Traveling Energy Exploration Station

Electricity

Educators Guide

Traveling Energy Exploration Station

You are about to begin your trip in the world of Electricity with the Traveling Energy Exploration Station provided to you by the Watt Watchers of Texas program. This station is full of electrifying information to assist you in learning more about electricity. Inside this station are hands-on activities, books, videos, and models to help you in the classroom.

This guide contains background information on electricity along with additional activities that you might like to use in your classroom.

Inside this station you will also find a disposable camera- please take pictures of your students using the station so that we can share your experience with other teachers in the state. Enjoy your exploration with the electricity station. If you have any questions or concerns please call Amy Neblett at Watt Watchers of Texas 1-888-USWATTS or email at abneblett@utep.edu.

This box has been checked out to you for two weeks, the box will be scheduled for pickup two weeks after you receive it. If you need the station longer, please contact Watt Watchers to see if the box is available for an extended period.

Enjoy!

ELECTRICITY STATION SUPPLIES LIST

The following activities are included in the Electricity Traveling Energy Exploration Station. Items in italics will need to be provided by the person using the station.

All these activities strive to use scientific inquiry teach students field and classroom investigative skills and foster critical thinking skills. We include lab supplies and basic hand tools whenever possible. With this said, each activity strives to include Science TEKS 1-4 to some degree.

<u>Model:</u>
Watts' Up Meter

<u>Activities:</u>
Tale of Two Light Bulbs - Compact Fluorescent vs. Incandescent Extension cord, Light bulb, Y socket, CFL bulb

Static Electricity- Glass jar with a plastic lid, foil from a candy wrapper, plastic pen or ruler, bare wire, aluminum foil, piece of wool

Pathway- aluminum foil strips, penny, duct tape, d battery, clothespins, rubber band, flashlight bulb, *other sizes of batteries, wooden pencil, paper*

Stickers- 9 inch round balloons, ruler, sewing thread, masking tape, *scissors, water, hand soap, towel, hair dryer, plastic wrap, puffed rice cereal*

Glow Bulb- dishwashing liquid, fluorescent tube, bath towel, plastic report cover, *very dark room, plastic wrap, wool scarf, balloon*

Flashlight - flashlight, aluminum foil strip, duct tape, 2 size D batteries

Make an Electromagnet- battery, wire, steel bolt, switch, paperclips, tape, *scissors*

Simple Circuits- battery, plastic coated wire, bulb, bulb holder, *wire cutters or pliers*

Read a Meter- meter dials, construction paper, fasteners, glue, dial pages worksheet

Electricity…

…is a form of energy that can produce light, heat, magnetism and chemical changes.

…can be generated by friction, induction, or chemical changes.

…is an “action” of atoms - not a “thing”.

…may flow <u>on</u> a surface or <u>through</u> a substance as current.

…is considered a secondary form of energy. It is generated from the conversion of a primary source - solar, oil, coal, natural gas, nuclear, wind, or water.

…is the conduction (or transfer) of energy from one place to another.

…is the flow of energy.

…powers many of the things we use each day.

What is Electricity?

Everything in the world is made up of atoms (Greek for indivisible). Atoms are tiny particles, too small to see. It would take thirty million atoms placed end to end to reach across the head of a pin!

Atoms are made up of even smaller particles: protons, neutrons and electrons.
The nucleus of the atom is made up of protons which have a positive (+) charge and neutrons, which have no charge. Electrons with a negative (-) charge circle the protons and neutrons much the way earth circles the sun. The positive charge of the protons is equal to the negative charge of the electrons.

Normally atoms are electrically neutral. If an atom gains or loses electrons the atom becomes electrically charged. Electrons that are loosely attached to atoms are called free electrons. Free electrons can move easily from one atom to another. This movement produces a current of electricity.

All substances contain free electrons. Copper wire and some other metallic materials contain numerous free electrons and are easily capable of carrying electric current. They are conductors, providing a path for the electric current. But some materials such as plastic, rubber, and glass do not allow electricity to pass through them. These are called insulators. These materials have few free electrons. Semiconductors are materials that have a moderate number of free electrons. The more free electrons a material has, the better it will conduct electricity. When electricity is going through a copper wire, the metal in the wire is a conductor that allows the current to flow throughout the circuit. The plastic around the wires and on the bulb holders is an insulator and stops the current from passing into any metal objects that the circuit may be touching.

