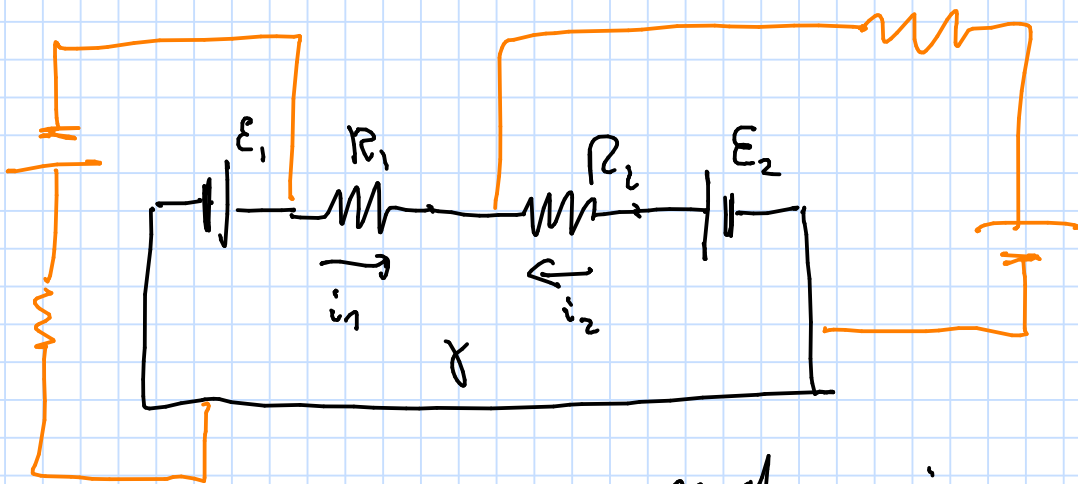
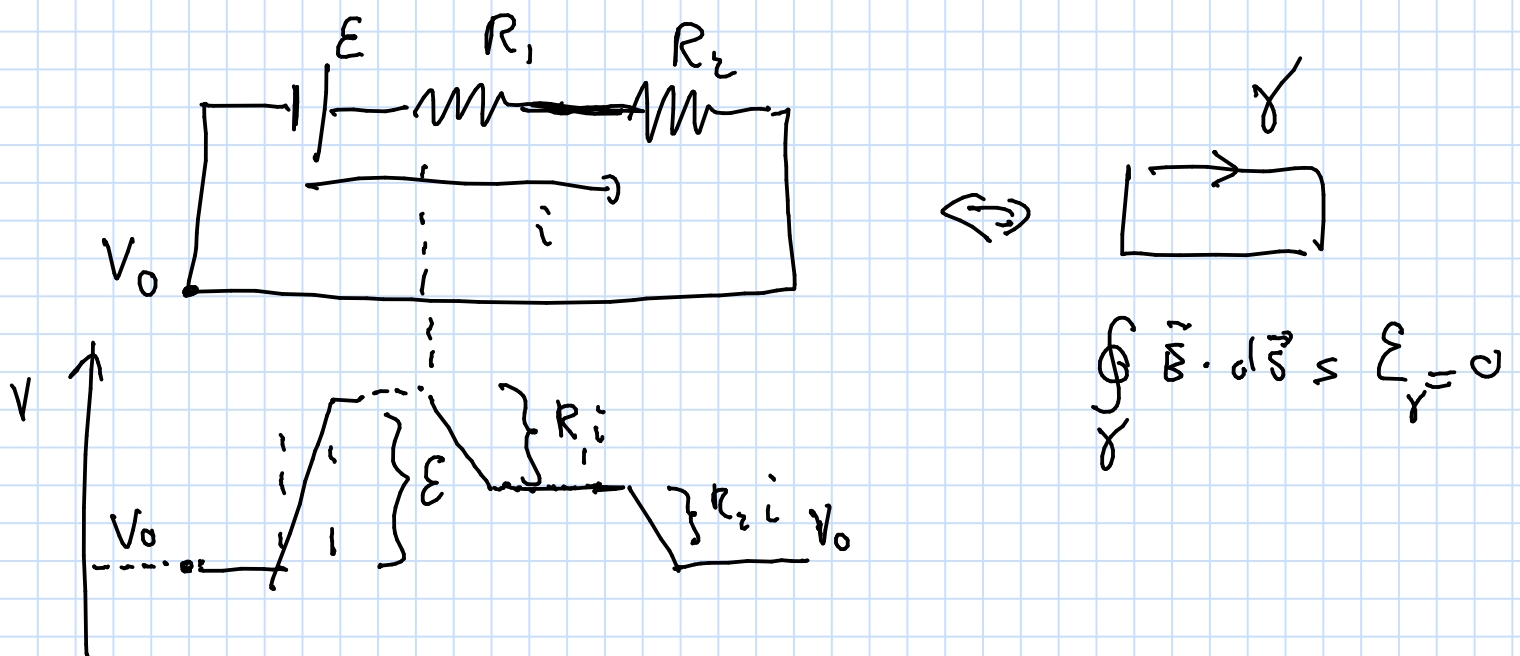




