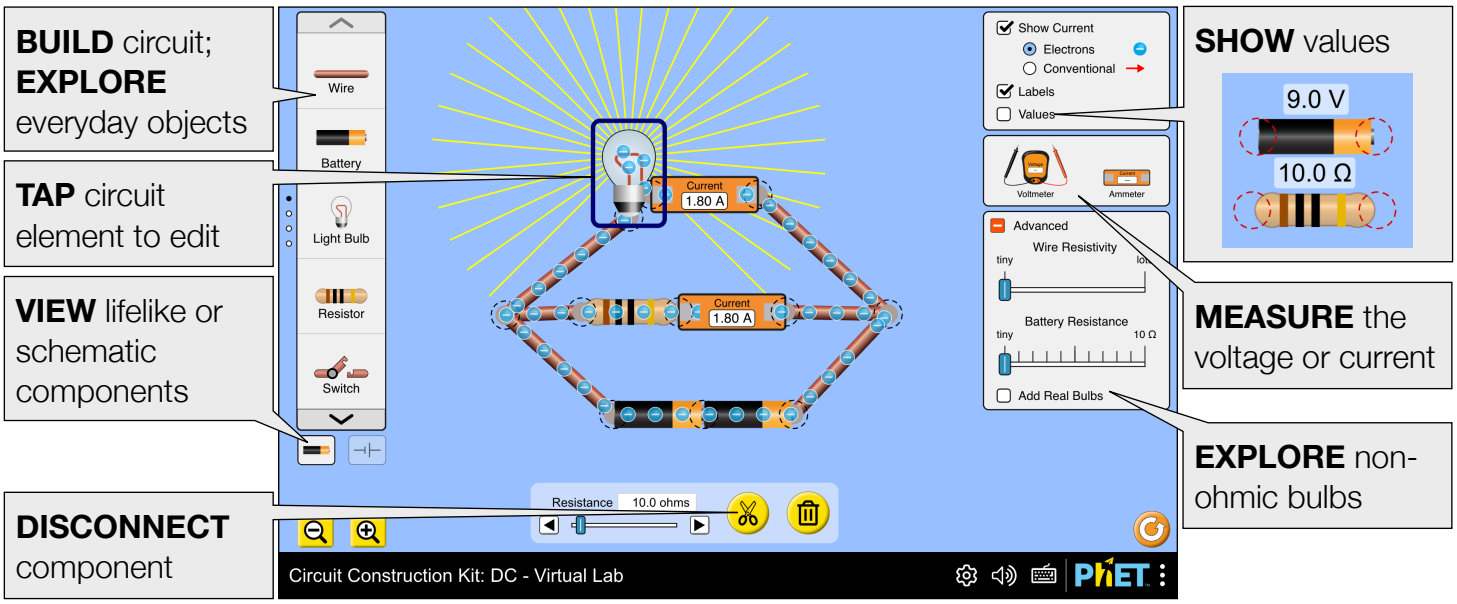
Circuit Construction Kit: DC - Virtual Lab

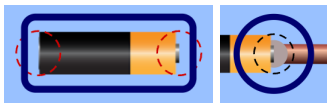
PhET Tips for Teachers

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



Complex Controls

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



Suggestions for Use

See all published activities for Circuit Construction Kit: DC - Virtual Lab.

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.
- 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.
- Predict what happens to the current in a circuit when battery resistance or wire resistivity is changed.

Simulation Details

See the sim's Model Documentation for more details.

- 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 animation conserves electrons/arrows, which can lead to situations with non-uniform density in parallel circuits. The current animation will pause while a circuit element is dragged.

