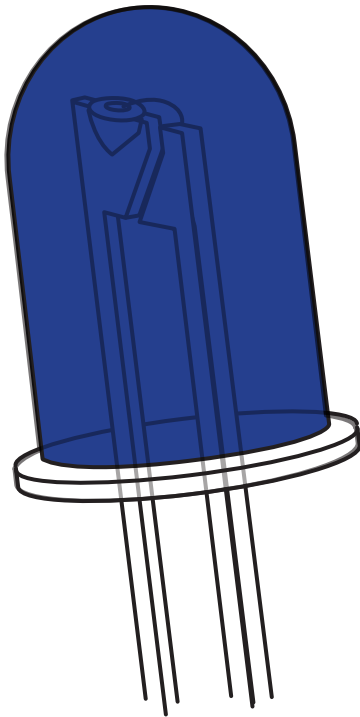


1 kilohm = 1,000 ohms

$$1 \text{ kilohm} = \frac{\text{V}}{\text{mA}}$$

$$1 \text{ mA} = \frac{\text{V}}{\text{kilohm}}$$

1 Volt = mA • kilohm



$$V = I R$$

$$I = \frac{V}{R}$$

$$R = \frac{V}{I}$$

Attending to Units

The mathematical models used to represent circuits require specific units of measurement. Typically, in $V=IR$, V is in volts, I is in milliamps, and R is in kilohms. However, many real-world resistors are in ohms, requiring a ohm to kilohm unit conversion.



Short Circuit

Short circuits are circuits where there is current flowing from the battery into the wires and directly back into the battery. Short circuits have far too much current in the system. This current overload can overheat wires and explode batteries.