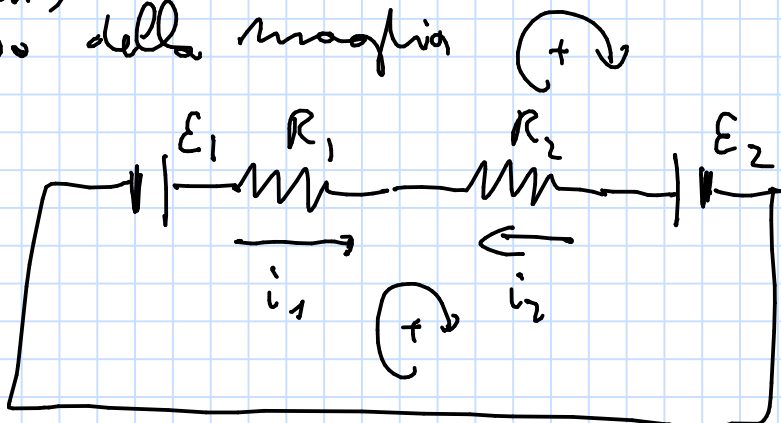
anche qui su γ (maglia)

$$\oint \vec{E} \cdot d\vec{s} = 0$$



2^a legge di Kirchhoff

1) (orient.)
1) senso della maglia (+)



$$E_1 - E_2 = R_1 i_1 - R_2 i_2$$

4)

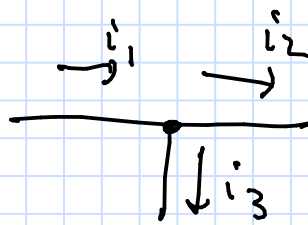
$$\begin{array}{c} A \text{---} E \text{---} B \\ V_A - V_B = -E \end{array}$$

$$\begin{array}{c} A \text{---} E \text{---} B \\ V_A - V_B = E \end{array}$$

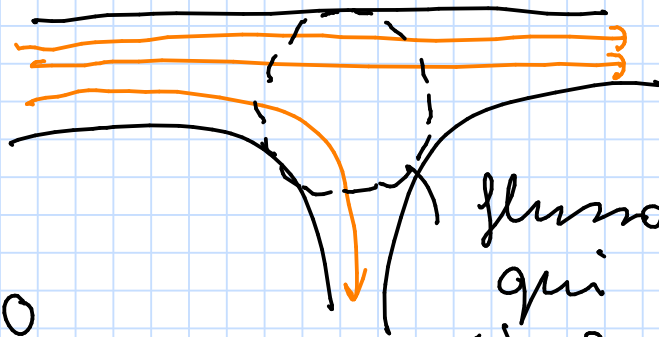
$$\begin{array}{c} A \text{---} R \text{---} B \\ V_A - V_B = R i \end{array}$$

