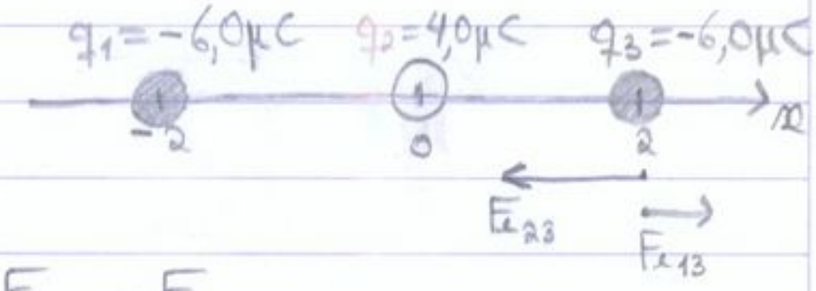
Física II - 1º Semestre

Capítulo 1 - Campo elétrico

Perguntas:

1. (Opção A).
2. (Opção E).
3. (Opção E).
4. (Opção D).
5. (Opção C).



$F_{e_3} = F_{e13} - F_{e23}$

$F_{e13} = \frac{K|q_1||q_3|}{K x^2} = \frac{9{,}0\times10^9 \times 6{,}0\times10^{-6} \times 6{,}0\times10^{-6}}{1 \times 4^2} =$

$= 0{,}02025\,N \quad F_{e23} = \frac{K|q_2||q_3|}{K x^2} = \frac{9{,}0\times10^9 \times 4{,}0\times10^{-6} \times 6{,}0\times10^{-6}}{1 \times 2^2} =$

$= 0{,}054 \quad |F_{e_3}| = |0{,}02025 - 0{,}054| = 3{,}4\times10^{-2}\,N$

Problemas:

(1) $A = 0{,}5\times0{,}5 = 0{,}25\,cm^2 = 2{,}5\times10^{-5}\,m^2 \quad m = 2{,}5\times10^{-5}\times80\times10^{-3} = 2\times10^{-6}\,kg$

$F_g = mg = 2\times10^{-6}\times9{,}8 = 1{,}96\times10^{-5}\,N \quad F_e = \frac{K\times q^2}{K x^2} = \frac{9{,}0\times10^9 \times q^2}{1\times(1\times10^{-3})^2} = 9\times10^{12} q^2\,N$

$F_g = F_e \Leftrightarrow 1{,}96\times10^{-5} = 9\times10^{12}\,q^2 \Leftrightarrow q = -4{,}67\times10^{-10} \vee q = 4{,}67\times10^{-10}\,C$

Logo, a ordem de grandeza da carga é de $10^{-10}\,C$.

(2) a) $24\times10^{-3} = \frac{9{,}0\times10^9\times|q_1|\times|q_2|}{1\times3^2} \Leftrightarrow \frac{9{,}0\times10^9\times q_1\times q_2}{9} = 24\times10^{-3} \Leftrightarrow q_1q_2 = 2{,}4\times10^{-11}$

$\begin{cases} q_1q_2 = 2{,}4\times10^{-11} \\ q_1 + q_2 = 10\times10^{-6} \end{cases} \Leftrightarrow q_1 = 4\mu C \wedge q_2 = 6\mu C$ ou $q_1 = 6\mu C \wedge q_2 = 4\mu C$.

b) $24\times10^{-3} = \frac{9{,}0\times10^9\times|q_1||q_2|}{1\times3^2} \Leftrightarrow \frac{9{,}0\times10^9\times(-q_1\times q_2)}{9} = 24\times10^{-3} \Leftrightarrow q_1q_2 = -2{,}4\times10^{-11}$

$\begin{cases} q_1q_2 = -2{,}4\times10^{-11} \\ q_1 + q_2 = 10\times10^{-6} \end{cases} \Leftrightarrow q_1 = 12\mu C \wedge q_2 = -2\mu C$ ou $q_1 = -2\mu C \wedge q_2 = 12\mu C$.

