Circuit Analysis

It turns out that one can understand an analyze even the most complicated circuits by just remembering one equation and two simple rules: 1) Ohm's Law, 2) charge is conserved and 3) energy is conserved. It's really that simple!

Ohm's Law

The fundamental equation behind circuit analysis is *Ohm's Law*, or

$$V=IR$$

You can think of it as a "cause and effect" equation. If there is a voltage (V) across a resistor (R) then a current (I) will flow. (It is sort of like F=ma.) While voltage is actually energy per charge, you can think of it as a sort of electrical push trying to get electrons to flow through a resistor. No push, no flow.

The "Junction Rule" *aka Conservation of Charge*

A *junction* is anyplace a wire branches off into 2 or more different wires or 2 or more wires come together into a single wire.

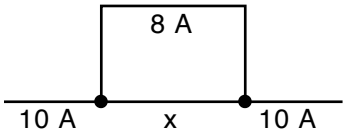
One of the fundamental ideas in physics is that electric charge must be conserved. In circuit analysis, this means that electrons cannot be created or destroyed while they move through the circuit. Therefore, the total current going into a junction has to equal the total current going out of a junction. (You can think of the electrons as cars, and the wires as roads - every car that enters an intersection leaves the intersection.)

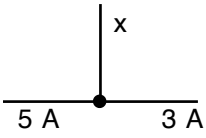
1. What is meant by the word *junction* in a circuit?

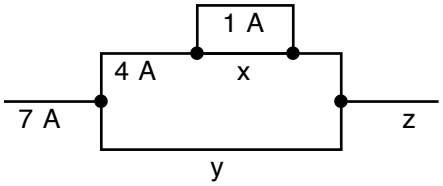
2. What is the *Junction Rule*?

3. The Junction Rule is really just a statement of what basic principle?

4. What could be the unmarked current in the pictures below?







5. When resistors are connected in series, what must be true about the currents through each of the resistors?

6. When resistors are connected in parallel, what must be true about the currents through each of the resistors?

Circuit Analysis

The "Loop Rule" *aka Conservation of Energy*

A *loop* is just any closed path that an electron might take in the circuit. We will keep the circuits fairly simple and not do multiple voltage sources, so for us, this simply means what are the possible ways that an electron might take to go from one terminal of the power supply to the other. (In college, you will probably see problems with multiple power supplies, but we won't do that.)

Another fundamental idea in physics is that energy must be conserved. In a circuit, a battery gives electrons energy. The electrons use that energy in going through resistors. (We are assuming ideal wires with no resistance.) Because energy can't be created or destroyed, the total energy "used up" by an electron going through a circuit must be the same as the total energy given the electron by the power supply. Since voltage is simply energy per charge, this also means that the voltage of the power supply has to equal the sum of the voltages of all the resistors that the electron went through.

1. Where does an electron get the energy to move through a circuit?

2. Where does an electron lose energy in a circuit?

3. What happens to the energy lost by an electron going through a resistor?

4. What is the *Loop Rule*?

5. The Loop Rule is really just a statement of what basic principle?

6. For each of the circuits shown below, sketch in the two possible paths (loops) that an electron could make in going from one terminal of the power supply to the other. (For our purposes, it doesn't matter if you go clockwise or counter clockwise.)