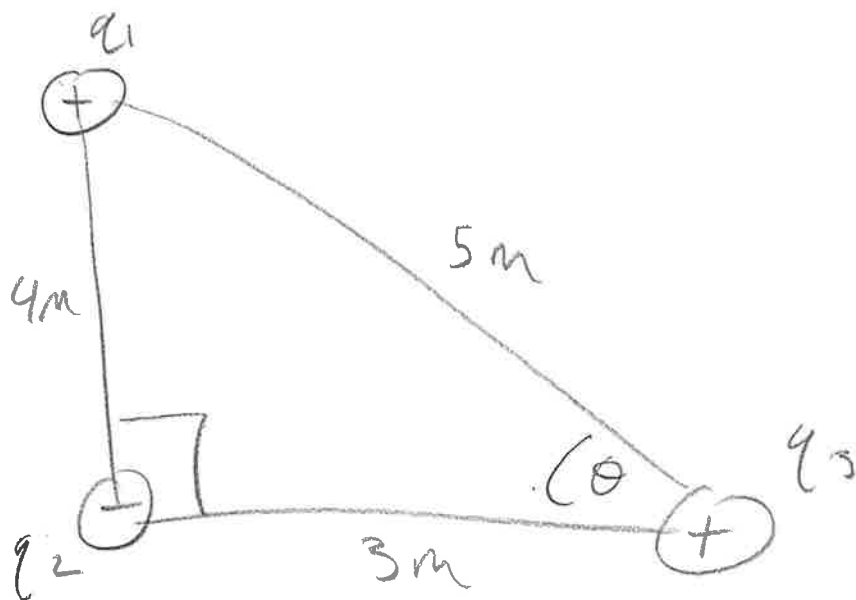


Warm up problem

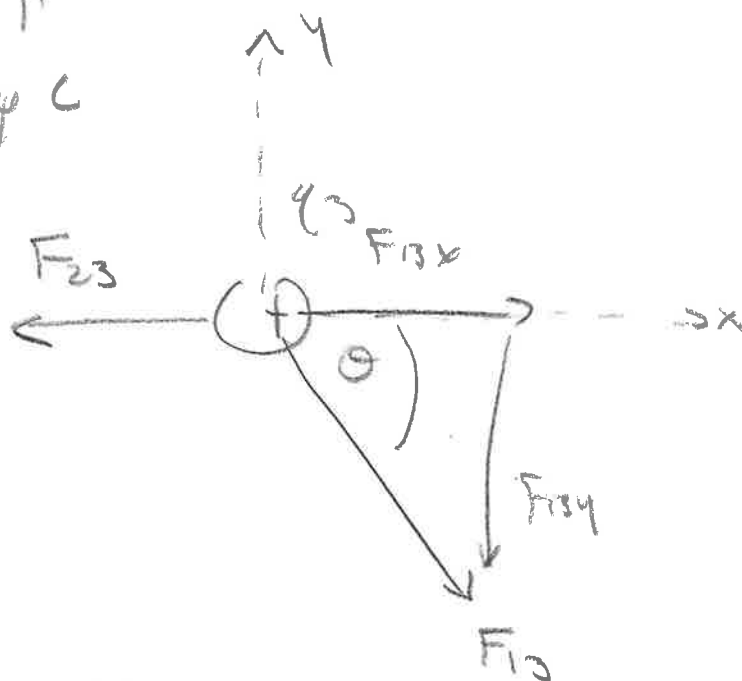
①



$$q_1 = 5 \mu\text{C}$$

$$q_2 = -7 \mu\text{C}$$

$$q_3 = 10 \mu\text{C}$$



$$\sum F_x = -F_{23} + F_{13x}$$

$$\sum F_x = -\frac{k q_2 q_3}{r_{23}^2} + \frac{k q_1 q_3}{r_{13}^2} \cos \theta$$

$$\sum F_x = \frac{-9 \times 10^9 (7 \times 10^{-6})(10 \times 10^{-6})}{(3)^2} + \frac{9 \times 10^9 (5 \times 10^{-6})(10 \times 10^{-6})}{(5)^2} \frac{3}{5} \quad (2)$$