(3) $E_{protual} = \frac{K|q_1|}{K x^2} = \frac{9{,}0\times10^9\times1{,}6\times10^{-19}}{1\times(5{,}3\times10^{-11})^2} = 5{,}13\times10^{11}\,N/C$

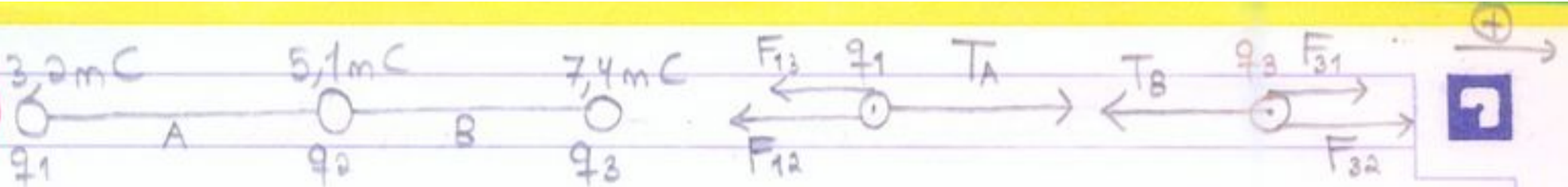
(4) $F_g = mg = 9{,}109\times10^{-31}\times9{,}8 = 8{,}93\times10^{-30}\,N$

$|\vec{E}| = \frac{|\vec{F}|}{|q_t|} \Leftrightarrow |F| = 150\times1{,}6\times10^{-19} = 2{,}4\times10^{-17}\,N$

$\frac{F_e}{F_g} = \frac{2{,}4\times10^{-17}}{8{,}93\times10^{-30}} = 2{,}7\times10^{12}$

A força eletrostática é $2{,}7\times10^{12}$ vezes maior que o peso.

⑤



Condição de equilíbrio para q_1: $T_A - F_{13} - F_{12} = 0 \Leftrightarrow T_A = F_{13} + F_{12} \Leftrightarrow$

$\Leftrightarrow T_A = \frac{K|q_1||q_3|}{K r_{13}^2} + \frac{K|q_1||q_2|}{K r_{12}^2} \Leftrightarrow T_A = \frac{9,0\times10^9 \times 3,0\times10^{-9} \times 7,4\times10^{-9}}{1\times(2\times2,65\times10^{-2})^2} + \frac{9,0\times10^9\times3,0\times10^{-9}\times5,1\times10^{-9}}{1\times(2,65\times10^{-2})^2} \Leftrightarrow$

$\Leftrightarrow T_A = 2,85\times10^{-4}\,N = 285\,\mu N$

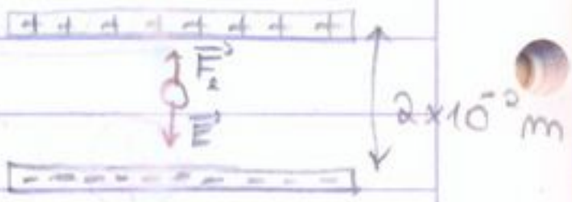
Condição de equilíbrio para q_3: $F_{31} + F_{32} - T_B = 0 \Leftrightarrow T_B = F_{31} + F_{32} \Leftrightarrow$

$\Leftrightarrow T_B = \frac{K|q_3||q_1|}{K r_{31}^2} + \frac{K|q_3||q_2|}{K r_{32}^2} \Leftrightarrow T_B = \frac{9,0\times10^9\times7,4\times10^{-9}\times3,0\times10^{-9}}{1\times(2\times2,65\times10^{-2})^2} + \frac{9,0\times10^9\times7,4\times10^{-9}\times5,1\times10^{-9}}{1\times(2,65\times10^{-2})^2} \Leftrightarrow$

$\Leftrightarrow T_B = 5,6\times10^{-4}\,N = 560\,\mu N$

⑥ a) $q = -e = -1,6\times10^{-19}\,C \quad \Delta t = 15\,\mu s = 15\times10^{-6}\,s$

$m = 9,109\times10^{-31}\,kg$



$E = \frac{F_e}{q} \qquad F_r = F_e = ma \qquad x = x_0 + v_0 t + \frac{1}{2}at^2 \Leftrightarrow$

