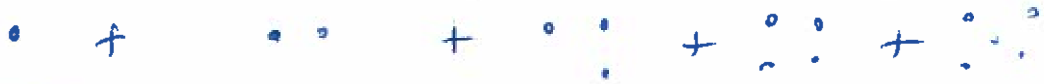
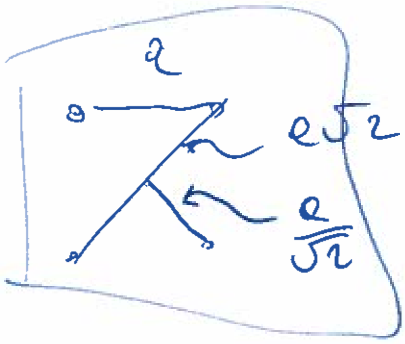
1) $$E_n = 0 + \frac{qq}{4\pi\varepsilon a} + \left(\frac{qq}{4\pi\varepsilon_0 a} + \frac{qq}{4\pi\varepsilon a\sqrt{2}}\right) +$$

$$+\left(2\frac{qq}{4\pi\varepsilon a} + \frac{qq}{4\pi\varepsilon a\sqrt{2}}\right) + 4\,\frac{\left(\frac{q}{2}\right) q\,\sqrt{2}}{4\pi\varepsilon a}$$






$$E_n = \frac{qq}{4\pi\varepsilon}\left(\frac{4}{a} + \frac{2}{a\sqrt{2}} + \frac{4\sqrt{2}}{2a}\right) =$$

$$= \frac{q^2}{4\pi\varepsilon}\left(\frac{4}{a} + \frac{6\sqrt{2}}{2a}\right) = \frac{q^2}{4\pi\varepsilon a}\left(4+3\sqrt{2}\right)$$

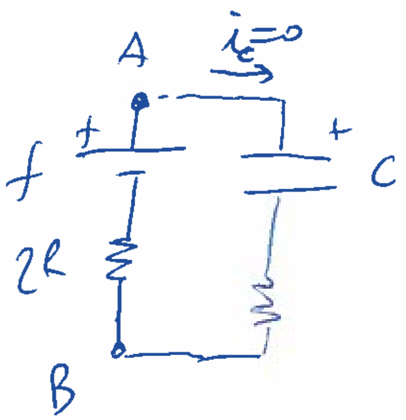
$$V(P) = 4\,\frac{q\,\sqrt{2}}{4\pi\varepsilon a}$$ (rispetto a ∞)

$$U_p(P) = \frac{q}{2}\,\frac{4q}{4\pi\varepsilon}\,\frac{\sqrt{2}}{a}$$

$$\frac{1}{2} m v_f^2 = U_p(P) = \frac{q^2\,\sqrt{2}}{2\pi\varepsilon a}$$

$$v_f = \sqrt{\frac{q^2\sqrt{2}}{m\pi\varepsilon a}}$$

2) caso A

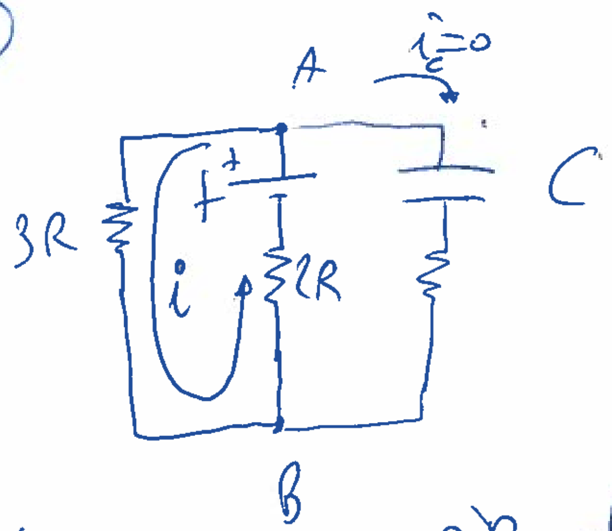



$i_c = 0$

$C = \frac{q}{V_C}$

$V_{C_0} = f \qquad q_0 = Cf \qquad U_e = \frac{1}{2} C f^2$

caso B




$i_c = 0$

$i = \frac{f}{5R}$

$$\Delta V_C = V_{AB} = 3R\,i = 3R \cdot \frac{f}{5R} = \frac{3}{5} f$$

oppure

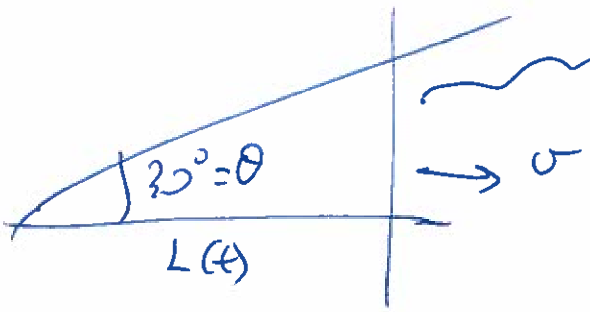
$$= f - 2Ri = f - 2R\frac{f}{5R} = \frac{5f - 2f}{5} = \frac{3}{5} f$$

$$q_{FIN} = C V_c = C \frac{3}{5} f \qquad U_{eFIN} = \frac{1}{2} C V_c^2 = \frac{1}{2} C \left(\frac{3}{5}\right)^2 f^2$$

$$\Delta U_e = U_{eFIN} - U_e = \frac{1}{2} C f^2 \left(\frac{3}{5}\right)^2 - \frac{1}{2} C f^2 = \frac{1}{2} C f^2 \left(\frac{9}{25} - 1\right) =$$

$$= \frac{1}{2} C f^2 \left(-\frac{16}{25}\right) = -\frac{1}{2} C f^2 \left(\frac{4}{5}\right)^2$$

