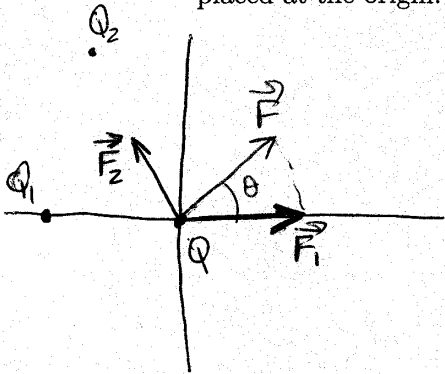


4. (35 pts) A point charge $Q_1 = -4.0 \times 10^{-9}$ C is on the negative x -axis at $r_1 = 3$ cm from the origin. A point charge $Q_2 = 6.0 \times 10^{-9}$ C makes a counterclockwise angle $\theta = 128^\circ$ to the positive x -axis, at $r_2 = 4$ cm from the origin. A charge $Q = -3.0 \times 10^{-9}$ C is placed at the origin. Q_1 and Q_2 act on Q with forces \vec{F}_1 and \vec{F}_2 .

Pink



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

$$|\vec{F}_1| = k \frac{|Q_1 Q|}{r_1^2} = \frac{(9 \times 10^9 \frac{N \cdot m^2}{C^2})(4 \times 10^{-9} C)(3 \times 10^{-9} C)}{(0.03 m)^2} = 12 \times 10^{-5} N$$

$$|\vec{F}_2| = k \frac{|Q_2 Q|}{r_2^2} = \frac{(9 \times 10^9)(6 \times 10^{-9})(3 \times 10^{-9})}{(0.04)^2} = 10.125 \times 10^{-5} N$$

- 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 .

$$F_x = |\vec{F}_1| + |\vec{F}_2| \cos 128 = 5.78 \times 10^{-5} N$$

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

$$F_y = |\vec{F}_2| \sin 128 = 7.98 \times 10^{-5} N$$

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

$$\tan \theta = \frac{F_y}{F_x} = 1.382, \quad \theta = 54.1^\circ$$

in first quadrant, as expected

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

$$|\vec{F}| = \sqrt{F_x^2 + F_y^2} = 9.85 \times 10^{-5} N$$

- g. Q_1 and Q_2 are rotated clockwise by 35 degrees about the origin. From parts e) and f) find the new F_x .

$$F_x' = |\vec{F}| \cos(54.1 - 35) = 9.31 \times 10^{-5} N$$