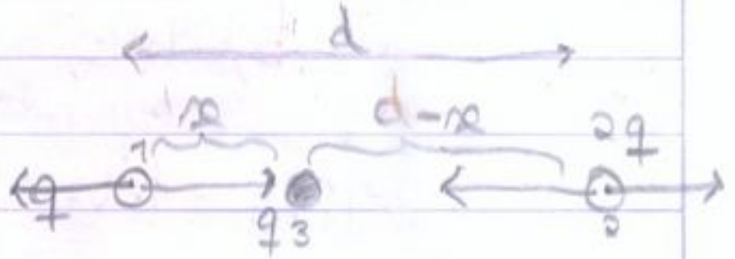
$\Leftrightarrow 2\times10^{-2} = \frac{1}{2}a\times(15\times10^{-6})^2 \Leftrightarrow a = 1,78\times10^8\,m/s^2$

$F_e = 9,109\times10^{-31}\times1,78\times10^8 = 1,6214\times10^{-22}\,N$

$E = \frac{-1,6214\times10^{-22}}{-1,6\times10^{-19}} = 1,01\times10^{-3}\,N/C$

b) $v = v_0 + at \Leftrightarrow v = 1,78\times10^8 \times 15\times10^{-6} = 2670\,m/s$

⑦ As cargas 1 e 2 têm o mesmo sinal.



$\vec{F_1} = \vec{F_{21}} + \vec{F_{31}} \Leftrightarrow$

$\Leftrightarrow \vec{F_1} = -\vec{F_{21}} + \vec{F_{31}} \Leftrightarrow -\frac{K2q^2}{Kd^2} + \frac{Kqq_3}{Kx^2} = 0$

$\vec{F_2} = \vec{F_{12}} + \vec{F_{32}} \Leftrightarrow \frac{K2q^2}{Kd^2} - \frac{Kqq_3}{K(d-x)^2} = 0$

A terceira carga ($-0,343\,q$) encontra-se no segmento de reta entre as outras 2 cargas, a uma distância $0,414\,d$ da carga q.

⑧ Ajustar unidades de K: $K = 9\times10^9 \frac{N\cdot(10^2\,cm)^2}{(10^9\,mC)^2} = 9\times10^{-5}\frac{N\cdot cm^2}{mC^2} = 0,09\frac{mN\cdot cm^2}{mC^2}$

$\cos\theta = \frac{\sqrt{3}}{2} = 0,866 \quad \sin\theta = \frac{1}{2} = 0,5$

$\vec{F_1} = \vec{F_{31}} + \vec{F_{21}} = \frac{0,09\times7\times5}{1\times1^2}\hat{j} + \frac{0,09\times9\times5}{1\times\sqrt{3}^2}\hat{i} = 1,35\hat{i} + 3,15\hat{j}$ (mN)

$\vec{F_2} = \vec{F_{12}} + \vec{F_{32}} = \left(-\frac{0,09\times9\times5}{1\times\sqrt{3}^2} + \frac{0,09\times7\times9}{1\times4}\times0,866\right)\hat{i} - \frac{0,09\times7\times9}{1\times4}\times0,5\,\hat{j} = (-0,12\hat{i} - 0,71\hat{j})\,mN$

$\vec{F_3} = \vec{F_{13}} + \vec{F_{23}} = \left(-\frac{0,09\times5\times7}{1\times1^2} + \frac{0,09\times7\times9}{1\times4}\times0,5\right)\hat{j} - \frac{0,09\times7\times9}{1\times4}\times0,866\,\hat{j} = (-1,22\hat{i} - 0,44\hat{j})\,mN$

$\vec{E} = \vec{E_1} + \vec{E_2} + \vec{E_3} = \left(-\frac{0,09\times5}{1^2}\times0,866 - \frac{0,09\times9}{1^2}\times0,866 + \frac{0,09\times7}{1^2}\times0,866\right)\hat{i} + \left(-\frac{0,09\times5}{1^2}\times0,5 + \frac{0,09\times9}{1^2}\times0,5 - \frac{0,09\times7}{1^2}\times0,5\right)\hat{j} =$

$\vec{E} = (0,545\hat{i} - 0,135\hat{j})\,N/\mu C$