$$\begin{array}{c} A \text{---} R \text{---} B \\ V_A - V_B = -R i \end{array}$$

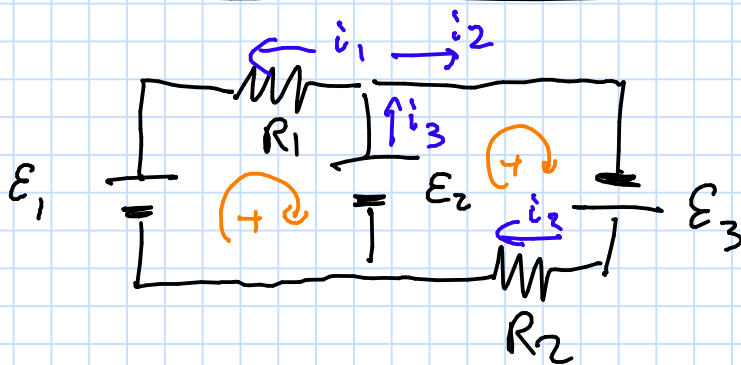
1^a legge di K



$$i_1 - i_2 - i_3 = 0$$



flusso d. $j=0$
qui
(in regime
stazionario)



es] circuito con 2
maglie

1) versi (+), (+)

2) concordi

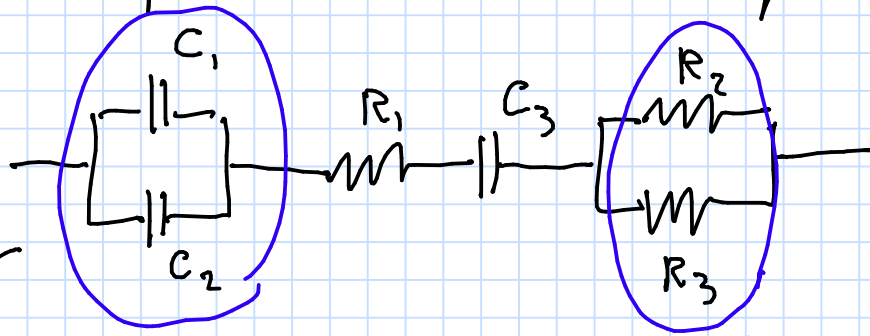
3) 1^a legge

4) maglie

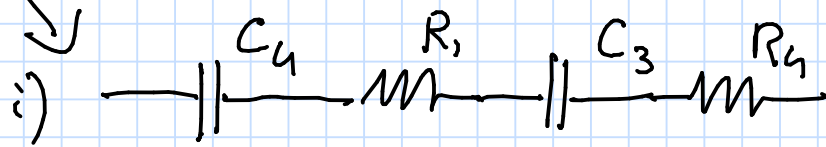
$$\begin{cases} i_3 = i_1 + i_2 \\ E_1 - E_2 = -R_1 i_1 \\ E_2 + E_3 = R_2 i_2 \end{cases}$$

risoluzione di sistema lineare

esempio di circuiti equivalenti

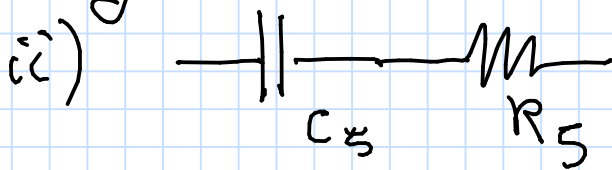
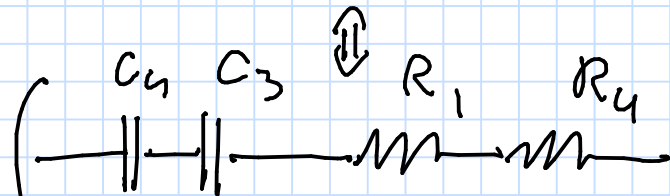


qual è la scala di tempo τ ?



$$C_4 = C_1 + C_2$$

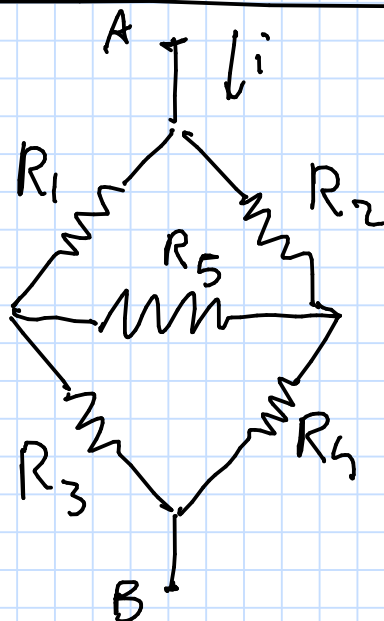
$$\frac{1}{R_4} = \frac{1}{R_2} + \frac{1}{R_3}$$



