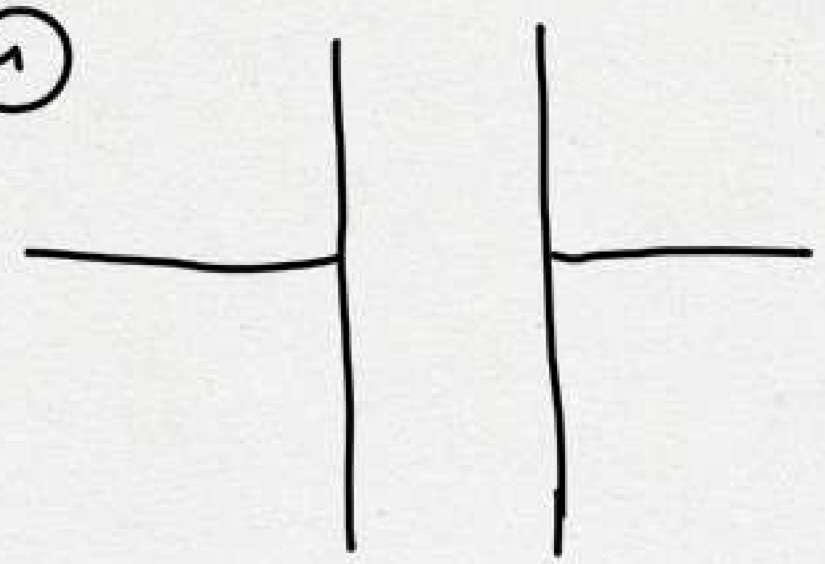
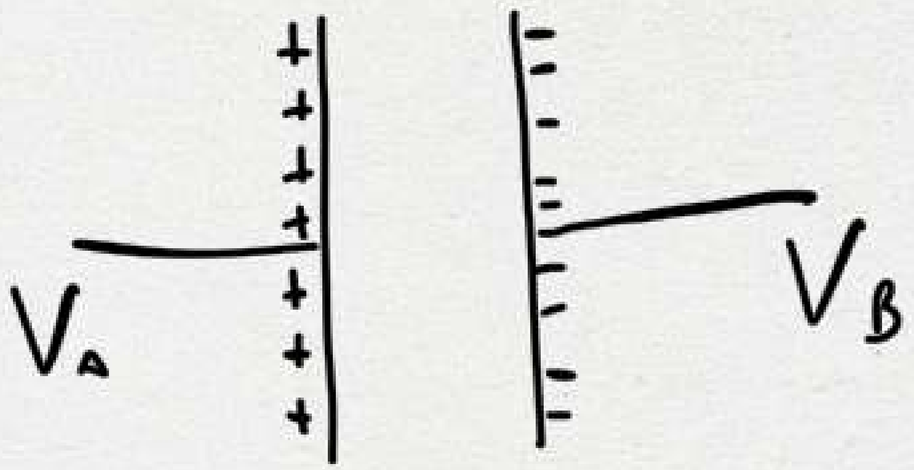
①



②



$$q = C\Delta V \qquad \Delta V = \frac{q}{C}$$

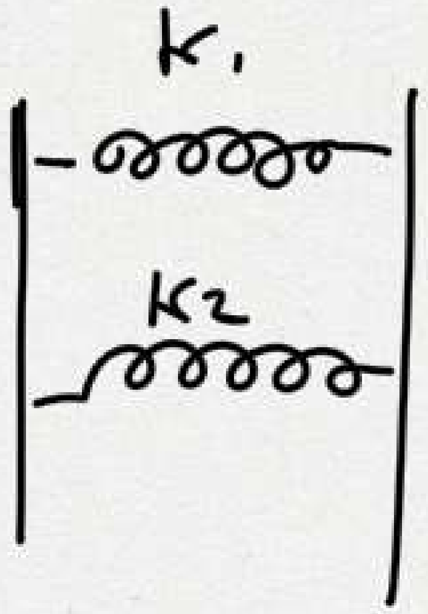
$$C = \frac{q}{\Delta V}$$

$$dW_{ext} = \Delta V dq = \frac{q}{C} dq \Rightarrow W_{ext} = \int_0^q \frac{q'}{C} dq' = \boxed{\frac{1}{2}\frac{q^2}{C} = \frac{1}{2} q \Delta V = \frac{1}{2} C \Delta V^2 = U_e}$$

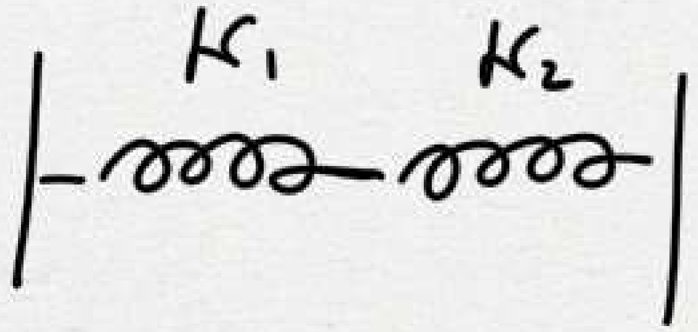
$$q = C \Delta V \qquad \longleftrightarrow \qquad F = k \Delta x$$

