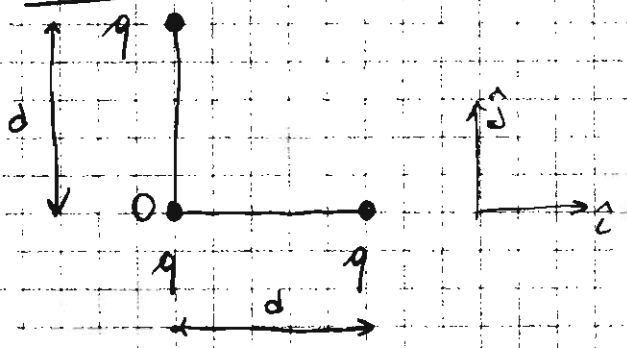
Ex. 1



m, q, d

1. $\vec{E}(0) = k_e \frac{q}{d^2}(-\hat{i}) + k_e \frac{q}{d^2}(-\hat{j})$

$\Rightarrow \vec{F_e} = -k_e \frac{q^2}{d^2}(\hat{i}+\hat{j}) = m\vec{a}$

$\vec{a} = -\frac{k_e}{m}\frac{q^2}{d^2}(\hat{i}+\hat{j})$

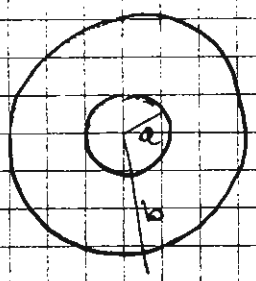
$|\vec{a}| = \frac{k_e}{m}\frac{q^2}{d^2}\sqrt{2}$

2. $U = k_e \frac{q^2}{d} \cdot 2 + k_e \frac{q^2}{\sqrt{2}d} = k_e \frac{q^2}{d}\left(2 + \frac{1}{\sqrt{2}}\right)$

3. $m v_0(\hat{i}) + m v_0(-\hat{j}) = m\vec{v_3}$

$v_3 = v_0\sqrt{2}$

Ex. 2



4. $E_{r>b} \rightarrow \quad 4\pi r^2 E = \frac{Q}{\varepsilon_0}$

$$E = \frac{Q}{4\pi\varepsilon_0 r^2} = k_e \frac{Q}{r^2}$$

$$\Rightarrow \quad E = k_e \frac{Q}{(2b)^2}$$

5 $E_{a<r<b} \rightarrow \quad 4\pi r^2 E = \frac{Q_{in}}{\varepsilon_0} = \frac{Q}{\frac{4}{3}\pi(b^3-a^3)} \frac{4}{3}\pi(r^3-a^3) \frac{1}{\varepsilon_0}$

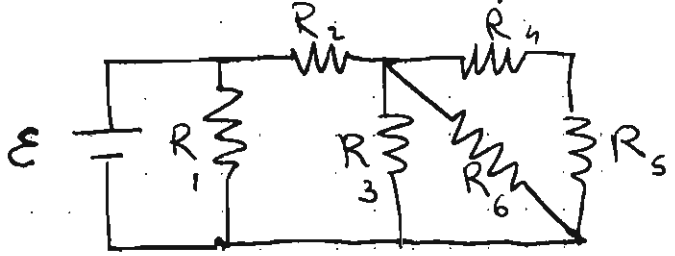
$$E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} \frac{r^3-a^3}{b^3-a^3} =$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{4Q}{(b+a)^2} \frac{\frac{(b+a)^3-a^3}{8}}{b^3-a^3}$$

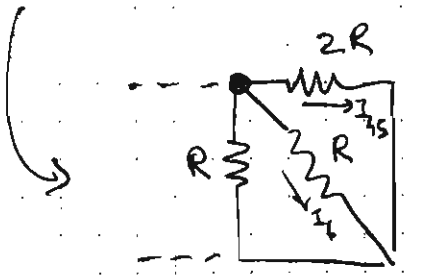
6. $E_{r<a} \rightarrow \quad 4\pi r^2 E = \frac{Q_{in}}{\varepsilon_0} = 0 \quad \Rightarrow \quad E = 0$

Ex 3 ⊙ No Kirchhoff

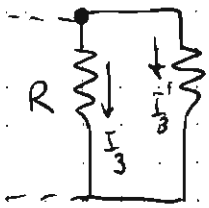
7.



f1

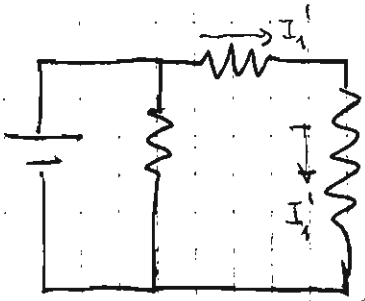


f2



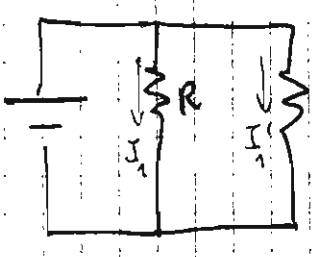
$\left(\frac{1}{R} + \frac{1}{2R}\right)^{-1} = R\left(1+\frac{1}{2}\right)^{-1} = R\,\frac{2}{3}$

f3



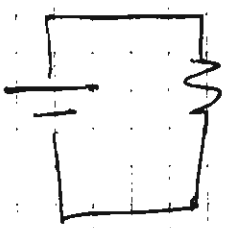
$\left(\frac{1}{R} + \frac{3}{2R}\right)^{-1} = R\,\frac{2}{5}$

f4



$\frac{2}{5}R + R = \frac{7}{5}R$

f5



$\left(\frac{1}{R} + \frac{5}{7R}\right)^{-1} = \frac{7}{12}R$

f6

$\Rightarrow \quad \mathcal{E} = \frac{7}{12} R\, I \qquad I = \frac{12}{7}\,\frac{\mathcal{E}}{R}$

