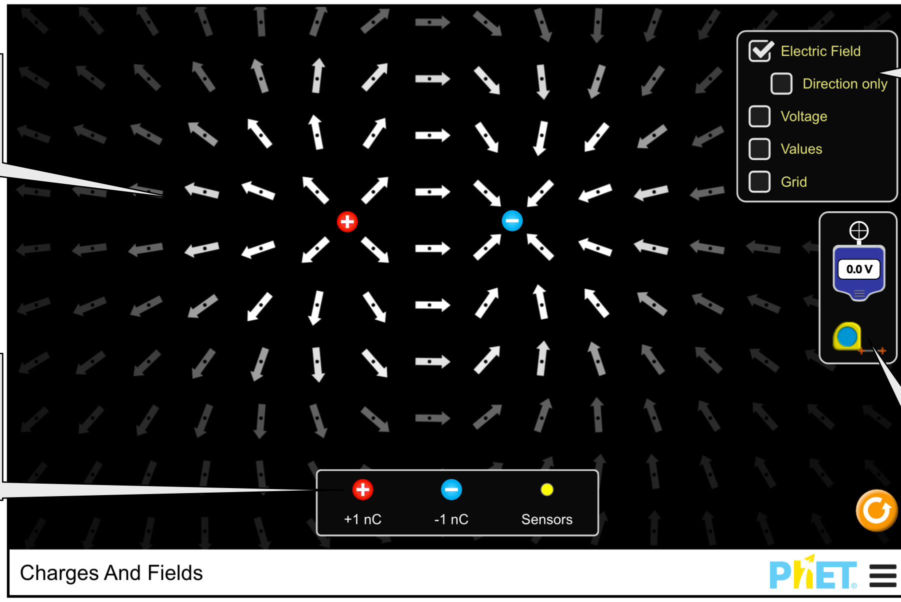
PhET Tips for Teachers — Charges and Fields

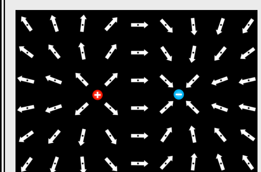
In **Charges and Fields** students explore electrostatics as they arrange positive and negative charges space and observe the resulting electric field, voltage, and equipotential lines.

OBSERVE the electric field

DRAG charges and sensors out of the toolbox



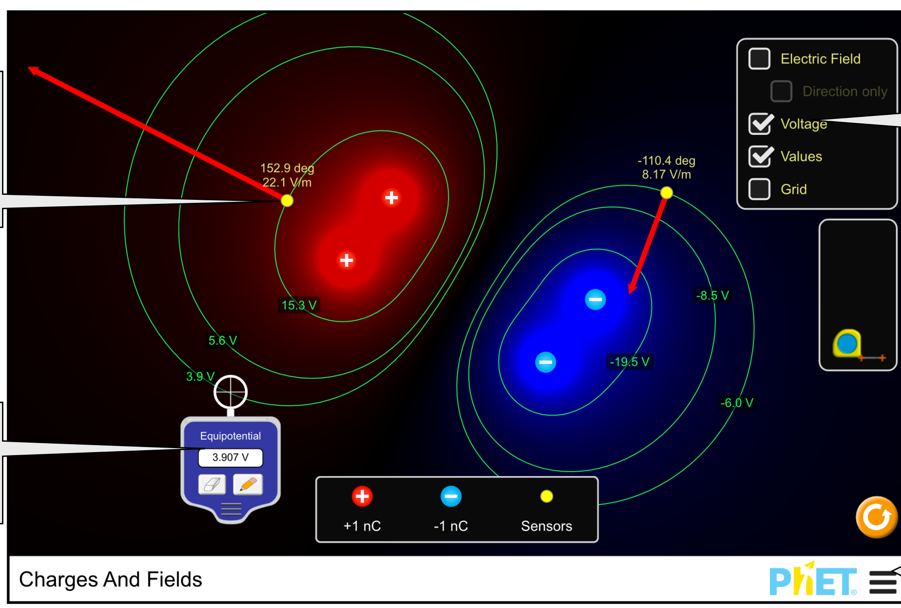
VIEW the direction of the electric field



MEASURE the distance

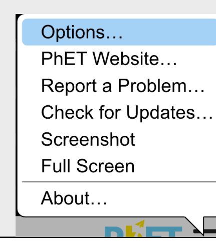
MEASURE the electric field at a precise location

PLOT equipotential lines



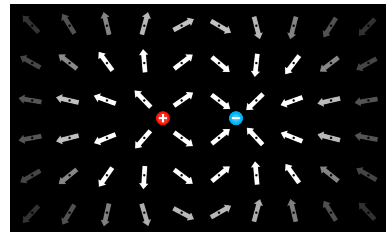
VIEW the electric potential

CHANGE the background color of the sim to white for projection

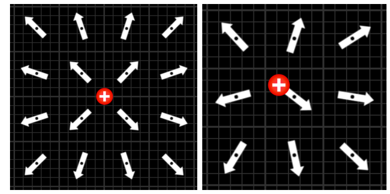


Rouinfar, September 2016

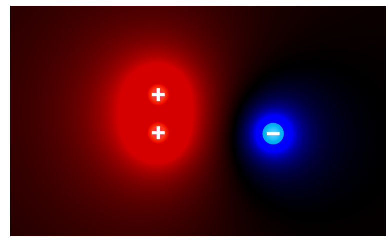
Model Simplifications



- The charges are assumed to pinned wherever they are placed.
- The electric field is displayed using an array of arrows fixed to a grid. The brightness of the arrows indicates the magnitude of the field. This representation allows for discussion about the direction and magnitude of the electric field.



- The grid is arranged so that if a single charge is placed on a major intersection, the electric field will look like a classic textbook picture (left), whereas a charge placed off the grid may look odd (though still correct) at first glance (right).
- The “Direction only” option removes the brightness gradient from the E-field arrows to allow the direction of the E-field to be explored separately from its magnitude.
- The sensors can be used to detect the precise magnitude and direction of the E-field at any location.
- Charges can be placed on top of one other. If a +/- pair is overlapped, the electric field will become zero. If three or more +/- pairs are overlapped, the sim may experience buggy behavior.



- The electrostatic potential can be displayed using the “Voltage” checkbox. The brighter the color, the larger the magnitude of the voltage. Positive voltages are red, and negative voltages are blue, black represents 0 V (though voltages that a relatively small may also appear black).

Suggestions for Use

Challenge Prompts

- Create a +2 nC (or +3 nC, -2 nC, - 3 nC) charge.
- Predict the direction and size of an E-field sensor before it is placed.
- Determine where the electric field is the greatest for two opposite charges in a line. Is there a point where the electric field is zero?
- Design an experiment to determine the relationship between distance, the magnitude of charge, and the strength of the electric field around a single charge.
- Choose a charge configuration with at least two charges, and predict how the electric field around the charges will look at four different points. Verify the prediction using vector addition.
- Construct a parallel-plate capacitor and examine the electric field between the plates.
- Identify the factors that contribute to a large electric potential (voltage).
- Explore the behavior of the electric field along an equipotential line.

See all published activities for Charges and Fields here.
For more tips on using PhET sims with your students, see Tips for Using PhET.