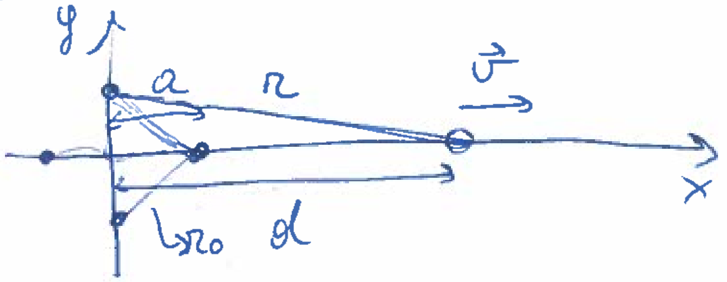



PER SIMMETRIA LA CARICA SI MUOVE LUNGO X POSITIVE

$$r = \sqrt{a^2+d^2} \qquad r_0 = \sqrt{a^2+a^2} = a\sqrt{2}$$

$$T_f + U_f = T_i + U_i$$

$$\frac{1}{2} m v_f^2 + qV_f = \underbrace{\cancel{\frac{1}{2} m v_i^2}}_{=0} + qV_i$$

$$\frac{1}{2} m v_f^2 = -q\left(V_f - V_i\right) \rightarrow v_F = \sqrt{\frac{-2q}{m}\left(V_f - V_i\right)}$$

$$V_i = \frac{q}{4\pi\varepsilon}\frac{1}{r_0} + \frac{q}{4\pi\varepsilon}\frac{1}{r_0} + \frac{q}{4\pi\varepsilon}\frac{1}{2a} = \frac{q}{4\pi\varepsilon_0}\left(\frac{2}{r_0} + \frac{1}{2a}\right)$$

$$V_f = \frac{q}{4\pi\varepsilon}\frac{1}{r} + \frac{q}{4\pi\varepsilon}\frac{1}{r} + \frac{q}{4\pi\varepsilon}\frac{1}{(a+d)} = \frac{q}{4\pi\varepsilon}\left(\frac{2}{r} + \frac{1}{a+d}\right)$$

$$V_f - V_i = \frac{q}{4\pi\varepsilon}\left(\frac{2}{r} + \frac{1}{a+d} - \frac{2}{r_0} - \frac{1}{2a}\right)$$

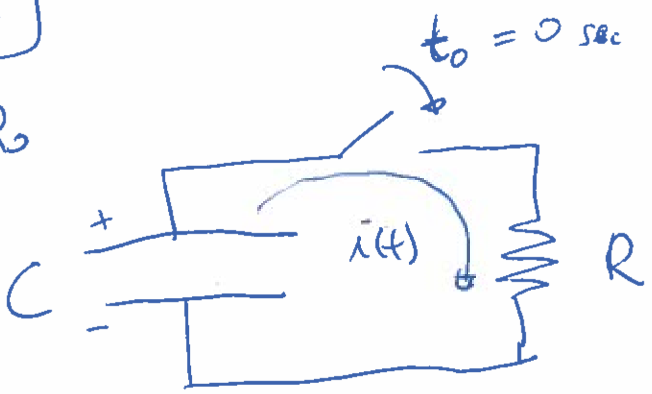
$$v_F = \sqrt{-\frac{2q^2}{4\pi\varepsilon m}\left(\frac{2}{r} + \frac{1}{a+d} - \frac{2}{r_0} - \frac{1}{2a}\right)}$$

$$v_F = \sqrt{\frac{2q^2}{4\pi\varepsilon m}\left(\frac{2}{a\sqrt{2}} + \frac{1}{2a} - \frac{2}{\sqrt{a^2+d^2}} - \frac{1}{d+a}\right)}$$

ES. 2



$Q_i = Q_0$




$V_0 = \frac{Q_0}{C}$

$$i(t) = \frac{V_0}{R} e^{-\frac{t}{\tau}} \qquad \tau = RC$$

$$i(t) = \frac{Q_0}{RC} e^{-\frac{t}{RC}} \qquad P(t) = i^2(t) R$$

$$U = V_{t_1 \to t_2} = \int_{t_1}^{t_2} i^2(t) R\, dt = \int_{t_1}^{t_2} \left(\frac{Q_0}{RC}\right)^2 R\, e^{-\frac{2t}{RC}} dt =$$

