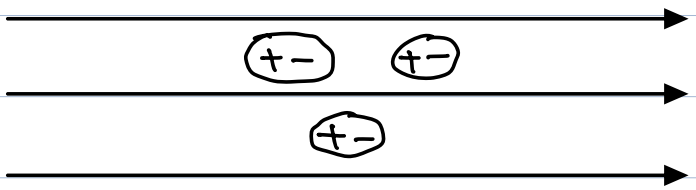


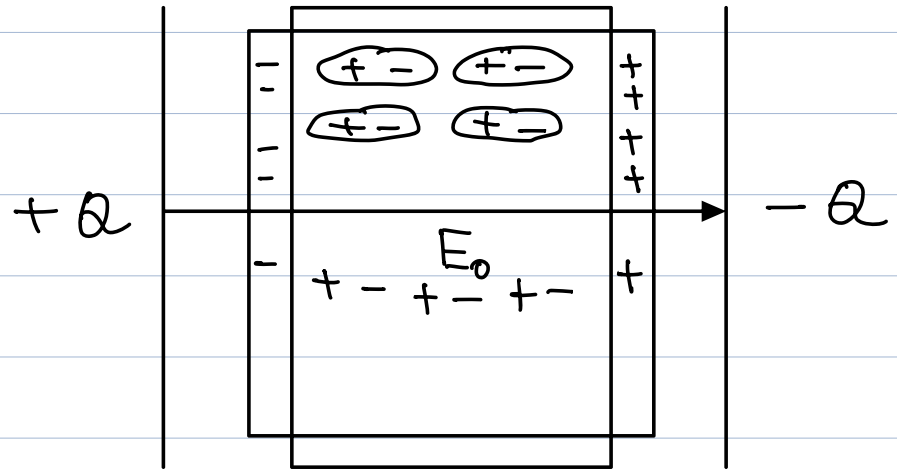
If $E = E_0$

$\vec{F} = q\vec{E}$ $q > 0$





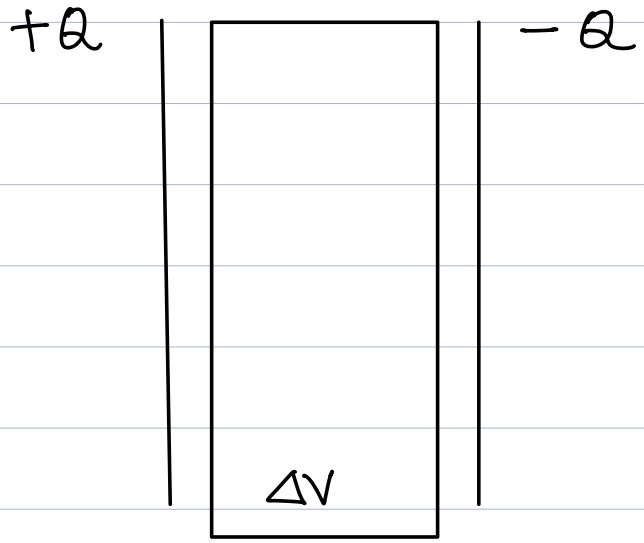




$E_0 > E'$

$E = E_0 - E'$

$E = \frac{E_0}{k}$ $\quad k \gg 1$



1) Charge

2) Turn of battery

3) Insert Dielectric

$$E_o = E_{old}$$

$$E = E_{new}$$

$$E_{new} = \frac{E_{old}}{k} \qquad V = Ed$$

$$E = \frac{V}{d}$$

$$\frac{\Delta V_{new}}{d} = \frac{\Delta V_{old}}{dk}$$

$$\Rightarrow \Delta V_{new} \times k = \Delta V_{old} \qquad k \gg 1$$

$$\therefore \Delta V_{new} \lesssim \Delta V_{old}$$

$$Q = CV$$

$$Q_{old} = C_{old} \times V_{old}$$

$$Q_{new} = C_{new} \times \Delta V_{new}$$

$$\Rightarrow C_{old} \times \Delta V_{old} = C_{new} \times \Delta V_{new}$$

$$\Rightarrow C_{old} \times K \Delta V_{new} = C_{new} \times \Delta V_{new}$$

$$\Rightarrow C_{new} = K C_{old} \qquad K > 1$$

