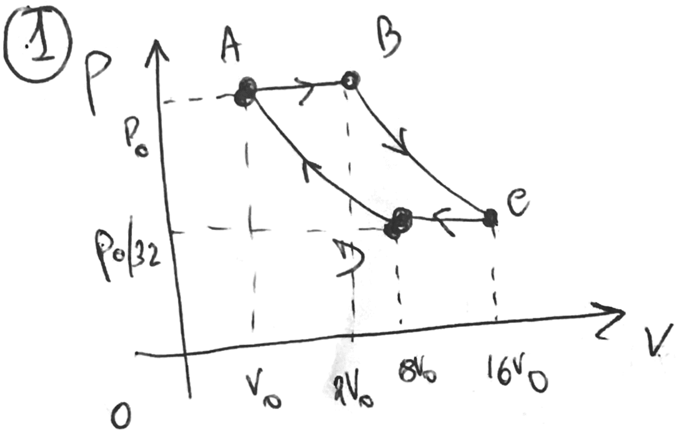
(1)



$$\eta = 1 - \frac{|Q_{CED}|}{|Q_{ASS}|} \; ; \; Q_{ASS} = n c_p (T_B - T_A)$$

$$Q_{CED} = n c_p (T_D - T_C)$$

$$Q_{ASS} = \cancel{n} c_p \left(\frac{2V_0 P_0}{\cancel{n}R} - \frac{P_0 V_0}{\cancel{n}R} \right) = c_p/R \, P_0 V_0 = \frac{5}{2} P_0 V_0$$

$$Q_{CED} = \cancel{n} c_p \left(\frac{\cancel{8}V_0 P_0}{\cancel{32}\cancel{n}R} - \frac{\cancel{16}V_0 P_0}{\cancel{n}R\,\cancel{32}} \right) = \frac{c_p}{R} P_0 V_0 \left(-\frac{1}{4}\right) = -\frac{5}{8} P_0 V_0$$

$$\eta = 1 - \frac{5/8\, P_0 V_0}{5/2\, P_0 V_0} = 1 - \frac{1}{4} = 3/4 \rightarrow 75\%$$

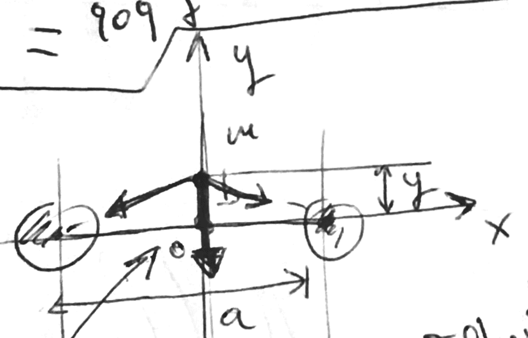
$$\Delta U_{BC} = n c_v (T_C - T_B) = \cancel{n} c_v \left(\frac{P_0 V_0}{2\cancel{n}R} - 2\frac{P_0 V_0}{\cancel{n}R} \right) = -\frac{3 c_v}{R} \frac{P_0 V_0}{2} =$$

$$= -\frac{9}{4} P_0 V_0 = -1818 \text{ J}$$

$$\Delta U_{DA} = n c_v (T_A - T_D) = n c_v \left(\frac{P_0 V_0}{nR} - \frac{P_0 V_0}{4 nR} \right) = \frac{c_v}{R} 3 \frac{P_0 V_0}{4} = \frac{9}{8} P_0 V_0$$

$$= 909 \text{ J}$$

(2)



$a = 2 \cdot 10^{-1}$ m ; $R = 5 \cdot 10^{-2}$ cm

$Q = 10^{-8}$ C ; $q = -10^{-6}$ C

$m = 10^{-5}$ Kg

forza risultante

$$-\frac{2}{4\pi\varepsilon_0} \frac{Q|q| \, y}{\left[\left(\frac{a}{2}\right)^2 + y^2\right]^{3/2}} = m\ddot{y}$$

$$\boxed{\ddot{y} + \frac{Q|q|}{2\pi\varepsilon_0 m} \frac{y}{\left[\left(\frac{a}{2}\right)^2 + y^2\right]^{3/2}} = 0}$$

Bei denti $y < a/2$

$$\frac{y}{\left[\left(\frac{a}{2}\right)^2 + y^2\right]^{3/2}} \simeq \frac{1}{(a/2)^3} y \quad \left(\text{PICCOLE OSCILLAZIONI}\right)$$

$$\boxed{\ddot{y} + \frac{Q|q|}{2\pi\varepsilon_0 m (a/2)^3}\, y = 0}$$

OSCILLATORE ARMONICO

$\omega_0^2 = \frac{4Q|q|}{\pi\varepsilon_0 m a^3}$

PULSAZIONE

PERIODO

$T = \frac{2\pi}{\omega_0} = 0{,}05$ sec

0,0468 sec

$L = -(U_f - U_i) = -q(V_f - V_i) =$

lavoro = − variazione energia potenziale

~~perchè nella posizione di equilibrio~~

$$= -q\left(\frac{1}{4\pi\varepsilon_0}\frac{2Q}{\sqrt{\left(\frac{a}{2}\right)^2}} - \frac{1}{4\pi\varepsilon_0}\frac{2Q}{\sqrt{\left(\frac{a}{2}\right)^2 + y^2}}\right); \quad T = \frac{\cancel{2}\pi}{\cancel{2}\sqrt{\frac{Q|q|}{\pi\varepsilon_0 m a^3}}}$$

$$= -\frac{\cancel{2}qQ}{\cancel{4}\pi\varepsilon_0}\left(\frac{1}{a/2} - \frac{1}{\sqrt{(a/2)^2 + y^2}}\right)$$

