Answer on Question #65019, Physics / Other

Elsa doesn't feel like making a snowman2 so she makes some snow jewelry for Anna instead. The jewelry consists of a straight string of three glittering ice balls and is really quite fetching. Elsa does great with the snow and ice stuff, but hasn't gotten electric charge down yet. The ice ball to the left has a charge of +5q and the ice ball to the right has a charge of +3q and they are fixed a distance of 9.00 cm apart from each other. The middle ice ball is free to slide from side to side, so that it winds up in the position where the net force it experiences is zero (assume that it has a very small charge itself). What position will this be (i.e., find the value of x)?

Solution:

Given: $q_1 = +5q,$ $q_2 = +3q,$ x = ?

The magnitude of the electric force is determined by the Coulomb's Law:

$$F_1 = k \frac{q_1 q}{x^2}$$
$$F_2 = k \frac{q_2 q}{(9-x)^2}$$

In the point where the net force is zero

$$F_{1} = F_{2}$$

$$k \frac{q_{1}q}{x^{2}} = k \frac{q_{2}q}{(9-x)^{2}}$$

$$q_{1}(9-x)^{2} = q_{2}x^{2}$$

$$5(9-x)^{2} = 3x^{2}$$

$$5(81 - 18x + x^{2}) = 3x^{2}$$

$$405 - 90x + 5x^{2} - 3x^{2} = 0$$

$$2x^{2} - 90x + 405 = 0$$

Solutions of equation:

$$x_1 = \frac{45}{2} - \frac{9\sqrt{15}}{2} = 5.07$$
$$x_2 = \frac{45}{2} + \frac{9\sqrt{15}}{2} = 39.93$$

Answer: 5.07 cm from left charge.

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