1 Overview

See also Chapter 21 of Young and Freedman 2015, 14th Edition

Electric Force

Magnitude: $F = \frac{1}{4\pi\epsilon_o}\frac{|q_1 q_2|}{r^2}$

Direction: Force is along line that connects q_1 and q_2. Direction depends on signs of q_1 and q_2. (Likes repel, opposites attract.) r is separation distance. Sometimes k is used in place of the proportionality constanat $1/4\pi\epsilon_o$.

Electric Field

Compute force $\mathbf{F}$ due to all other charges on a hypothetical charge q at point where you want to compute $\mathbf{E}$. To find $\mathbf{E}$ at that point, divide $\mathbf{F}$ by q.

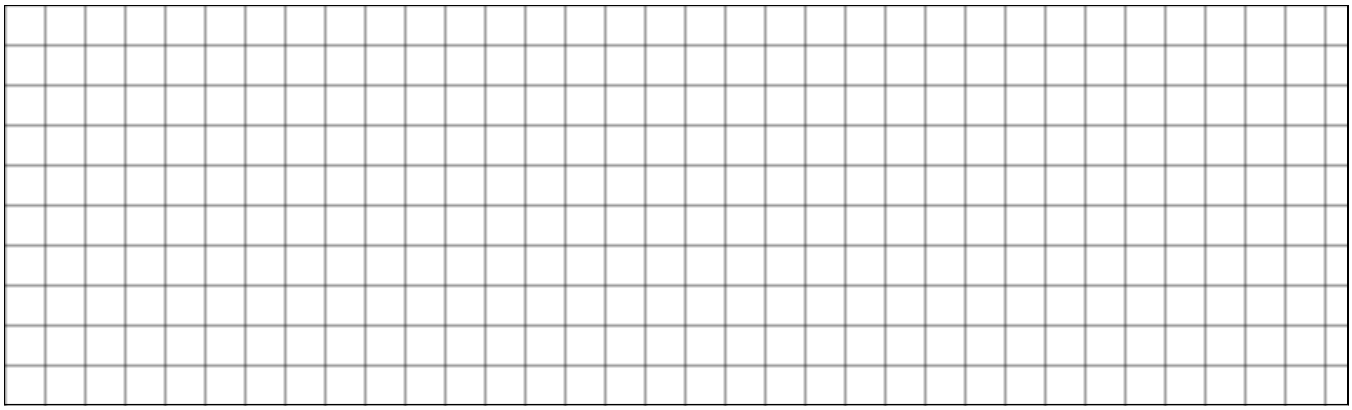
$$\mathbf{E} = \frac{\mathbf{F}}{q}$$

To find $\mathbf{F}$ when a different charge Q is placed where q was, multiply $\mathbf{E}$ by Q.

2 Electric Force

Charge q_1 is at $(x, y) = (a, a)$. Charge q_2 is at $(x, y) = (a, 2a)$. Draw this charge configuration on the provided graph paper.

1. Find the magnitude of the force that q_1 exerts on q_2. Show your work in the space below. Compare your answer with other students in your group.



2. Find the direction of the force that q_1 exerts on q_2 assuming both q_1 and q_2 are positive. Express your answer as an angle with respect to the x-axis, with counterclockwise rotation being positive. Show your work in the space below.

Draw the two charges described above three times in the space below and label them 3., 4., and 5. Draw arrows to indicate the directions of movement.

3. If q_1 and q_2 are both positive, in what directions will each move if released?
4. If q_1 and q_2 are both negative, in what directions will each move if released?
5. If q_1 and q_2 have opposite signs, in what directions will each move if released?

3 Electric Field

Charge q_1 is at $(x, y) = (a, a)$.

1. Find the magnitude of the electric field at $(x, y) = (a, 2a)$. Show your work. Compare your answer with other students in your group.

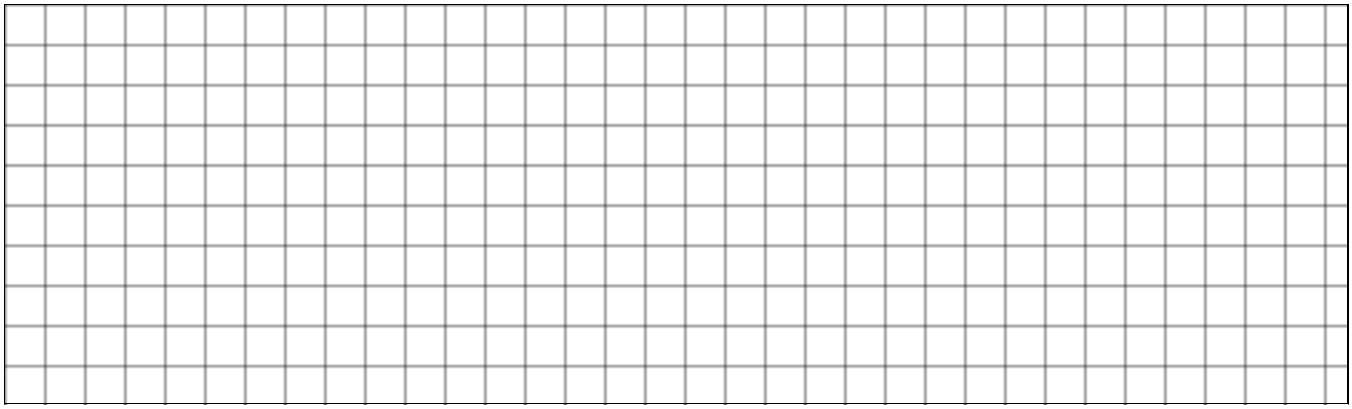
2. Find the direction of the electric field at $(x, y) = (a, 2a)$ if q_1 is positive. Express your answer as an angle with respect to the x-axis, with counterclockwise rotation being positive. Show your work.

3. If there are no other charges besides q_1, why it does not make sense to ask what the electric force is at $(x, y) = (a, 2a)$?

4. If a charge Q is placed at $(a, 2a)$, what will be the magnitude of the electric force that is exerted on it? Will the direction of this force depend on the signs of q_1 and Q?

4 E for a System of Charges

Charge $q_1 = +q$ is at $(x, y) = (a, 0)$, charge $q_2 = +q$ is at $(x, y) = (-a, 0)$, and charge $q_3 = -q$ is at $(x, y) = (0, a)$. Assume that the quantity associated with q is positive. Draw this charge configuration on the provided graph paper.



1. Find the electric field magnitude and direction at the origin. Show your work in the space below.

2. Find the electric field magnitude and direction at the origin if $q_1 = -q$.

3. What is still confusing about electric forces and fields? If nothing, what is one thing that you learned from this tutorial?