March 1, 2019

8th Grade Electricity and Magnetism Review

* **Circuit**: an uninterrupted path between the terminals (ends) of a power source
	+ Electrons (**e-**) move from a negative terminal to a positive terminal
	+ Electricity only flows through *closed* circuits
* **Voltage**: measure of *electrical potential* between two points in a circuit
	+ Measured in *volts* (V)
	+ How much electricity is the device capable of producing?
	+ In our labs, we increased voltage by increasing the number of batteries in the circuit
* **Current**: the amount of electric charge that *actually passes* a given point in a specified time period
	+ Measured in amperes (amps, A)
	+ Represented by a capital **I**
	+ The direction of current flow is **opposite** from the direction of electron flow in a circuit
		- Current flows from the *positive terminal to the negative terminal* of the battery

*What is the charge of electrons and in which direction do they move in a circuit?*

* Electrons are negative, and they move from negative to positive

*How does current move through a wire?*

* Metals like copper are very conductive due to the outer electrons around their atoms
* One electron from a copper atom jumps to a nearby copper atom and knocks into one of its outer e-
* This electron that was knocked into then jumps to another nearby copper atom and knocks into another e-
* This pattern of electrons knocking each other out of place continues down the wire
* The movement of electrons from atom to atom creates the electron flow that is electricity
* **Amperage**: amount of charge that passes a given point in the circuit in a specific period of time
	+ Used to measure current
* **Multimeter**: an instrument used to measure current, voltage, and resistance
* **Resistance**: decreasing the flow of electrons and current by changing the diameter or material of a wire
	+ As resistance increases, current decreases
	+ Thin wires (smaller diameter) cause more resistance than thick wires (large diameter)
		- Similarly, it is more difficult to drink a milkshake through a skinny straw than through a wider straw
	+ Resistance is measured in Ohms (Ω)
* **Resistor**: any wire in a circuit which decreases the flow of current
* **Series vs. Parallel Circuits**
	+ **Series**: more than one resistor arranged on one path
		- Increasing the length of a resistor (increasing the number of resistors in a series circuit) increases resistance and decreases current
			* Current struggles to move through several resistors in a row, making bulbs dimmer
		- If one bulb goes out, they all go out
	+ **Parallel**: more than one resistor arranged on many paths
		- Increasing the cross section of a resistor (increasing the number of resistors in parallel, or making the resistor “wider”) decreases resistance and increases current
			* There are several paths for the current to move through, keeping bulbs bright
		- If one bulb goes out, the other bulbs stay lit
* **Ohm’s Law**: V = IR
	+ Voltage (V) = Current (I) x Resistance (R)
	+ ***As resistance increases, current decreases***
	+ ***As voltage increases, current increases***
* **Useful resistance**: if a circuit has high resistance, then electricity will struggle to flow through it
	+ The more electricity struggles, the more energy is wasted
	+ We often experience this wasted energy as *heat*
		- Phones and laptops frequently get hot, which we do not want – this energy is being wasted as heat rather than used as electricity
	+ “Wasted” energy can be used to our advantage in some appliances, such as ovens, irons, toasters, and toasters
		- For instance, when you turn on a toaster, you are sending electricity through a series of long, thin wires on either side of the bread slots
			* These wires create a LOT of resistance, so they get VERY hot – we use this heat to toast our bread!

*How does an incandescent bulb work?*

* When you turn on a light switch, electricity begins to flow through the tungsten wire in the lightbulb
* The tungsten wire is thin and super long, which creates a lot of resistance
* This resistance produces *light*, which we use! But the resistance also produces heat, which is wasted
* 90% of electrical energy used by incandescent bulbs is lost as heat
* **Battery**: a source of power in which chemical energy is converted into electricity
	+ chemical *potential* energy is converted into *kinetic* energy (electrons are moving) when introduced into a circuit, causing a flow of electrons
	+ electrons are concentrated in the negative terminal, “waiting” for a completed circuit
* **Reduction reaction**: takes or gains electrons
* **Oxidation reaction**: gives away or loses electrons
	+ ***OIL RIG – oxidation is losing, reduction is gaining***

*How does a battery work?*

* In a battery, electrons are all crowded near the negative end, or anode
	+ In a typical battery, the anode is the outer zinc case
* These crowded electrons are desperate to move away from each other and towards the positive end of the battery, but an *electrolyte paste* separates electrons from the positive end
* When plugged into a closed circuit, electrons escape the anode
* The electrons flow through a wire, usually copper, towards the positive end of the battery, or cathode
	+ In a typical battery, the cathode is the inner carbon rod
	+ You can tell where the cathode is by the bump on one end of a battery
* SUMMARY: Electrons leave the anode of the battery and move through the copper wire in the direction of the cathode, while current moves in the opposite direction of the electron flow
* **Electromagnet**: a metal object made into a magnet by surrounding the object with a coil and passing an electric current through the coil
	+ A magnetic field is produced by a strong electric current
	+ More coils, more current → more magnetism
	+ In Inv. #3, we made an electromagnet by surrounding a nail with a coil and sending a current through the coil

 

* **Electric motor**: when an electric current is sent through a coil of wires surrounded by a magnet, the coil will turn
	+ Electricity causes this motor to run and do work
* **Electric generator**: when a coil is surrounded by fixed magnets and the coil is *mechanically* turned (NO current is applied!), an electrical current is produced
	+ - The coil could be turned by hand, by steam from coal, by water flow from a dam or river, by wind, etc.
	+ The electricity produced is then purchased by consumers to use in their homes
* **MRI**: Magnetic Resonance Imaging
	+ Takes images of soft tissue, such as muscles and organs

*What is the relationship between voltage, current, and resistance?*

* ***As voltage increases, current increases but the resistance remains the same***
* ***As resistance increases, current decreases but voltage remains the same***
* The relationship among voltage, current, and resistance is described by Ohm’s law, V= IR

*How do the dimensions of a resistor affect current?*

* Increasing the length of a resistor increases the amount of resistance and decreases current
	+ In Inv. #2, putting two resistors in series (in a row) increased resistance
* Increasing the diameter of a resistor decreases the amount of resistance and increases current
	+ In Inv. #2, putting two resistors in parallel (next to each other) decreased resistance because it gave the current more area to move through

*What factors affect the strength of an electromagnet?*

* The number of turns of wire in the coil over a specific length
	+ (Number of turns over a specific length)
* The amount of current flowing through the wire

*In what ways can we produce electricity?*

* Solar power, wind power
* Fossil fuels (natural gas and coal)
* Hydroelectric (water, ex. dams, water wheels)
* Nuclear