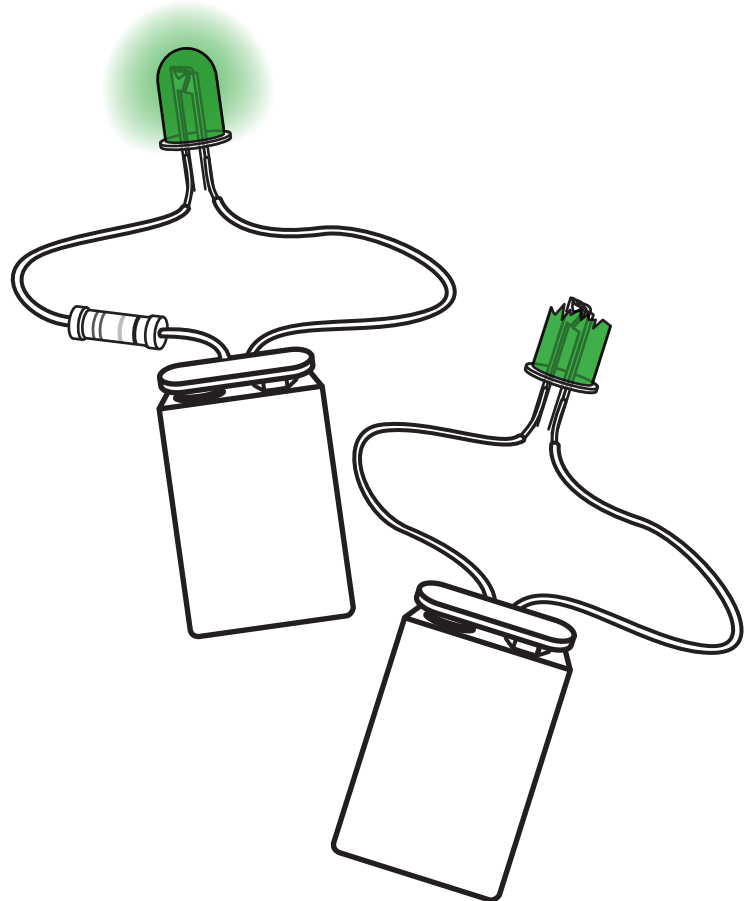
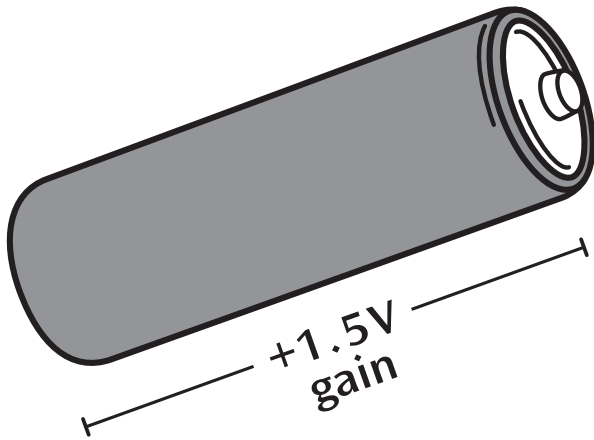
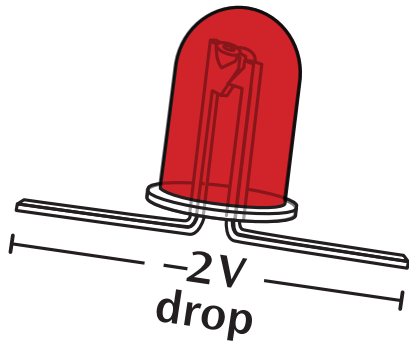
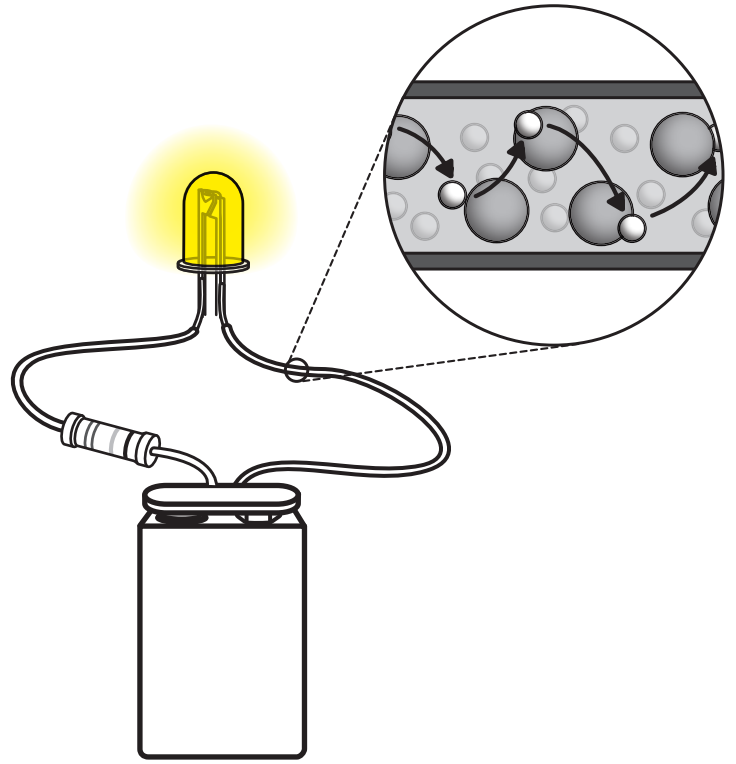
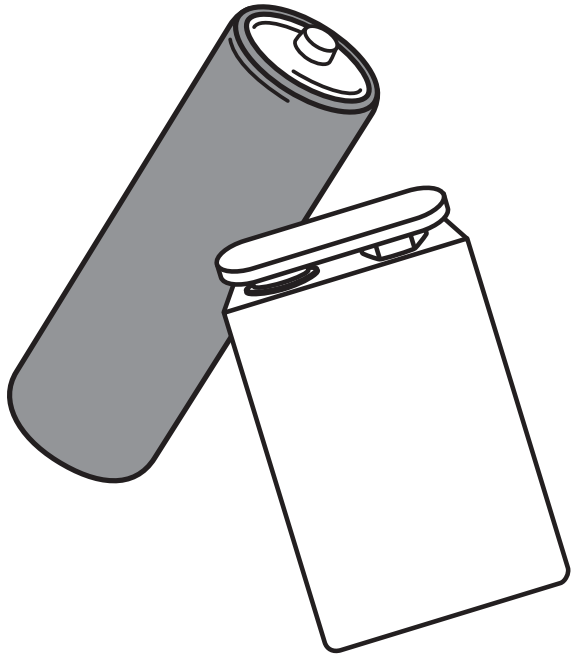


Formulas

The current in a circuit is determined by the *voltage* across the components in the circuit and the *resistance* of the circuit. Because formulas can be rearranged algebraically, you can calculate any unknown variable if you know the other two.

Bulbs

Bulbs have voltage drops across them. They are engineered to provide minimal resistance and function with a limited range of current (e.g., a typical LED bulb can only handle 20 mA). However, some bulbs, such as LEDs, provide a lot less resistance than other bulbs, such as incandescent bulbs.



Current

Current is how much charge is moving past a given point per second. It is the same everywhere in a circuit. As electrons are pushed out of a battery, the electrons of the atoms of the conductive components in the circuit move forward out of the way. This flow of electrons is what creates current. It is often measured in milliamps (mA).



Resistors

Current higher than what a component is engineered for will damage the component. Resistors reduce the current in a circuit, and thus protect other components for current overload. Resistors are engineered to provide a specific value of resistance, often measured in ohms.



Batteries

Connecting a battery in a circuit triggers chemical reactions that shift electrons toward its negative end, these then push electrons in circuit forward, creating current. Circuits with high-voltage batteries can have the same current, more current, or less current than circuits with low-voltage batteries. Batteries provide very little resistance.

Voltage

Voltage is the difference in charge between two points. The voltage across a battery is a positive number, while the voltage across a bulb (or motor or buzzer) is a negative number. Voltage is a property of an individual component, determined by how the component was engineered. It is often measured in volts (V).