

In the **Circuit Construction Kit: DC - Virtual Lab** simulation, students build circuits with resistors, batteries, and switches; experiment with conductors and insulators; and take measurements with laboratory equipment.

**BUILD** circuit; **EXPLORE** everyday objects

**TAP** circuit element to edit

**ZOOM** in or out

**SHOW** values

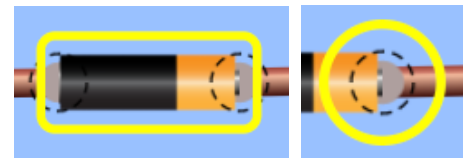
**MEASURE** the voltage or current

**VIEW** lifelike or schematic components

The screenshot shows a central circuit diagram with a light bulb, a battery, and a resistor. A current meter shows 1.80 A. The interface includes a toolbar on the left with items like Wire, Paper Clip, Coin, Eraser, and Pencil. On the right, there are control panels for 'Show Current' (Electrons/Conventional), 'Labels', 'Values', 'Wire Resistivity', and 'Battery Resistance'. A 'SHOW values' panel displays 9.0 V and 10.0 Ω. A 'Voltage' slider at the bottom is set to 9.0 volts. The PhET logo is in the bottom right corner.

## Complex Controls

- The delete key can be used to delete a selected circuit component or cut a selected vertex.



## Model Simplifications

- Both the electrons and conventional current representations are *cartoon-like* and do not perfectly model the current in the circuit. Their speed and density are an approximation, and should not be taken literally. The current animation will pause while a circuit element is dragged.
- The fire graphic denotes a short circuit or very high current (greater than 15 amps). When the current is very large, the simulation cannot properly animate the current, so the simulation speed will be reduced and an on-screen warning will appear.
- Wires are not ideal (minimum resistivity of  $10^{-5} \Omega \cdot m$ ) and long wires can affect the current in the circuit, as resistance is proportional to length. To find the resistance for any wire segment within a complete circuit, measure the current and voltage and use Ohm's Law to calculate the resistance.
- If a short is introduced in parallel, the rest of the circuit will likely continue to have a non-zero current (due to wire resistivity) but the electrons will appear to be frozen (due to reduced animation speed).
- When the current is (0 A, 0.02 A), a third decimal place will be added to the ammeter readout.
- The voltmeter probes read anywhere within a component's vertices. At times, this may create the illusion that the probes are not in contact with the conductive portions of the component.
- Batteries with internal resistance are modeled as a battery and resistor in series. Therefore, the voltage drop across the battery in a complete circuit will be zero (unless wire resistivity is high).

- The colored bands on the resistors accurately represent the resistance within  $\pm 5\%$ , as indicated by the gold tolerance band.
- The pencil has a resistance of  $25\ \Omega$ , which considers its **core** (graphite/clay), not its wooden casing.
- The light bulb behaves Ohmically, though a more realistic non-Ohmic bulb will be added at a later date.
- The light bulb brightness is proportional to the power through the bulb ( $P=V^2/R$ ), and maximum brightness is achieved at 2000 W.
- When fuses are connected in series and the current suddenly exceeds the highest rating (e.g. increasing voltage while switch is open, then closing the switch), one fuse will randomly blow regardless of current rating.

## Suggestions for Use

### Sample Challenge Prompts

- Build a circuit to turn on a light bulb.
- Predict what will happen to the brightness of a light bulb when the voltage is changed.
- Discover a way to connect two light bulbs in a circuit so that: (a) if one bulb is disconnected both bulbs go out, and (b) if one bulb is disconnected the other bulb will remain lit.
- Compare a circuit with two resistors connected in series to a circuit with two resistors connected in parallel. Describe what happens to the current and voltage across each resistor.
- Explain the advantages and disadvantages of series and parallel circuits.
- Design an experiment to determine which objects are insulators and which are conductors.
- Determine how to increase the electron speed or reverse the direction of motion. Explain your method.
- What does the fire represent?
- Predict what happens to the current in a circuit when battery resistance or wire resistivity is changed.

See all published activities for Circuit Construction Kit: DC - Virtual Lab [here](#).

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