$$\downarrow$$

$$\frac{1}{2} C \Delta V^2 \qquad \qquad \frac{1}{2} k \Delta x^2$$



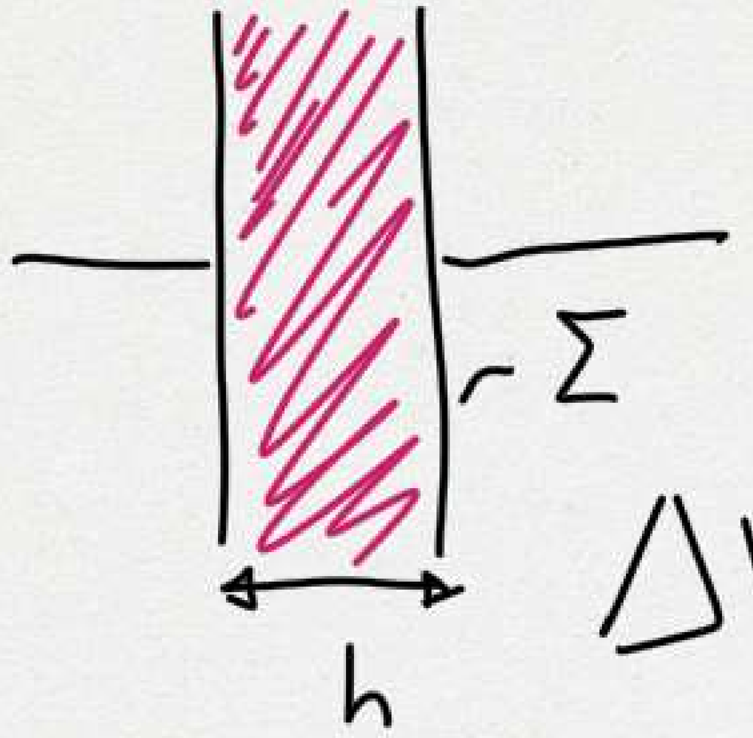
$$k_{TOT} = k_1 + k_2$$



$$\frac{1}{k_{TOT}} = \frac{1}{k_1} + \frac{1}{k_2}$$

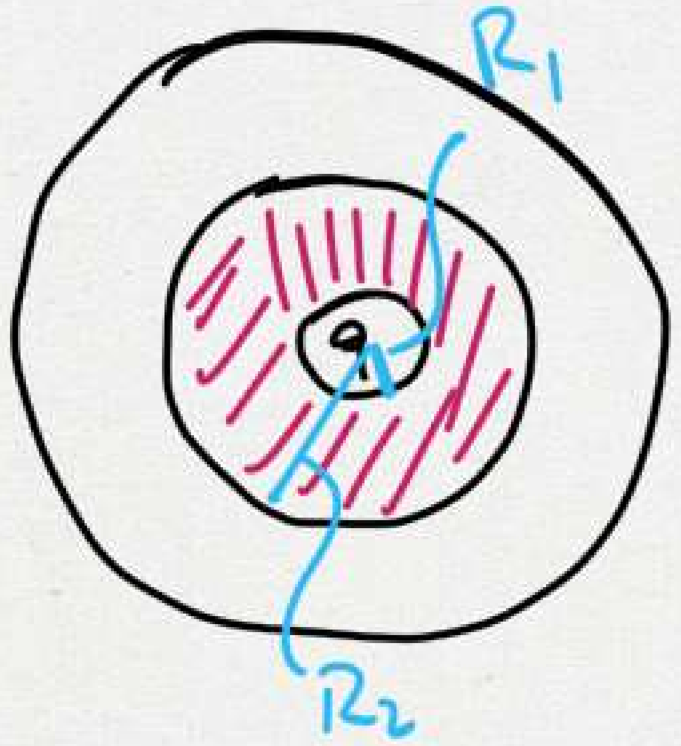
$$U_e = \frac{1}{2} C \Delta V^2 = \frac{1}{2} \frac{\varepsilon_0 \Sigma}{\cancel{h}} E^2 h^{\cancel{2}} = \frac{1}{2} \varepsilon_0 E \Sigma h = \frac{1}{2} \varepsilon_0 E^2 \tau$$

$$\equiv u_e \tau \; , \; \boxed{u_e = \frac{1}{2} \varepsilon_0 E^2} \Rightarrow U_e = \int_\tau u_e \, d\tau$$



$$C = \frac{\varepsilon_0 \Sigma}{h}$$

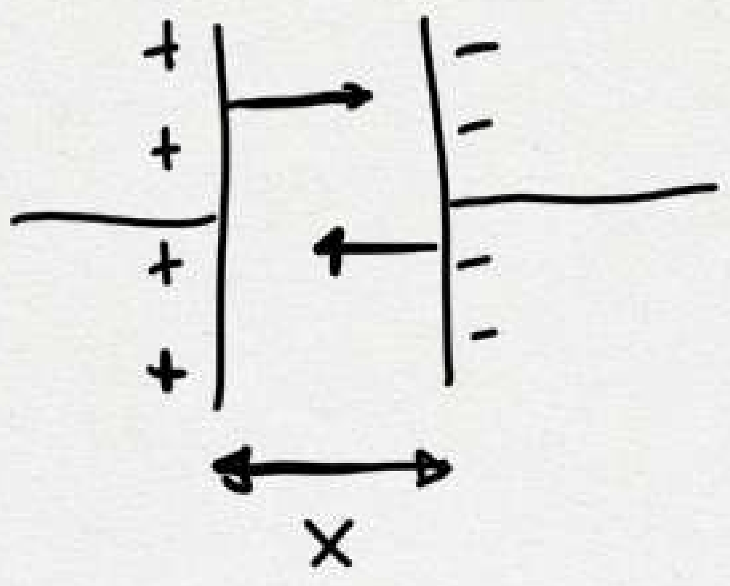
$$\Delta V = Eh = \frac{\sigma}{\varepsilon_0} h$$



$$E(r) = \frac{q}{4\pi\varepsilon_0} \frac{1}{r^2} \Rightarrow$$

$$U_e = \int \frac{1}{2} \varepsilon_0 E^2(r) \, d\tau = \int_{R_1}^{R_2} \frac{1}{2} \varepsilon_0 E^2(r) \, 4\pi r^2 \, dr = \frac{1}{2} \cancel{\varepsilon_0} \frac{q^2}{(4\pi\varepsilon_0)^{\cancel{2}}} \cancel{4\pi} \int_{R_1}^{R_2} \frac{1}{r^2} \, dr =$$

