Dielétricos

A) Polares

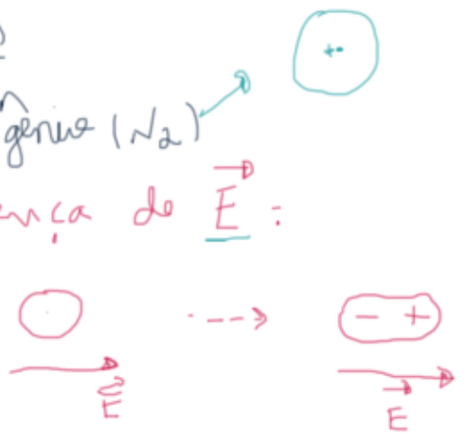
Ex: Água

Na presença de $\vec{E}$, $\vec{p}$ tende a se alinhar com $\vec{E}$

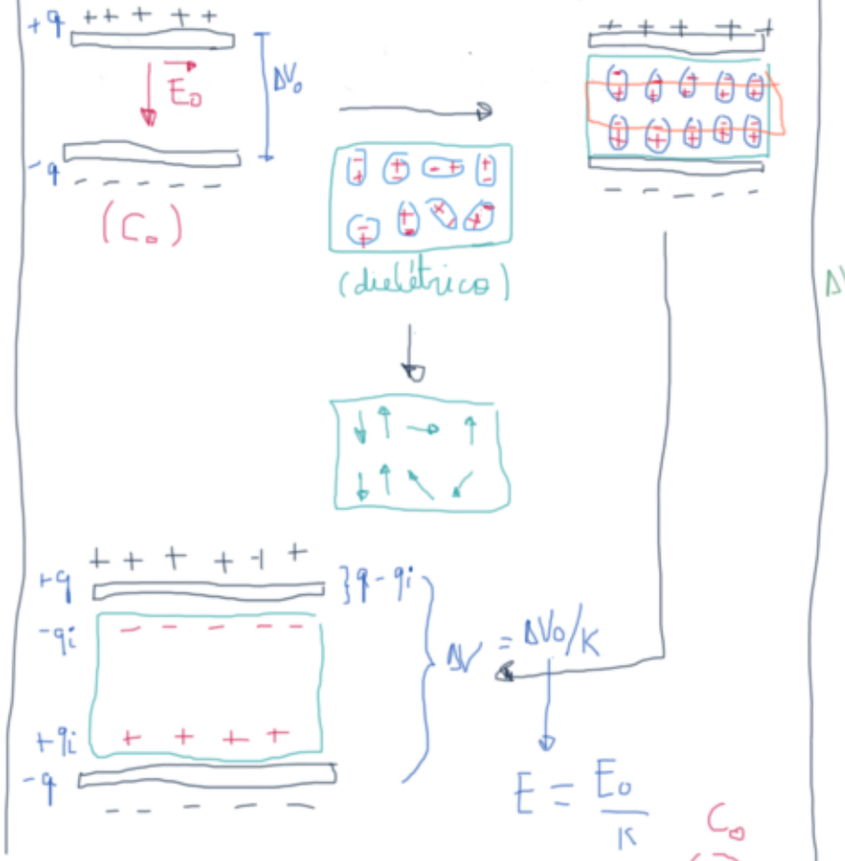
B) Não polares

Ex: Nitrogênio (N_2)

Na presença de $\vec{E}$:



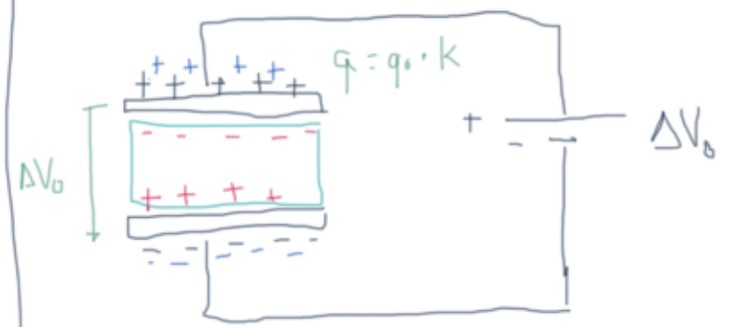
Dentro de um capacitor...



