

## Capacitance Screen

Explore the relationship between capacitance, plate separation, and plate area.

**Capacitance** 0.40 pF

Separation 8.8 mm

Plate Area 400 mm<sup>2</sup>

1.5 V

-1.5 V

0.488 V

Capacitor Lab: Basics

Capacitance Light Bulb

**TOGGLE** switch to disconnect battery

**SET** voltage across capacitor (when connected)

**ADJUST** plate separation and plate area

**VIEW** electric field lines

**MEASURE** the voltage

## Light Bulb Screen

Connect a capacitor to a light bulb and experiment with a discharging RC-circuit.

**Capacitance** 1.77 pF

**Top Plate Charge** 0.64 pC

**Stored Energy** 0.11 pJ

Separation 2.0 mm

Plate Area 400 mm<sup>2</sup>

1.5 V

0 V

-1.5 V

Capacitor Lab: Basics

Capacitance Light Bulb

**OBSERVE** capacitance, charge, and stored energy in real-time

**CONNECT** light bulb; **OBSERVE** capacitor discharge

**VIEW** direction of current when the voltage is changed

**EXPLORE** bulb brightness and rate of decay

## Model Simplifications

- Resistance is not explicitly modeled when charging the capacitor. The capacitor appears to charge instantaneously, which could be explained by very low internal resistance in the battery and wires. This was done so that students would see immediate feedback when charging the capacitor.

- The resistance of the light bulb is extremely large ( $5 \times 10^{12} \Omega$ ) so that the rate of decay is observable.
- The battery is used to set capacitor voltage, which can have odd side effects. For example, connecting a charged capacitor to a 0 V battery will immediately drain the capacitor.
- The electric field is idealized as that of an infinite parallel plate capacitor, and fringe fields are not represented. The density of the electric field lines maps to its magnitude, and there are a minimum of four E-field lines (one per quadrant of the capacitor).
- The current arrows appear when there is a change in voltage in a complete circuit, and indicate the direction of the current, but not its magnitude.
- Due to limitations of precision, it is possible for some values to appear to be zero when they are not (e.g. zero stored energy when light bulb is dim). To minimize this issue, the battery slider will snap to zero when released if the voltage is less than 0.150 V.
- The entire metallic portion of the voltmeter probe is conductive, so it's possible to encounter situations where the voltmeter shows some value, despite the tip being located in the air or on an insulator (e.g. light bulb glass or battery casing).
- The voltmeter will display 0 V when its probes touch on another or are very close together.
- The Plate Charge bar graph displays the absolute value of the charge on the top plate. The color of the bar indicates the sign of those charges (red = positive, blue = negative).
- When the capacitor is disconnected (switch in vertical position) its charge is conserved.

## Suggestions for Use

### Sample Challenge Prompts

- Discover a method to change the capacitance of a capacitor.
- Predict what will happen to the capacitance when the plate separation or plate area is changed.
- Describe what happens to a charged capacitor when it is disconnected from the battery.
- Determine the relationships between the voltage, capacitance, plate charge, and stored energy.
- Design an experiment to determine what happens to the plate charge, stored energy, and voltage when the capacitance of a disconnected (but charged) capacitor is changed.
- Describe what happens to the brightness of the bulb as the capacitor drains.
- Determine how to maximize (a) the bulb's initial brightness and (b) the amount of time that the bulb remains lit.

See all published activities for Capacitor Lab: Basics [here](#).

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