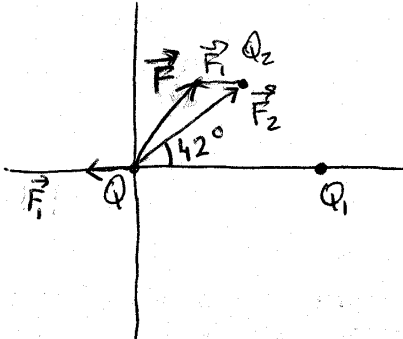


Johannes Kerimo ✓

Yellow

4. (35 pts) A point charge $Q_1 = -4.0 \times 10^{-9} \text{ C}$ is on the positive x -axis at $r_1 = 6 \text{ cm}$ from the origin. A point charge $Q_2 = 5.0 \times 10^{-9} \text{ C}$ makes a counterclockwise angle $\theta = 42^\circ$ to the positive x -axis, at $r_2 = 4 \text{ cm}$ from the origin. A charge $Q = -2.0 \times 10^{-9} \text{ C}$ is placed at the origin. Q_1 and Q_2 act on Q with forces \vec{F}_1 and \vec{F}_2 .



- a. Find $|\vec{F}_1|$ and $|\vec{F}_2|$.

$$|\vec{F}_1| = \frac{k |Q_1 Q|}{r_1^2} = \frac{(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}) (4 \times 10^{-9} \text{ C}) (2 \times 10^{-9} \text{ C})}{(0.06 \text{ m})^2} = 2 \times 10^{-5} \text{ N}$$

$$|\vec{F}_2| = \frac{k |Q_2 Q|}{r_2^2} = \frac{(9 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}) (5 \times 10^{-9} \text{ C}) (2 \times 10^{-9} \text{ C})}{(0.04 \text{ m})^2} = 5.6 \times 10^{-5} \text{ N}$$

- b. On the figure, draw \vec{F}_1 and \vec{F}_2 with their tails on Q , and in relative proportion.

- c. Find F_x , the x -component of the total force \vec{F} on Q .

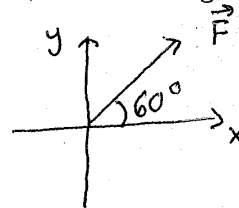
$$F_x = -|\vec{F}_1| + |\vec{F}_2| \cos 42^\circ = 2.2 \times 10^{-5} \text{ N}$$

- d. Find F_y , the y -component of \vec{F} .

$$F_y = |\vec{F}_2| \sin 42^\circ = 3.8 \times 10^{-5} \text{ N}$$

- e. Find the angle \vec{F} makes with respect to the x -axis, and on the figure sketch the direction of \vec{F} .

$$\theta = \tan^{-1} \left(\frac{F_y}{F_x} \right) = 60^\circ$$



- f. Find $|\vec{F}|$.

$$|\vec{F}| = \sqrt{F_x^2 + F_y^2} = 4.35 \times 10^{-5} \text{ N}$$

- g. Q_1 and Q_2 are rotated clockwise by 65 degrees about the origin. From parts e) and f) find the new F_x .

$$F'_x = |\vec{F}| \cos(60^\circ - 65^\circ) = 4.33 \times 10^{-5} \text{ N}$$