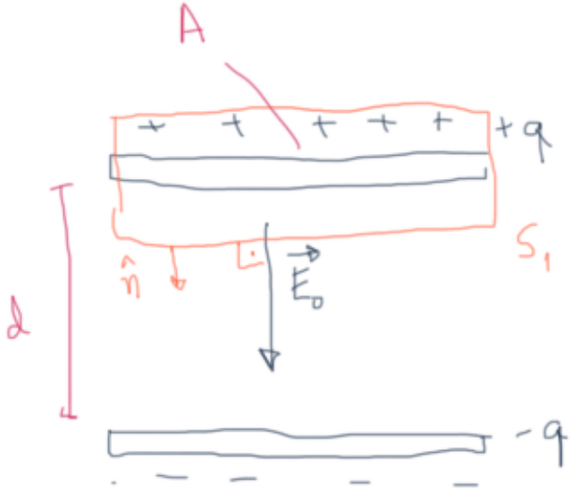
$$E = \frac{E_0}{K}$$

$$C = \frac{q}{\Delta V} = \frac{q}{\frac{\Delta V_0}{K}} = K \cdot \frac{q}{\Delta V_0} = K C_0$$

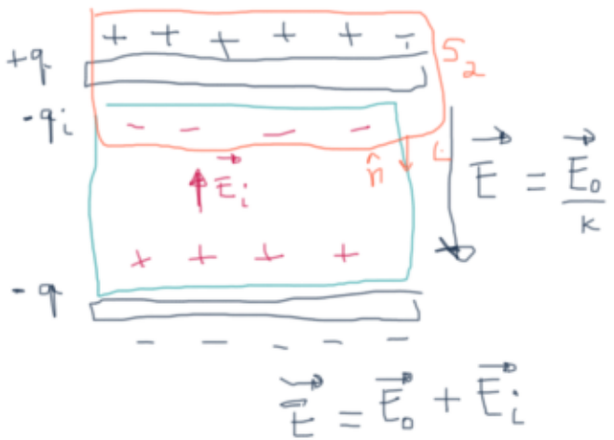
E se o capacitor estiver ligado à bateria?



$$C = \frac{q}{\Delta V_0} = K \frac{q_0}{\Delta V_0} = K C_0$$



$$C_0 = \frac{q}{\Delta V_0}, \quad E_0 = \frac{q}{\varepsilon_0 A}, \quad \Delta V_0 = E_0 \cdot d \Big\} C_0 = \frac{\varepsilon_0 A}{d}$$



$$\vec{E} = \vec{E}_0 + \vec{E}_i$$

$$\vec{E} = \frac{\vec{E}_0}{K}$$

$$\oint \vec{E}_0 \cdot d\vec{A} = \frac{q_{int}}{\varepsilon_0} = \frac{q}{\varepsilon_0}$$

S_1

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

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{int}}{\varepsilon_0} = \frac{q - q_i}{\varepsilon_0}$$

S_2

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

$$E = \frac{q - q_i}{A\varepsilon_0} = \frac{E_0}{K} = \frac{q}{K\varepsilon_0 A}$$

$$\frac{q - q_i}{A\varepsilon_0} = \frac{q}{K\varepsilon_0 A} \Rightarrow q - q_i = \frac{q}{K}$$

$$q - \frac{q}{K} = q_i$$

$$q_i = q\left(1 - \frac{1}{K}\right)$$

$$\sigma_i = \sigma\left(1 - \frac{1}{K}\right)$$

$q_i < q$ ou $\sigma_i < \sigma$

$$\oint \vec{E} \cdot d\vec{A} = \frac{q}{K\varepsilon_0} = \frac{q}{\varepsilon}$$

ε = permissividade elétrica do meio

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{livre}}{\varepsilon}$$ (Lei de Gauss geral)

ou

$$\oint \vec{D} \cdot d\vec{A} = q_{livre}, \quad \vec{D} = \text{vetor deslocamento elétrico} = \varepsilon \vec{E}$$