An electrical conductor such as aluminum is a material that allows an electric current to pass through it. Conductors, like all matter, are composed of atoms that have a nucleus with positively charged protons and negatively charged electrons spinning around the nucleus. Conductors differ from other matter in that they have more electrons called free electrons that are free to move through them. When the conductor is connected to a battery, the free electrons are pushed in the same direction. The path through which the electrons move is called an electric circuit. The repulsion of the electrons at one end of the wire and their attraction at the opposite end of the wire results in electrons moving in one direction. This movement of electric charges is called an electric current, and since the current moves in one direction it is called a direct current.

Electric current is the movement of free electrons from atom to atom. An electromotive force (or voltage) is needed to start that movement. A force such s a battery or electric power plant generator guides the free electrons in an orderly fashion from atom to atom. Electric current flows as long as the electromotive force is applied.

Voltage is the measurement of force that pushes electrons. In the United States 110 volts of electric power is regularly used. 220 volts is used for large appliances. Electric current is measured in amperes and is the amount of electrons passing a given point in one second. An ampere is equal to about 6.25 x 10 (to the 18th power) electrons per second.

Energy is sold by kilowatt-hours. A kilowatt hour (KwH) is 1000 watt hours and a watt hour is a very small unit of energy. The kilowatt hour tells us how much electrical energy is being used. The cost of a KwH varies from community to community because of many factors, including the kind of fuel used to run the generators and the expense of delivering the electrical energy to the customers.

Static Electricity

Static electricity is made of electrons that are not moving. When certain materials are rubbed together, free electrons are transferred by friction from one to another, and both become electrically charged. When you walk across carpet, electrons rub off the carpet and onto your body, giving you a negative charge. When you touch a doorknob or another person (a positive charge) the charge is transferred from you to the other surface. What a shock!

When atoms lose electrons, we say they become positively charged. When they gain electrons, they are negatively charged. Two like charges repel each other – and different charges, like hair and a comb, attract each other.

Lightning is another type of static electricity. Clouds become charged as ice crystals move inside the cloud. The friction causes the cloud to get so highly charged that the electrons jump to another cloud or to the ground.

Electrochemistry

Electrochemistry is the production of electricity by chemical changes. Two dissimilar metal electrodes (one negative, one positive) are placed in a conducting chemical solution (an electrolyte). The chemical reaction between the electrodes and the electrolyte produces an electromotive force. A battery, or electric cell, is a perfect example. The zinc metal housing of the battery acts as the negative electrode. A carbon rod in the center is the positive electrode. The electrolyte is a chemical paste of ammonium chloride mixed with manganese dioxide. If the zinc and carbon electrodes are connected in a circuit, electrons will flow from the zinc electrode to the carbon electrode, producing electric current. Since the electric current flows in only one direction, it is called direct current (d.c.).

Electromagnetism

A motor works using electromagnetism. When a magnet rotates inside a loop of wire or a loop of wire rotates around a magnet, an electromotive force is produced which causes the electrons in the wire to move, inducing an electric current. When current flows through the wire coil, another magnetic field is produced. The rotation of the wire or magnet alternates between attracting and repulsing, or “pushing” and “pulling”, due to the magnets polarity. The north pole of the fixed magnet attracts the south pole of the coiled wire. The two north poles push away from each other. The electric current, then, alternates its flow and is called alternating current (a.c.). In the United States, alternating current changes direction 60 times a second.

Electrical Safety

We use electricity everyday. Electricity can be dangerous. Understanding how it works helps us handle it more safely. Remember: Electricity always takes the easiest path to the ground. If you are between the electricity and the ground, you could become the path. Electricity can shock, burn, or kill. Most utility companies have excellent electrical safety programs and publications available. When attempting experiments using electricity, safety rules should always be followed.

Electricity Use

How does electricity get to our homes, schools and businesses?

In earlier days people needed to live next to a primary source of energy to use it. Cities were built by rivers so the water could turn water wheels to power machines. When energy from a primary source is used to make electricity, it can be transported anywhere to light homes, power machinery and heat and cool buildings!

Power plants produce most of the electricity we use. The fission of uranium or combustion of coal, natural gas or oil produces heat which turns water to steam. The pressure of the steam turns the blades on a turbine, which is connected to a generator. The force of wind or water energy directly turns the blade of a turbine.

From the power plant, the electricity goes to transformers where the voltage is increased. This increase helps transmit the electricity more efficiently.

