UNIT 20 – Static and Current Electricity

- ☐ LESSON A: Observation & Discussion
    - o Read the lesson carefully to make sure that you have all needed supplies and that you understand the content.
    - o Observation Record
- ☐ ACTIVITY A: Draw & Label
- ☐ ACTIVITY B: Nature Journaling
- ☐ ACTIVITY C: Research & Write

PARENT NOTES:

Lesson A: Observation & Discussion

Before the Lesson:

- Read this Lesson.
- Gather materials needed.
- Check the weather to see if this lesson may be completed outdoors.

Materials:

- *Discussion Materials - Electricity:* flashlight, hair dryer
- *Activity, Static Electricity:* aluminum foil, scissors, comb
- *Activity, Current Electricity:* two D batteries, masking tape or electrical tape, aluminum foil, a very small flashlight bulb (1.5 volt)
- *Activity, Chemical and Electrical Energy:* a potato (or lemon), a small strip of copper OR a copper penny minted before 1982, a small strip of zinc OR galvanized steel nail, bell wire (lacquered copper wire), a galvanometer (a device that detects and measures electrical current)

In Class:

Class Observation:

- Begin class with the basic question: When do we use electricity?
- Allow students time to list things that use electricity.
- Ask students from where we get electricity. (They might suggest electrical plants, wind mills, water, etc.)
- Ask if they have ever seen or experienced electricity without a machine (e.g. lightening, sparks from static electricity, etc.)
- Explain that you are going to complete a few experiments today to help them understand electricity even better.

Memory Work

Electricity has to do with electrons. Static electricity is one kind of electricity. Static electricity occurs when the negative charges (from electrons) are out of balance with the positive charges (from protons).

Electricity. Place on the table a flashlight and a small electrical appliance such as a hair dryer, toaster, or small lamp. Ask what these objects have in common. What provides their energy? The students might say "a battery" for the flashlight, or they might say "electricity" for the other appliance. Explain that both the flashlight and the appliance use electricity to work. Later on, they will understand that a battery supplies electricity just as a wall socket does. Electricity is the interaction of electric charges. We have already learned a little bit about electric charges earlier in the year when we learned about protons and electrons.

Write the word "electricity" on a whiteboard or piece of paper and ask the students to look at the word and think about what other word they see in it. They might say "electric". This is true, but ask them to think about the particles that make up an atom; which one do they think the word "electricity" comes from? (Electron.) To understand electricity it is important to have a very basic understanding of electrons.

Review what the students learned in Unit 1: Electrons are small particles that orbit the nucleus of an atom, and they have a negative charge. Protons are found in the nucleus, and they have a positive charge. The overall charge of a "stable" atom is neutral, since the charges of the electrons and protons cancel each other out. However (and this is a new concept so it might need to be said more than once), atoms can gain or lose electrons, in which case they will have an overall negative or overall positive charge. Note: An atom that has gained or lost an electron is called an ion, but there's no need to introduce that term at this point. Unlike charges attract each other, while like charges repel each other. Remind them again that electricity is the interaction of these electrical charges.

Static Electricity. There are two basic kinds of electricity. In Unit 1 we did a demonstration of one kind of electricity: static electricity. Static electricity occurs when there is an imbalance of negative and positive charges. The charges themselves build up on objects, but do not actually move anywhere. They've seen the effect of static electricity before, during the activity in which they rubbed a balloon on their hair and held it close to another balloon, or used it to pick up paper circles. Both of those were demonstrations of electricity, which is the interaction of electric charges. We will now do one more demonstration of static electricity as a review.

Activity, Static Electricity: This activity will demonstrate the effect of static electricity. Cut about ten small pieces of aluminum foil and place them on the table. Move a comb through your hair quickly several times. Hold the comb above the foil pieces without touching them. The students should observe the foil pieces jumping upwards toward the comb. Explain that the comb rubbed electrons off of your hair onto the comb, which then had a negative charge. As the comb moved toward the aluminum pieces, the comb's negative charge due to the excess electrons caused the electrons in the aluminum atoms to move away, leaving the positive charge from the protons in the nucleus closer to the surface of the foil. The attraction between the positive charge and the negative charge was strong enough to overcome gravity and allow the foil pieces to move toward the comb.

Practice the Science Question and the first part of the answer.

Current electricity means the electrons are moving from place to place. This is how a battery works. The electrons move from one end of the battery, through a wire, to something that needs energy such as a light bulb, and back to the other end of the battery. Do Activity.

Current Electricity. We have discussed static electricity, in which the electrical charges simply build up on objects but do not flow anywhere. The second kind of electricity is current electricity, which is the flow of electrons from one atom to another. Draw the students' attention to the flashlight and appliance shown at the beginning of the discussion and explain that both of these objects work because electrons are flowing from one atom to another. The movement of the electrons along a path can cause thermal energy (heat) and light to be released, or it can turn a small motor, such as in a hairdryer. Both objects rely on a source of electricity, which can be either a generator (from which we get electricity that comes into our houses through wall sockets) or a battery. We will discuss batteries as electrical sources since it might be easier to have a visual picture of how the battery works.