24.38 . p.129

$C_0 = 5{,}0\ pF = 5{,}0 \cdot 10^{-12}\ F$

$K_{ar} \cong 1$

$d = 1{,}50\ mm = 1{,}50 \cdot 10^{-3}\ m$

a) $q_{0\,max} = ?$

$E_{0\,max} = 3{,}0 \cdot 10^4\ \frac{V}{m}$

$\Delta V_{0\,max} = E_{0\,max} \cdot d$

$= 3{,}0 \cdot 10^4 \cdot 1{,}50 \cdot 10^{-3}$

$= 4{,}5 \cdot 10\ V$

$= 45\ V$

$C_0 = \frac{q_0}{\Delta V_0}$

$q_0 = C_0\ \Delta V_0$

$q_{0\,max} = C_0\ \Delta V_{0\,max}$

$= 5{,}0 \cdot 10^{-12} \cdot 45$

$q_{0\,max} = 225\ pC$

b) $K = 2{,}70$

$q_{max} = ?$

$E_{max} = 3{,}0 \cdot 10^4\ \frac{V}{m}$

$\Delta V_{max} = 45\ V$

$q_{max} = C \cdot \Delta V_{max}$

$q_{max} = K C_0\ \Delta V_{max}$ ($C_0\ \Delta V_{max} = q_{0\,max}$)

$q_{max} = K\, q_{0\,max}$

$q_{max} = 2{,}70 \cdot 225\ pC$

$q_{max} = 608\ pC$

24.39 , p. 129

$E_0 = 3{,}20 \cdot 10^5 \frac{V}{m}$

$E = 2{,}50 \cdot 10^5 \frac{V}{m} = \frac{E_0}{K}$

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

$\frac{E_0}{E} \Rightarrow K$

a) $\sigma_i = ?$

$\sigma_i = \sigma \left(1 - \frac{1}{K}\right)$

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

$\sigma_i = \varepsilon_0 E_0 \left(1 - \frac{1}{\frac{E_0}{E}}\right)$

$= \varepsilon_0 E_0 \left(1 - \frac{E}{E_0}\right)$

$= \varepsilon_0 E_0 - \varepsilon_0 E$

$= \varepsilon_0 (E_0 - E)$

$\sigma_i = 8{,}85 \cdot 10^{-12} (3{,}20 - 2{,}50) \cdot 10^5$

$\boxed{\sigma_i = 6{,}20 \cdot 10^{-7} \frac{C}{m^2}}$

b) $K = \frac{E_0}{E}$

$K = \frac{3{,}20 \cdot 10^5}{2{,}50 \cdot 10^5}$

$\boxed{K = 1{,}28}$

24.40, p.129

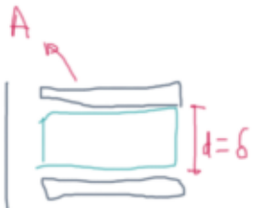
Capacitância = 1,0 nF
$= 1,0 \cdot 10^{-9}$ F

$K = 3,6$

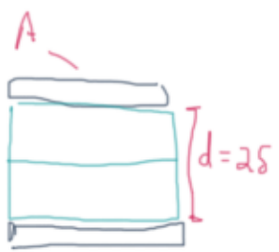
δ = espessura do papel = 0,20 mm
$= 0,20 \cdot 10^{-3}$ m

$A = 22\,cm \times 28\,cm = 616\,cm^2$
$= 6,16 \cdot 10^{-4}\,m^2$

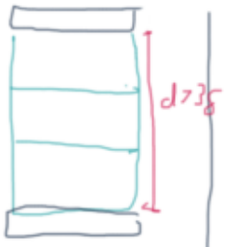
a) n = nº de folhas de papel = ?



$C_1 = kC_0$
$= k\frac{\varepsilon_0 A}{d}$
$= k\frac{\varepsilon_0 A}{\delta}$



$C_2 = kC_0'$
$= k\frac{\varepsilon_0 A}{2\delta}$



$C_3 = \frac{k\varepsilon_0 A}{3\delta}$

No caso geral, para n folhas de papel:

$C_n = \frac{k\varepsilon_0 A}{n\delta}$

$n = \frac{k\varepsilon_0 A}{C_n \delta} = \frac{3,0 \cdot 8,85 \cdot 10^{-2} \cdot 616 \cdot 10^{-4}}{1,0 \cdot 10^{-9} \cdot 0,20 \cdot 10^{-3}}$

$\boxed{n \cong 8}$ //

b) $\delta = 12,0$ mm $= d$

$C = \frac{k\varepsilon_0 A}{\delta}$

$A = \frac{C\delta}{k\varepsilon_0}$

$A = \frac{1,0 \cdot 10^{-9} \cdot 12,0 \cdot 10^{-3}}{3,0 \cdot 8,85 \cdot 10^{-12}}$

$\boxed{A = 0,45\,m^2}$

c) $K_{teflon} = 2,1 < K_{papel}$

$A \propto \frac{1}{K}$

$A_{teflon} > A_{papel}$