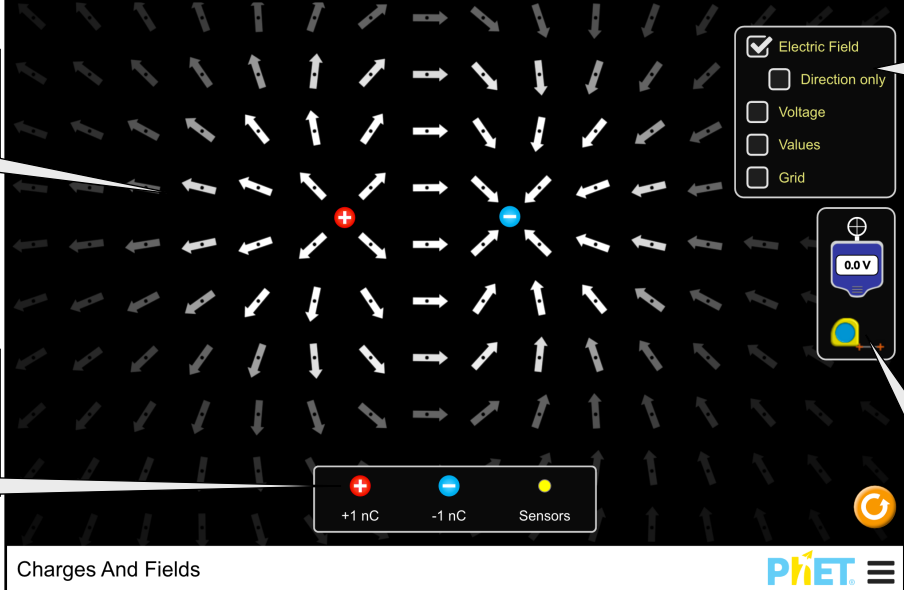


In **Charges and Fields** students explore electrostatics as they arrange positive and negative charges space and observe the resulting electric field, voltage, and equipotential lines.



OBSERVE the electric field

DRAG charges and sensors out of the toolbox

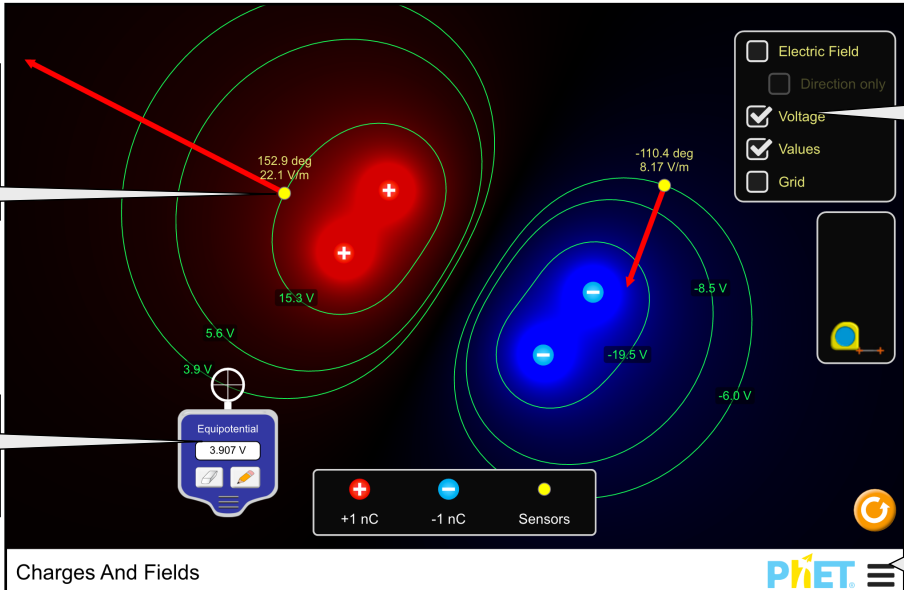
VIEW the direction of the electric field

MEASURE the distance

Charges And Fields

PhET

The screenshot shows the 'Charges and Fields' simulation interface. A central workspace displays a grid of white arrows representing the electric field between a positive charge (+1 nC) and a negative charge (-1 nC). A toolbox at the bottom contains icons for adding charges and sensors. On the right, a control panel allows toggling 'Electric Field', 'Voltage', 'Values', and 'Grid'. A small inset window shows a zoomed-in view of the field lines. A sensor icon is also visible, used for measuring 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

Options...

- PhET Website...
- Report a Problem...
- Check for Updates...
- Screenshot
- Full Screen
- About...

Charges And Fields

PhET

This screenshot shows the same simulation but with different settings. The background is dark, and equipotential lines are plotted as concentric circles around the charges. A red arrow points to a specific location where the electric field is being measured, showing a value of 22.1 V/m. Another red arrow points to a location where the electric potential is being measured, showing a value of -19.5 V. The control panel on the right now has 'Voltage' and 'Values' checked. An 'Options...' menu is open, showing various settings like 'PhET Website...', 'Report a Problem...', 'Check for Updates...', 'Screenshot', 'Full Screen', and 'About...'.

Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '?' to the sim URL, and separating each query parameter with an '&'. The general URL pattern is:

```
...html?queryParameter1&queryParameter2&queryParameter3
```

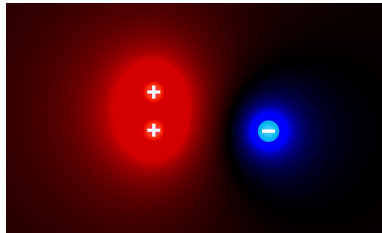
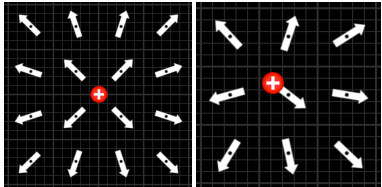
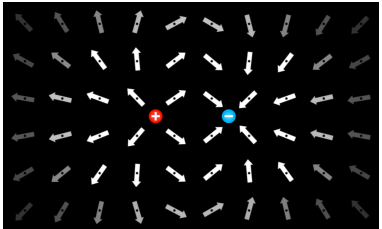
For example, in Charges and Fields, if you want to run the sim in Spanish (`locale=es`) and disable external links (`allowLinks=false`) use:

```
https://phet.colorado.edu/sims/html/charges-and-fields/latest/charges-and-fields_all.html?locale=es&allowLinks=false
```

Query Parameter and Description	Example Links
<code>locale</code> - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on the simulation page on the Translations tab. Note: this only works if the simulation URL ends in “_all.html”.	<code>locale=es</code> (Spanish) <code>locale=fr</code> (French)
<code>allowLinks</code> - when <code>false</code> , disables links that take students to an external URL. Default is <code>true</code> .	<code>allowLinks=false</code>

Model Simplifications

- The charges are assumed to be 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 are 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](#).