High power transmission lines transport the electricity from the power plant transformers throughout an electric utility’s service area. At local substations, transformers decrease the voltage to 110 and 220 volts so that it can be used by homes and industries.

In homes, electricity is brought to the house through a three-wire cable connected through an electric meter to the house circuit breaker or fuse box.

Electricity Efficiency and Conservation

There is a subtle difference between energy efficiency and energy conservation yet people use the terms interchangeably. In addition, even worse, many people have the wrong idea about both. People think that efficiency is very complicated or expensive and think that conservation means being uncomfortable. Wrong and wrong again.

Energy efficiency is using your energy wisely. Energy efficiency usually means being smarter in the way we use energy. For the most part, people are efficient with the money they spend when buying groceries, clothing and vehicles. A person should be just as efficient in the way he or she spends energy. Yes, spend energy. Energy is not free, at least not the type used in most of the buildings and homes in America. When we burn coal, it is gone. We can't recycle coal and use it again – what's done is done and all that is left over is the pollution we leave behind. We have renewable energy sources, such as solar power, wind power, hydropower, and biomass. However, according to the Energy Information Administration, in 2002 only 6 percent of our energy usage in the United States was from renewable sources.

Energy efficiency is as simple as adopting better technology by screwing in a compact fluorescent light bulb (CFL). True, CFLs cost more to buy but they cut energy use by 75% and pay for themselves many times over. They are "smart" bulbs and cut pollution, too. The amount of energy wasted by the basic incandescent light bulb is amazing. Only 10% of the energy used by the bulb is needed to produce light. The remaining 90% of the energy consumed produces wasted heat energy. This is obvious only moments after the bulb has been turned on. It is too hot to hold in your hand. The CFL in contrast is only slightly warm to touch because it uses smarter technology to turn most of the energy consumed into light with little energy wasted.

To put it simply, society needs to do more to cut back the generation of pollution. Some people shiver at the thought of cutting back on energy; some envision classrooms in the dark, students and teachers bundled in layers of clothing in the winter and sweating profusely in the spring and summer months. Reducing energy usage does not mean going without.

Some people think of energy conservation as having to be uncomfortable or suffer to save energy. The truth is: comfort and conservation are completely compatible! Energy conservation usually means being more careful in the way we use energy or improving our habits. Each of us needs energy each day to maintain our lives. However, the way in which people use energy is another story. Conserving energy is really quite simple. You can turn off lights when you leave the room.

One thing to remember is that when doing a project about energy efficiency, we don't want people to get the wrong idea about what it means to be efficient or conserve energy. For example, when we want people to be energy-smart when using a computer, we would not tell the person to go without the computer for a day -- we would simply show the person how to put the computer monitor to sleep and explain the savings gained by doing so. The message is not to go without, simply to conserve what you have –by being efficient.

Electrical Current Activities

Flashlight

Warning: Other 1 ½ volt batteries such as AAA, AA, or C may be used, but do not use more than three 1 ½ volt batteries. Electricity can be dangerous.

Lesson Overview: Students will investigate how a flashlight works.

Materials: Flashlight that holds 2 size D batteries, 16 inch aluminum foil strip, duct tape, 2 size D batteries, *other sizes of batteries, other types of flashlight bulbs*

TEKS: Science: 5.8(C), 6.9(A,B), 7.6(C), 8.10(A)

Background Information:

The bulb of a flashlight glows when an electric current flows through a circuit, which in this experiment includes the battery, foil strip, and fine wire filament inside the flashlight bulb. The movement of the current through the wire filament causes the wire to get hot enough to give off light.

Instructions:

1. Unscrew the top section (which holds the bulb) from the flashlight.
2. Wrap one end of the foil strip around the base of the bulb holder.
3. Tape the two batteries together with the positive terminal of one touching the negative terminal of the other.
4. Stand the flat, negative terminal of the battery column on the free end of the foil strip.
5. Press the metal tip at the bottom of the flashlight bulb against the positive terminal of the battery. The bulb should light up.

Discussion Questions:

1. Does the number of batteries affect the results? Repeat the experiment using only one battery. It is not advisable to increase the number of batteries unless you are willing to risk burning out the bulb with excessive current.

2. Does the size of the flashlight bulb affect the results? The type of bulb a flashlight needs depends on the number of batteries used. Repeat the original experiment using different types of bulbs. Compare and record the illumination of the bulbs as bright, medium or dim.

