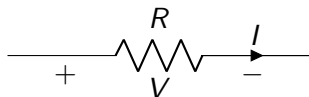# Circuit Theory

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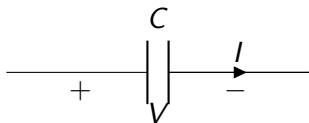
# A resistor satisfies Ohm's law.



$$V = IR$$

- $V$ is the voltage across the resistor. The $+$ and $-$ mean that if $V > 0$ then the electric potential is higher on the left. If $V < 0$, then the electric potential is higher on the right.
- $I$ is the current through the resistor. If $I > 0$, then (positive) current flows to the right. If $I < 0$, then current flows to the left.
- If the arrow for $I$ is to the right, then the $+$ for $V$ must be on the left. Otherwise $V = IR$ fails and needs a minus sign, which we don't want.

# A capacitor satisfies some other equations.



$$Q = CV \qquad\qquad I = \frac{dQ}{dt} \qquad\qquad I = C\frac{dV}{dt}$$

- ▶ The $+$ and $-$ mean that if $V > 0$ then the electric potential is higher on the left. If $V < 0$, then the electric potential is higher on the right. (Same meaning as for a resistor.)
- ▶ If $I > 0$, then (positive) current flows to the right. If $I < 0$, then current flows to the left. (Same meaning as for a resistor.)
- ▶ If the arrow for $I$ is to the right, then the $+$ for $V$ must be on the left. (Same as for a resistor.)

# A battery is a constant voltage source.
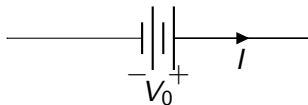


- ▶ We assume $V_0 > 0$. Electric potential is higher at the long bar.
- ▶ If $I > 0$, the battery is supplying power to the rest of the circuit. If $I < 0$, the battery is being recharged.

# A circuit
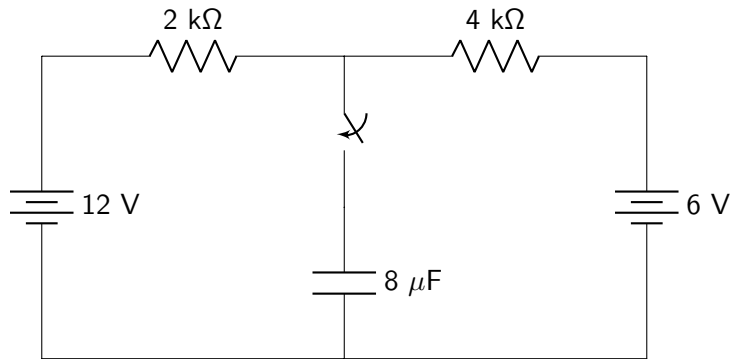
# Step 1: Label voltages and currents