$$\frac{1}{C_5} = \frac{1}{C_4} + \frac{1}{C_3}$$

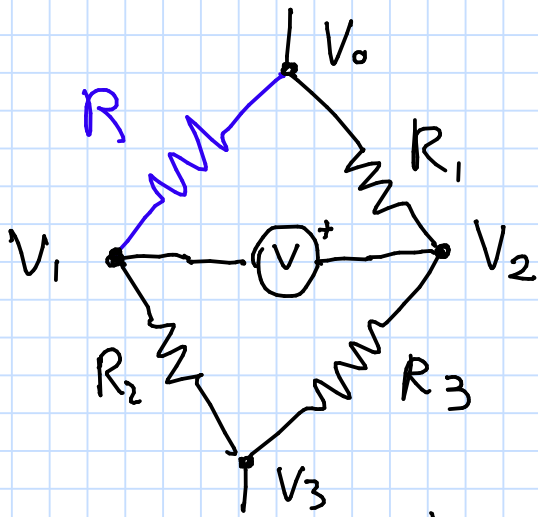
$$R_5 = R_1 + R_4$$

$$\tau = C_5 R_5$$



$$R_{eq} = ?$$

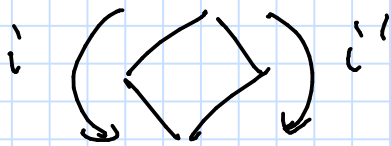
Ponte di Wheatstone



Rincoyita

$\text{---} \bigcirc \text{V} \text{---}$ voltmeters

2 arrivals and area $V_1 = V_2$



$$V_0 - V_1 = V_0 - V_2$$

$$\underline{R_i = R_i i'}$$

$$V_1 - V_3 = V_2 - V_3$$

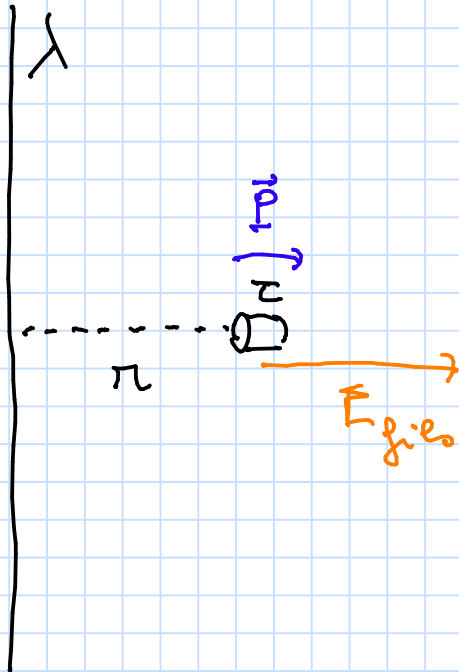
$$\boxed{R_2 i = R_3 i'}$$

$$\frac{R}{R_2} = \frac{R_1}{R_3}$$

$$\Rightarrow R = R_2 \frac{R_1}{R_3}$$

2. $\oint_V \vec{a} \cdot d\vec{a} \neq 0$

esercizio simile al 5.12 MNV pag 406



diel. $\chi = 2$

$$r = 15 \text{ mm} \\ \tau = 8 \text{ mm}^3 \quad \text{dim} < r$$

$$\lambda = 2 \text{ mC/m}$$

calcolare P su τ

$$\vec{P} = \epsilon_0 \chi \vec{E} = \epsilon_0 \underbrace{\chi+1}_K \vec{E}_0$$

↑
nel
dielettrico
(come risultato
di E_0 applicato)

$$\chi = K - 1$$

$$\vec{D} = \epsilon_0 \vec{E}_0$$

$$\vec{P} = \frac{K-1}{K} \vec{D}$$

vettore di
induzione
elettrica $\vec{D}$

$$\text{filo: } \vec{D} = \frac{\lambda}{2\pi r}$$

$$[P] = \frac{C}{m^2} = [D]$$

$$\vec{P} = \frac{K-1}{K} \frac{\lambda}{2\pi r}$$

alla polarizz. $\left[\frac{\text{dipolo}}{\text{volume}} \right]$ corrisp. momento
di dipolo el.