WHAT'S A WATT?

Lesson Overview: Students will learn to read a meter and determine electricity use and cost.

Materials: meter dials, *construction paper, fasteners, glue, dial page, worksheet*

TEKS: **Math:** 3.1(A), 3.3(A,B), 3.14(A,C), 3.15(A), 3.16(A,B), 4.1(A,B), 4.3(A), 4.4(D), 4.14(A), 4.15(B), 5.3(A,B), 5.12(A), 5.14(A), 5.15(A), 6.11(A), 6.12(A), 7.11(A), 7.13(A), 8.1(B), 8.2(A,B), 8.14(A), 8.15(A)
Science: 3.16(A,B), IPC 6(C,D), Environmental Science 5(C), GMO 9(B,C)
Social Studies: US history 23(B), World Geography 19(B), 20(A,B), US Government 20(A,B)
Consumer Sciences: Management 6(A,B,C,D), Consumer and Family Economics 2(E), 6(A), 7(E), Housing 2(D), 7(A,B), Interior Design 1(F), 6(A,D), Engineering Principals 11(B)

Background Information:
A meter records the energy used by all the electrical circuits in your home. The meter has dials, which look almost like clocks. The dials on the electric meter record kilowatt hours by units of 100,000; 10,000; 100; and 10. When the pointer is between 0 and 1, read it as 0. Zero stands for 10, and so when the pointer is between 0 and 9, read it as 9. Meter readers write 0 instead of 10 when the pointer is on 0, because they do not use two digit numbers.

Instructions:
1. Using either an overhead or enlarged dials, demonstrate meter readings.
2. Students cut out the five dials and glue them on construction paper alternating clockwise and counter-clockwise rotation of numbers (be sure that the dial farthest to the right has numbers in a clockwise direction).
3. Attach fasteners to arrows at center of dials.
4. The dials are read in order from right to left, and the numbers are recorded from right to left.
5. Practice reading and recording.
6. Record meter readings at home for one 24 hour period. (Read meter at same time each day). Subtract to find kwh usage for one day.
7. Graph your results.
8. Find the cost of one kwh (ask electric company, or look at household electric bill). Multiply cost per kwh times kwh used to find cost of electricity for one day.
9. Discuss reasons for differences in kwh usage among students (home size, number of people, more lights, etc.).
10. Appliances have watts marked on them. Take the number of watts marked on the appliance times the number of hours used each month divided by 1000 to find average monthly kwh for any appliance.

Simple Circuits

Lesson Overview: Students will make a circuit and test some household objects to see if they are conductors or insulators.

Materials: battery, 1 foot of plastic coated wire, bulb , bulb holder, *a collection of household items*

TEKS: Science: 5.8(C), 6.9(A), 8.10(A)

Instructions: Making a Circuit

1. Cut the wire in half. Use wire cutters or pliers to strip the plastic coating from the ends, without cutting the wire itself.
2. Push the bare end of one piece of wire through the clamp on the bulb holder.
3. Touch the other ends of the wire to each side of the battery – make sure you have a wire touching the positive end and the negative end.
4. Add batteries to the circuit – what happens?

Instructions: Testing for Conductors

1. Make a circuit with a gap in it.
2. Touch an object with both wires. If the bulb lights up, you know that electricity must be passing through in order to complete the circuit. That means that the object must be a conductor.
3. Test other objects and test to find if they are conductors or insulators.

Discussion Questions:

1. Which items were conductors? Which items were insulators?
2. What characteristics did conductors have in common?
3. What characteristics did insulators have in common?

Pathway

<u>Lesson Overview:</u> Students will determine if aluminum is an electrical conductor.

<u>Materials:</u> 2 12 inch (30 cm) aluminum foil strips, penny, duct tape, size D battery, 2 spring clip type clothespins, short, wide rubber band, flashlight bulb, *iron nail, nickel, other metals, paper, pencil, plastic ruler, AA, AAA, and C batteries*

<u>TEKS:</u> Science: 5.8(C), 6.9(A), 8.10(A)

