Three point charges are located on the x-axis.

$q_1 = -10\ nC$ is at $x_1 = -1.74\ m$

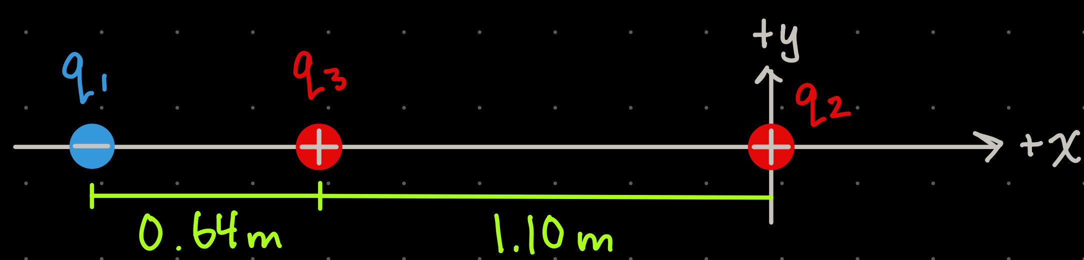
$q_2 = +32.5\ nC$ is at the origin

$q_3 = +55\ nC$ is at $x_3 = -1.10\ m$

→ What is the net force exerted on q_3 by q_1 and q_2?

1. Understand the Problem

- The problem is asking to calculate the net force on q_3. This net force is the sum of two forces: q_1 on q_3 and q_2 on q_3.
- We can use Coulomb's law to find the two forces F_{13} and F_{23}, where $F_{13} = \frac{k|q_1 q_3|}{r_{13}^2}$ and $F_{23} = \frac{k|q_2 q_3|}{r_{23}^2}$
- We can determine the direction of the force by inspecting the signs of the interacting charges. Like charges repel and unlike charges attract.
- We are given the magnitudes and signs of the three charges. We are also given the locations of the charges relative to the origin. A diagram helps to show the distances between the charges, which is what we need to use in Coulomb's Law.

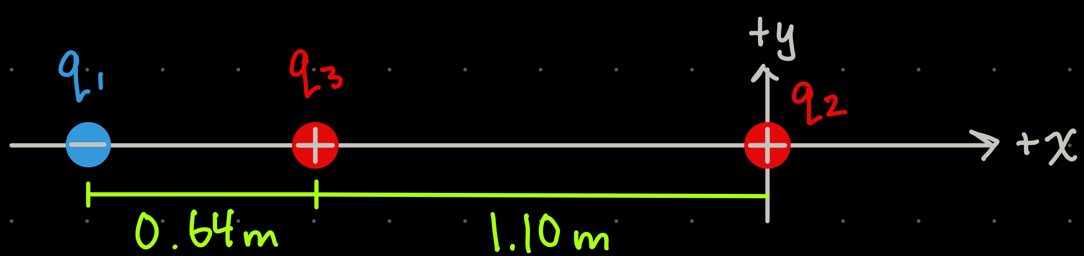


2. Plan Your Approach

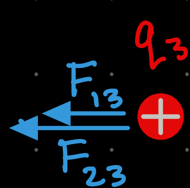
- Calculate two forces: F_{13} and F_{23}, then determine the direction of each force
- $\vec{F}_{net} = \sum \vec{F} = \vec{F}_{13} + \vec{F}_{23}$ $\Rightarrow$ If the forces are in the same direction, add the magnitudes. If the forces are in opposite directions, subtract the magnitudes.
- Since q_3 is interacting with q_1 and q_2 simultaneously, we need to find the forces separately first. Then we can apply Newton's 2nd Law to find the net force.
- We only care about the force on q_3 so we can ignore any interaction between q_1 and q_2

3. Execute the solution

- calculate $|\vec{F}_{13}| = \dfrac{k|q_1 q_3|}{r_{13}^2} = \dfrac{\left(9\times10^{9} \frac{N\cdot \cancel{m^2}}{\cancel{C^2}}\right)\left(10\times10^{-9}\,\cancel{C}\right)\left(55\times10^{-9}\,\cancel{C}\right)}{(0.64\,\cancel{m})^2}$
- cancel units, end up with N which is what we expect
  $|\vec{F}_{13}| = 1.21\times10^{-5}\ N$
- calculate $|\vec{F}_{23}| = \dfrac{k|q_2 q_3|}{r_{23}^2} = \dfrac{\left(9\times10^{9} \frac{N\cdot \cancel{m^2}}{\cancel{C^2}}\right)\left(32.5\times10^{-9}\,\cancel{C}\right)\left(55\times10^{-9}\,\cancel{C}\right)}{(1.10\,\cancel{m})^2}$
- cancel units, $|\vec{F}_{23}| = 1.33\times10^{-5}\ N$



- q_1 pulls on q_3 to the left ($-x$ direction)
- q_2 pushes on q_3 to the left ($-x$ direction



- since the two forces point in the same direction, we can add the magnitudes to find the net force

$$F_{net} = 1.21 \times 10^{-5} N + 1.33 \times 10^{-5} N$$
$$= 2.54 \times 10^{-5} N$$

- since both forces point in the $-x$ direction, the net force also points in the $-x$ direction

$$\vec{F}_{net} = -2.54 \times 10^{-5} N \hat{i}$$

4. Reflect on Initial Results
   - my calculations seem correct since the units work out correctly with N for force.
   - the magnitude of the force makes sense. The charges are pretty small (nC) and the distance between the charges is pretty big (m), so the resulting force should be small.
   - double checking the directions of the forces, and they make sense. q_1 and q_3 have opposite signs so the force is attractive. q_2 and q_3 have the same sign so the force is repulsive.

5. Identify and address errors
   - checking the units and order of magnitude of the net force gives me confidence that my calculations do not contain errors.
   - checking the directions of the two forces gives me confidence that the direction of the net force is correct.

6. Iterate and Improve

- I didn't find errors or mistakes, so I do not need to improve on this solution. If I had found mistakes in step 5, then I would correct them here.

7. Connect and Reflect

- I learned how to apply Coulomb's Law to a system of charges and how to determine both magnitude and direction of the forces
- I related this back to the Physics I concept of Newton's 2nd Law to find the net force : $\vec{F}_{net} = \Sigma \vec{F}$
- Using the principle of superposition, I was able to simplify a complex system by calculating the individual forces first and then bringing them together in the end. I will continue using this problem-solving method in future problems.