Electric Circuits

The most basic electric circuit is formed by a voltage source and a resistor. When the circuit is closed, an electric current will flow through it.

Voltage (V): Difference of electric potential. Intuitively, we can think of voltage as stored energy (similar to potential energy) that charged particles can use once the circuit is closed.

$$V = \frac{\Delta U}{Q}$$

Current (I): Amount of charge flowing through a specific point per unit of charge. Intuitively, this quantity gives us an idea of how many charged particles are moving through the circuit and how fast they're going.

$$I = \frac{\Delta Q}{\Delta t}$$

Resistance (R): Opposition to the flow of electric current. Intuitively, resistance can be thought of as friction in the circuit. The energy of the charged particles is deposited on the resistor, so if we are clever we can use this energy to do useful work !
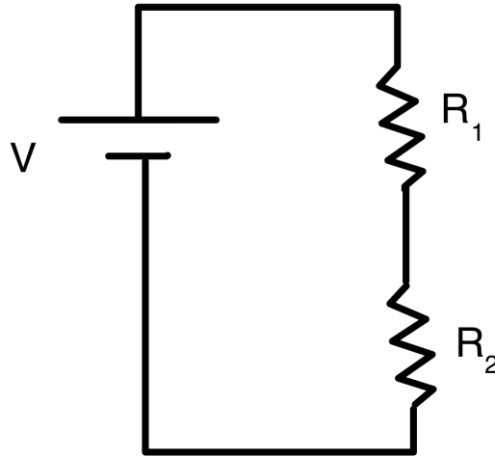
These are related to each other through Ohm's Law:

$$V = R \times I$$
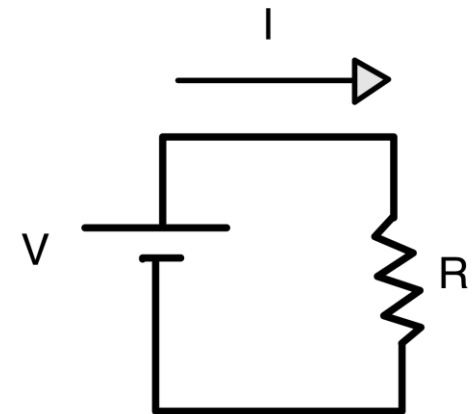
Series and Parallel Circuits

If we consider a circuit with two resistors, we can make two different circuits that result in different currents.
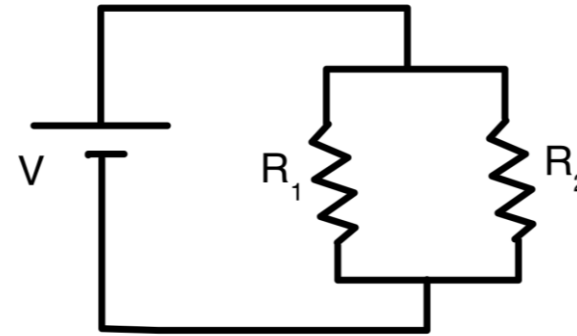

Series: The current flowing through R_1 and R_2 is the same, so

$$I = I_1 = I_2$$

After each resistor, there is a voltage drop. The sum of these drops equals the total voltage in the circuit, so

$$V = V_1 + V_2$$

Parallel: The current splits between R_1 and R_2, so

$$I = I_1 + I_2$$

The voltage drop at each resistor must be the same, and it must be equal to the total voltage, so

$$V = V_1 = V_2$$

Homework

Problem 1. Consider the circuit shown below. Suppose that the voltage source produces a voltage of V=10V. Resistor 1 has a resistance of $R_1 = 2\Omega$ and $R_2 = 7\ \Omega$. Find the current I_1 and I_2 flowing through resistor R_1 and R_2 respectively. Use these currents to find the total current I entering the voltage source. Show all your work!
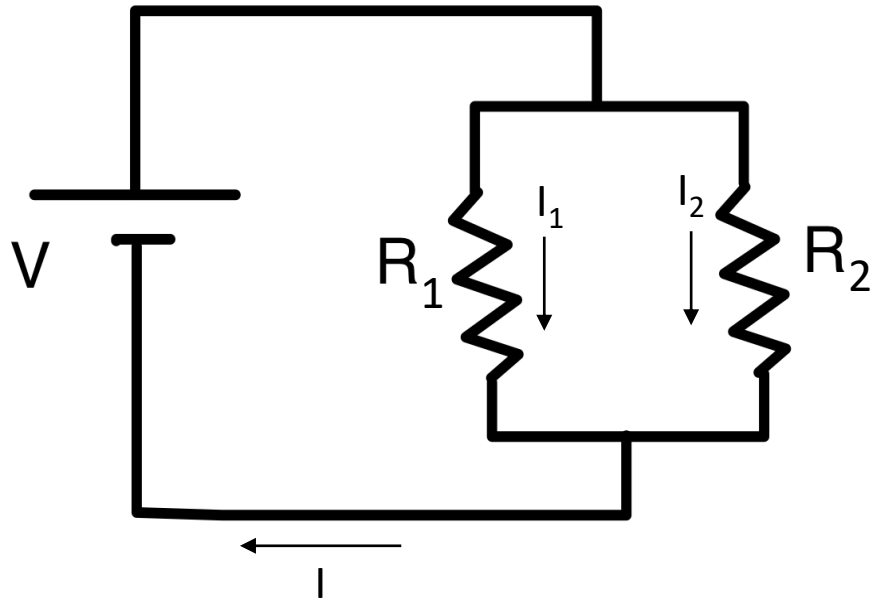

Now, go to https://www.brainpop.com/games/circuitconstructionkitdc/ and click "Play game" and then select the "Intro" option. Check your answer experimentally (do it only after you did your own calculations).

