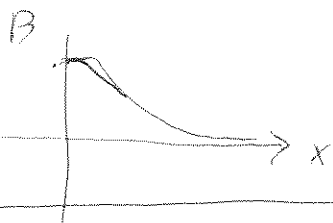


✓ $P \in$ asse x i 2 fili hanno la stessa distanza

$r = [x^2 + d^2]^{1/2}$ - La componente y si elide e resta la comp. x

$$B = 2 \cdot \frac{\mu_0 I}{2\pi r} \cos \alpha = \frac{2\mu_0 I}{2\pi \sqrt{x^2 + d^2}} \cdot \frac{d}{\sqrt{x^2 + d^2}} = \frac{\mu_0 I}{\pi (x^2 + d^2)} \cdot d$$



② a) $E_1 = \frac{Q}{\epsilon_0 4\pi r_1^2}$; $E_2 = \frac{Q}{4\pi \epsilon_0 r_2^2}$

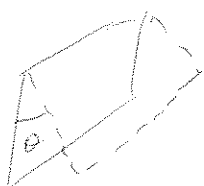
b) dopo, $V_1 = V_2 \Rightarrow \begin{cases} \frac{Q_1}{4\pi \epsilon_0 r_1} = \frac{Q_2}{4\pi \epsilon_0 r_2} \\ Q_1 + Q_2 = 2Q \end{cases}$ equipotenziali
conservazione della carica

$$Q_1 = Q_2 \frac{r_1}{r_2} \quad ; \quad Q_2 \left(1 + \frac{r_1}{r_2}\right) = 2Q \Rightarrow \boxed{\begin{aligned} Q_2 &= \frac{2Q}{r_1 + r_2} \cdot r_2 \\ Q_1 &= \frac{2Q}{r_1 + r_2} \cdot r_1 \end{aligned}}$$

c) $V = V_1 = V_2 = \frac{2Q}{4\pi \epsilon_0 (r_1 + r_2)}$

d) $E_i = \frac{Q_i}{4\pi \epsilon_0 r_i^2} = \frac{Q}{2\pi \epsilon_0 (r_1 + r_2) r_i}$

3)



La spirale è soggetta ai momenti delle forze peso e di Laplace

$$|\vec{M}| = I \ddot{\theta} = -\left(\frac{3}{4} m g\right) z_{CM} \sin \theta + (i a B) \cdot a$$

esplicitando

$$I = 2 \frac{M}{4} \left(\frac{a}{2}\right)^2 + \frac{M}{4} a^2 = \frac{3}{8} M a^2$$

$$z_{CM} = \left[\frac{M}{4} \frac{a}{2} \cdot 2 + \frac{M}{4} a \right] \frac{1}{\sqrt{\frac{3M}{4}}} = \frac{2}{3} a$$

$$i = -\frac{\phi(B)}{R} = -\frac{d}{dt} \frac{a^2 \sin \theta B}{R} = -\frac{B a^2 \cos \theta}{R} \dot{\theta}$$

$$\frac{3 M a^2}{8} \ddot{\theta} = -\frac{1}{2} m g a \sin \theta - \frac{B^2 a^2}{R} \cos \theta \dot{\theta}$$

$$\ddot{\theta} + \frac{4 g}{3 a} \sin \theta + \frac{8 B^2 a^2}{3 R m} \cos \theta \dot{\theta} = 0$$

Ora, per $\theta \ll 1$, approssimo $\sin \theta \approx \theta$ e $\cos \theta \approx 1$

$$\ddot{\theta} + \frac{8 B^2 a^2}{3 m R} \dot{\theta} + \frac{4 g}{3 a} \theta = 0$$

$$a) T_0 = \frac{2\pi}{\omega} = 2\pi \sqrt{\frac{3 a}{2 g}}$$