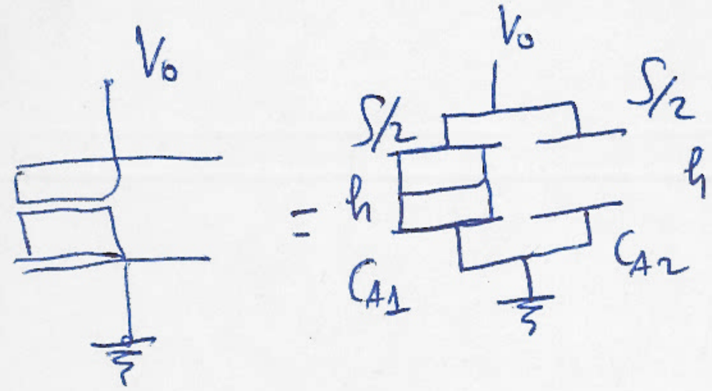
$C_0 = \varepsilon_0 \frac{S}{h}$ 02-07-2020 P. 1

1)

C_A



$C_A = C_{A1} + C_{A2}$

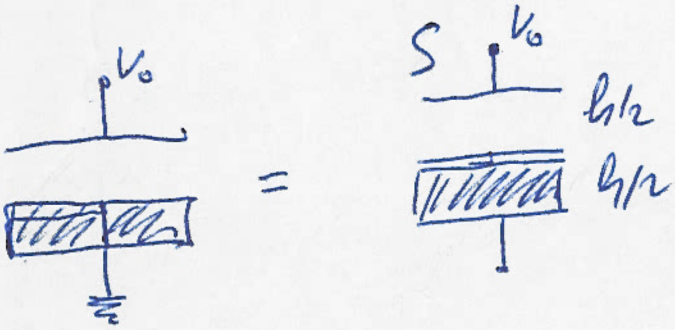
$C_{A_1} = \varepsilon_0 k \frac{S}{2h}$

$C_{A_2} = \varepsilon_0 \frac{S}{2h}$

$$C_A = \varepsilon_0 k \frac{S}{2h} + \varepsilon_0 \frac{S}{2h} = \frac{\varepsilon_0 S}{2h}(1+k) = \frac{1}{2} C_0 (1+k)$$

$$U_A = \frac{1}{2} C_A V_0^2 = \frac{1}{2} \frac{\varepsilon_0 S}{2h}(1+k) V_0^2 \qquad Q_A = C_A V_0$$

C_B



$$C_B = \frac{1}{\frac{1}{C_{B_1}} + \frac{1}{C_{B_2}}}$$

$$C_{B_1} = \frac{\varepsilon_0 S 2}{h} \qquad C_{B_2} = \frac{\varepsilon_0 k S 2}{h} \qquad C_B = \frac{1}{\frac{h}{\varepsilon_0 S 2} + \frac{h}{\varepsilon_0 k S 2}}$$

$$C_B = \frac{\varepsilon_0 k S 2}{k h + h} = \frac{\varepsilon_0 k S 2}{(1+k) h} = \frac{2k C_0}{(1+k)} \qquad U_B = \frac{1}{2} C_B V_0^2 = \frac{1}{2} \frac{\varepsilon_0 k S 2}{(1+k) h} V_0^2$$

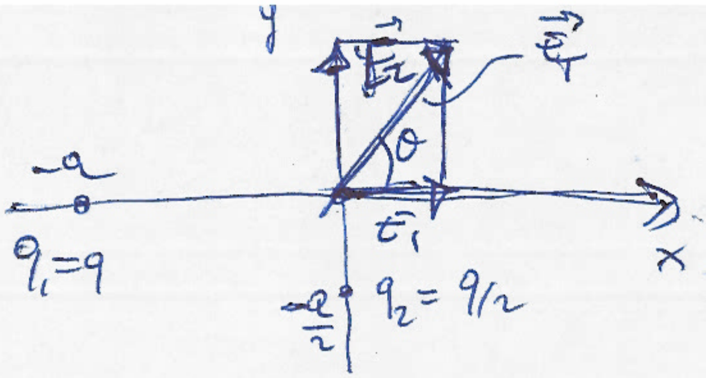
$$Q_B = C_B V_0$$

$$\Delta U = U_B - U_A = \frac{1}{2} V_0^2 \left[\frac{\varepsilon_0 k 2 S}{(1+k) h} - \frac{\varepsilon_0 S}{2h}(1+k)\right] = \frac{1}{2} V_0^2 \frac{\varepsilon_0 S}{h}\left[\frac{2k}{(1+k)} - \frac{(1+k)}{2}\right]$$

$$\Delta U = \frac{1}{2} V_0^2 (C_B - C_A)$$

$$\mathcal{E}_{gen} = V_0 (Q_B - Q_A) = V_0^2 (C_B - C_A) = 2 \Delta U$$

2)



$$\vec{E}_1 = \hat{x}\,\frac{q}{4\pi\varepsilon a^2}; \quad \vec{E}_2 = \hat{y}\,\frac{q}{2}\,\frac{1}{4\pi\varepsilon_0}\,\frac{4}{a^2} = \hat{y}\,2\,\frac{q}{4\pi\varepsilon a^2}$$

$$|E_2| = 2|E_1| \qquad \vec{E}_T = \vec{E}_1 + \vec{E}_2 \qquad E_T = \sqrt{E_1^2 + E_2^2}$$