<u>Instructions: Building a Circuit Tester:</u>

1. Wrap the end of one foil strip around a penny, and tape the foil wrapped penny to the negative terminal (part of the battery from which electrons leave; flat end) of the battery.
2. Open a clothespin and wrap the free end of the foil strip around its tip. Secure the strip to the pin with tape. This pin will be called the material holder.
3. Tape the second foil strip to the positive terminal (the part of a battery toward which electrons flow; raised end) of the battery.
4. Place the rubber band around the ends of the battery to securely hold the foil and coin against the battery.
5. Wrap the free end of the foil strip around the base of the flashlight bulb. Be careful not to let the foil strip touch the metal dot on the end of the bulb.
6. Place the foil wrapped base of the bulb in the jaws of the second clothespin. This pin will be called the bulb holder.
7. Lay the foil strip down the side of the bulb holder, and secure with tape.
8. Hold the bulb holder, and press the metal bottom of the bulb against the aluminum strip on top of the material holder (the other clothespin).

<u>Discussion Questions:</u>

1. Aluminum is a metal. Are other metals conductors? Repeat the experiment using other metals such as a coin made of nickel (a nickel) and an iron nail. Test each metal one at a time by placing one side of the metal in the jaws of the material holder. Then press the bulb’s metal bottom against the opposite of the metal being tested.
2. Do materials other than metals conduct an electric current? Repeat the above experiment using materials such as paper, a wooden pencil, and plastic.
3. Would other batteries produce the same results? Repeat the original experiment three times using one of these battery sizes for each experiment: AA, AAA, or C.

Electrical Current bonus activities- not included in the station

Make a Model of an Atom

Lesson Overview: Students will build and label a model of an atom.

Materials: *a variety of materials to represent the protons, neutrons and electrons that comprise an atom such as candies, Styrofoam, balls or balloons…*

TEKS: Science: 7.7(B), 8.8(A,B)

Instructions:
Have students create a model of an atom using either class provided materials or free choice from home. Have students color code (or somehow indicate) the protons, neutrons and electrons that make up their atom and show the charge on each.

People Model of Electric Current

Lesson Overview: Students will illustrate how a battery helps electrons escape from atoms and flow through wires.

Materials: *six to ten students, cardboard box containing small balls (Styrofoam, ping pong, etc.), markers*

TEKS: Science: 5.8(C), 7.5(A), 8.10(A)

Instructions:
1. Have the six to ten students stand side by side in a row. (These people represent atoms in a wire. Since atoms are always moving, have the students wiggle a little in place.)
2. The balls represent electrons. Give each "atom" (student) one electron to hold.
3. The box represents a battery. If you connect one end of the wire to the battery, electrons will flow into the wire. Begin passing balls from one end of the line of students and tell the "atoms" to pass them on. The "atom" at the other end will end up with too many electrons and start dropping them - this is called sparking. Electrons cannot keep moving smoothly through the wire when it is filled up.
4. To keep the electrons moving smoothly through the wire, the other end of the wire needs to be connected to the other battery terminal. Have students form a circle with the "battery" (box) between the two "end atoms". Begin passing "electrons" again and have students return and retrieve them from the box.
5. You may "increase the electric current" by having students pass two balls as fast as they can.

Discussion Questions:
1. Did the students feel themselves getting warmer as they increased the current? A real wire will heat up too as current increases.
2. What is a limiting factor on how fast the "electrons" can be passed?
3. Label the positive and negative ends of the "battery." Does the flow of electrons change based on how the battery is positioned?

Static Electricity Activities

Static Electricity
Lesson Overview: Students will create an electroscope and investigate static electricity

Materials: piece of wool, glass jar with a plastic lid, Foil from a candy wrapper, plastic pen or ruler, bare wire, aluminum foil

TEKS: Science: 6.9(A), 8.10(A)

Background Information:
When you comb your hair does it sometimes stand straight up and stick to the comb? That's static electricity. With an electroscope you can test for the presence and strength of static electricity.

All things are made up of tiny particles called atoms. When a comb and hair rub together, the outer layer of electrons are rubbed off the hair atoms and cling to the atoms of the comb, producing static electricity.

When atoms lose electrons, we say they become positively charged. When they gain electrons, they are negatively charged. Two like charges repel each other – and different charges, like the hair and the comb, attract each other.

Instructions: Making an Electroscope:
Ask an adult to help you push a piece of wire through the lid of a jar. Bend one end of the wire and drape a thin piece of foil from a candy wrapper over it. Crumple a ball of aluminum foil around the other end. Put the lid back on the jar. Rub the plastic ruler (or pen) with a piece of wool, and then hold it over the foil ball. If the plastic ruler (or pen) is charged the candy wrapper will move. Try rubbing some other objects and see what happens.

