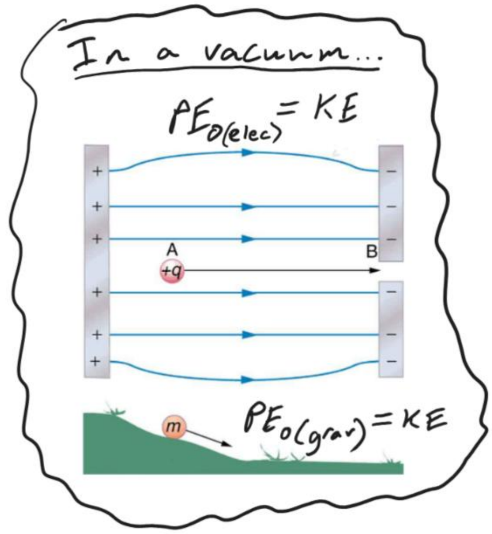
Physics 200 Name: ____________________

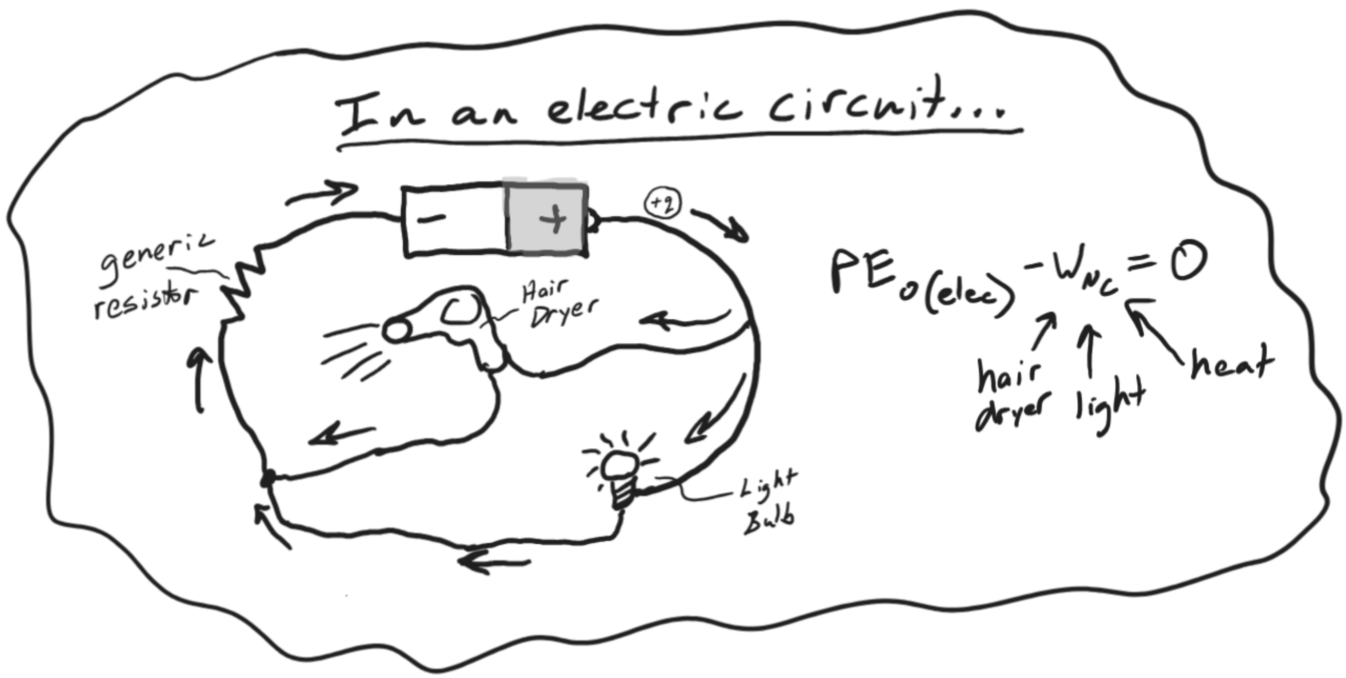
Unit 8 Handout (current and Circuits)

What makes circuits go?

