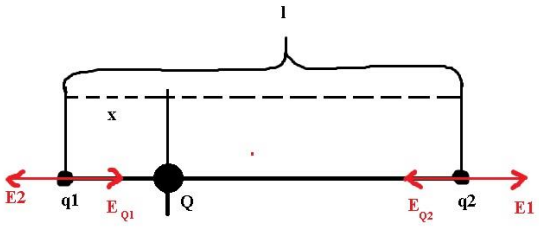
Answer to Question #67118, Physics / Electromagnetism



Problem: Charges q1=0.09 C, q2=0.01 C, are a distance l = 1m apart. a charge Q is held fixed on the line between them, a distance x from q1. What value must Q,x have for q1,q2 to feel no net force?

Solution:

For the charges q1 and q2 to feel no net force, the value of electric field at the charges should be equal to 0.

Considering the picture, one can write

$$\begin{cases} E_2 = E_{Q1} \\ E_1 = E_{Q2} \end{cases}$$

Where E_2 is the field of q_2 at the point of q_1, E_{Q1} is the field of Q at the point of q_1, E_1 is the field of q_1 at the point of q_2 and Eq_2 is the field of Q at q_2.

Considering that in general $E = kq/d^2$ one can write the following:

$$\frac{kq_2}{l^2} = \frac{kQ}{x^2} \quad (1)$$

And

$$\frac{kq_1}{l^2} = \frac{kQ}{(l-x)^2} \quad (2)$$

From (1):

$$Q = q_2 * \frac{x^2}{l^2}$$

Then

$$\frac{kq_1}{l^2} = \frac{kq_2}{(l-x)^2} * \frac{x^2}{l^2}$$

$$q_1(l^2 - 2xl + x^2) = q_2x^2$$

$$(q_1 - q_2)x^2 - 2lq_1x + q_1l^2 = 0$$

$$x = \frac{2q_1l \pm \sqrt{(4q_1l^2 - 4 * (q_1 - q_2)q_1l^2)}}{2(q_1 - q_2)}$$

$$x = \begin{cases} 1.5m & (1) \\ \frac{3}{4}m & (2) \end{cases}$$

The first solution is not between the charges, so we chose

$$x = \frac{3}{4}m$$

Then

$$Q = q_2 * \frac{x^2}{l^2} = 0.005625C$$

Answer:

$$\boldsymbol{x = \frac{3}{4}m,\ Q = q_2 * \frac{x^2}{l^2} = 0.005625C}$$