3)




$y(t) = tg\theta \, L(t)$

$i = \dfrac{f_{em}}{R}$ $\qquad f_{em} = -\dfrac{d}{dt}\phi(\vec{B})$

antioraria ↺

$$\phi(B) = \frac{1}{2} B L(t) \, y(t) = \frac{1}{2} B L(t) L(t) \, tg\theta$$
$$= \frac{1}{2} B L^2(t) \, tg\theta$$

$$\frac{d}{dt}\phi(B) = \frac{1}{2} B \, tg\theta \, 2 L(t) \overbrace{\frac{dL(t)}{dt}}^{v} = \frac{1}{\cancel{2}} B \, tg\theta \, \cancel{2} v L(t)$$

$$f_{em} = - v B \, tg\theta \, L(t)$$

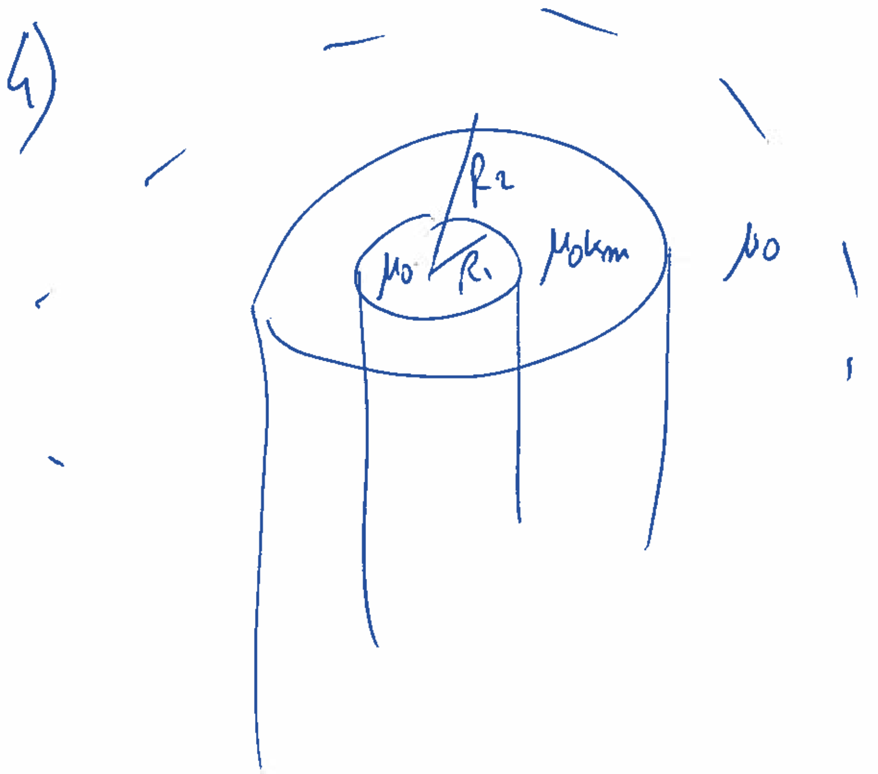
$$i(t) = -\frac{1}{R} \frac{1}{\cancel{2}} B \, tg\theta \, \cancel{2} v L(t)$$

$$i \,@\, L = -\frac{B \, tg\theta \, \cancel{2} v L}{\cancel{2} R}$$

$$i \,@\, 2L = -\frac{B \, tg\theta \, \cancel{2} v \, 2L}{\cancel{2} R}$$

oppure $f_{em} = \oint \vec{E} \cdot dl = \int_0^{tg\theta L} \vec{v} \times \vec{B} \, dl = - v B \, tg\theta \, L(t)$

4)




$$j = \frac{I}{\pi R_1^2}$$

uso AMPERE per H

$$\oint \vec{H} \cdot d\vec{l} = i_{conc}$$

per $0 < r < R_1$ $\quad 2\pi \cancel{r} H(r) = \frac{I}{\cancel{\pi} R_1^2} \cdot \cancel{\pi} r^{\cancel{2}}$

$$H(r) = \frac{I}{2\pi R_1^2} \cdot r$$

per $R_1 < r < R_2$ $\quad 2\pi r H(r) = I$

$$H(r) = \frac{I}{2\pi r}$$

per $r > R_2$ $\quad 2\pi r H(r) = I$

$$H(r) = \frac{I}{2\pi r}$$

$B = \mu_0 H$ for $0 < r < R_1$ $\qquad M = 0 \cdot H = 0$

$B = \mu_0 \kappa_m H$ for $R_1 < r < R_2$ $\qquad M = \chi_m H = (\kappa_m - 1) H$

$B = \mu_0 H$ for $r > R_2$ $\qquad M = 0 \cdot H = 0$