Homework

Problem 2. Three resistors: $R_1=10\ \Omega$, $R_2=20\ \Omega$ and $R_3=30\ \Omega$ are connected in series as shown in the figure below. Suppose that the voltage source provides a voltage of 5V.

a) Find the total current flowing through the system.

b) How does the total current flowing through the system compared to the current flowing through each individual resistor?
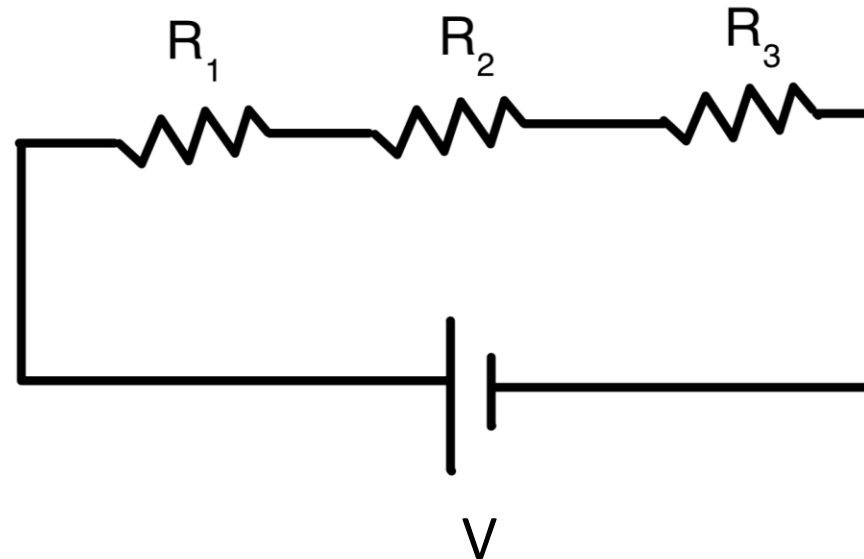
Homework

Bonus problem. Suppose that you have the electric circuit shown below. The voltage source delivers a voltage of V=15 V. Resistors 1 and 2 have a resistance of $R_1 = 2\Omega$ and $R_2 = 7\Omega$ respectively. Suppose that we have a third resistor R_3 placed after the parallel circuit with a resistance of $R_3 = 5\Omega$. Find the current flowing right after the voltage source.
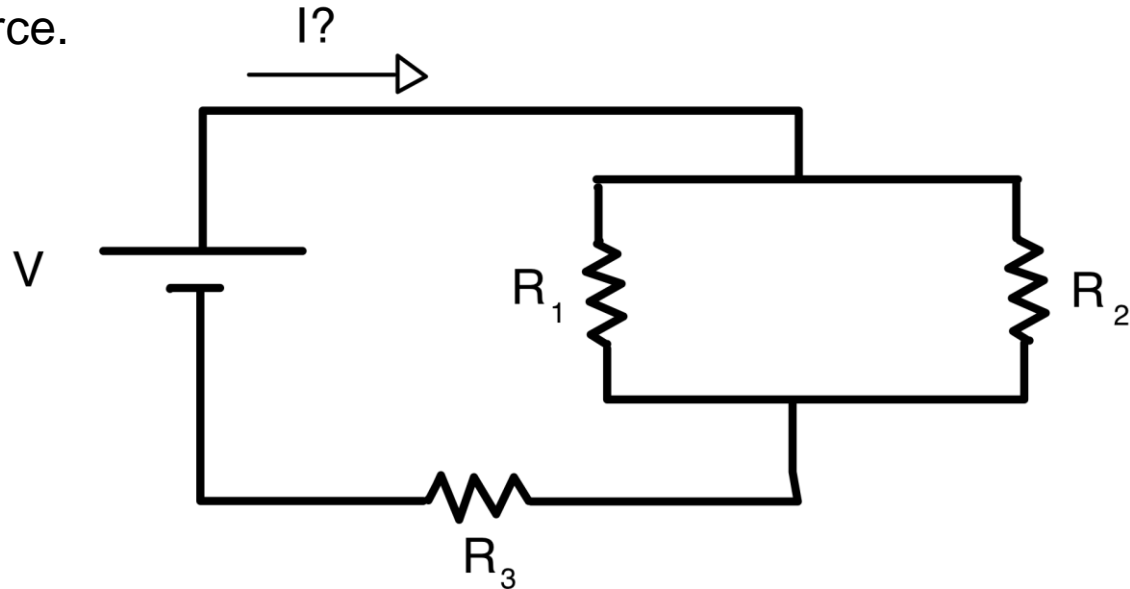
Hint: First, find the voltage drop at Resistor 3. This and the value of the voltage source determine precisely the voltage drop between the beginning and the end of the parallel bit of the circuit. Then, use the same logic from Problem 1 to find the total current.

Now, go to https://www.brainpop.com/games/circuitconstructionkitdc/ and click "Play game" and then select the "Intro" option. Check your answer experimentally.