QUIZ6- CHAPTER 21
DATE: 5/03/20

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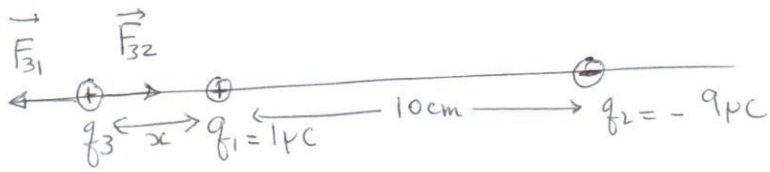
1. Two fixed particles, of charges $q_1 = +1.0 \times 10^{-6}$ C and $q_2 = -9.0 \times 10^{-6}$ C, are 10 cm apart. How far from charge q1 should a third charge be located so that no net electrostatic force acts on it?

assume $q_3 > 0$



equilibrium $\Rightarrow$ $F_{31} = F_{32}$

$$\frac{k|q_1||q_3|}{x^2} = \frac{k|q_2||q_3|}{(10+x)^2}$$

$$\frac{1}{x^2} = \frac{9}{(10+x)^2}$$

$$\frac{(10+x)^2}{x^2} = 9 \Rightarrow \frac{10+x}{x} = 3 \Rightarrow 2x = 10$$

$x = 5$ cm

$x = 0.05$ m

2. Two neutral metal sphere are separated by 20 cm. How many electrons must be transferred from one sphere to the other so that their electrical attraction is 10^{-10} N?

$$F = \frac{kq^2}{r^2} \Rightarrow q = \sqrt{\frac{Fr^2}{k}}$$

$$q = \sqrt{\frac{10^{-10} \times (0.2)^2}{9 \times 10^9}} = 2.1 \times 10^{-11} \text{ C}$$

$$n = \frac{q}{e} = \frac{2.1 \times 10^{-11}}{1.6 \times 10^{-19}} = 1.32 \times 10^8 \text{ electrons}$$

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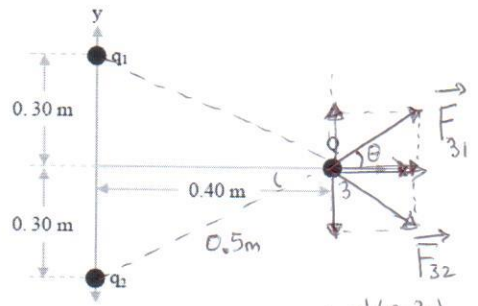
1. Three charges, $q_1 = q_2 = 4.0\ \mu C$ and $Q = 10\ \mu C$, are fixed in their places as shown in the figure. Find the net electrostatic force on Q due to q_1 and q_2.



$$\vec{F}_{net,3} = \vec{F}_{31} + \vec{F}_{32}$$

$\theta = \tan^{-1}\left(\frac{0.3}{0.4}\right) = 36.9°$

x-axis: $F_{net,x} = F_{31,x} + F_{32,x}$

$$F_{net,x} = \frac{k|q_3||q_1|}{r_{13}^2}\cos 36.9 + \frac{k|q_3||q_2|}{r_{23}^2}\cos 36.9°$$

$$= \frac{9\times10^9 \times 10\times10^{-6} \times 4\times10^{-6}}{(0.5)^2}\cos 36.9 \times 2 = 2.3\ N$$

$$F_{net,y} = \frac{k|q_3||q_1|}{r_{13}^2}\sin 36.9 - \frac{k|q_3||q_1|}{r_{23}^2}\sin 36.9° = 0$$

$$\boxed{\vec{F}_{net,3} = 2.3\ \hat{i}\ (N)}$$

2. Consider two identical conducting spheres separated from one another. Sphere A with an initial charge of -40e is touched to sphere B with an initial charge of -20e and then separated. Sphere A is then touched to an identical sphere C (initially uncharged). What is the final charge of sphere A?

① $(Q_A + Q_B)_i = (Q_A + Q_B)_f = (2Q_A)_f$

$-40e - 20e = 2Q_{Af} = -60e \Rightarrow Q_{Af} = -30e$

② $(Q_A + Q_C)_i = -30e + 0 = 2Q_A$

$$\boxed{Q_A = -15e}$$

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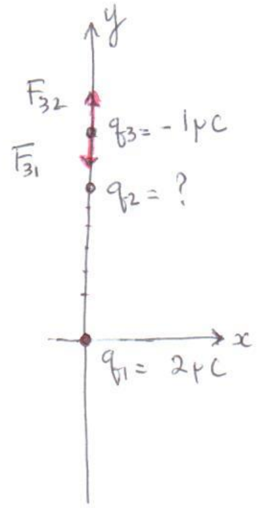
1. Consider the following three point charges fixed on the y-axis: $q_1 = +2.00\ \mu C$ located at $y_1 = 0$, q_2 located at $y_2 = 6.00$ m, and $q_3 = -1.00\ \mu C$ located at $y_3 = 8.00$ m. What is the value of q_2 such that q_3 is in equilibrium?



$$F_{32} = F_{31}$$

$$\frac{k|q_3||q_2|}{(2)^2} = \frac{k|q_3||q_1|}{(8)^2}$$

$$\frac{|q_2|}{4} = \frac{|q_1|}{64} \Rightarrow |q_2| = |q_1|\frac{4}{64}$$

$$|q_2| = 2\mu C \times \frac{1}{16} = 0.125\mu C$$

$$\boxed{q_2 = -0.125\mu C}$$

q_2 should be negative

2. Two small identical conducting spheres A and B carry equal charge Q, and are separated by a distance d. Initially the electrostatic force between them is F. A third identical uncharged conducting sphere C is first touched to A, then to B, and then moved away. As a result of this, the electrostatic force between A and B becomes:

A) F/2 B) F/4 (C) 3F/8 D) F/16 E) F

$$F = \frac{kQ^2}{r^2}$$

$A(Q)$ $B(Q)$ $\longrightarrow$ $A(Q/2)$ $B\left(\frac{Q + Q/2}{2}\right)$

$B\left(\frac{3Q}{4}\right)$

$\rightarrow A\left(\frac{Q}{2}\right)$ $B\left(\frac{3Q}{4}\right)$

$$F' = k\frac{(Q/2)(3Q/4)}{r^2} = k\frac{3Q^2}{8r^2} = \frac{3}{8}\frac{kQ^2}{r^2}$$

$$\boxed{F' = \frac{3}{8}F}$$