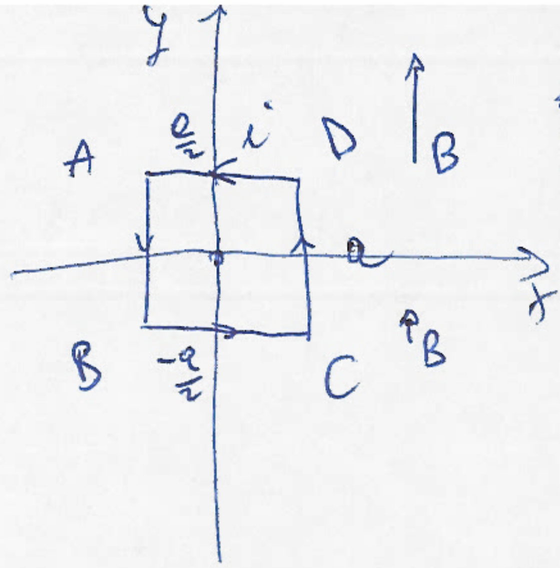
$$E_T = \sqrt{E_1^2 + 4E_1^2} = E_1\sqrt{5} = 2\sqrt{5}\,\frac{q}{4\pi\varepsilon a^2}$$

$$\theta = \operatorname{arctg}\frac{E_2}{E_1} = \operatorname{arctg} 2 \simeq 63^\circ$$

il dipolo forma l'angolo θ all'equilibrio $\vec{p} \parallel \vec{E}_T$

$$U_e = -\vec{p}\cdot\vec{E}_T = -p\,E_T\cos(0^\circ) = -p\,E_T$$

Es 3)



$\vec{B} = \hat{y}\, B_0\left(1 + \frac{y}{a}\right)$

$$\vec{F}_{AB} = i \int_A^B \underbrace{d\vec{l} \times \vec{B}}_{\text{sono paralleli}} = 0$$

$$\vec{F}_{CD} = i \int_C^D \underbrace{d\vec{l} \times \vec{B}}_{\text{sono paralleli}} = 0$$

$$\vec{F}_{BC} = \hat{z}\, i \int_B^C d\vec{l} \times \vec{B} = \hat{z}\, i \int_B^C dl \cdot \underbrace{\operatorname{sen} 90°}_{1} \cdot \underbrace{B_0\left(1 - \frac{a}{2a}\right)}_{\frac{B_0}{2}}$$

$$= \hat{z}\, i\, a\, \frac{B_0}{2}$$

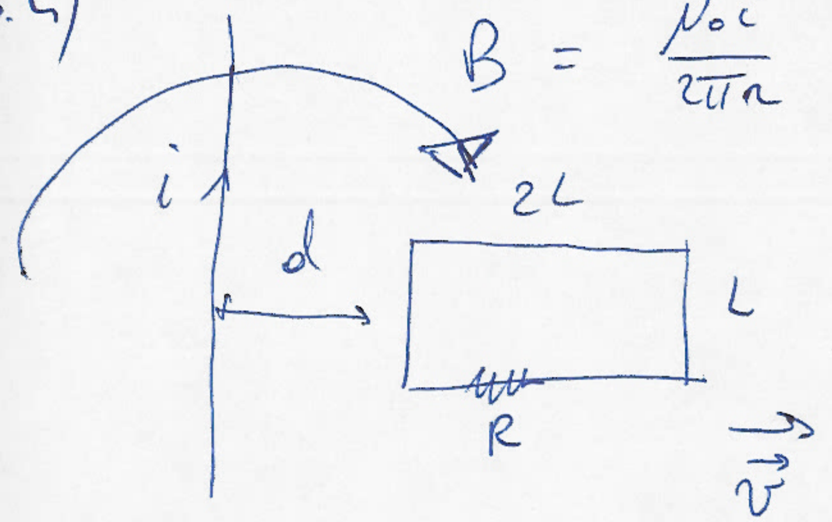
$$\vec{F}_{DA} = -\hat{z}\, i \int_D^A dl\, \operatorname{sen}(90°)\, B_0\left(1 + \frac{a}{2a}\right)$$

$$= -\hat{z}\, i\, a\, \frac{3}{2} B_0$$

$$\vec{F}_T = \vec{F}_{AB} + \vec{F}_{BC} + \vec{F}_{CD} + \vec{F}_{DA} = -\hat{z}\,(i\, a\, B_0)$$