$$\vec{p} = \tau \vec{P} = \tau \frac{K-1}{K} \frac{\lambda}{2\pi r}$$

energia del dipolo

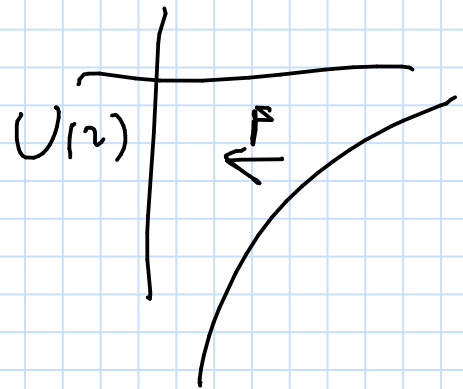
$$U = -\vec{p} \cdot \vec{E}_0 = -\tau \frac{K-1}{K} \epsilon_0 \frac{\lambda^2}{4\pi^2 r^2}$$

non dipende
dal segno
di λ

↗ cresce con r : genera F attrattiva tra
filo / dipolo

$$P = - \frac{\partial U}{\partial \lambda} = - \tau \frac{\kappa - 1}{\kappa} \frac{\lambda^2}{4\pi^2} \frac{1}{\epsilon_0} \frac{2}{\pi^3}$$

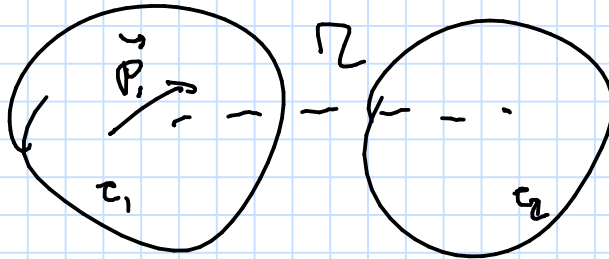
attrattivo



London / Van der Waals / Lennard-Jones

corpi neutri si attraggono... e sono microscopici

molecole
neutre



t: momenti dipolo $\vec{p}_1 \neq 0 \Rightarrow \vec{E}_1 \sim \frac{1}{r^3}$ in 2