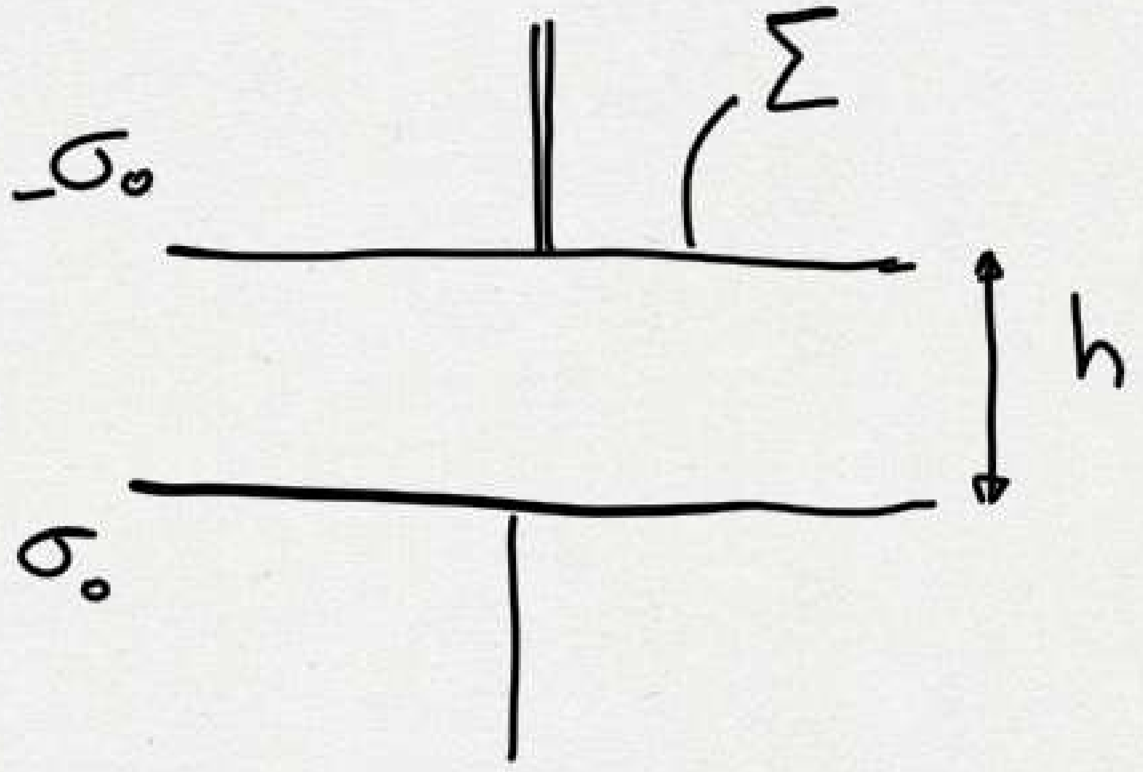
$$= \frac{1}{2} \frac{q^2}{4\pi\varepsilon_0} \left(\frac{1}{R_1} - \frac{1}{R_2} \right) = \frac{1}{2} \frac{q^2}{C} = U_e$$