$$\sum F_x = -0.0592 \text{ N}$$

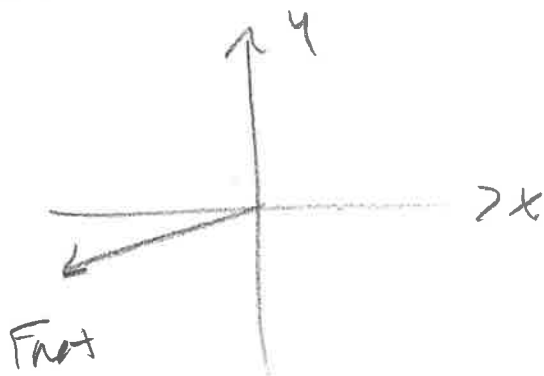
$$\sum F_y = -F_{13y}$$

$$\sum F_y = -k \frac{q_1 q_3 \sin \theta}{r_{13}^2}$$

$$\sum F_y = \frac{-9 \times 10^9 (5 \times 10^{-6})(10 \times 10^{-6})}{(5)^2} \frac{4}{5}$$

$$\sum F_y = -0.0144 \text{ N}$$

$$F_{\text{net}} = \langle -0.0592, -0.0144 \rangle \text{ N}$$



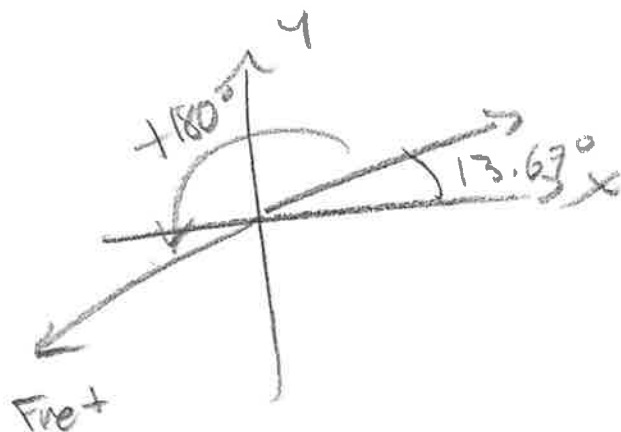
$$|F_{\text{net}}| = \sqrt{(-0.0592)^2 + (-0.0144)^2}$$

$$|F_{\text{net}}| = 0.0609 \text{ N}$$

$$\theta = \tan^{-1} \left(\frac{F_y}{F_x} \right)$$

$$\theta = \tan^{-1} \left(\frac{-0.0144}{-0.0592} \right)$$

$$\theta = 13.67^\circ$$



$$\theta = 13.67 + 180$$

$$\theta = 193.67^\circ$$

$$F_{net} = 0.0609 \text{ N @ } 193.67^\circ$$

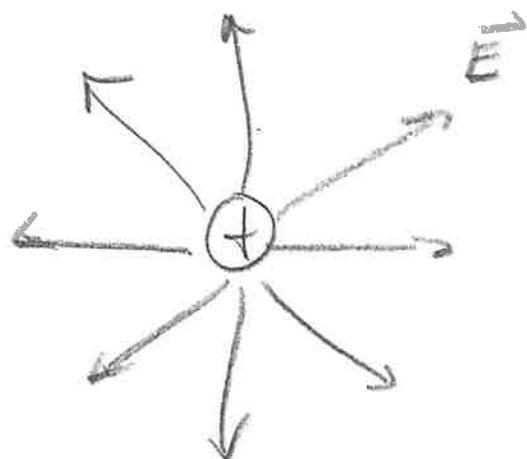
Electric Field

- A method for visualizing how a small, positive charge (i.e., a test charge) interacts with a charge Q at any point.