$\Rightarrow \vec{p}_2 \neq 0$

$p_2 \sim E_1 \sim \frac{1}{r^3}$

$\vec{p}_2 \sim \vec{p}_1$

London
↓
VdW

$$\Rightarrow U = -\vec{p}_2 \cdot \vec{E}_1 \sim -\frac{1}{r^6}$$

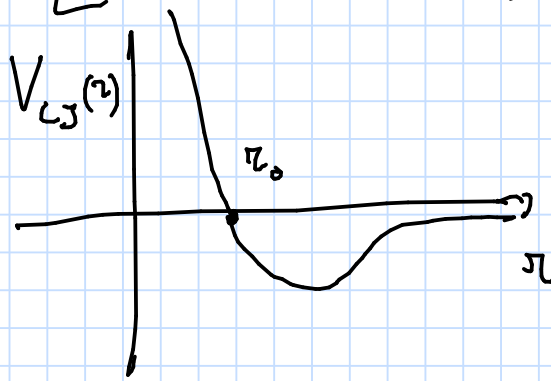
Lennard Jones

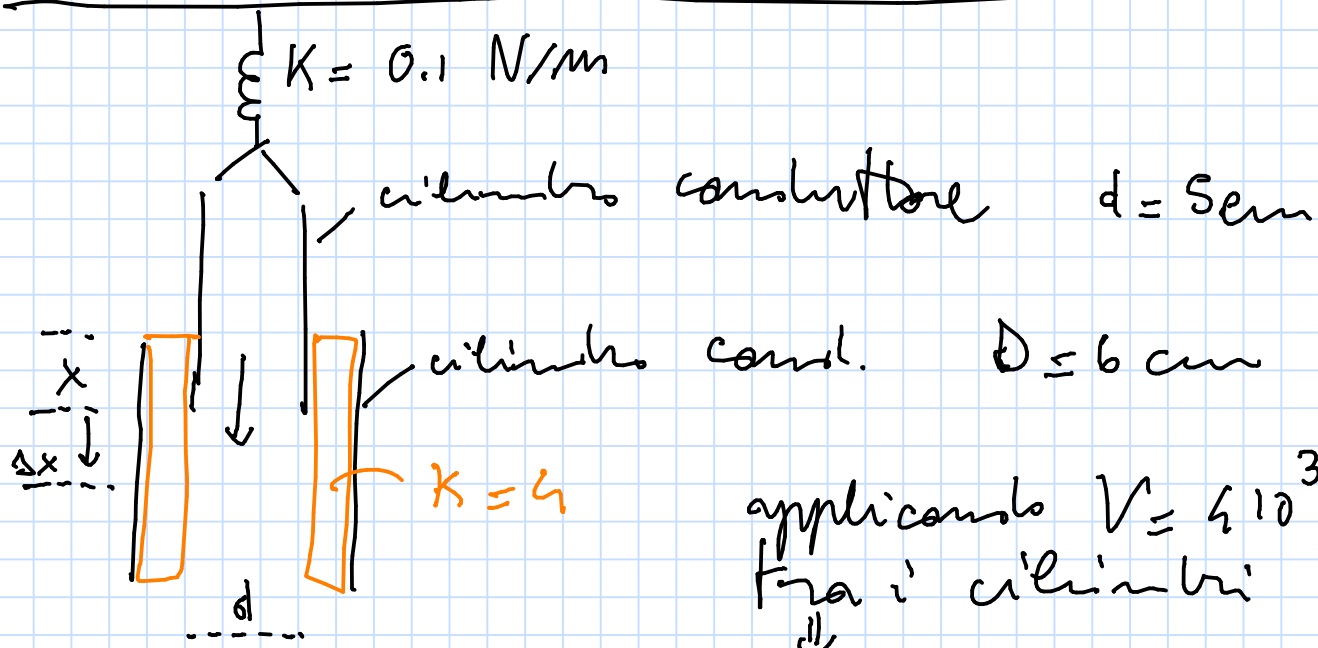
$$\left\{ \begin{array}{l} - \left(\frac{r}{r_0} \right)^{-6} \\ \left(\frac{r}{r_0} \right)^{12} \end{array} \right.$$

attrattivo

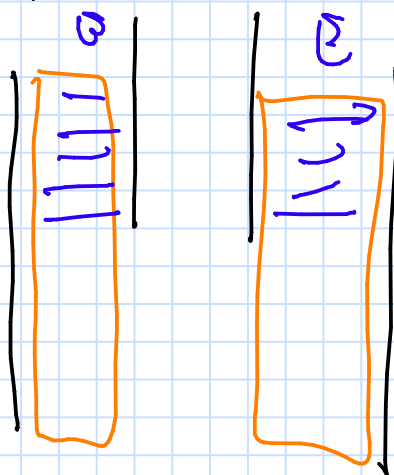
repulsivo

$$V_{LJ} = \epsilon \left[\left(\frac{r}{r_0} \right)^{-12} - \left(\frac{r}{r_0} \right)^{-6} \right]$$





Δx ?



$$C(x) = \frac{2\pi K \epsilon_0 x}{\log R/r}$$

$$= \left(\frac{2\pi K \epsilon_0}{\log D/d} \right) x$$

$$\begin{cases} U_e(x) \text{ nel cond.: } U_e(x) = \frac{1}{2} C(x) V^2 > 0 \\ U_{gh}(x) = - C(x) V^2 \end{cases}$$

$$U^{TOT}(x) = - \frac{1}{2} C(x) V^2$$

scende con x : F nella dir. x

$$F = - \frac{\partial U^{TOT}}{\partial x} = \frac{\pi K \epsilon_0 V^2}{\log D/d}$$

