(1) $\boxed{r \leq R}$ $E_1(r) = 0$

$\boxed{R \leq r \leq 3R}$ $\cancel{4\pi} r^2 E_2(r) = \frac{\rho}{\varepsilon_0}\left(\frac{\cancel{4}}{3}\cancel{\pi} r^3 - \frac{\cancel{4}}{3}\cancel{\pi} R^3\right)$

$$E_2(r) = \frac{\rho}{3\varepsilon_0}\left(r - \frac{R^3}{r^2}\right)$$

$\boxed{r \geq 3R}$ $\cancel{4\pi} r^2 E_3(r) = \frac{\rho}{\varepsilon_0}\left(\frac{\cancel{4}}{3}\cancel{\pi}(3R)^3 - \frac{\cancel{4}}{3}\cancel{\pi} R^3\right)$

$$E_3(r) = \frac{\rho}{3\varepsilon_0}\, 26 R^3 \frac{1}{r^2}$$

$V(\infty) = 0$

$\boxed{r \geq 3R}$ $\boxed{V(3R) = \frac{26}{9}\frac{\rho}{\varepsilon_0} R^2}$

$$V(r) - \cancel{V(\infty)} = \int_r^\infty E_3(r)\,dr = \frac{26}{3}\cdot\frac{\rho}{\varepsilon_0} R^3 \frac{1}{r}$$

$$V(R) - V(3R) = \int_R^{3R} E_2(r)\,dr = \frac{\rho}{3\varepsilon_0}\left[\left.\frac{r^2}{2}\right|_R^{3R} + \left.R^3 \frac{1}{r}\right|_R^{3R}\right]$$

$$V(R) - V(3R) = \frac{\rho}{3\varepsilon_0} R^2\left(\frac{9}{2} - \frac{1}{2} + \frac{1}{3} - 1\right)$$

$$V(R) = \frac{\rho R^2}{3\varepsilon_0}\left(\frac{26}{3} + \frac{9}{2} - \frac{1}{2} + \frac{1}{3} - 1\right) = \frac{4\rho R^2}{\varepsilon_0}$$

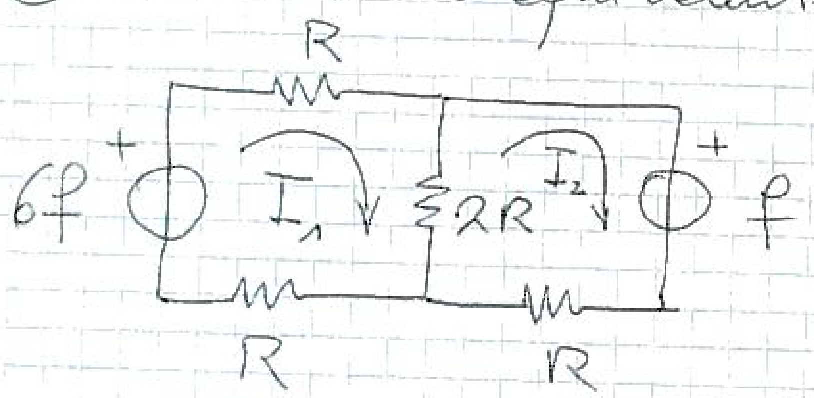
(2) $\vec{M} = (\mu_r - 1)\vec{H} \Rightarrow \mu_r = 1 + \frac{M}{H}$

Teo. delle Circuitazione $\oint \vec{H}\cdot d\vec{l} = Ni$

$$H\, 2\pi R = NI \Rightarrow H = \frac{NI}{2\pi R}$$

$$\mu_r = 1 + \frac{2\pi M R}{NI} \cong 5000$$

③ Il circuito equivalente a regime è:



$$\begin{cases} 6f = 4RI_1 - 2RI_2 \\ -f = -2RI_1 + 3RI_2 \end{cases}$$

$$\begin{cases} \frac{3f}{R} = 2I_1 - I_2 \\ \frac{f}{R} = 2I_1 - 3I_2 \end{cases}$$

$\Rightarrow 2I_1 - I_2 = 6I_1 - 9I_2$

$\Rightarrow I_1 = 2I_2$

$\Rightarrow \boxed{I_2 = \frac{f}{R}}$ e $\boxed{I_1 = \frac{2f}{R}}$

$$W_1 = 6f \cdot 2\frac{f}{R} = 12\frac{f^2}{R}$$

$$W_2 = -f\,\frac{f}{R} = -\frac{f^2}{R}$$

(4) Una carica q sulla barretta è soggetta alla forza di Lorentz, diretta lungo la barretta stessa:

$$F = qvB$$

a cui corrisponde un campo elettrico:

$$E = vB = \omega r B$$

$\Rightarrow$ sulla barretta si induce una f.e.m.:

$$f_i = \int_{\text{barretta}} \vec{E}\cdot d\vec{l} = \int_0^{\ell} \omega r B\, dr = \frac{\omega B \ell^2}{2}$$

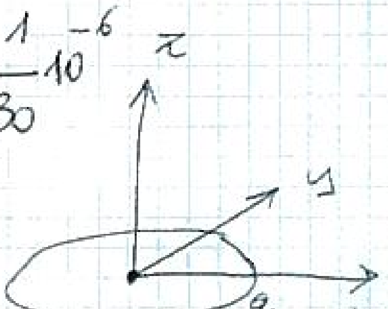
$$f_i = \frac{\cancel{100 \cdot 2 \cdot 10^{-2}}}{\cancel{2}}\ V = 1\ V$$

Per la legge di Ohm:

$$I = \frac{f_i}{r+R} = \frac{1}{1+9}\ A = 0{,}1\ A$$

(5)

$$\frac{a}{\lambda} = \frac{a\nu}{c} = \frac{0{,}1 \cdot 1\,08\ \cancel{m/s}}{300 \cdot 10^6\ \cancel{m/s}} = \frac{1}{30}10^{-6}$$



$\omega = 2\pi\nu$; $k = \frac{2\pi\nu}{c}$;

$$-\frac{d\Phi}{dt} = -\frac{dB_z}{dt}\cdot\pi a^2 = R\, I(t)$$

$$\Rightarrow \frac{dB_z}{dt} = -\frac{RI_0}{\pi a^2}\sin(\omega t) \Rightarrow B_z(t) = \frac{RI_0}{\pi a^2 \omega}\cos(\omega t)$$

$\vec{B} = \hat{z} B_z$ $B_z = \frac{RI_0}{\dots}\cos(kx-\omega t)$; $\vec{E} = \hat{y}\frac{cRI_0}{\pi a^2 \dots}\cos(kx-\omega t$