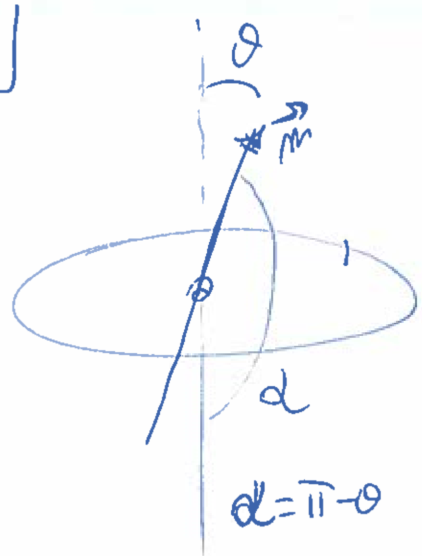
$$= \frac{Q_0^2 \cancel{R}}{R^{\cancel{2}} C^2} \int_{t_1}^{t_2} e^{-\frac{2t}{RC}} dt = -\frac{Q_0^2}{\cancel{R}C^{\cancel{2}}} \frac{R\cancel{C}}{2} \left(e^{-\frac{2t_2}{RC}} - e^{-\frac{2t_1}{RC}}\right) =$$

$$= \frac{Q_0^2}{2C} \left(e^{-\frac{2t_1}{RC}} - e^{-\frac{2t_2}{RC}}\right) = U$$

$$Q_0 = \sqrt{\frac{2UC}{\left(e^{-\frac{2t_1}{RC}} - e^{-\frac{2t_2}{RC}}\right)}}$$

ES.3






$$L_{est} > 0$$

per cui

$$L_{est} = -L_{\text{del campo } B} = -L_B$$

$$L_B = -\Delta U_m \rightarrow L_{est} = \Delta U_m$$

all'equilibrio $\vec{m} \parallel \vec{B}$

$$\left(U_{m_{in}} = -\vec{m}\cdot\vec{B} = -mB\right)$$

$$L_{est} = U_{m_{fin}} - U_{m_{in}} =$$

$$L_{est} = \begin{cases} -mB\cos\theta + mB & \text{se } i_0 \text{ è antioraria} \\ \quad \text{oppure} \\ -mB\cos(\pi-\theta) + mB & \text{se } i_0 \text{ è oraria} \end{cases}$$

$$= \begin{cases} -mB\cos(10^\circ) + mB = mB\left(1-\cos(10^\circ)\right) > 0 & i_0 \text{ antior.} \\ -mB\cos(170^\circ) + mB = mB\left(1-\cos(170^\circ)\right) > 0 & i_0 \text{ or.} \end{cases}$$

VANNO BENE ENTRAMBE

$$B = \frac{\mu_0 i_0}{2R} \begin{cases} \rightarrow B^+ = \dfrac{\mu_0 i_0^+}{2R} & \text{(antior.)} \\ \rightarrow B^- = \dfrac{\mu_0 i_0^-}{2R} & \text{(orario)} \end{cases}$$

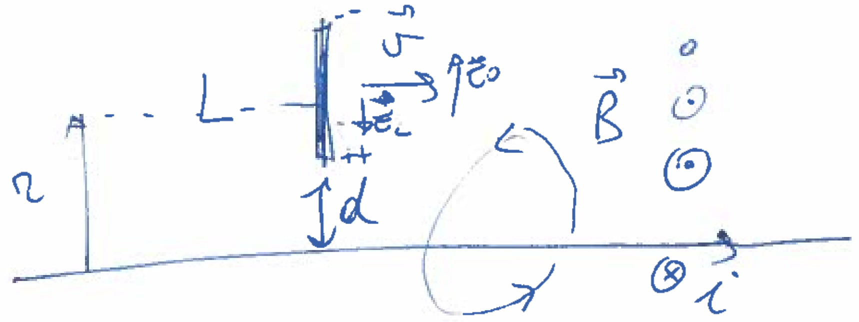
$i_0^+ = i_0$ ANTIORARIO : $L_{est} = m\dfrac{\mu_0 i_0^+}{2R}\left(1-\cos\theta\right) \rightarrow$

$$i_0^+ = \frac{2R\,L_{est}}{m\mu_0}\,\frac{1}{1-\cos\theta}$$

$i_0^- = i_0$ ORARIO : $L_{est} = \dfrac{m\mu_0 i_0^-}{2R}\left[1-\cos(\pi-\theta)\right]$

$$i_0^- = \frac{2R\,L_{est}}{m\mu_0}\,\frac{1}{1-\cos(\pi-\theta)}$$

$$T^+ = 2\pi\sqrt{\frac{I}{mB^+}} \qquad T^- = 2\pi\sqrt{\frac{I}{mB^-}}$$




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

$$\vec{F}_{Lorentz} = q\vec{v}\times B \qquad \vec{E}_L = \frac{\vec{F}}{q} = \vec{v}\times\vec{B}$$

$$E_L(r) = -v\cdot\frac{\mu_0 i}{2\pi r} \qquad E_L = -E_0$$

(ALL'EQUILIBRIO IL CAMPO DOVUTO A LORENTZ È EQUILIBRATO DA QUELLO ELETTROSTATICO)

$$\Delta V = -\int_d^{d+L} \vec{E}_0 \cdot d\vec{l}$$

$$\Delta V = +\int_d^{d+L} -\frac{v\mu_0 i}{2\pi r}\,dr = -\frac{v\mu_0 i}{2\pi}\int_d^{d+L}\frac{dr}{r} =$$

$$V(d+L)-V(d) = -\frac{\mu_0 v i}{2\pi}\ln\left(\frac{d+L}{d}\right) = \frac{\mu_0 v i}{2\pi}\ln\left(\frac{d}{d+L}\right) < 0$$