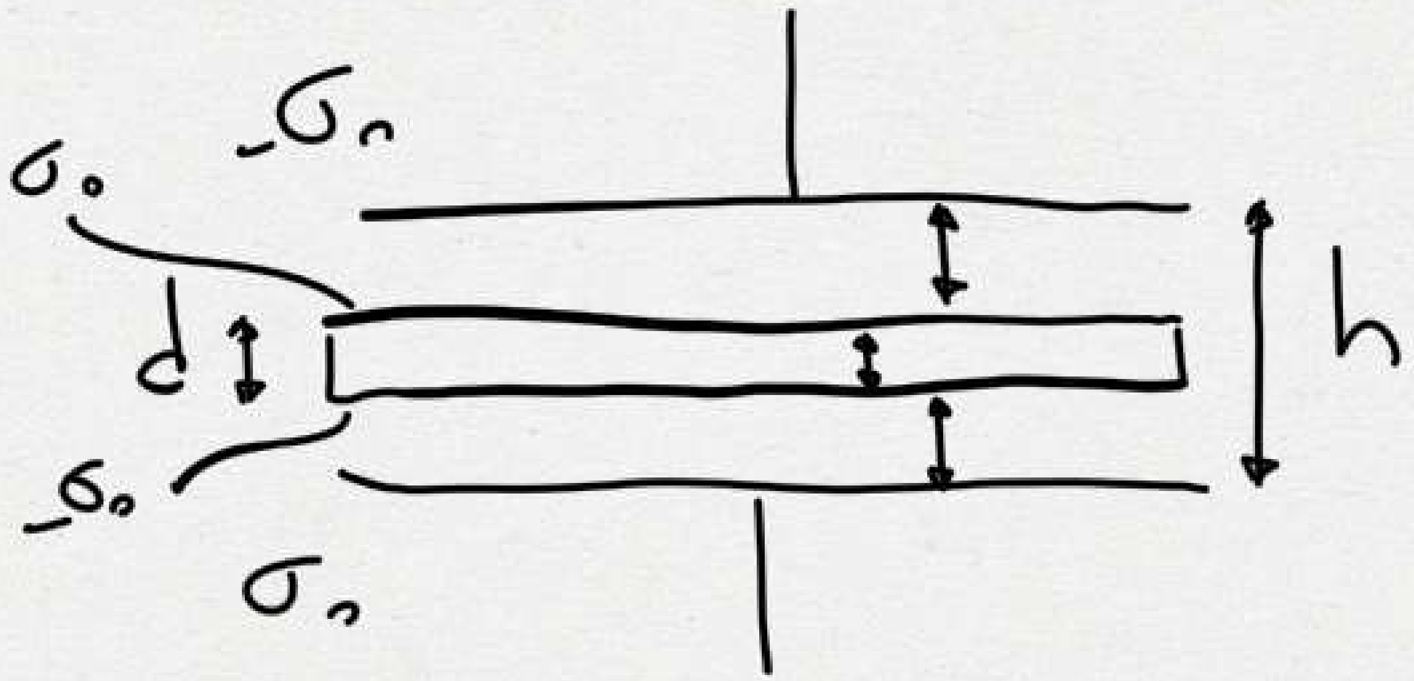
$$dW = F_x\, dx = -dU_e \implies$$

$$F_x = -\frac{dU_e}{dx} \longrightarrow E_x = -\frac{\partial V}{\partial x}$$

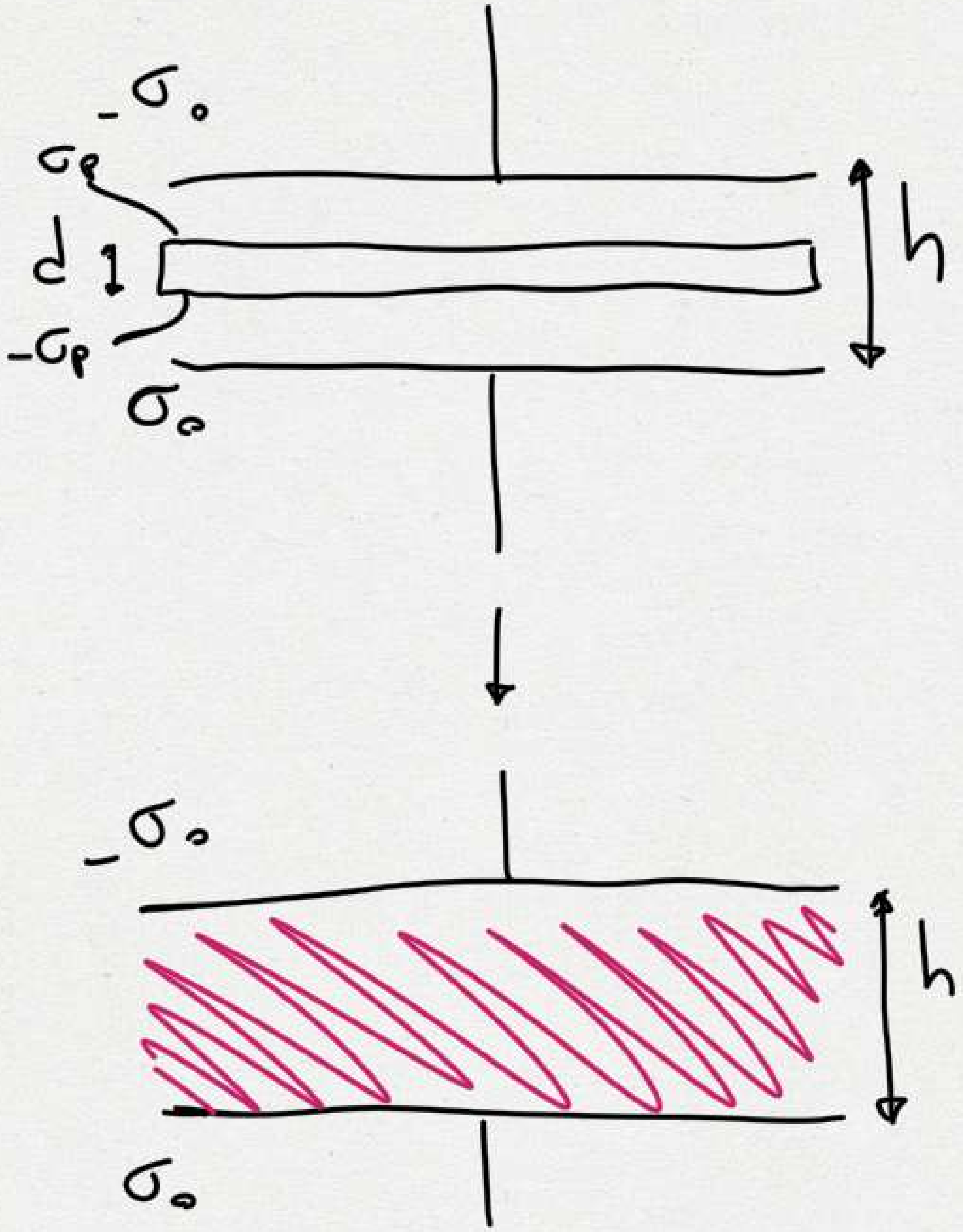
DIELETTRICI (LINEARI)



$$\Delta V_0 = \frac{\sigma_0}{\varepsilon_0} h$$



$$\Delta V = \frac{\sigma_0}{\varepsilon_0}(h-d) < \Delta V_0$$



$$\Delta V < \Delta V_p < \Delta V_0$$

$$\frac{\Delta V_0}{\Delta V_p} = K \quad \text{COSTANTE DIELETTRICA RELATIVA}$$

$$\updownarrow$$

$$\varepsilon_r$$

$$\Delta V = E h$$

$$\Delta V_0 = E_0 h$$

$$\Delta V_p = E_p h$$

$$\Rightarrow \frac{\Delta V_0}{\Delta V_p} = \frac{E_0}{E_p} = K \Rightarrow$$

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

$$\underbrace{E_0 - E_p} = \frac{\sigma_0}{\varepsilon_0} - \frac{\sigma_0}{K\varepsilon_0} = \frac{\sigma_0}{\varepsilon_0}\left(1 - \frac{1}{K}\right) = \frac{\sigma_0}{\varepsilon_0}\left(\frac{K-1}{K}\right) \equiv \frac{\sigma_0}{\varepsilon_0}\frac{\chi}{\chi+1}, \quad \chi = K - 1$$

