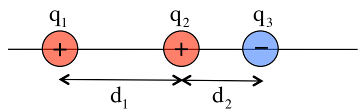
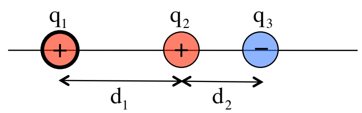
Problem 23.8

The charges and distances are shown, along with the Coulomb force calculations. Something to note before starting. Notice below that I have not used $-2.00\text{x}10^{-6}$ coulombs in my force calculations but, rather, the magnitude $+2.00\text{x}10^{-6}$ coulombs. Why? Because positive and negative signs in force equations denote the DIRECTION of the force, and in Coulomb force equations that is determined by whether the two charges are attracted or repulsed by one another. Bottom line: Use Coulomb's Law to determine the magnitude of the Coulomb force using only the magnitude of the charges involved, then assign a sign relative to the coordinate axis, depending upon whether there is attraction or repulsion between the two charges.



With that in mind:

Our force quantities are:



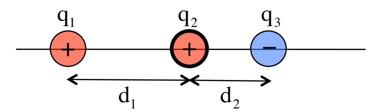
$$F_{\text{on } q_1} = -k\frac{q_1q_2}{d_1^{\,2}} + k\frac{q_1q_3}{(d_1+d_2)^2}$$

$$= kq_1\left[-\frac{q_2}{d_1^{\,2}} + \frac{q_3}{(d_1+d_2)^2}\right]$$

$$= \left(8.99\text{x}10^9\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\left(6.00\text{x}10^{-6}\ \text{C}\right)\left[-\frac{\left(1.50\text{x}10^{-6}\ \text{C}\right)}{\left(3.00\text{x}10^{-2}\ \text{m}\right)^2} + \frac{\left(2.00\text{x}10^{-6}\ \text{C}\right)}{\left(5.00\text{x}10^{-2}\ \text{m}\right)^2}\right]$$

$$= -46.7\ \text{N}$$

Our force quantities are:



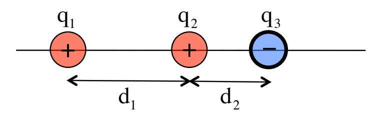
$$F_{\text{on } q_2} = k\frac{q_1q_2}{d_1^{\,2}} + k\frac{q_2q_3}{d_2^{\,2}}$$

$$= kq_2\left[\frac{q_1}{d_1^{\,2}} + \frac{q_3}{d_2^{\,2}}\right]$$

$$= \left(8.99\text{x}10^9\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\left(1.50\text{x}10^{-6}\ \text{C}\right)\left[\frac{\left(6.00\text{x}10^{-6}\ \text{C}\right)}{\left(3.00\text{x}10^{-2}\ \text{m}\right)^2} + \frac{\left(2.00\text{x}10^{-6}\ \text{C}\right)}{\left(2.00\text{x}10^{-2}\ \text{m}\right)^2}\right]$$

$$= 157\ \text{N}$$

Our force quantities are:



$$F_{\text{on } q_3} = -k\frac{q_3q_2}{d_2^{\,2}} - k\frac{q_1q_3}{(d_1+d_2)^2}$$

$$= kq_3\left[-\frac{q_2}{d_2^{\,2}} - \frac{q_3}{(d_1+d_2)^2}\right]$$

$$= \left(8.99\text{x}10^9\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\left(2.00\text{x}10^{-6}\ \text{C}\right)\left[-\frac{\left(1.50\text{x}10^{-6}\ \text{C}\right)}{\left(2.00\text{x}10^{-2}\ \text{m}\right)^2} - \frac{\left(6.00\text{x}10^{-6}\ \text{C}\right)}{\left(5.00\text{x}10^{-2}\ \text{m}\right)^2}\right]$$

$$= 111\ \text{N}$$