es. 4) P.4

$$B = \frac{\mu_0 i}{2\pi r}$$



$\hat{n}_{spira} = \hat{z}$

$$\phi(\vec{B}) = -L \int_{d(t)}^{d(t)+2L} B\, dr = -L \int_{d(t)}^{d(t)+2L} \frac{\mu_0 i}{2\pi} \frac{dr}{r}$$

$$\phi(B) = -\frac{\mu_0 i L}{2\pi} \ln \frac{d(t)+2L}{d(t)} \qquad \boxed{d(t) = d_0 + vt}$$

$$fem = -\frac{d\phi}{dt} = \frac{\mu_0 i L}{2\pi} \frac{d}{dt} \ln\left(\frac{d(t)+2L}{d(t)}\right) =$$

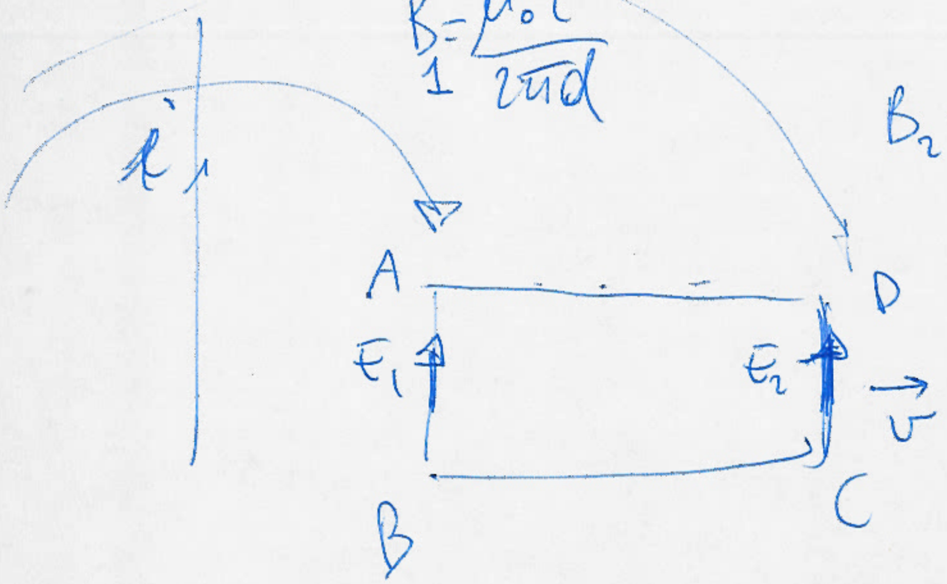
$$= \frac{\mu_0 i L}{2\pi} \frac{1}{\frac{d(t)+2L}{d(t)}} \cdot \frac{d}{dt}\left(\frac{d(t)+2L}{d(t)}\right) =$$

$$= \frac{\mu_0 i L}{2\pi} \frac{d}{(d+2L)} \cdot \left[\frac{d d(t)}{dt} \cdot \frac{1}{d} + (d+2L) \cdot (-1)\, d^{-2} \cdot \frac{d d(t)}{dt}\right] =$$

$$= \frac{\mu_0 i d L}{2\pi (d+2L)} \cdot \left[\frac{v}{d} - \frac{(d+2L)}{d^2} \cdot v\right]$$

$$i_s = \frac{fem}{R} = \frac{\mu_0 i d L}{2\pi R (d+2L)} \frac{v}{d} \left[1 - \frac{(d+2L)}{d}\right]$$

il flusso diminuisce ed è diretto $-\hat{z}$ per cui i_s lo tende ad aumentare verso i_s = orario oppure



$$B_1 = \frac{\mu_0 i}{2\pi d}$$

$$B_2 = \frac{\mu_0 i}{2\pi(d+2L)}$$

$$fem = \oint \vec{E}\cdot d\vec{l} = \int_A^B \vec{E}_1\cdot dl + \cancel{\int_B^C \vec{E}_l\cdot dl} + \int_C^D \vec{E}_2\cdot d\vec{l} + \cancel{\int_D^A \vec{E}_l\cdot dl} \text{ si annullano}$$

$$E_1 = \vec{v}\times\vec{B}_1 \qquad E_2 = \vec{v}\times\vec{B}_2$$

$$fem = v\frac{\mu_0 i L}{2\pi d} - \frac{v\mu_0 i L}{2\pi(d+2L)} = \frac{v\mu_0 i L}{2\pi}\left(\frac{1}{d} - \frac{1}{d+2L}\right)$$

$$i_s = \frac{fem}{R} = \frac{\mu_0 i L}{2\pi R}\left(\frac{1}{d} - \frac{1}{d+2L}\right) = \frac{\mu_0 i L}{2\pi R}\,\frac{-2L}{d(d+2L)}$$