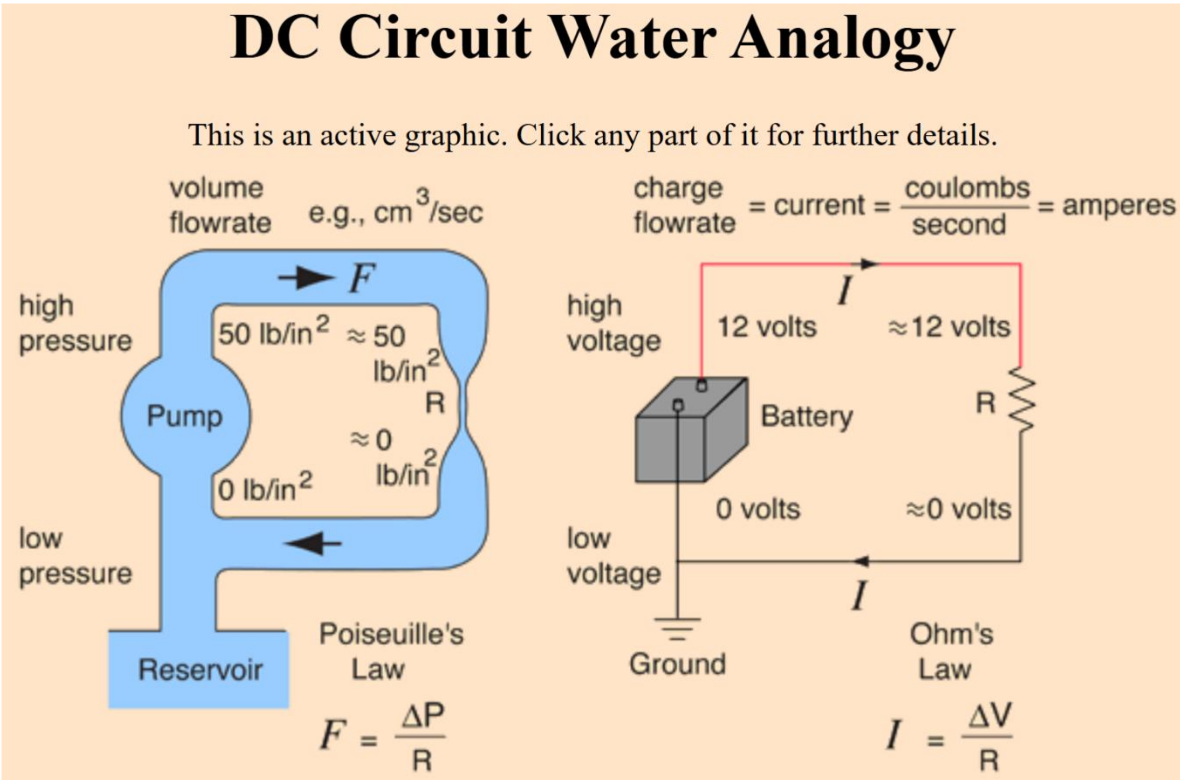
The diagram on the right presents an analogy comparing electric potential energy to gravitational potential energy. In both cases, potential energy is stored when an object is moved in the opposite direction that it "wants to go." Gravity causes objects to experience a downhill force, and charged objects experience attractive or repulsive forces (depending on what other objects are nearby). In both cases, when the objects are released, that potential energy gets turned into kinetic energy – IFF this is happening in a vacuum (where no energy is lost to non-conservative work).



When charges flow through the wires of an electric circuit, none of this energy gets conserved. Every bit of it is converted to some sort of work. Always. In the diagram below, charges leave the positive battery terminal with a lot of potential energy, and charges enter the negative terminal with no energy at all. If you remove the hair dryer, the light bulb, and the simple resistor, the wire itself will take all of the energy, and it will probably melt and start a fire. The charges at the end of the circuit are always totally depleted of energy. *[**Note that the charges are moving the wrong way. It is electrons that move through circuits, and they flow from negative to positive, but we pretend current goes the other way because that is what Ben Franklin thought it did. All of the early textbooks followed his lead.]*



<u>One Analogy For Thinking About Circuits:</u> There is another analogy that will will look at later. They both have problems, but they are both useful.



Based on the graphic above, provide units and a basic description for…

<u>Voltage:</u>

Units for Voltage:

<u>Electric Current:</u>

Units for Current:

<u>Resistance:</u>

Units for Resistance

Working Definitions (for now): But the terms need to be filled in…

- __________________ is a change in potential energy. That's sort of what it is, and it's a good enough definition for now.

- ____________________ and ____________________ are pumps that take in low potential energy charges on their negative ends and push out high potential energy charges on their positive ends; they pump up the voltage of the charges that pass through them.