2

il lavoro è positivo!!

$$L = -\frac{qQ}{2\pi\varepsilon_0}\left(\frac{1}{a/2} - \frac{1}{\sqrt{(a/2)^2 + y^2}}\right) = 0{,}000035 \text{ J}$$

$\simeq 3{,}5 \cdot 10^{-5}$ J

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(3) $I(t) = I_0 e^{-t/\tau}$ $\quad \tau = RC$ $\quad I_0 = \frac{V_0}{R} = \frac{Q_0}{CR} = \frac{Q_0}{\tau}$

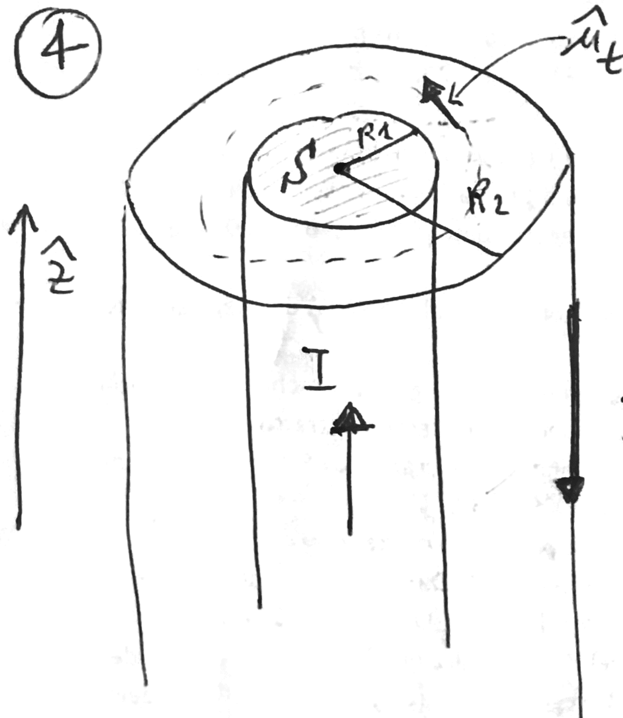
$I(t) = \frac{Q_0}{RC} e^{-t/RC}$

$I(0) = \frac{Q_0}{RC} = 1{,}3 \cdot 10^{-5}$ A; $I(1\,\text{sec}) = \frac{Q_0}{RC} e^{-\frac{1\,\text{sec}}{RC}} = 2{,}16 \cdot 10^{-11}$ A

$\mathcal{E}_{din} = \frac{1}{2}\frac{Q_0^2}{C} = 10^{+4}$ J

energia inizialmente immagazzinata nel condensatore..

④



$$r > R_2 \Rightarrow \vec{B} = 0$$

$$R_1 < r < R_2 \Rightarrow \vec{B} = \frac{\mu_0}{2\pi}\frac{I}{r}\hat{u}_t$$

$$I \quad 0 < r < R_1$$

$$I = \int_{S'} \vec{J} \cdot d\vec{S}$$

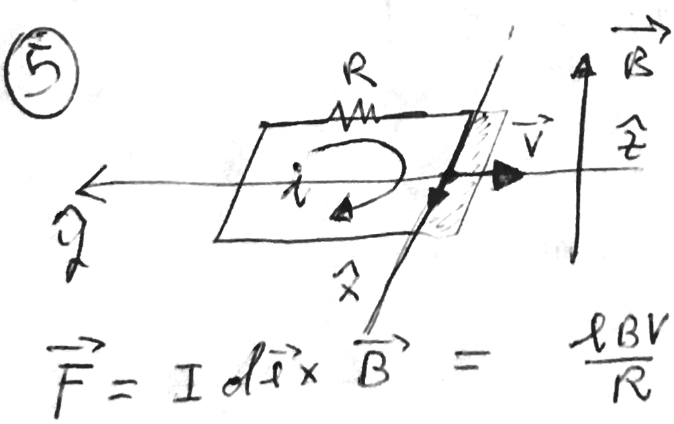
$$I = \int_{S'} A e^{-k\rho^2} \rho\, d\rho\, d\theta = 2\pi A \int_0^R e^{-k\rho^2} \rho\, d\rho = \cancel{2}\pi A \frac{e^{-kR^2} - 1}{-\cancel{2}k}$$

$$\Rightarrow A = \frac{kI}{\pi(1 - e^{-kR^2})} \quad ; \quad I(r) = \frac{I}{1 - e^{-kR^2}}\left(1 - e^{-kr^2}\right)$$

$$2\pi r |\vec{B}| = \mu_0 I(r) \qquad \boxed{|\vec{B}| = \frac{\mu_0}{2\pi}\frac{I}{1 - e^{-kR^2}}\frac{1 - e^{-kr^2}}{r}}$$

$$|\vec{B}|(r = 2\,\text{cm}) = 8 \cdot 10^{-6}\ T.$$

⑤



$$i = -\frac{1}{R}\frac{d\Phi(\vec{B})}{dt} = -\frac{1}{R}\, l B |\vec{v}|$$

$$|i| = \frac{lBv}{R} = 5 \cdot 10^{-9}\ A$$

$$\vec{F} = I\, d\vec{l} \times \vec{B} = \frac{lBv}{R}\, l\hat{x} \times B\hat{z} = \frac{l^2 B^2 v}{R}\hat{y}$$

la forza si oppone all'avanzata del circuito.

$$|\vec{F}| = \frac{l^2 B^2 v}{R} = 2{,}5 \cdot 10^{-13}\ N.$$