Discussion Questions:

1. Would other objects cause the same reaction? Repeat the experiment with teams of other objects (replacing the plastic ruler and the candy wrapper)
2. What causes the candy wrapper to move?
3. Does the candy wrapper move more if the ruler has more charge?

Glow Bulb

Note: This experiment is best performed at night or in a darkened room without windows. Care should be taken not to press too hard when rubbing the fluorescent tube, as the tube could break.

Lesson Overview: Students will make a fluorescent tube glow without being connected to an electric current.

Materials: Dishwashing liquid, Fluorescent tube (size and shape of the tube do not matter and it can be a burned out tube), Large bath towel (longer than the fluorescent tube), Plastic report cover, *Paper towels, plastic food wrap, wool scarf, inflated balloon, incandescent light bulb, CFL*

TEKS: Science: 5.8(A), 6.8(A), 8.10(A)

Background Information:
Rubbing the fluorescent tube with the report cover results in a build up of charges, called static charge, on the outside of the glass. This outside charge attracts charged particles inside the tube. The phosphor powder coating on the inside of the tube gives off light when struck by these charged particles.

Instructions:
1. Wash and thoroughly dry the outside of the fluorescent tube with paper towels.
2. Stretch out the bath towel near the edge of a table.
3. Lay the fluorescent tube on the bath towel.
4. Darken the room by turning off the lights.
5. Ask your adult helper to rub the plastic folder back and forth across the tube. Caution: Care should be taken not to press too hard, as the tube could break.
6. The fluorescent tube starts to glow and the light moves back and forth with the movement of the plastic.

Discussion Questions:
1. Can other materials produce a static charge on the glass? Repeat the experiment, replacing the plastic report folder with materials such as a piece of plastic food wrap, a wool scarf, and an inflated balloon.
2. Will other types of light bulbs give the same results? Repeat the original experiment replacing the fluorescent tube with an ordinary filament light bulb or a CFL.

Stickers

Note: This experiment works best on a dry day. If the air is very humid, ask an adult to dry the balloon with a hair dryer.

Lesson Overview: Students will determine how static electricity is produced

Materials: a 9 – inch round balloon, ruler, scissors, sewing thread, masking tape, *hand soap, water, towel, hair dryer (if air is humid), puffed rice cereal, plastic food wrap, paper, marker, different shapes of balloons, cotton, silk and rayon material*

TEKS: Science: 5.8(A,C), 7.5(A), 8.8(A,B), 8.10(A)

Background Information:
Static Electricity is the build up of electric charges on an object. These charges are called static charges because they are stationary (not moving). These static charges can be positive or negative. All substances are made up of atoms. Every atom has a nucleus containing protons and electrons spinning around it. The protons have a positive electrical charge, and the electrons have a negative charge. When two substances such as the balloon and your hand are rubbed together; electrons are pulled over from the material that has the weaker attraction for them (the hand) and attach to the material that has the stronger attraction (the balloon). This causes both materials to become charged. The material losing electrons becomes positively charged and the material gaining electrons becomes negatively charged.

Instructions:
1. Inflate the balloon and knot the end.
2. Tie a 12 inch (30cm) piece of thread to the balloon.
3. Tape the free end of the string to the edge of the table.
4. Wash and dry your hands. Your hands must be clean and very dry.
5. Sit on the floor near the balloon.
6. Hold the balloon in one hand and quickly run the other hand back and forth across the surface of the balloon eight to ten times.
7. Release the balloon and allow it to hang freely.
8. Hold the hand rubbed against the balloon near and to the side of, but not touching, the balloon. The balloon moves toward your hand. The balloon will move upward through the air to reach your hand.

Discussion Questions:
1. Does the number of times the balloon is rubbed affect the results? Repeat the experiment twice: first decrease the number of times the balloon is rubbed, and then increase the number of rubbings.
2. Would rubbing the balloon with different materials affect the results? Repeat the original experiment, rubbing the balloon with different types of cloth such as cotton, wool, silk, and/or rayon and with materials such as paper and plastic.
3. Does the shape of the balloon affect the results? Repeat the original experiment replacing the round balloon with a long balloon and/or balloons with wavy shapes.

Going Further:

1. Demonstrate that there is an excess of charge on the area where the balloon was rubbed. Use a marker to put an X on the area of the balloon to be rubbed. Repeat the original experiment, giving the balloon a slight spin to cause it to rotate. The balloon will turn and stop with the X facing your hand.