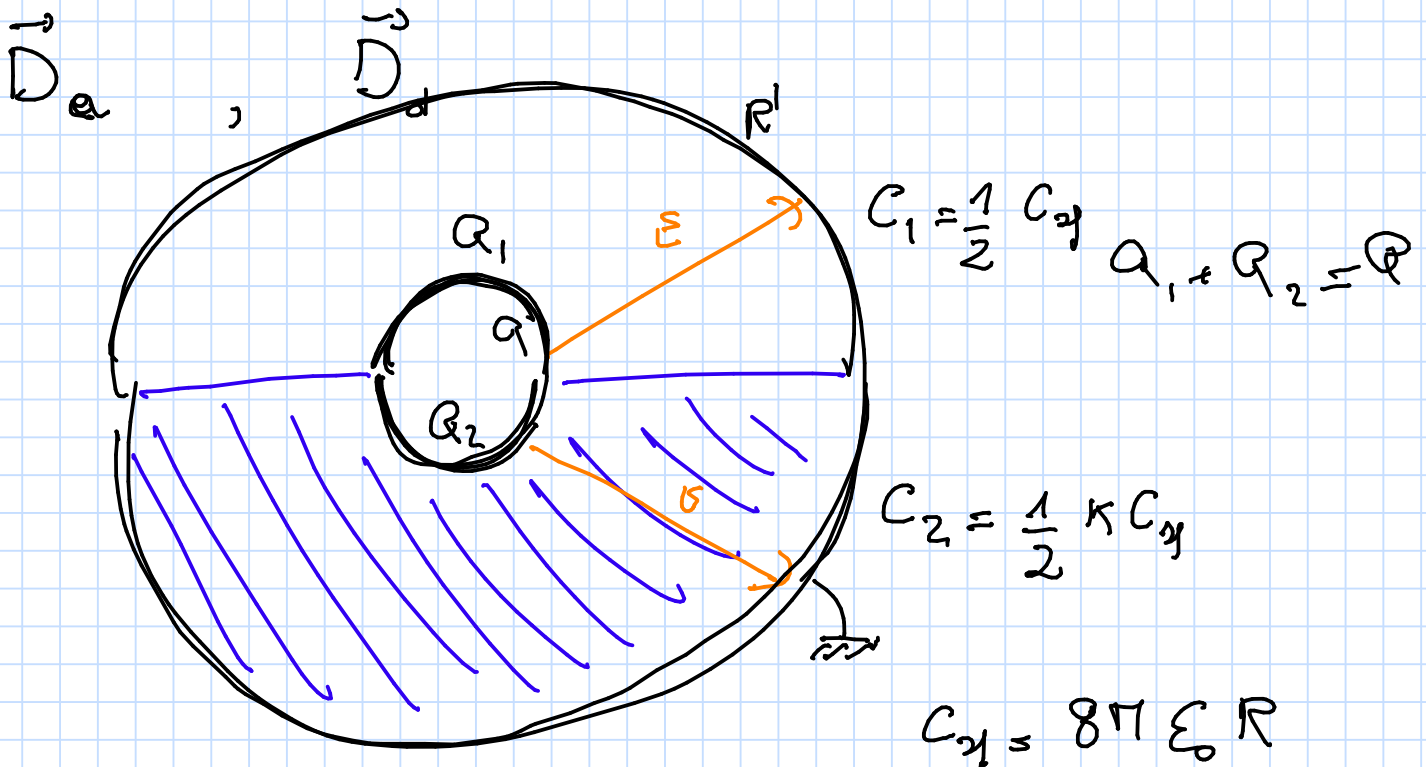
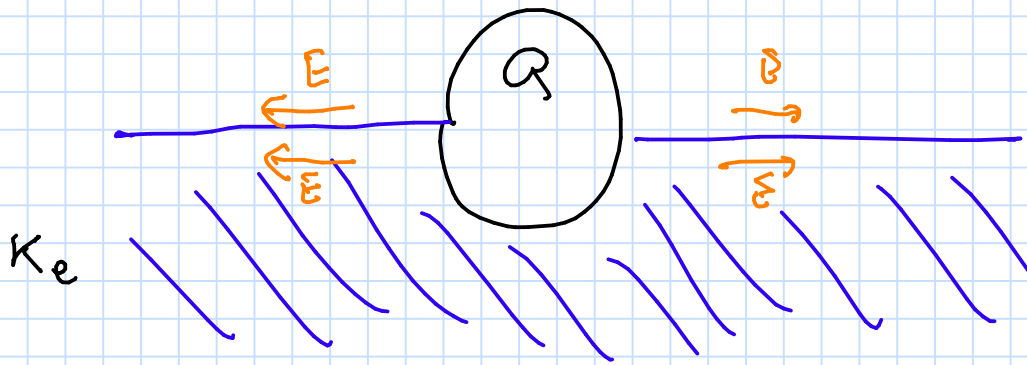
$$\left. \begin{array}{l} \text{equilibrio } F = K \Delta x \\ \Delta x = \frac{1}{K} F = 9.8 \text{ cm} \end{array} \right\}$$

