HW #1

(1)

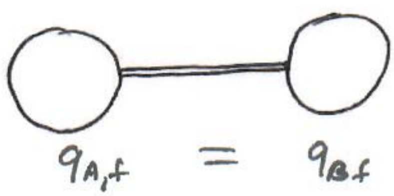
$$q = -90\,nC = e \cdot N_e$$

$$N_e = \frac{q}{e} = \frac{-.90 \times 10^{-9}}{-1.6 \times 10^{-19}} = \underline{\underline{5.6 \times 10^{11}}}$$

(2)

$$\Downarrow$$

$$q_A = N_e \cdot e = 5 \times 10^{10} \times (-1.6 \times 10^{-19}) = 8 \times 10^{-9}\,C$$



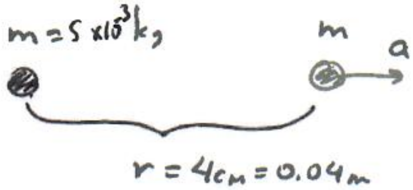
$$q_A + q_B = q_{Af} + q_{Bf} = 2q_{A,f}$$

$$q_{Af} = q_{Bf}$$

then: $q_{A,f} = q_{B,f} = \frac{1}{2}(q_A + q_B) =$

$$= \frac{1}{2}(8 \times 10^{-9} + 0) = \underline{\underline{4 \times 10^{-9}\,C}}$$

(3)



$$F = k_e \frac{q^2}{r^2} = ma$$

then: $q^2 = \frac{mar^2}{k_e} \Rightarrow q = \sqrt{\frac{mar^2}{k_e}} =$

$$= \sqrt{\frac{5 \times 10^{-3} \cdot 2 \cdot 0.04^2}{9 \cdot 10^9}} = \underline{\underline{0.42 \times 10^{-7}\,C}}$$

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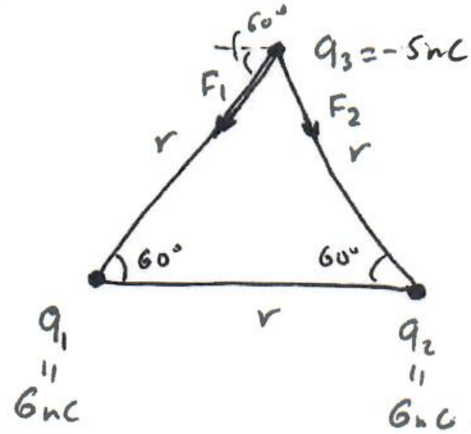

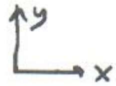

$r = 1\,cm = 0.01\,m$

$$F_1 = F_2 = k_e \frac{|q_3||q_1|}{r^2} =$$

$$= 9 \cdot 10^9 \cdot \frac{5 \times 10^{-9} \cdot 6 \cdot 10^{-9}}{(0.01)^2} = 2.7 \times 10^{-3} N$$

(x, y) ;

$$\vec{F_1} = (-F_1 \cos 60°, -F_1 \sin 60°)$$

$$\vec{F_2} = (F_2 \cos 60°, -F_2 \sin 60°)$$

$$\vec{F_{net}} = (0 ; -2F_1 \sin 60°) = \left(0; -2.7 \times 10^{-3} \frac{\sqrt{3}}{2}\right)$$

$$= (0, -2.3 \times 10^{-3})$$

$F_{net} = 2.3 \times 10^{-3} N$

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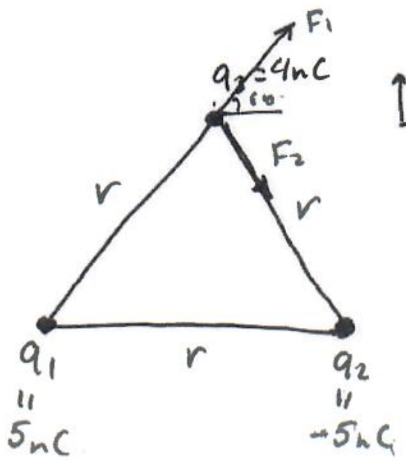