$$\therefore C_{new} > C_{old}$$

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

$$U_{old} = \frac{1}{2} C_{old} \Delta V_{old}^2$$

$$U_{new} = \frac{1}{2} C_{new} \Delta V_{new}^2$$

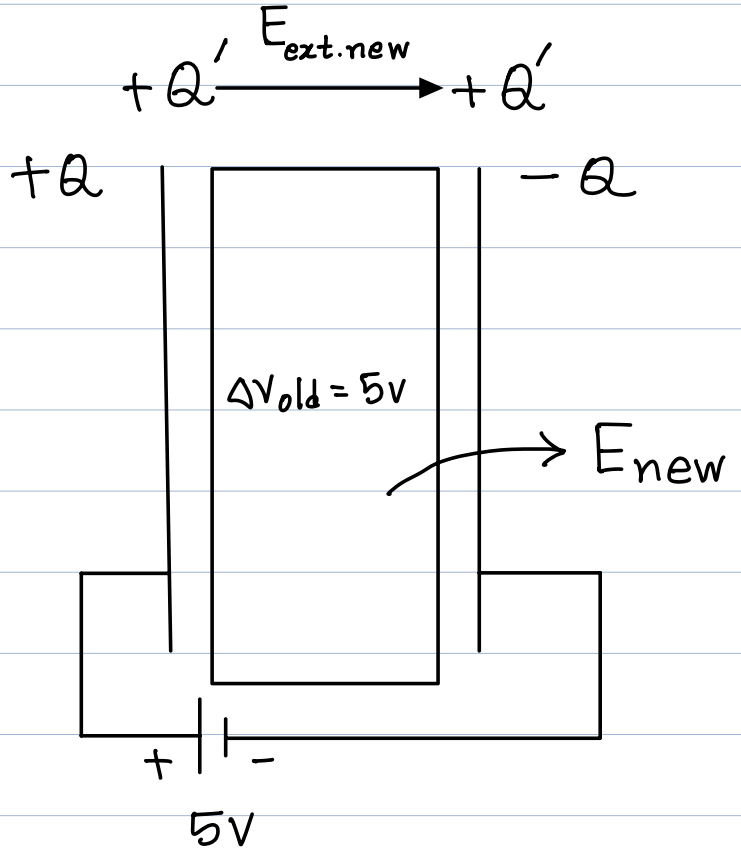
$$\frac{U_{old}}{U_{new}} = \frac{C_{old} \Delta V_{old}^2}{C_{new} \Delta V_{new}^2}$$

$$= \frac{C_{old} \Delta V_{old}^2}{K C_{old} \left(\frac{\Delta V_{old}}{K}\right)^2}$$

$$= K$$

$U_{old} = k\, U_{new}$

$U_{old} \gg U_{new}$



Previous: $\Delta V_{old} > \Delta V_{new}$

Latest: $\Delta V_{old} = \Delta V_{new}$

$$E_{old} = E_{new}$$

$$E_{new} = \frac{E_{ext.new}}{k}$$

$$\Rightarrow \frac{\sigma}{\varepsilon_0} = \frac{\sigma'}{\varepsilon_0 k}$$

$$\Rightarrow \frac{Q}{A\varepsilon_0} = \frac{Q'}{A\varepsilon_0 k}$$

$$\Rightarrow Q' = kQ$$

$$\Rightarrow Q' > Q$$

$$Q_{new} > Q_{old}$$

Summery:

