Quiz 3d Solution

Charges are placed in a plane as follows: $q_1 = +4 \mu C$ at $r_1 = (0, 3\, \text{cm})$, $q_2 = 4 \mu C$ at $r_2 = (0, -3\, \text{cm})$, and $q_3 = -6 \mu C$ at $r_3 = (-8\, \text{cm}, 0)$. 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 $F_{\text{tot}x} = F_{13x} + F_{23x} = 2F_{13x}$, so we need only compute the $\hat{x}$ component of $F_{13}$.

First

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

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

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 $|F_{\text{tot}}| = 2 \cdot 29.56 \cdot \cos \theta$ which is 55.35 $\, \text{N}$ in the $+\hat{x}$ direction.