$r = 1\,cm = 0.01\,m$

$$F_1 = F_2 = k_e \frac{|q_1||q_3|}{r^2} =$$

$$= 9 \times 10^9 \cdot \frac{5 \times 10^{-9} \cdot 4 \cdot 10^{-9}}{(0.01)^2} = 18 \times 10^{-4} N$$

$$\vec{F_1} = (F_1 \cos 60°; F_1 \sin 60°)$$

$$\vec{F_2} = (F_2 \cos 60°, -F_2 \sin 60°)$$

$$\vec{F_{net}} = (2F_1 \cos 60°, 0) = (2 \times 18 \times 10^{-4} \cdot \cos 60°, 0) =$$

$F_{net} = 18 \times 10^{-4} N$

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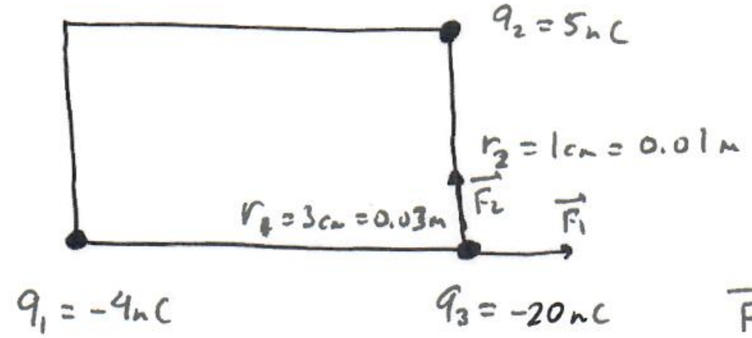
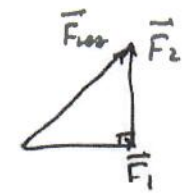


$\vec{F_{net}} = \vec{F_1} + \vec{F_2}$



$F_{net} = \sqrt{F_1^2 + F_2^2}$; $F_1 = k_e \dfrac{|q_1||q_3|}{r_1^2} =$

$= 9\times10^9 \cdot \dfrac{4\cdot10^{-9}\cdot 20\cdot10^{-9}}{(0.03)^2} = \underline{8\times10^{-4}\ N}$

$F_2 = k_e \dfrac{|q_2||q_3|}{r_2^2} = 9\times10^9 \cdot \dfrac{5\times10^{-9}\cdot 20\cdot10^{-9}}{(0.01)^2} = \underline{9\times10^{-3} N}$

$F_{net} = \sqrt{(9\times10^{-3})^2 + (8\times10^{-4})^2} = \underline{\underline{90\times10^{-3}\ N}}$

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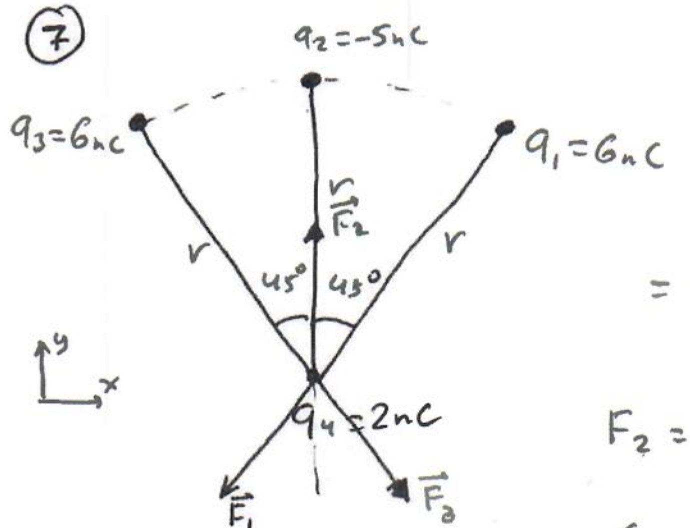