SUSCETTIVITÀ ELETTRICA

$$E_0 - E_p = E_d \Rightarrow$$

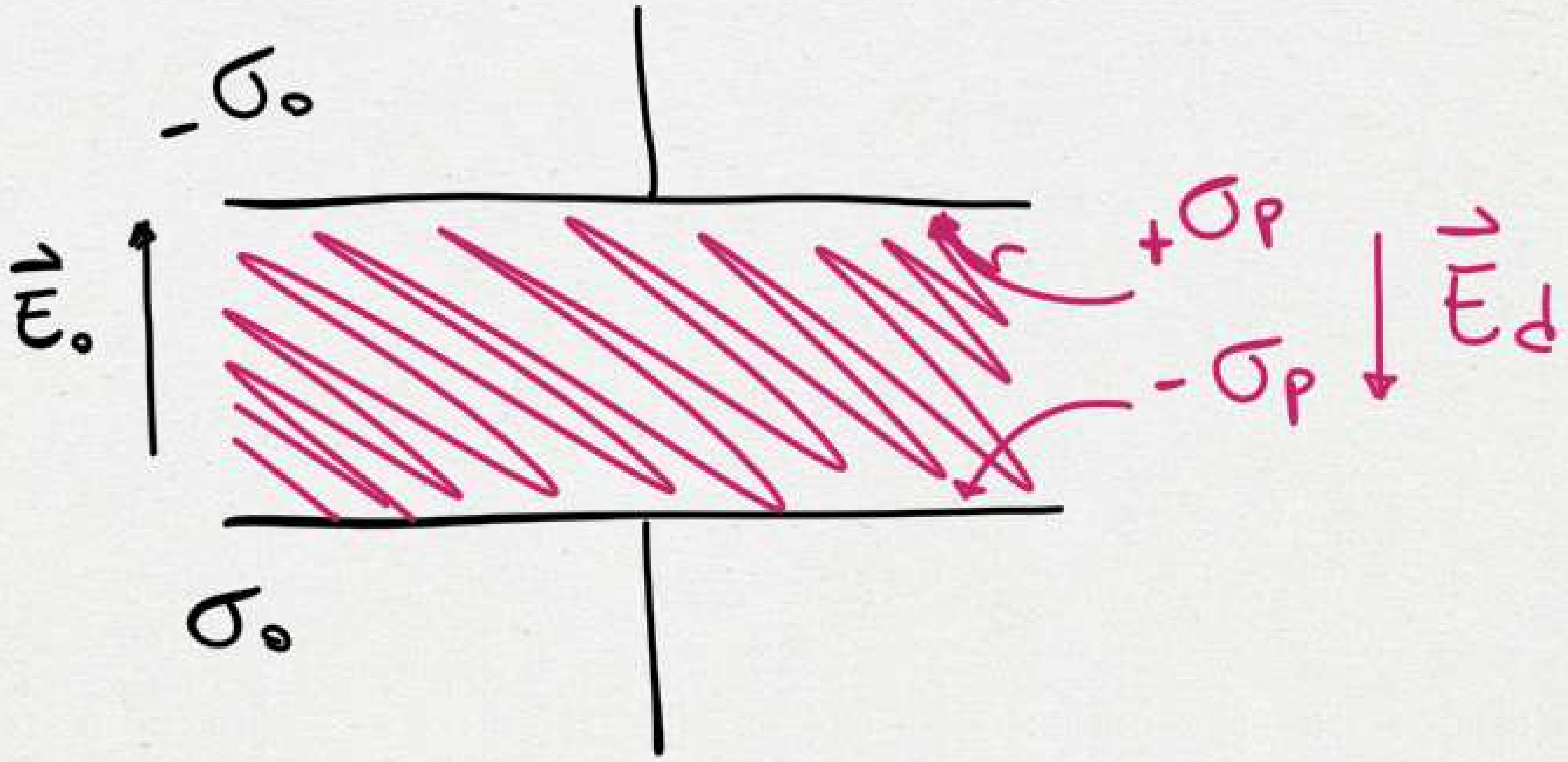
VUOTO — CON IL DIELETTRICO — CAMPO DOVUTO AL DIELETTRICO

$$E_p = E_0 - E_d = \frac{\sigma_0}{\varepsilon_0} - \frac{K-1}{K}\frac{\sigma_0}{\varepsilon_0} \equiv \frac{\sigma_0}{\varepsilon_0} - \frac{\sigma_p}{\varepsilon_0}$$

$$\sigma_p \equiv \frac{K-1}{K}\sigma_0 < \sigma_0$$

$$\downarrow$$

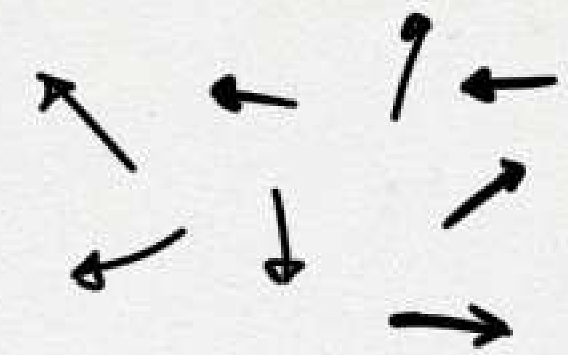
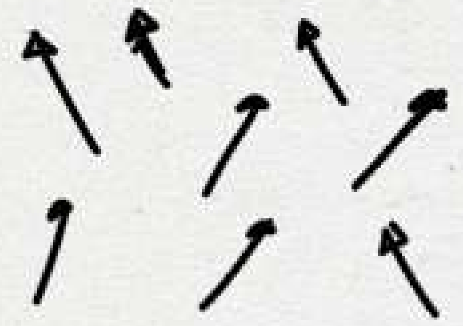
$$q_p = \frac{K-1}{K} q_0 < q_0$$



