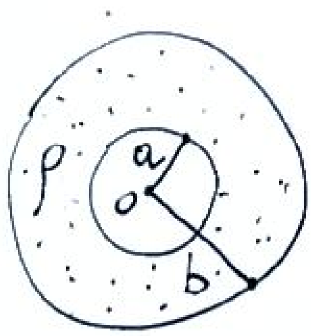
Soluzioni:

1.



$$V(0)-V(A)=\cancel{\int_0^a \vec{E}_0^{INT}\cdot d\vec{l}}^{\,=0}+\int_a^b \vec{E}\cdot d\vec{l}+\int_b^{2b}\vec{E}_0^{EST}\cdot d\vec{l}$$

$$V(0)-V(A)=\int_a^b E(r)\,dr+\int_b^{2b} E_0^{EST}(r)\,dr$$

$a<r<b$ (teorema di Gauss)

$$E(r)\,4\pi r^2=\frac{Q^{INT}(r)}{\varepsilon_0}$$

$$Q^{INT}(r)=\int_a^r \rho(r')\,4\pi r'^2\,dr'=4\pi K(r-a)$$

$$Q_{TOT}=4\pi K(b-a)$$

$$E(r)=\frac{K(r-a)}{\varepsilon_0 r^2}$$

$r>b$

$$E_0^{EST}(r)=\frac{K(b-a)}{\varepsilon_0 r^2}$$

$$V(0)-V(A)=\int_a^b \frac{K(r-a)}{\varepsilon_0 r^2}\,dr+\int_b^{2b}\frac{K(b-a)}{\varepsilon_0 r^2}\,dr=$$

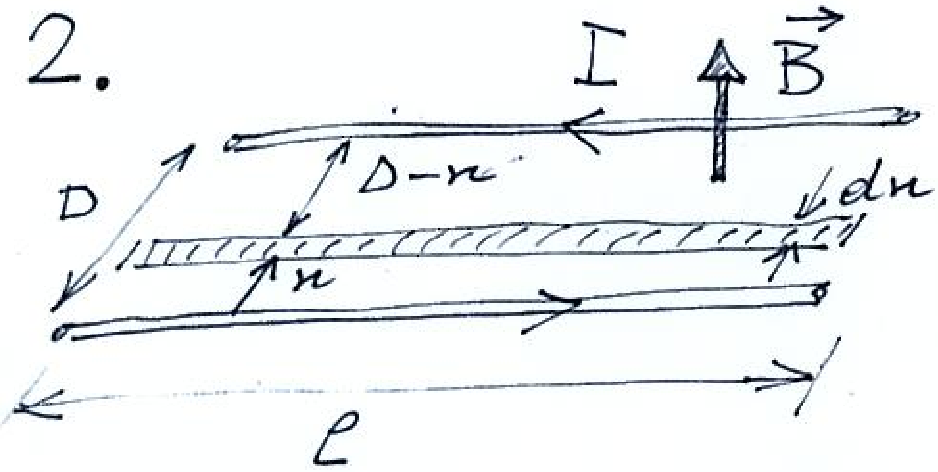
$$=\frac{K}{\varepsilon_0}\left[\int_a^b \frac{1}{r}\,dr-a\int_a^b\frac{1}{r^2}\,dr+(b-a)\int_b^{2b}\frac{1}{r^2}\,dr\right]=$$

$$= \frac{K}{\varepsilon_0}\left[\ln\left(\frac{b}{a}\right) - a\left(\frac{1}{a} - \frac{1}{b}\right) + (b-a)\left(\frac{1}{b} - \frac{1}{2b}\right)\right] =$$

$$= \frac{K}{\varepsilon_0}\left[\ln\left(\frac{b}{a}\right) \cancel{-1} \cancel{+\frac{a}{b}} \cancel{+1} - \frac{1}{2} \cancel{-\frac{a}{b}} + \frac{a}{2b}\right] =$$

$$= \frac{K}{\varepsilon_0}\left[\ln\left(\frac{b}{a}\right) + \frac{a}{2b} - \frac{1}{2}\right]$$

2.



