SAMPLE PROBLEM C

Equilibrium

PROBLEM

Three charges lie along the *x*-axis. One positive charge, q_1 = 15 μC, is at $x = 2.0$ m, and another positive charge, $q_2 = 6.0$ μC, is at the origin. At what point on the *x*-axis must a negative charge, q_3, be placed so that the resultant force on it is zero?

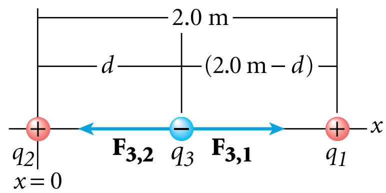
SOLUTION

Given: $q_1 = 15\ \mu\text{C}$ $\quad r_{3,1} = 2.0\ \text{m} - d$

$q_2 = 6.0\ \mu\text{C}$ $\quad r_{3,2} = d$

Unknown: the distance (d) between the negative charge q_3 and the positive charge q_2 such that the resultant force on q_3 is zero

Diagram:



Because we require that the resultant force on q_3 be zero, $F_{3,1}$ must equal $F_{3,2}$. Each force can be found by using Coulomb's law.

$$F_{3,1} = F_{3,2}$$

$$k_C\left(\frac{q_3 q_1}{(r_{3,1})^2}\right) = k_C\left(\frac{q_3 q_2}{(r_{3,2})^2}\right)$$

$$\frac{q_1}{(2.0\ \text{m} - d)^2} = \frac{q_2}{d^2}$$

TIP *Because k_C and q_3 are common terms, they can be canceled from both sides of the equation.*

Now, solve for d to find the location of q_3.

$$(d^2)(q_1) = (2.0\ \text{m} - d)^2(q_2)$$

Take the square root of both sides, and then isolate d.

$$d\sqrt{q_1} = (2.0\ \text{m} - d)\sqrt{q_2}$$

$$d\left(\sqrt{q_1} + \sqrt{q_2}\right) = \sqrt{q_2}(2.0\ \text{m})$$

$$d = \frac{\sqrt{q_2}(2.0\ \text{m})}{\sqrt{q_1} + \sqrt{q_2}} = \frac{\sqrt{6.0\ \mu\text{C}}\ (2.0\ \text{m})}{\sqrt{15\ \mu\text{C}} + \sqrt{6.0\ \mu\text{C}}} = 0.77\ \text{m}$$

$$\boxed{d = 0.77\ \text{m}}$$