$$C = \frac{q_0}{\Delta V_p} = K\frac{q_0}{\Delta V} = K C_0 > C_0$$

$$[\text{RIGIDITÀ DIELETTRICA}] = \frac{V}{m}$$

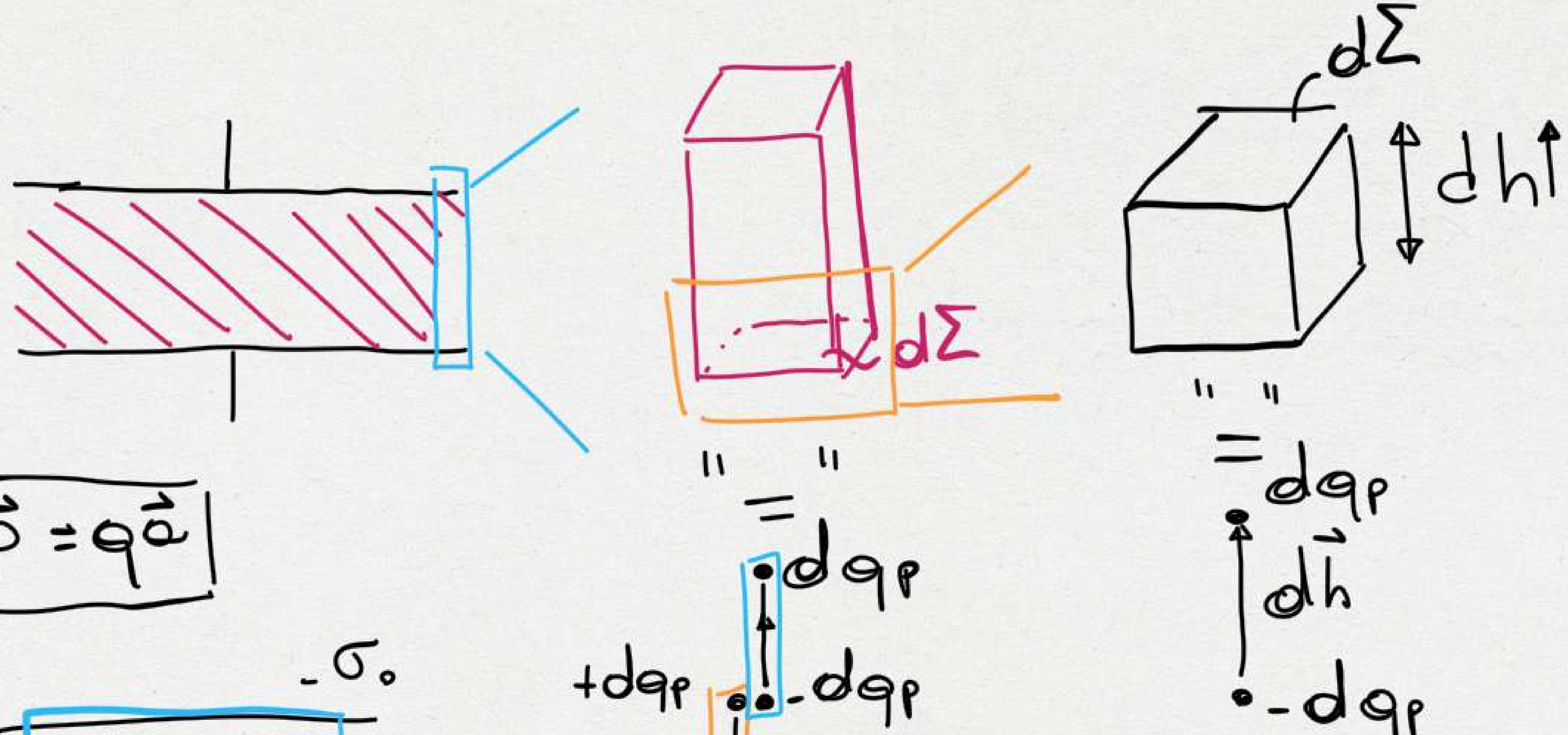
POLARIZZAZIONE

1.  $\xrightarrow{\vec{E}\uparrow}$  $\langle \vec{p} \rangle \parallel \vec{E}$ PER ORIENTAMENTO

2.  $\xrightarrow{\vec{E}\uparrow}$  "="  $\langle \vec{p} \rangle \parallel \vec{E}$ ELETTRONICA

$N\langle \vec{p} \rangle = \vec{P}_{TOT}$, $\vec{P} \equiv \dfrac{N}{\tau}\langle \vec{p} \rangle =$ VETTORE POLARIZZAZIONE