Problema "0"

ϵ_0 and $R = 4.5 \text{ cm}$
 $Q = 8.2 \cdot 10^{-7} \text{ C}$

aria

$k_e = 5.5$



C_1 e C_2 in parallel monobus $R' \rightarrow \infty$

$Q_1 = C_1 V$

$Q_2 = C_2 V$

$Q_1 + Q_2 = Q$

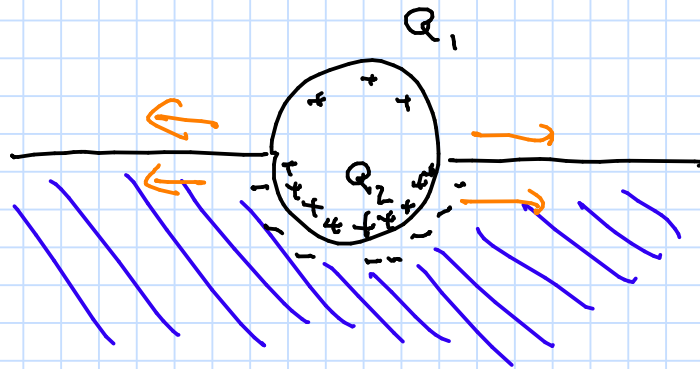
$\Rightarrow Q_1 = \frac{C_1}{C_1 + C_2} Q = \frac{1}{k_e + 1} Q$

$Q_2 = \frac{C_2}{C_1 + C_2} Q = \frac{k_e}{k_e + 1} Q$

Q_1 e Q_2 sono cariche libere
 $\Rightarrow$ generano $\vec{D}_1$ e $\vec{D}_2$, risp.

Gauss: $\vec{D}_1 = \frac{Q_1}{4 \pi r^2} \hat{r} = \frac{1}{2 + \pi r^2} \frac{Q}{k_e + 1} \hat{r}$

$$\vec{D}_d = \frac{Q_2}{\Sigma} = \frac{1}{2\pi r^2} \frac{\kappa_e}{\kappa_e - 1} Q$$



$$c) \quad \sigma_{ea} = \frac{Q_1}{2\pi R^2} = \frac{1}{2\pi R^2} \frac{Q}{1 + \kappa_e}$$

$$\sigma_{ed} = \frac{Q_2}{2\pi R^2} = \frac{1}{2\pi R^2} \frac{\kappa_e Q}{\kappa_e + 1}$$

$$d) \quad \sigma_p = \frac{\kappa_e - 1}{\kappa_e} \sigma_{ed}$$

$$\sigma_p + \sigma_{ed} = \sigma_{ea} \Rightarrow \text{stesso } \vec{E}_0 \text{ in aria e diel.}$$

Van de Graaf

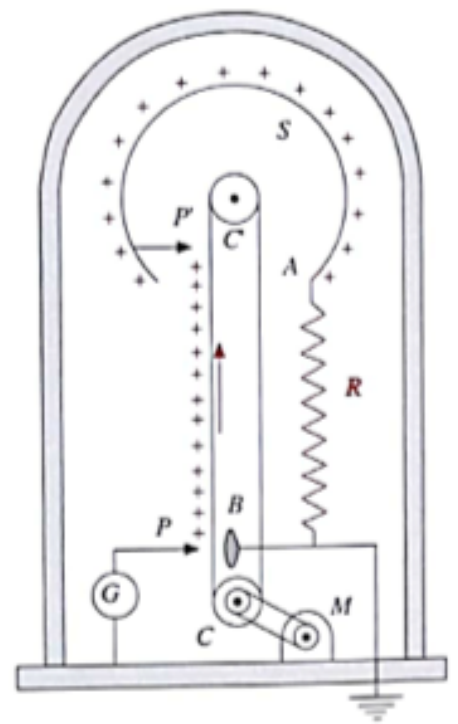


Figura 6.35