

## Background

*Electric fields* are used to describe the region of space in the vicinity of electric charges. *Electric potential energy* is used to describe the Work that it takes to move charges through those fields.

We can also describe the *Work per unit charge* that it takes to move through those fields, without having to look at energy changes for a specific charge.

This lab activity asks you to experiment with these ideas.

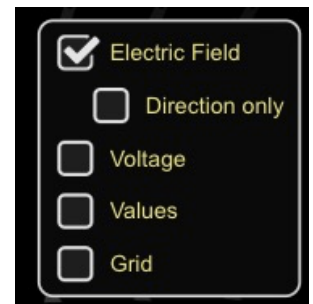
## Objectives

To use a computer model of electric fields and electric potentials to better understand the relationships between charges  $q$ , electric fields  $E$ , electric potential energy  $U$ , and electric potential  $V$ .

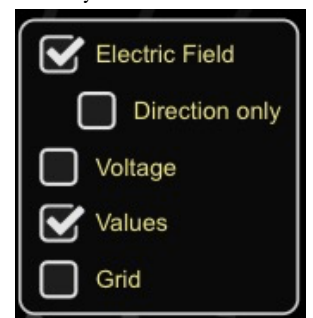
## Procedure

1. Go to the PhET page at <https://phet.colorado.edu/en/simulation/charges-and-fields> and click on the arrow to open up the activity.
2. Electric Fields

- a. Make sure that for this part of the activity, only the Electric Field box is checked.
- b. Onto the blank work area drag one or two charges, and notice how the electric field vectors adjust to indicate the Electric field in the vicinity of those charges.
- c. Drag a yellow sensor into the Electric field area. The sensor doesn't have a charge, but it does represent a polarity. Is it a *positive* or *negative* polarity?



- d. Move the sensor around from place to place. What does the magnitude of the yellow sensor's vector represent?
- e. Click on the Values checkbox now, and identify the units associated with the yellow sensor's vector. What type of value do those units indicate? Does it correspond with your answer for (d) above?
- f. Drag one or two more charges into the work area to create a more complex field. Use a yellow sensor to get some sense of how the field looks, and then draw a representation of your electric field in the space here. You should draw your field using *field lines*, not the field vectors that have been calculated for this simulation.



## Lab: Electric Potentials

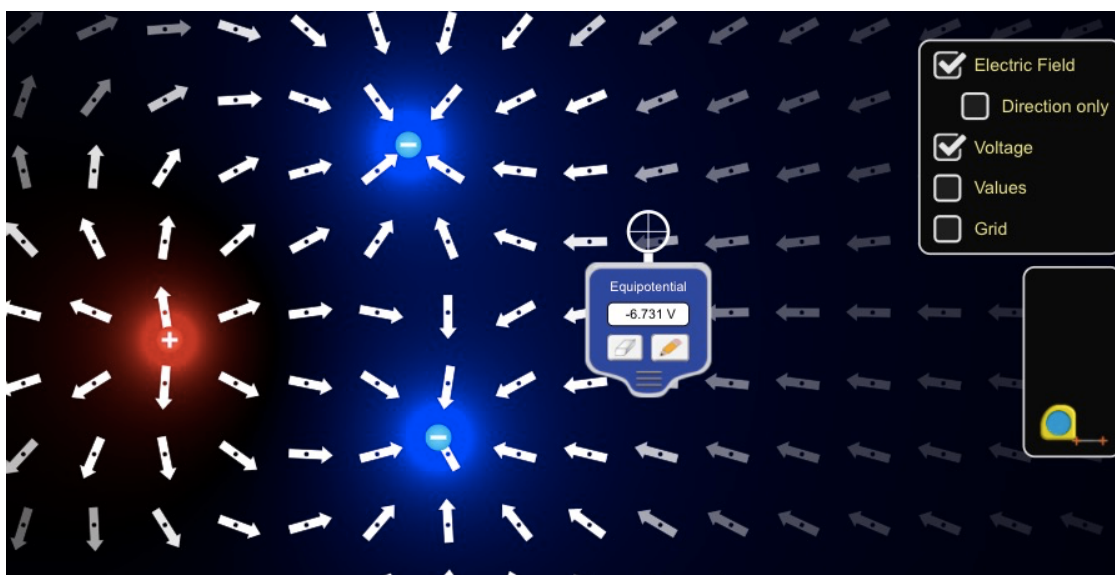
## AP Physics

### 3. Electric Potential

- Clear out your work area by clicking on the orange reset button in the lower right of the simulation.
- Place three charges of your choice into the work area (as shown below), separated by a distance of about 2.00 meters. (You can use the measuring tape tool on the side to help identify the distance between charges.)