(4)

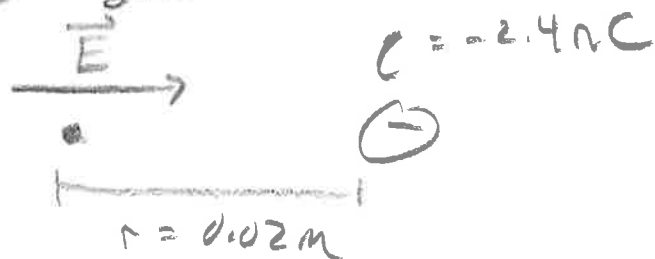
$$E = \left| \frac{F}{q} \right| = \frac{k|q|}{r^2}$$

- $\vec{E}$ has units N/C



Electric Field Example

1. Calculate the strength of the electric field 2cm away from a charge of -2.4 nC .



$$E = \frac{k|q|}{r^2}$$

$$E = \frac{9 \times 10^9 \cdot |-2.4 \times 10^{-9}|}{(0.02)^2}$$

$$|E| = 54000 \text{ N/C}$$

(5)

Electric Field Example 2

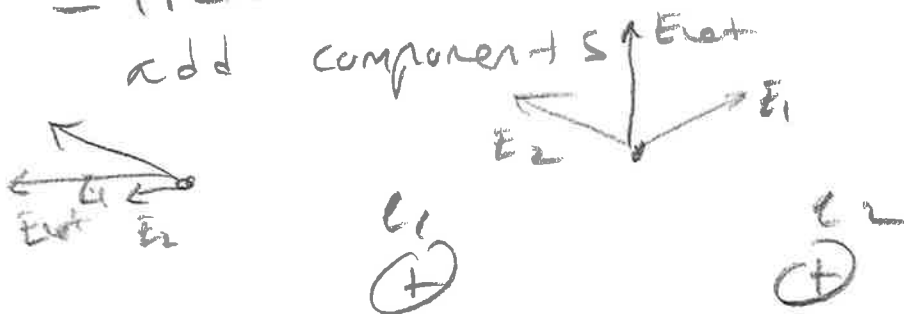
2. An electron is released in an electric field $E = 100 \text{ N/C}$.

a) Find the magnitude of the force applied on the electron.

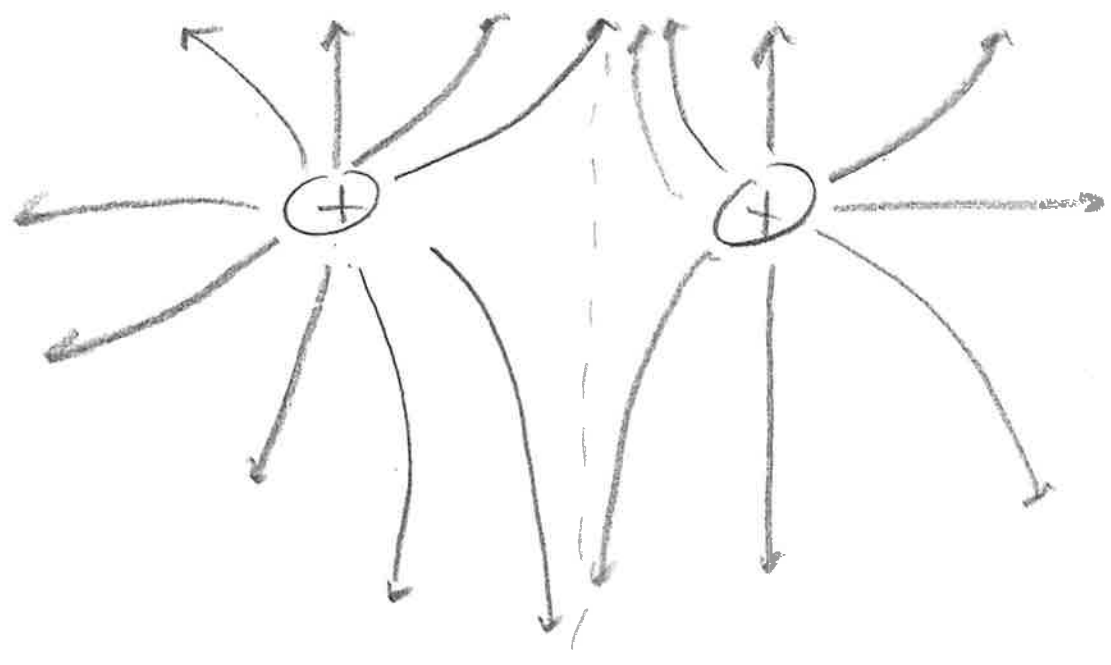
b) Calculate the speed of the electron after it has moved 1 m.

Electric Field lines for multiple charges.

- Treat each charge individually, and add components



6



E-field lines Example

