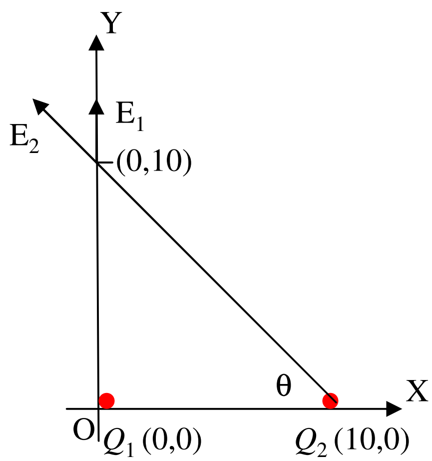
Quiz 1 Name: Key

ID: ____________________

1. Positive charges with magnitudes 3.50 mC (=3.50×10^{-3}C) and 6.75 mC are located at the origin and at the point (10.00, 0) meters on the *x* axis, respectively. What are the strength and direction of the field they generate at the point (0, 10.00) meters on the *y* axis?



Step 1, formulas or related concepts.

electric field from multi - point charges

$$\vec{\mathbf{E}} = k_e \sum \frac{Q}{r^2}\vec{\mathbf{r}}$$

Step 2, known quantities.

$$Q_1 = 3.50\,\text{mC},\ r_1 = 10.00\,\text{m}$$
$$Q_2 = 6.75\,\text{mC},\ r_2 = 10.00\sqrt{2}\,\text{m}$$

Step 3, direct application of the formula

$$\vec{\mathbf{E}}_1 = k_e \frac{Q_1}{r_1^2}\hat{\mathbf{j}}$$

$$\vec{\mathbf{E}}_2 = k_e \frac{Q_2}{r_2^2}\left[-\hat{\mathbf{i}}\cos(\theta) + \hat{\mathbf{j}}\sin(\theta)\right]$$

$$\cos(\theta) = \frac{10.00}{10.00\sqrt{2}} = \frac{1}{\sqrt{2}} = \sin(\theta)$$

$$\vec{\mathbf{E}} = \vec{\mathbf{E}}_1 + \vec{\mathbf{E}}_2 = k_e\left[-\frac{Q_2}{r_2^2}\cos(\theta)\hat{\mathbf{i}} + \left(\frac{Q_1}{r_1^2} + \frac{Q_2}{r_2^2}\sin(\theta)\right)\hat{\mathbf{j}}\right]$$

$$= k_e\left[-\frac{6.75\times10^{-3}}{\left(10.00\sqrt{2}\right)^2}\frac{1}{\sqrt{2}}\hat{\mathbf{i}} + \left(\frac{3.50\times10^{-3}}{(10.00)^2} + \frac{6.75\times10^{-3}}{\left(10.00\sqrt{2}\right)^2}\frac{1}{\sqrt{2}}\right)\hat{\mathbf{j}}\right]$$

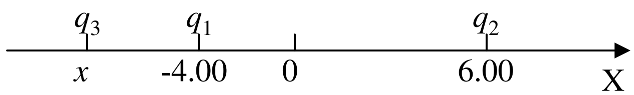
$$= -2.15\times10^5\,\hat{\mathbf{i}} + 5.30\times10^5\,\hat{\mathbf{j}}\ \text{(N/C)}$$

Step 4, vector involved? Yes and properly processed.

Step 5, unit in the final answer correct? Answered all were asked?

final answer in unit of electric field: Newton/Coulomb.

2. A charge of $-3.50\ \mu C$ ($= -3.50 \times 10^{-6}$C) is located on the x axis at $x = -4.00$ m, and a second point charge of $4.00\ \mu C$ is located at $x = 6.00$ m. Where should a third point charge of $6.00\ \mu C$ be placed to make the electric field zero at the origin?



Step 1, formulas or related concepts.

electric field from multi - point charges

$$\vec{\mathbf{E}} = k_e \sum \frac{q}{r^2} \vec{\mathbf{r}}, \text{ or in only one dimention : } \vec{\mathbf{E}} = k_e \sum \frac{q}{x^2} \hat{\mathbf{x}} \text{ and } E_x = k_e \sum \frac{q}{x^2}$$

Step 2, known quantities.

$$q_1 = -3.50\ \mu\text{C},\ \ x_1 = -4.00\ \text{m}$$

$$q_2 = 4.00\ \mu\text{C},\ \ x_2 = 6.00\ \text{m}$$

$$\text{q}_3 = 6.00\ \mu\text{C},\ \ x_3 = x\ \text{m (assumed)}$$

Step 3, direct application of the formulas/concept or the condition to form an equation.

$$\text{at } x = 0,\ \ E_x = k_e \sum \frac{q}{x^2} = 0$$

$$k_e \left(-\frac{|q_1|}{x_1^2} - \frac{q_2}{x_2^2} + \frac{q_3}{x_3^2} \right) = 0 \text{ so } \frac{3.50}{(-4.00)^2} + \frac{4.00}{6.00^2} + \frac{6.00}{x^2} = 0$$

solve for x, $x = \pm 4.26$ m,

only $x = -4.26$ m is accepted by physics

Step 4, vector involved? yes

Step 5, unit in the final answer correct? Answered all were asked?

yes, and all questions answered.