$\Delta V_{old} > \Delta V_{new}$

$C_{new} > C_{old}$

$U_{old} > U_{new}$

$Q_{new} > Q_{old}$

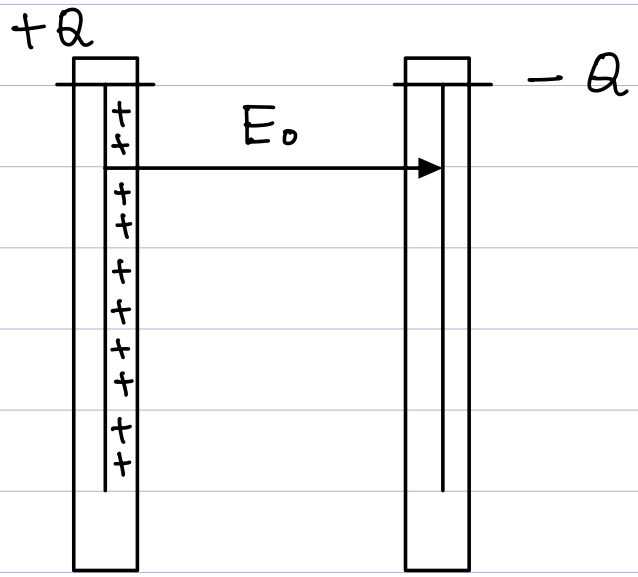
$$Q = C_{old} \cdot \Delta V_{old}$$

$$Q' = C_{new} \Delta V_{new}$$

$$\Rightarrow \frac{Q}{Q'} = \frac{C_{old}}{C_{new}}$$

$$\Rightarrow \frac{Q}{kQ} = \frac{C_{old}}{C_{new}}$$

$$\Rightarrow C_{old} = k C_{new}$$

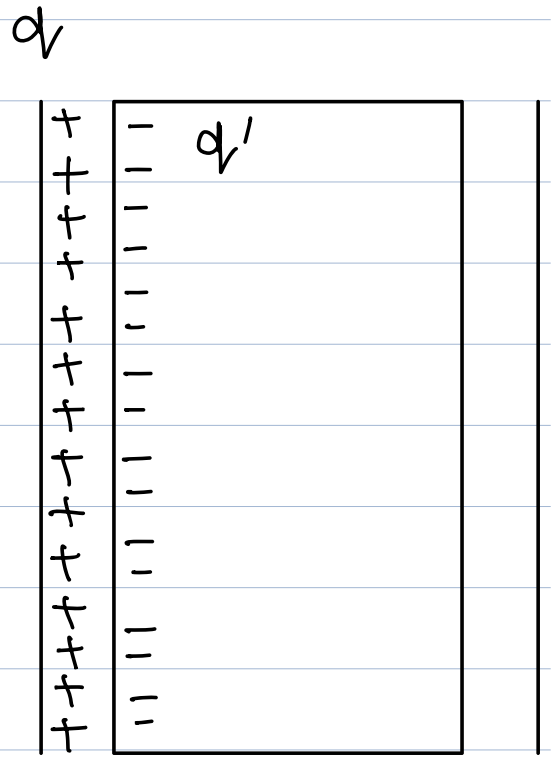


$$\oint_A \vec{E_0} \cdot d\vec{A} = \frac{q}{\varepsilon_0}$$

$$\Rightarrow \oint E_0 \, dA = \frac{q}{\varepsilon_0}$$

$$\Rightarrow E_0 A = \frac{q}{\varepsilon_0}$$

$$E_0 = \frac{q}{A \varepsilon_0}$$



$$\int_A \vec{E} \cdot d\vec{A} = \frac{q - q'}{\varepsilon_0}$$

$$\Rightarrow E \cdot A = \frac{q - q'}{\varepsilon_0}$$

$$\Rightarrow E = \frac{q - q'}{A \varepsilon_0}$$

$$E = \frac{E_0}{k}$$

$$\Rightarrow \frac{q - q'}{A \varepsilon_0} = \frac{q}{A \varepsilon_0 k}$$

$$\Rightarrow q - q' = \frac{q}{k}$$

$$\oint_A \vec{E} \cdot d\vec{A} = \frac{q - q'}{\varepsilon_0}$$

$$\Rightarrow \oint_A \vec{E} \cdot d\vec{A} = \frac{q}{k\epsilon_0}$$

$$\Rightarrow k \oint \vec{E} \cdot d\vec{A} = \frac{q_{capacitor}}{\epsilon_0}$$

Gauss Law for dielectric