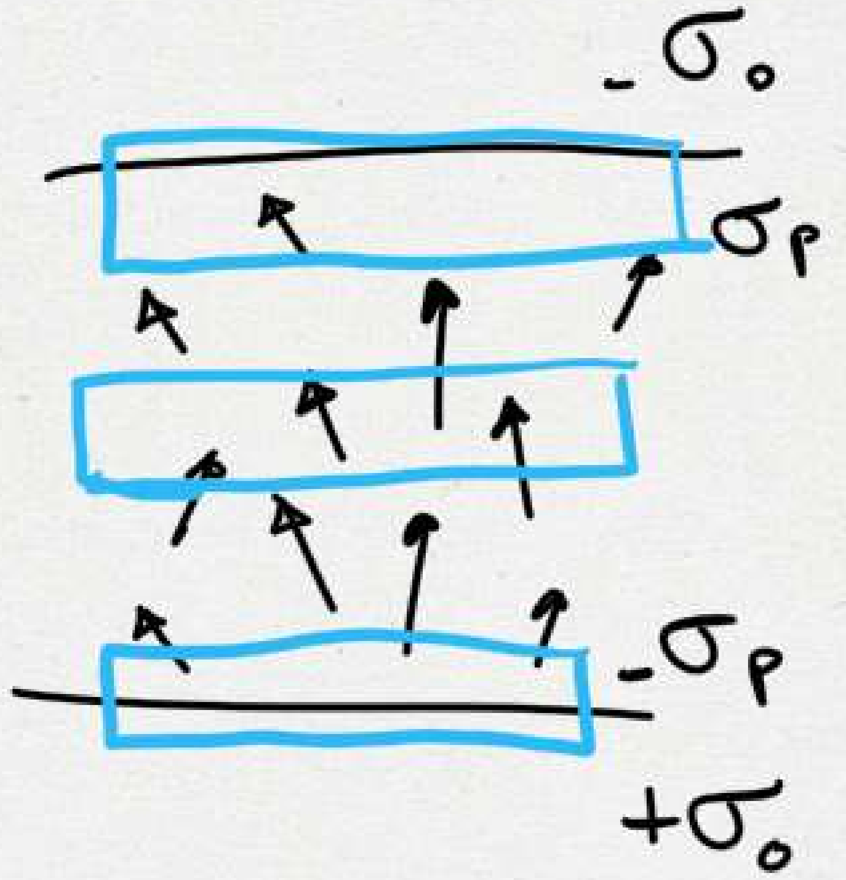
$= n\langle \vec{p} \rangle \parallel \vec{E}$

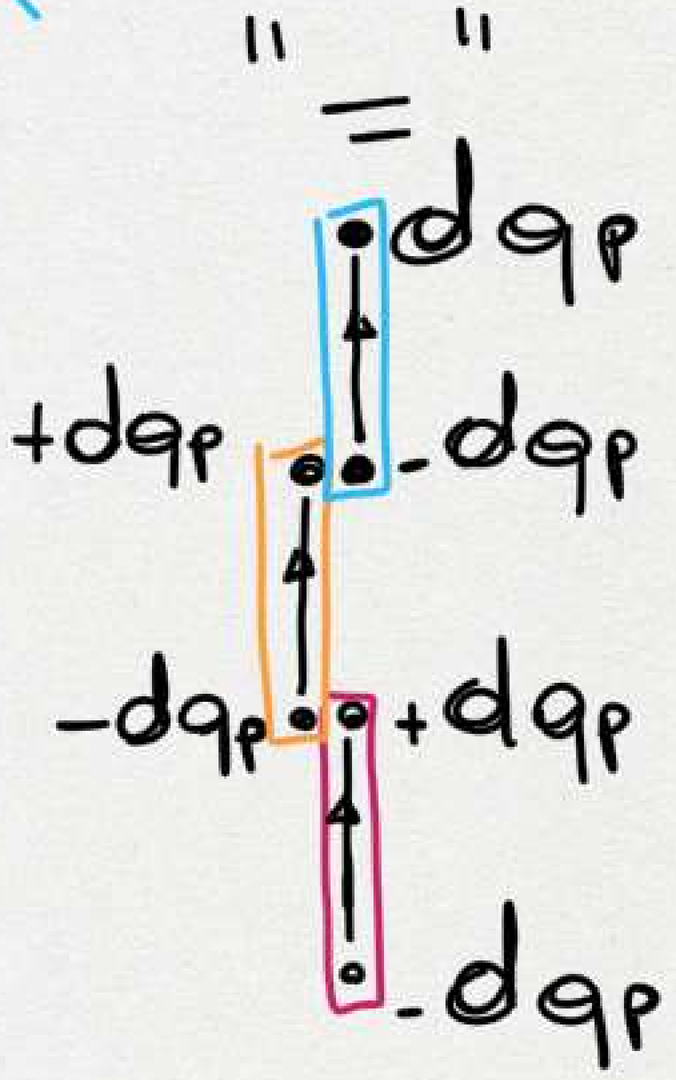


$$d\tau = d\Sigma\, dh$$

$$\vec{P}\, d\tau = \vec{P}\, d\Sigma\, dh = \underbrace{P\, d\Sigma}_{\text{"}dq_p\text{"}}\, \underbrace{d\vec{h}}_{\text{"}\vec{a}\text{"}}$$

