

## Macro Scale Screen

Visualize the electrostatic force that two charges exert on each other, and adjust the charge magnitude and separation to see how they affect the force.

**SEE** the forces in the system

**MEASURE** the distance between charges

**VIEW** forces in standard or scientific notation

## Atomic Scale Screen

Explore electrostatic attraction and repulsion at the atomic scale, and build a Hydrogen atom.

**DRAG** charges apart or together

**OBSERVE** the distance scale

**SHOW/HIDE** force magnitude

## 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 Coulomb's Law, if you only want to include the 1st screen (`screens=1`), with projector mode enabled (`colorProfile=projector`) use:

[https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law\\_all.html?screens=1&colorProfile=projector](https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law_all.html?screens=1&colorProfile=projector)

To run this in Spanish (`locale=es`), the URL would become:

[https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law\\_all.html?locale=es&screens=1&colorProfile=projector](https://phet.colorado.edu/sims/html/coulombs-law/latest/coulombs-law_all.html?locale=es&screens=1&colorProfile=projector)

Query Parameter and Description	Example Links
<code>screens</code> - specifies which screens are included in the sim and their order. Each screen should be separated by a comma. For more information, visit the <a href="#">Help Center</a> .	<code>screens=1</code> <code>screens=2,1</code>
<code>initialScreen</code> - opens the sim directly to the specified screen, bypassing the home screen.	<code>initialScreen=1</code> <code>initialScreen=2</code>
<code>locale</code> - specify the language of the simulation using <a href="#">ISO 639-1</a> codes. Available locales can be found on the simulation page on the <a href="#">Translations tab</a> . Note: this only works if the simulation URL ends in "_all.html".	<code>locale=es</code> (Spanish) <code>locale=fr</code> (French)
<code>colorProfile</code> - changes simulation colors for easier projection.	<code>colorProfile=projector</code>
<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 color of the charge represents its sign (blue = negative, red = positive, gray = no charge). The saturation of the color represents the magnitude of the charge.
- The Force Values checkbox displays the **magnitude** of the forces, and is therefore always positive.
- The vector arrows represent the direction of the force, and scale with its magnitude. Due to the large range of possible values, the force vectors do not scale linearly, and are meant to be a qualitative representation.
- The figures attached to the charges are displayed to help students understand why the objects stay in place, despite their attraction or repulsion. When the force is attractive, the figures will pull on the masses. When the force is repulsive, the figures will push against the masses. The figures will take a deeper stance to indicate that the force exerted on the charge it is holding has increased. However, the figures are massless and do not contribute to the forces in the system.



- The figures on the Atomic Scale screen appear to be built out of a ball-and-stick modeling kit to help cue the scale differences between the screens.

## Suggestions for Use

### Sample Challenge Prompts

- Identify two ways you can change the amount of electrostatic force that the charges experience. How could you increase electrostatic force using each factor? How could you decrease electrostatic force using each factor?
- Select two different values for charge 1 and charge 2. How does the force that the smaller charge exerts on the larger charge compare to the force that the larger charge exerts on the smaller charge?
- Predict what happens to the electrostatic force as the distance between the charges is doubled.
- Explain the difference between attractive and repulsive forces.
- On the Atomic Scale Screen, measure the electrostatic force in a Hydrogen atom.
- Pick an independent variable to manipulate and design an experiment to determine what happens to the electrostatic force as this variable is changed. What do you observe?
- Design an experiment to determine the equation that describes the relationship between the electrostatic force, the charges, and the distance between the charges. Plot your data and choose an appropriate trend line.

### Explore Inverse Square Laws

Use [Gravity Force Lab](#) to investigate the gravitational force.

- Determine the similarities and differences between the gravitational and electrostatic forces.
- Compare the magnitudes of the gravitational and electrostatic forces in the hydrogen atom.

See all published activities for Coulomb's Law [here](#).

For more tips on using PhET sims with your students, see [Tips for Using PhET](#).