- ____________________ is the flow rate of charge through a circuit. If a circuit were a river, this would be measured in gallons per minute, but instead it is measured in Coulombs per second (a.k.a. Amps).

- _______________________ is something that resists the flow of charge, and in the process it takes energy from the charges, reducing their potential energy (voltage).

Ohm's Law (a very important law):

- What happens to the flow of charge through a circuit if we increase voltage and keep resistance the same?

- What happens to the flow of charge through a circuit if we increase resistance and keep voltage the same?

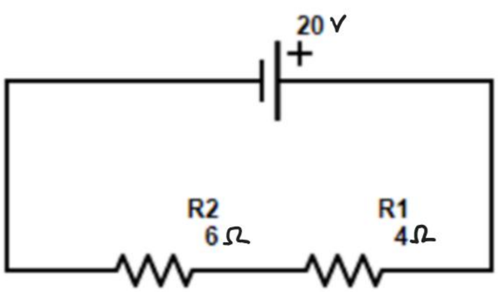
- If 3A of current is flowing through a 5Ω resistor, how much voltage does it use up?

KIRCHHOFF'S RULES

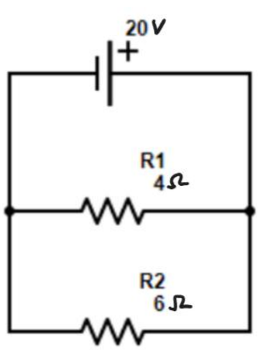
- Kirchhoff's first rule—the junction rule. The sum of all currents entering a junction must equal the sum of all currents leaving the junction.
- Kirchhoff's second rule—the loop rule. The algebraic sum of changes in potential around any closed circuit path (loop) must be zero.

1. When applying Kirchhoff's first rule, the junction rule, you must label the current in each branch and decide in what direction it is going. For example, in Figure, Figure, and Figure, currents are labeled I_1, I_2, I_3, and I, and arrows indicate their directions. There is no risk here, for if you choose the wrong direction, the current will be of the correct magnitude but negative.
2. When applying Kirchhoff's second rule, the loop rule, you must identify a closed loop and decide in which direction to go around it, clockwise or counterclockwise. For example, in Figure the loop was traversed in the same direction as the current (clockwise). Again, there is no risk; going around the circuit in the opposite direction reverses the sign of every term in the equation, which is like multiplying both sides of the equation by -1.

- When a resistor is traversed in the same direction as the current, the change in potential is $-IR$. (See Figure.)
- When a resistor is traversed in the direction opposite to the current, the change in potential is $+IR$. (See Figure.)
- When an emf is traversed from – to + (the same direction it moves positive charge), the change in potential is +emf. (See Figure.)
- When an emf is traversed from + to – (opposite to the direction it moves positive charge), the change in potential is $-$emf. (See Figure.)

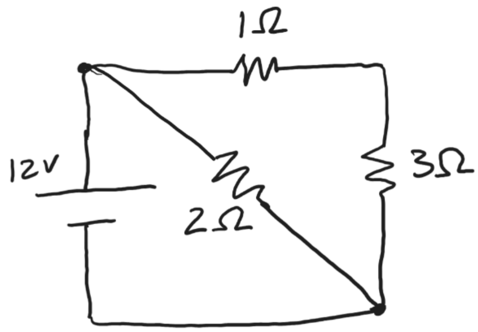


	V	I	R
Source	20		
R_1			4
R_2			6

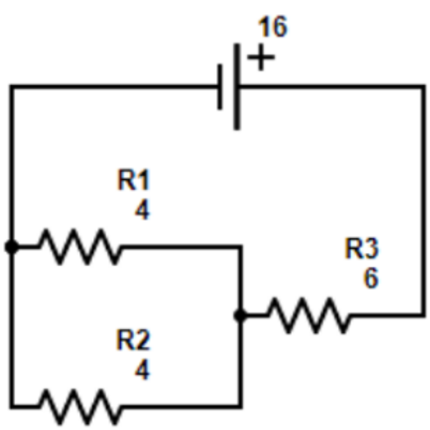


	V	I	R
Source	20		
R_1			4
R_2			6

Circuits With 1 Battery: Fill in the tables



	V	I	R
Source	12		
			1
			2
			3



	V	I	R
Source	16		
R_1			4
R_2			4
R_3			6

Circuits With 2 Batteries: Name and Calculate the Currents, and Indicate Their Directions