

Coulomb's Law & Electric Fields:

1. Consider a fixed point charge of $+1.5 \mu\text{C}$ (q_1). A 2nd charge of $-0.5 \mu\text{C}$ (q_2) is placed at a distance of 0.5 m from q_1 .



a. What is the magnitude and direction of the electric force exerted on q_2 due to q_1 ?

Ans.

$$\vec{F}_e = -k \frac{q_1 q_2}{d^2} \hat{i} = -(8.99 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}) \frac{(1.5 \times 10^{-6} \text{C})(0.5 \times 10^{-6} \text{C})}{(0.5 \text{m})^2} \hat{i} = -0.0270 \text{N} \hat{i}$$

b. A 3rd charge of $-1.0 \mu\text{C}$ (q_3) is placed 0.25 m directly to the right of q_2 . What is the magnitude and direction of the electric force exerted on q_3 ?

Ans.

Diagram showing three point charges in a horizontal line: $q_1 = +1.5 \mu\text{C}$, $q_2 = -0.5 \mu\text{C}$, and $q_3 = -1.0 \mu\text{C}$. The distance between q_1 and q_2 is $d = 0.5 \text{ m}$, and between q_2 and q_3 is $d = 0.25 \text{ m}$.

$$\vec{F}_e = \left(-k \frac{q_1 q_3}{d_{1 \rightarrow 3}^2} + k \frac{q_2 q_3}{d_{2 \rightarrow 3}^2} \right) \hat{i} =$$

$$\vec{F}_e = (8.99 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}) (1.0 \times 10^{-6} \text{C}) \left(-\frac{(1.5 \times 10^{-6} \text{C})}{(0.75 \text{m})^2} + \frac{(0.5 \times 10^{-6} \text{C})}{(0.25 \text{m})^2} \right) \hat{i} = 0.0479 \text{N} \hat{i}$$

c. If q_3 is exactly halfway between q_1 and q_2 , what is the magnitude and direction of the electric force exerted on q_3 ?

Ans.

Diagram showing three point charges in a horizontal line: $q_1 = +1.5 \mu\text{C}$, q_3 , and $q_2 = -0.5 \mu\text{C}$. The distance between q_1 and q_3 is $d = 0.25 \text{ m}$, and between q_3 and q_2 is $d = 0.25 \text{ m}$.

$$\vec{F}_e = \left(-k \frac{q_1 q_3}{d_{1 \rightarrow 3}^2} - k \frac{q_2 q_3}{d_{2 \rightarrow 3}^2} \right) \hat{i} =$$

$$\vec{F}_e = (8.99 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}) (1.0 \times 10^{-6} \text{C}) \left(-\frac{(1.5 \times 10^{-6} \text{C})}{(0.25 \text{m})^2} - \frac{(0.5 \times 10^{-6} \text{C})}{(0.25 \text{m})^2} \right) \hat{i} = -0.288 \text{N} \hat{i}$$

d. If q_3 is moved 0.3 m downward but still equidistant to q_1 and q_2 , what is the magnitude and direction of the electric force exerted on q_3 ?

Ans.

Diagram showing three point charges: $q_1 = +1.5 \mu\text{C}$, $q_2 = -0.5 \mu\text{C}$, and q_3 . q_3 is positioned below the line connecting q_1 and q_2 , such that the distance from q_3 to both q_1 and q_2 is d .

$$\vec{F}_e = \left(-k \frac{q_1 q_3}{d_{1 \rightarrow 3}^2} - k \frac{q_2 q_3}{d_{2 \rightarrow 3}^2} \right) \hat{i} + \left(-k \frac{q_1 q_3}{d_{1 \rightarrow 3}^2} - k \frac{q_2 q_3}{d_{2 \rightarrow 3}^2} \right) \hat{j} =$$

$$\vec{F}_e = -0.288 \text{N} \hat{i} + (8.99 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}) (1.0 \times 10^{-6} \text{C}) \left(\frac{(1.5 \times 10^{-6} \text{C})}{(0.30 \text{m})^2} - \frac{(0.5 \times 10^{-6} \text{C})}{(0.30 \text{m})^2} \right) \hat{j}$$

$$\vec{F}_e = -0.288 \text{N} \hat{i} - 0.010 \text{N} \hat{j}$$

Electrostatic Electric Field Practice Exercises Answer Key

Scott C. Dulebohn



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