Quiz 3d Solution

Charges are placed in a plane as follows: $q_1 = +4\mu C$ at $r_1 = (0, 3cm)$, $q_2 = 4\mu C$ at $r_2 = (0, -3cm)$, and $q_3 = -6\mu C$ at $r_3 = (-8cm, 0)$. Determine the magnitude and direction of the total force on q_3.

We must compute the force of charge 1 on 3 ($= F_{13}$) and charge 2 on 3 ($= F_{23}$) and add them as vectors. Because of the symmetry of the problem (make a neat figure!) the $\hat{y}$ components of the forces cancel: $F_{13y} + F_{23y} = 0$. Similarly the $\hat{x}$ components are the same $F_{totx} = F_{13x} + F_{23x} = 2F_{13x}$, so we need only compute the $\hat{x}$ component of F_{13}.

First

$$|F_{13}| = \frac{4 \cdot 10^{-6} C 6 \cdot 10^{-6} C}{4\pi\epsilon_0 r^2}$$

where $r^2 = (0.03^2 + 0.08^2)$ m^2. Computing gives $|F_{13}| = 29.56$ N.

The angle above the horizontal which F_{13} points at is $\tan\theta = 3/8$, $\theta = 20.5$ degrees.

Finally, the magnitude of the total force is given by $|F_{tot}| = 2 \cdot 29.56 \cdot \cos\theta$ which is 55.35 N in the $+\hat{x}$ direction.