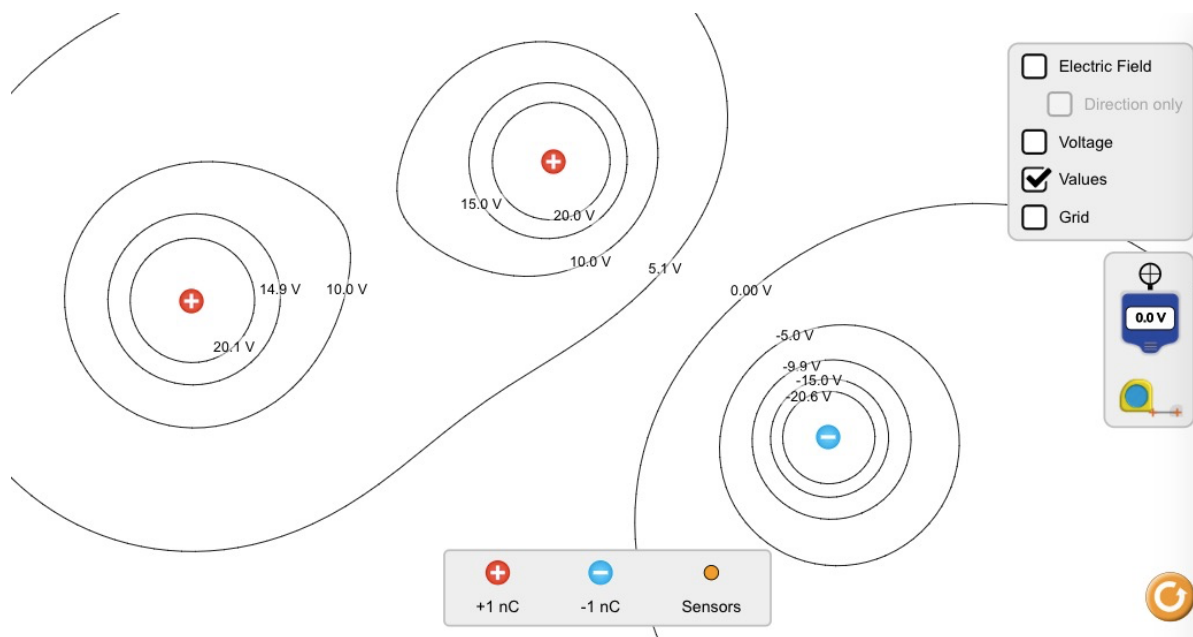


- Once your charges have been set up, bring out the Potential Sensor tool from the right side and begin moving it around (see below). Try to identify a region of space where the electric potential is around 0 Volts. Once you've moved the Potential Sensor to that position, click on the pencil icon to draw the 0 Volt equipotential. You might want to click on the Values checkbox as well to see the value of that equipotential line.



- Create equipotentials for every 5 Volts or so, in both the positive (+5 V, +10 V, +15 V, etc.) and the negative direction (-5 V, -10 V, -15V). What do you notice about the orientation of the equipotential lines and the orientation of the electric fields along those equipotentials?

- e. Take a look at the equipotential diagram below. What would the electric field look like in the vicinity of these charges? How would you use the location of the equipotentials to draw that field? Draw your own electric field lines on this diagram to indicate the electric field.



- f. Calculate much *net* Work per unit charge would it take to move a particle from a -15 V potential to a +10 V potential? Does the path of the motion matter?
- g. Calculate how much actual Work it would take to move an electron from -15 V to +10 V.

- h. Consider the electric field/electric potential around a lone point charge of  $+5 \text{ nC}$ . (You can model this by piling five  $1\text{-nC}$  charges on top of the same location.) Use the Potential Sensor tool to identify the electric potential at 1 meter away, 2 meters away, 3 meters away, and 4 meters away.
  
- i. How well do the values determined in the simulation match the theoretical calculations of electric potential near a  $+5 \text{ nC}$  point charge? Give mathematical evidence.
  
- j. What would the initial acceleration of an electron, placed at the  $10 \text{ V}$  potential near the  $+5 \text{ nC}$  point charge, experience?
  
- k. How fast will that electron be traveling once it arrives at a  $20 \text{ V}$  potential? Will it be traveling *towards* or *away from* the  $+5 \text{ nC}$  charge?