$$B(x) = \frac{\mu_0 I}{2\pi x} + \frac{\mu_0 I}{2\pi(D-x)}$$

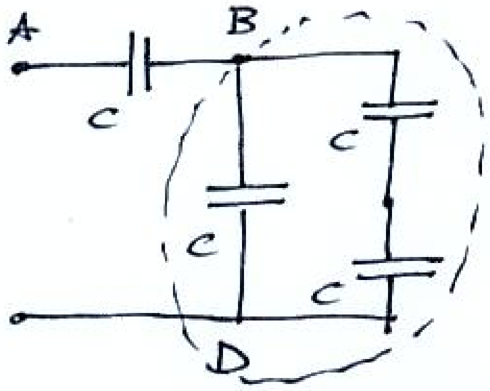
$$\Phi(B) = \int_R^{D-R}\left(\frac{\mu_0 I}{2\pi x} - \frac{\mu_0 I}{2\pi(D-x)}\right)\ell\, dx =$$

$$= \frac{\mu_0 I \ell}{2\pi}\, 2\ln\left(\frac{D-R}{R}\right) \simeq$$

$$\simeq \frac{\mu_0 I \ell}{2\pi}\, 2\ln\frac{D}{R} = L I$$

3. Inizialmente la corrente sul ramo del generatore f è nulla.
L'apertura di T_1 non ha alcun effetto.

T_1 aperto:

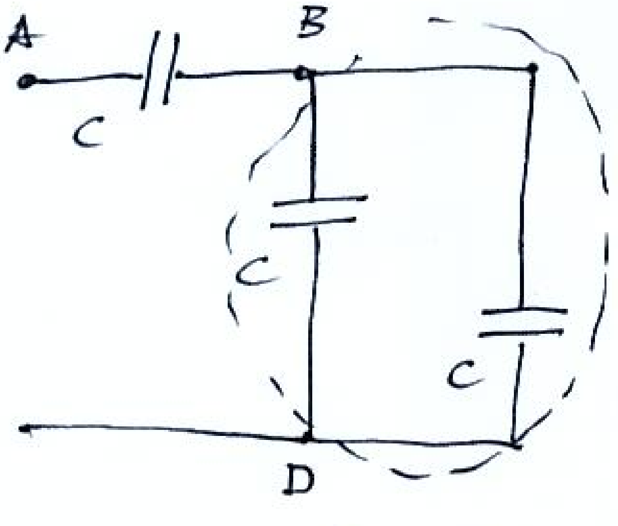


$$(V_A - V_D)_{in} = f$$

$$(V_A - V_B)_{in} = \frac{C'}{C+C'} f = \frac{3}{5} f$$

$$C' = C + \frac{C}{2} = \frac{3}{2} C$$

T_2 chiuso:



Il condensatore tra A e B non si può scaricare.

$$(V_A - V_B)_{fin} = (V_A - V_B)_{in} = \frac{3}{5} f$$

C e C'' sono in SERIE

$$Q_{fin} \text{ su } C_{AB} = Q_{fin} \text{ su } C''_{BD}$$

$$\parallel$$

$$C'' = 2C \qquad Q_{in} \text{ su } C_{AB} = C \frac{3}{5} f$$

$$(V_A - V_D)_{fin} = (V_A - V_D)_{in} + \frac{Q}{C''} = \frac{3}{5} f + \frac{1}{2C} \left(C \frac{3}{5} f \right) = \frac{9}{10} f$$

4. La corrente che scorre a causa delle f_i:

$$I = \frac{f_i}{R} = -\frac{1}{R}\frac{d\Phi(B)}{dt}$$

$$|q| = \left|\int_{IN}^{FIN} I\,dt\right| = \frac{1}{R}\left|\int_{IN}^{FIN} \frac{d\Phi}{\cancel{dt}}\cancel{dt}\right| =$$

$$= \frac{|\Phi_{FIN} - \Phi_{IN}|}{R} = \frac{Bh\Delta x}{R} = 10^{-4}\,C$$

5. $$E_0^{TERRA} = \sqrt{2Z I} = 1027\,\frac{V}{m}$$

Per un onda e.m. l'ampiezza del campo è proporzionale ad $1/r$

$$E_0(r) = \frac{K}{r}$$

$$E_0^{TERRA} = \frac{K}{D} \Rightarrow K = E_0^{TERRA}\cdot D$$

$$E_0^{SOLE} = \frac{K}{R_S} \rightarrow E_0^{SOLE} = \frac{E_0^{TERRA}\cdot D}{R_S}$$

$$E_0^{SOLE} = 1027\cdot\frac{150\cdot\cancel{10^{9}}}{7\cdot\cancel{10^{8}}} \simeq 220\,k\frac{V}{m}$$