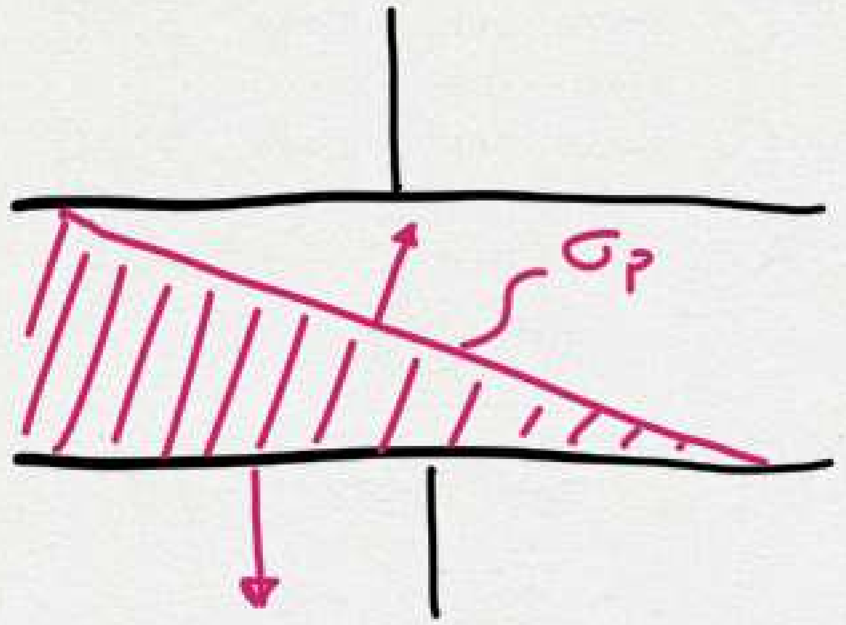
$$\boxed{\vec{p} = q\vec{a}}$$





$$P\, d\Sigma = dq_p \implies$$

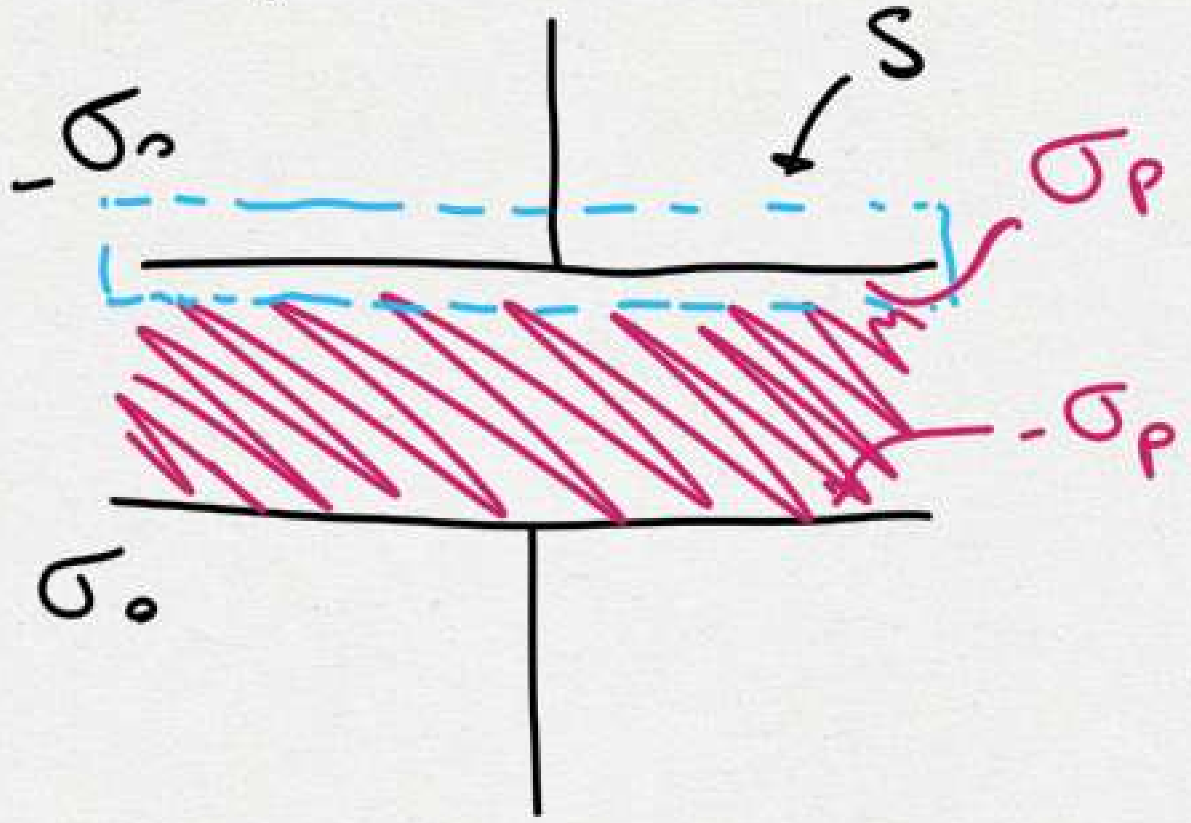
$$P = \frac{dq_p}{d\Sigma} = \sigma_p$$



$$\vec{P} \cdot \hat{n} = \sigma_p$$

DIELETTRICI LINEARI $\longrightarrow$ $\vec{P} = \varepsilon_0 (K-1)\vec{E} = \varepsilon_0 \chi \vec{E}$

TEOREMA DI GAUSS



$$\rightarrow \int_S \vec{E}\cdot\hat{n}\, d\Sigma = \frac{Q_s}{\varepsilon_0} = \frac{q_0 + q_p}{\varepsilon_0}$$

$$\vec{P} = \varepsilon_0 (k-1)\vec{E} \Rightarrow$$

$$\vec{E} = -\frac{\vec{P}}{\varepsilon_0} + k\vec{E}$$

$$k\vec{E} = \vec{E}_0$$

$$\int_S \left(k\vec{E} - \frac{\vec{P}}{\varepsilon_0}\right)\cdot\hat{n}\, d\Sigma = \frac{q_0 + q_p}{\varepsilon_0} =$$

$$= \cancel{\underbrace{\int_S \vec{E}_0 \cdot \hat{n}\, d\Sigma}_{= \frac{q_0}{\varepsilon_0}}} - \int_S \frac{\vec{P}}{\varepsilon_0}\cdot\hat{n}\, d\Sigma = \cancel{\frac{q_0}{\varepsilon_0}} + \frac{q_p}{\varepsilon_0} \Rightarrow$$

$$\int_S \vec{P}\cdot\hat{n}\, d\Sigma = -q_p$$

$$\int_S (\varepsilon_0\vec{E} + \vec{P})\cdot\hat{n}\, d\Sigma = q_0 \Rightarrow \varepsilon_0\vec{E} + \vec{P} \equiv \vec{D} \quad \text{INDUZIONE DIELETTRICA}$$

1) $\underbrace{\int_S \vec{D}\cdot\hat{n}\,d\Sigma = q_0}$

COSTANTE DIELETTRICA ASSOLUTA

2) $\vec{D} = \varepsilon_0\vec{E} + \vec{P} = \cancel{\varepsilon_0\vec{E}} + \varepsilon_0(k-\cancel{1})\vec{E} = \varepsilon_0 k\vec{E} \equiv \varepsilon\vec{E}$

$\boxed{\vec{P}\cdot\hat{n}}$