$r = 5cm = 0.05m$

$F_1 = F_3 = k_e \dfrac{|q_1||q_4|}{r^2} =$

$= 9\times10^9 \cdot \dfrac{10^{-9}\cdot 6\cdot10^{-9}}{(0.05)^2} = 2.2\times10^{-5}\ N$

$F_2 = k_e \dfrac{|q_2||q_4|}{r^2} = 9\times10^9 \cdot \dfrac{5\times10^{-9}\cdot 2\cdot10^{-9}}{(0.05)^2} = 3.6\times10^{-5} N$

$\vec{F_1} = (-F_1 \sin 45°;\ -F_1 \cos 45°)$

$\vec{F_2} = (\ 0\ ;\ F_2)$

$\vec{F_3} = (F_3 \sin 45°;\ -F_3 \cdot \cos 45°)$

$\vec{F_{net}} = (\ 0\ ;\ F_2 - 2F_1 \cos 45°) = (0, -0.5\times10^{-5})$

$\underline{\underline{F_{net} = 0.5\times10^{-5} N}}$

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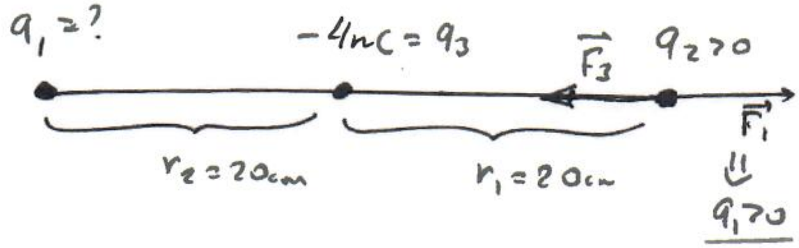
Assume $q_2 > 0$



$\underline{\underline{q_1 > 0}}$

$$F_1 = F_3 \Rightarrow \cancel{k_e} \frac{|q_1||\cancel{q_2}|}{(r_1+r_2)^2} = \cancel{k_e} \frac{|\cancel{q_2}||q_3|}{r_1^2}$$

$$q_1 = \left(\frac{r_1+r_2}{r_1}\right)^2 |q_3| = 4 \cdot |q_3| = \underline{\underline{16\,nC}}$$

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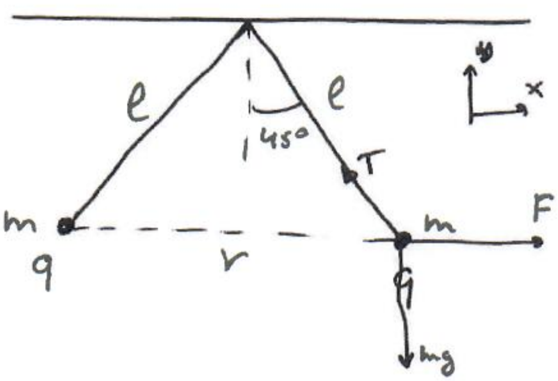

equilibrium:

$$\vec{T} + \vec{F} + m\vec{g} = 0$$

$$x: \quad F - T\cos 45° = 0$$

$$y: \quad T\sin 45° - mg = 0$$

then:

$$F \tan 45° = mg$$

$$k_e \frac{q^2}{r^2} = mg \Rightarrow q = \sqrt{\frac{mg \cdot r^2}{k_e}}$$

$$r = \sqrt{\ell^2 + \ell^2} = \sqrt{2^2 + 2^2} = \sqrt{8}\,m \quad , \quad m = 10g = 10 \times 10^{-3}\,kg$$

then:

$$q = \sqrt{\frac{10 \times 10^{-3} \cdot 9.8 \cdot 8}{9 \cdot 10^9}} = \underline{\underline{9.3 \times 10^{-6}\,C}}$$