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- 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^{-10} Ω·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.
- Batteries are not ideal and have a small internal resistance to accurately model the dynamics. The minimum internal resistance is 10^{-4} Ω. The internal resistance is modeled by adding a resistor in series. Therefore, the voltage drop across the battery in a complete circuit may be zero, if there are no other sources of resistance within the circuit.
- If a short is introduced in parallel, internal resistance is added to the battery. This is done so that the current through the other branch(es) of the circuit is more realistic. Note that this internal resistance will not be displayed when "Values" is turned on.
- 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.
- The ammeter displays magnitude by default. To explore negative currents, use the `ammeterReadout=signed` query parameter described in the Customization Options section above. For DC circuits, the current is positive by default. When an element is connected to a circuit, its current polarity will match the rest of the circuit. The sign clears whenever the current through an element becomes zero. This means that opening and closing a switch will reset the sign to positive. The current within a circuit will be self-consistent, but won't necessarily be consistent between separate circuits.
- The colored bands on the resistors accurately represent the resistance within ±5%, as indicated by the gold tolerance band.
- The pencil has a resistance of 25 Ω, which considers its **core** (graphite/clay), not its wooden casing.
- The standard and high-resistance light bulbs behave Ohmically. A non-Ohmic bulb can be accessed on the Lab screen by checking the "Add Real Bulbs" checkbox (or by running the sim with the `addRealBulbs` query parameter, see Customization Options above).
- 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.

Inclusive Features

See the simulation page for all supported inclusive features.

Alternative Input

- This simulation supports custom alternative input interactions, including hotkeys to jump between the component toolbox and circuit. See the Keyboard Shortcuts dialog in the simulation for more information.

Interactive Description (Core)

Core description is a subset of a fully described interactive experience.

- Bulb brightness is expressed as a percentage, following the same algorithm as the visual brightness, which is derived from the power in the bulb. Brightness is proportional to power, though not linearly.
- When 'Show Current' is checked, users will be notified whenever an action they take causes the current in the circuit to change.

Rouinfar, March 2026

- Teachers can access the Accessibility (A11y) View to see the descriptions available to screen reader users to decide if the sim's description meets their instructional needs. *Please note: A11y View is not intended for student use and will not provide a good experience for learners using screen reader software.*

Customization Options

Option 1: Use PhET Studio to configure a sim exactly how you want students to see it, save your preset, then send the preset link to your students. This is a premium product. Start a free trial today!

Option 2: 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 a '`&`'. The general URL pattern is:
`…html?queryParameter1&queryParameter2&queryParameter3`

For example, in Circuit Construction Kit: DC, if you would like to se the IEC standard for schematic components (`schematicStandard=iec`), with Real Bulbs enabled by default (`addRealBulbs`) use:
https://phet.colorado.edu/sims/html/circuit-construction-kit-dc-virtual-lab/latest/circuit-construction-kit-dc-virtual-lab_all.html?schematicStandard=iec&addRealBulbs

To run this in Spanish (`locale=es`), the URL would become:
https://phet.colorado.edu/sims/html/circuit-construction-kit-dc-virtual-lab/latest/circuit-construction-kit-dc-virtual-lab_all.html?schematicStandard=iec&addRealBulbs&locale=es

⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	Examples

⚙ `schematicStandard` - displays schematic circuit components using IEEE (default), IEC, or British standards.	`schematicStandard=ieee`
	`schematicStandard=iec`
	`schematicStandard=british`

`showCurrent` - specifies the initial state of the Show Current checkbox. (Default is true.)	`showCurrent=false`
`currentType` - specifies the initial current representation: electrons (default) or conventional.	`currentType=conventional` `currentType=electrons`
`addRealBulbs` - enables non-Ohmic bulbs on startup (checks “Add Real Bulbs” checkbox).	`addRealBulbs`
⚙ `ammeterReadout` - displays magnitude (default) or signed readout, see Model Simplifications below.	`ammeterReadout=magnitude` `ammeterReadout=signed`
`interactiveHighlightsInitiallyEnabled` - opens the sim with interactive highlights enabled.	`interactiveHighlightsInitiallyEnabled`
⚙ `locale` - 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”.	`locale=es` (Spanish) `locale=fr` (French)

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Query Parameter and Description	Examples
`audio` - if muted, audio is muted by default. If disabled, all audio is permanently turned off.	`audio=muted` `audio=disabled`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`
`supportsPanAndZoom` - when true, enables panning and zooming of the simulation using pinch-to-zoom or browser zoom controls.	`supportsPanAndZoom=false`

Additional PhET Resources

See PhET's Inclusive Design page to learn more about each Inclusive Feature and how to use them with your students.
For more tips on using PhET sims with your students, see Tips for Using PhET.
To learn more about ways to create and facilitate sim-based lessons, visit our free Virtual Workshops.