2. Another way to demonstrate static electricity is to lay about 20 pieces of puffed rice cereal on a table. Wad a 2 ft piece of plastic food wrap to form a piece about the size of your fist. Quickly rub the plastic wrap back and forth across a sheet of paper 10 to 15 times. Immediately hold the plastic above the puffed rice. The plastic should be near, but not touching, the cereal.

Static Electricity bonus activities- not included in the station

Balloon Keep Away

Lesson Overview: Students will investigate the properties of static electricity.

Materials: *Two balloons, string, a piece of wool, piece of scrap paper*

TEKS: Science: 5.8(A,C), 6.9(A), 8.10(A)

Instructions:

1. Rub one balloon with wool. Then hold it up to a wall. It will stay there by itself.
2. Now tie the two balloons together. Rub both balloons with the wool. Hold the string in the middle. The balloons will stay apart.
3. Slide a piece of paper between the two balloons and observe what happens.

Discussion questions:

1. Why did the balloon stick to the wall? (When the balloon was rubbed the friction caused it to pick up extra (negative charge) electrons. The negative charges in the balloon are attracted to the positive charges in the wall.)
2. Why did two balloons tied to the same string stay apart? (The two balloons both have negative charges. Negative charges always repel negative charges so they repel each other.)
3. Why were the balloons attracted to the paper? (The negatively charged balloons are attracted to the positively charged paper.)

Static Snakes

Lesson Overview: Students will investigate the properties of static electricity.

Materials: *Tissue paper, scissors, water based markers, tag board, plastic ruler, and piece of wool*

TEKS: Science: 5.8(A,C), 6.9(A), 8.10(A)

Instructions:

1. Draw a snake pattern on tag board and cut it out.
2. Carefully trace then cut out the snake pattern onto tissue paper.
3. Carefully decorate with markers (tissue paper tears easily)
4. Place the snakes on a flat surface.
5. Rub a ruler with the piece of wool to charge it.
6. Pass the charged ruler over the snakes and watch them wiggle!

Discussion Questions:

1. What causes the snakes to move?
2. Does the material the snakes are made of change the ability to move?
3. Do the snakes move differently when the ruler is charged longer?

Electrochemistry bonus activities- not included in the station

Make a Battery
This experiment requires adult supervision

Lesson Overview: Students will make a battery.

Materials: *one lemon, two six inch pieces of copper wire, nail, metal thumbtack, small flashlight bulb, scissors, galvanometer, other food items to test*

TEKS: Science: 5.8(A,C), 6.8(A), 6.9(A,C), 7.5(A), 8.10(A)

Instructions:
1. Push nail in near one end of the lemon. Push the thumbtack in near the other end of the lemon.
2. Twist one piece of wire around the nail and the other piece around the thumbtack.
3. Touch the two free ends to the bumps on the bottom of the flashlight bulb. Observe what happens.
4. Attach the galvanometer to see how much electricity the lemon is producing.

Discussion Questions:
1. Do other foods work?
2. Which types of foods work best and why?
3. Would your “food battery” run out of power like a real battery would?

Electromagnet Activities

Making an Electromagnet
Electromagnets are used in power station generators, but have many other uses too, such as lifting old cars in scrap metal yards.

Lesson Overview: Students will build an electromagnet and switch system.

Materials: battery, 5ft and 18 inch lengths of thin single core wire, 6 in long iron or steel bolt (or nail), switch (paper clip, 2 thumbtacks, and small block of wood), paper clips, cellophane tape

TEKS: Science: 5.8(A,C), 6.9(A,B), 8.10(A)

Instructions for building the electromagnet:

1. Strip 1 inch of the insulating plastic coating from both ends of the two wires, using a pair of scissors or pliers.
2. Leaving 18 inches free on one end of the longer wire, wind it tightly on to the bolt. When you get to the end of the bolt, wind the wire back to the top of the first coil. Make several more layers, ending up with the wire back at the start.
3. The more coils you can get onto the bolt, the more powerful the electromagnet will be.
4. Leave about 12 inches free and tape the wire in place.
5. When an electric current is passed through the wire the combined wire and bolt will become an electromagnet.
6. To make the switch, first twist the bare end of the 12 inch wire from the electromagnet around the point of a thumbtack. Push this, through a paper clip into the wooden block. Then twist one of the bare ends of the second piece of wire (the unused 18 inch piece) around the point of the second thumbtack. Stick this into the block of wood 1 ½ from the other pin and tape the wires down.
7. Attach the two remaining loose ends of the wire to the two terminals of the battery.