8. $P = I_6^2 R_6 = R I_6^2 \Rightarrow$ devo trovare I_6

Da f5 $\quad R I_1 = \frac{7}{5} R I_1' \qquad I_1 + I_1' = I \Rightarrow \left(\frac{7}{5}+1\right) I_1' = I$

$I_1' = \frac{5}{12} I$

Da f3 $\quad I_1' = I_3 + I_3' \qquad R I_3 = \frac{2}{3} R I_3' \qquad I_1' = I_3'\left(1+\frac{2}{3}\right)$

$I_3' = \frac{5}{12} I \cdot \frac{3}{5} = \frac{I}{4}$

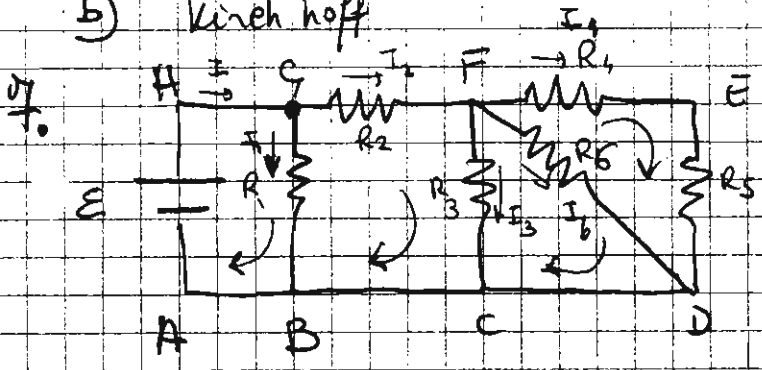
Da $\rho 2$:

$I_3 = I_{45} + I_6$ $\qquad$ ~~$R_4 I_6 = 2R I_{45}$~~

$\frac{I}{4} = I_6\left(1 + \frac{1}{2}\right) \Rightarrow I_6 = \frac{I}{4_2}\frac{2}{3} = \frac{I}{6}$

$\Rightarrow P = \frac{I^2 R}{36}$ ■

b) Kirchhoff



ABGH $\qquad -R I_1 + \mathcal{E} = 0$ $\qquad I_1 + I_2 = I$

GFCB $\qquad -R I_2 - R I_3 + R I_1 = 0$

FDC $\qquad -R I_6 + R I_3 = 0$

FED $\qquad -2R I_4 + R I_6 = 0$ $\qquad I_2 = I_4 + I_6 + I_3$

$I_1 = \frac{\mathcal{E}}{R}$ $\qquad I_2 = I - \frac{\mathcal{E}}{R}$

$-RI + \mathcal{E} - RI_3 + \mathcal{E} = 0$ $\qquad I_3 = 2\frac{\mathcal{E}}{R} - I$

$I_6 = I_3$ $\qquad I_6 = 2\frac{\mathcal{E}}{R} - I$

$I_4 = \frac{I_6}{2}$ $\qquad I_4 = \frac{\mathcal{E}}{R} - \frac{I}{2}$

$$I - \frac{\varepsilon}{R} = \frac{\varepsilon}{R} - \frac{I}{2} + 2\frac{\varepsilon}{R} - I + 2\frac{\varepsilon}{R} - I$$

$$\left(3 + \frac{1}{2}\right) I = 6\,\frac{\varepsilon}{R} \qquad \frac{7}{2} I = 6\,\frac{\varepsilon}{R}$$

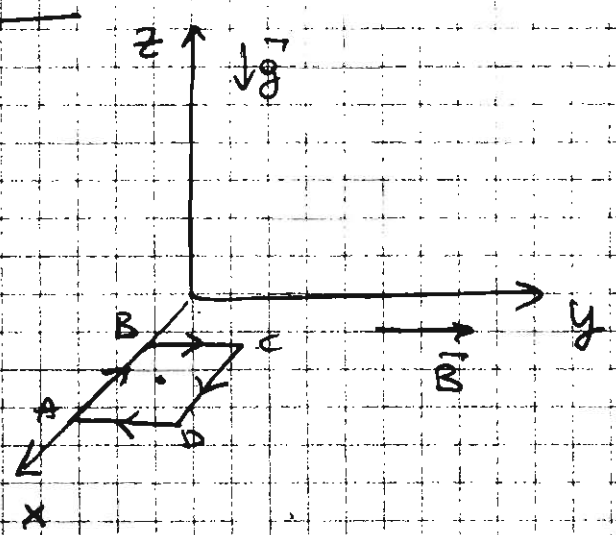
$$I = \frac{12}{7}\,\frac{\varepsilon}{R}$$

8.

$$\Rightarrow \quad I_6 = 2\frac{\varepsilon}{R} - \frac{12}{7}\,\frac{\varepsilon}{R} = \frac{2}{7}\,\frac{\varepsilon}{R}$$

$$\mathcal{P} = I_6^2 R = \frac{4}{49}\,\frac{\varepsilon^2}{R^2} R = \frac{4}{49}\,\frac{\varepsilon^2}{R}$$

Ex 4



a. $\vec{F}_{cb} = i\,\ell\,B\,\hat{z}$

b. $\vec{M}_{peso} + \vec{M}_{mag} = 0$

$\vec{M}_{peso} = \frac{b}{2} mg\,(-\hat{x})$

$\vec{M}_{mag} = b\,i\,\ell B\,(+\hat{x})$

$i\,\ell B b - \frac{b}{2} mg = 0$

$mg = 2\,i\,\ell B$

$m = 2\,\frac{i\,\ell B}{g}$