Place one D battery on the table and show it to the students. Explain that the purpose of a battery is to separate electrical charges so that electrons will flow from one end of the battery to the other. Inside the battery are chemicals which react together to cause an excess of electrons at one end of the battery and a shortage of electrons at the other. In other words, the battery is a source of chemical energy that is transformed into electrical energy, which is the flow of electrons. Show the students the two poles, or terminals, of the battery, and note that one of them is marked with a "+" sign. This means it has a positive charge because it has a shortage of electrons. The other end has a negative charge because it has extra electrons. When a wire connects the two poles of the battery, the electrons flow from the negative end to the positive end since they are strongly attracted by the unlike charge at the positive end. If there is a light bulb, motor, or other device along the path of the wire, the electrons will flow through that device and can do "work" by either lighting the bulb or turning a motor. Practice the Science Q and A now and throughout the activity.

Activity, Current Electricity: The purpose of this activity is to demonstrate how a battery works, by using one to light a lightbulb. Cut a rectangle from the aluminum foil that is about 24 inches long and 12 inches wide. Fold it in half lengthwise five times so that you have a thin strip (about one-third of an inch wide) that is 24 inches long. Cut the strip in half so you have two strips that are both 12 inches long. This is going to transmit the flow of electrons, just as a wire does. Tape one end of one of the foil strips to the positive end of one battery (tape the foil down firmly on the battery so there is good contact). Mark the foil about three inches away from the battery it is taped to, and tape the positive end of the second battery in the general vicinity of that mark. You should now have one strip of foil connecting the positive ends of both batteries, with about eight inches of it left hanging. Next, tape one end of the second piece of foil to the negative end of both of the batteries, in a similar way, with the batteries about three inches apart and about eight inches of foil hanging free. Wrap the free end of one of the strips of foil around the base of the bulb, where the threads on most bulbs are, and tape it (or simply wind it around tightly; it should remain in place). Make sure the very bottom of the bulb is accessible. Next, touch the free end of the other foil strip to the bottom of the bulb.

The students should be able to observe the bulb lighting up. Explain that the electrons are flowing from the negative end of the battery, through the wire to the light bulb, and then on to the positive end of the battery. They are doing this because they are attracted to the unlike charge at the other end of the battery. When they reach the light bulb, they flow through a wire inside the bulb called the filament, which resists the flow of electrons. The resistance causes friction, which in turn causes some of the electrical energy to be given off as thermal energy (heat). The filament heats up so much that it glows, providing light.

Remind the students that we have been observing the flow of electrons; this is called current electricity. Although we have been talking about batteries, the principle is the same for the current electricity that comes into our houses through wall sockets. Electrical power plants create large amounts of electricity (electron flow) that is brought through wires to each wall socket. The electricity passes through the electrical cord to the device, then passes out again and back to the plant

Explain that to make the electrons move from one end of the battery to the other, we need to make a reaction happen between an acid and certain metals. We can make a battery from a potato or a lemon because they both have an acid in them already, so if we insert two metal strips in them (such as zinc and copper), the reaction that makes electrons flow can happen. Do Activity.

Chemical Energy and Electrical Energy. The students have learned that a battery is a source of chemical energy; chemical reactions in the battery cause electrical current to flow through wires from one end of the battery to the other. To tie this in with what they have learned about energy, chemical energy can be transformed into electrical energy. Do they remember the Law of Conservation of Energy? Energy cannot be created or destroyed. However, it can be changed from one form into another. The chemical energy in the battery is a form of potential energy; when it is transformed into electrical energy and the electrons are flowing, it has become kinetic energy (the energy of motion; in this case, the movement of the electrons).

If there is time, the students can do Activity, which involves making a battery using a potato or lemon. This will enable them to learn a bit more about the chemical energy in batteries.

Activity, Chemical and Electrical Energy: Explain that a potato contains a small amount of an acid called phosphoric acid (a lemon contains an acid called acetic acid). When zinc is placed in an acid, electrons flow from the zinc to the copper if there is a metal connection between them. In other words, the zinc acts as the negative terminal of the battery, which has an excess of electrons, and the copper acts as the positive terminal, which has a shortage of electrons. Insert the strips of copper and zinc into the potato, about 1 cm apart. They must not be touching. If you are using a lemon, roll it around the table first, pressing down on it slightly with your hands. Take one piece of wire (approximately 6 inches long) and thread it through the hole in the positive terminal of the galvanometer, then wrap it around the metal at the base of the terminal several times. Do the same with the second piece of wire, but connect it to the negative terminal. Take the free end of the wire coming from the positive terminal, and wrap it around the copper strip (making sure there is good contact). Then, take the end of the wire coming from the negative terminal, and touch it to the zinc strip. Touch only the very tip of the wire to the strip, so that the end of the wire, rather than the side of the wire, comes into contact with the zinc. Observe the galvanometer; the students should see the needle move in a positive direction as the galvanometer measures the electrical current.

Note: There are some kits that use potatoes to power a small clock. If your student is interested, that would be a great extension of these activities. More than one potato has to be used (the potatoes must be connected together to increase the electrical current). The amount of current from one potato or one lemon is too small to light a bulb or power a clock, which is why we simply used the galvanometer to measure the current in the previous activity.

Observation Record

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CURRENT ELECTRICITY

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CHEMICAL AND ELECTRICAL ENERGY

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Activity A: Draw & Label

Put on socks and rub your socked feet vigorously on a rug or carpet. Then, touch one of your siblings or a parent on the fingertip. What happens? Label the "conductor."

Activity B: Nature Journal

Observe a thunderstorm at night, from inside the house through a window. Lightening is an example of current electricity. Draw the lightening and storm. Describe what you see.

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Activity C: Research & Write

Instructions:

- Write a paragraph description about the electricity your family uses each day. What would you not wish to do without, if electricity did not exist?
- Illustrate.