Instructions for using your magnet
Your magnet should now work when you complete the electrical circuit by closing the switch. This allows current to flow through the wire. To close the switch, swivel the paper clip so that it touches the second pin. The magnet should pick up the paper clips. Experiment with other things to see what else it will attract.

Remember to switch off the electromagnet when you are not using it, or it will quickly run down the battery.

Discussion Questions:

1. What types of items will your magnet pick up?
2. Does your magnet have a weight limit?
3. How could you modify the magnet to pick up more weight?

Electromagnet Bonus Activities- not included in the station

Creating Electricity From Magnets
Lesson Overview: Students will investigate the connection between electricity and magnets.

Materials: *Current indicator (galvanometer), two bar magnets (one stronger than the other), six feet insulated copper wire*

TEKS: Science: 5.8(A,C), 6.8(A), 6.9(A,B), 8.10(A)

Instructions:
1. Scrape about three inches of insulation off each end of the copper wire.
2. Starting about one foot from one of the ends of the copper wire, coil the wire until there is about one foot left at the other end
3. Attach the ends of the copper wire to the current indicator.
4. Move the magnet back and forth on the outside of the coil. Record your observations.
5. Now move the magnet back and forth inside the coil. Record your observations.
6. Repeat the experiment using the opposite end of the magnet. Record observations.
7. Repeat the experiment using a stronger magnet. Record observations.

Discussion Questions:
1. Does it matter which end (North or South) faces up in the experiment?
2. Does a stronger magnet affect the amount of electricity produced?

Electricity Efficiency and Conservation Activities

The Tale of Two Light Bulbs
Lesson Overview: Students will examine life costs of different light bulbs to find the best deal and best technology.

Materials: 75 watt incandescent bulb, Equivalent Compact Fluorescent Bulb, Y- socket, extension cord, *Electricity*

TEKS: **Math:** 6.2(B,C), 6.11(A,B,D), 7.2(B,D), 7.3(B) 7.13(A,B), 8.2(A,B), 8.14(A,B), Math Models: 1,2
Science: 8.5(A,B), IPC: 6(D), GMO: 9(B), Environmental Systems: 5(C,E), 7(C,D)
Social Studies: 6.20(A), 6.21(B,C), 6.23(A,B), 7.20(A), 7.21(B,C), 7.23(A,B), 8.30(C,B), Sociology: 18(B), US Government: 18(B), 19(A,B), 20(A,B)
Consumer Sciences: Management: 6(D), Consumer and Family Economics: 7(E), Housing: 7(B), Interior Design: 1(F), 2(A,B,C), Energy, Power and Transportation Systems: 9(B)

Instructions:

1. Using questioning have your students fill out a blank version of the following chart and do the math to calculate the savings resulting from changing out standard incandescent light bulbs and replacing them with a CFL.

Incandescent (standard) vs. Compact Fluorescent Light Bulbs (CFLs)		
Bulb Type	75W Incandescent	20W CFL
Lumens Produced	1,100	1,200
Purchase Price	$0.75	$5.00
Number of Hours Burned per Day	4 hours	4 hours
Life of the Bulb	750 hours or ½ of 1 year	10,000 hours or 6.8 years
Number of Bulbs Needed to equal life of 1 CFL/Total cost of those bulbs	~13/$10.00	1/$5.0
Total Cost of Purchasing Bulbs	$10.00	$5.00
kilo-Watt hours (kWh) over the 6.8 years	75W x 750 hrs = 56,250 Whrs 56,250/1000 = 56.25 kWh 56.25 kWh x 13 = 731.25 kWh	20W x 10,000hrs = 200,000Whrs 200,000/1000 = 200 kWh
Total Cost of Electricity for 6.8 years (8 cents x **kWh)**	$58.50	$16.00
Total cost over the 6.8 years	$68.50	$21.00

Total Savings using a CFL compared to an incandescent bulb:	**$47.50**

<u>Discussion Questions:</u>

1. What similarities do you observe between an incandescent bulb and a compact fluorescent bulb?
2. What differences do you observe?
3. After doing the math, which bulb would you pick and why?