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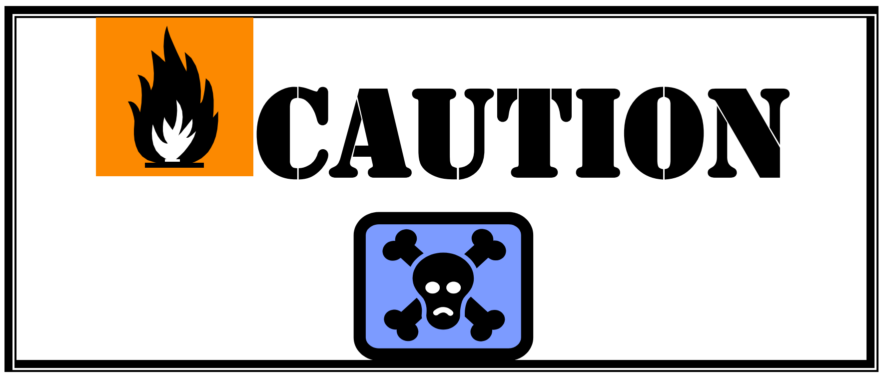
MUSEUM OF SCIENCE & HISTORY

Volts & Jolts Curriculum Guide



- A general safety rule to follow: Adhere to the instructions.
- Stay at least 10 feet away from overhead power lines.
- Don't touch electric tools, equipment, or cords that are wet, or with wet hands.
- Never use damaged power tools or electrical cords.
- Avoid using several high-amperage appliances - such as irons or other heat-producing appliances - on the same circuit.
- Always supervise children when doing electricity-related experiments.
- Protect children from electrical shock by installing plastic safety inserts in unused outlets.
- Keep electrical cords out of traffic paths and away from areas where children play.

MOSH is not responsible for any accidents resulting from irresponsible or incompetent use of the demonstrations and activities suggested in this packet.

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Volts & Jolts

Program Description: You'll have a hair-raising experience in this exciting class on electricity. Students will learn about different types of electricity, such as static, AC, DC, and broadcast electricity. Hands on demonstrations enable the students to have a shockingly fun visit.

Learning Goals: At the end of this program students should have an understanding of the following:

- The relationship between electric current and magnetism
- Electrons are responsible for electricity
- Lightning is a type of electricity
- Everything in the universe wants to be neutral, but sometimes things carry a charge
- Insulators stop the flow of electricity; conductors allow the flow of electricity
- Common types of electricity used in everyday life and other types that aren't widely used

Pre-Visit Activities

1. Have the students list ways they personally use electricity every day.
2. Discuss electrical safety in the home and outside.

Vocabulary (see below for definitions)

volts	amps	electricity	atoms
protons	neutrons	electrons	current
attract	repel	lightning	charge
conductor	insulator	generator	

Post–Visit Activities

1. Experiment with static electricity using balloons. Have the students charge up a balloon by rubbing it on their hair or clothing. Hold the charged balloon near a wall, near a thin stream of water from a faucet, and near some glitter or torn pieces of paper.
2. Experiment with batteries, wire, and miniature light bulbs to build simple electrical circuits.
3. Talk to your students about power plants and how they create electricity.
4. Do the activities included in this guide.

Volts & Jolts Sunshine State Standard Benchmarks

SC.5.P.11.1	Investigate and illustrate the fact that the flow of electricity requires a closed circuit (a complete loop).
SC.5.P.11.2	Identify and classify materials that conduct electricity and materials that do not.
SC.912.P.10.13	Relate the configuration of static charges to the electric field, electric force, electric potential, and electric potential energy.
SC.912.P.10.14	Differentiate among conductors, semiconductors, and insulators.
SC.912.P.10.15	Investigate and explain the relationships among current, voltage, resistance, and power.
SC.912.P.10.16	Explain the relationship between moving charges and magnetic fields, as well as changing magnetic fields and electric fields, and their application to modern technologies.

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Volts & Jolts Vocabulary

Definitions

Volt A way to measure electricity.

Protons Positively charged particles.

Attract To cause to draw near by physical force. Protons and electrons are attracted to one another and come together to make static electricity.

Conductor A material that allows electrons to easily flow through it, such as metal, water, salt, our bodies, etc.

Amps A way to measure electricity.

Neutrons Particles that do not have a charge.

Repel To push away from; like charges or poles repel each other.

Insulator A material that does not allow electrons to pass through it easily, such as rubber, plastic, wood, and glass.

Electricity The result of the interaction of electrons and protons that is caused by the attraction of particles with opposite charges and the repulsion of particles with the same charge. The way charged particles of matter interact can create electricity.

Electrons Negatively charged particles.

Lightning A release of energy in the form of static electricity between a cloud and the ground.

Generator Something that creates electricity.

Atoms The building blocks of life.

Current Movement of negatively charged particles.

Charge Small particles carry electric charges, positive or negative.

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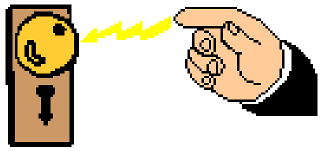
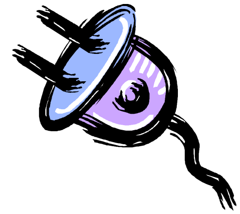


Volts & Jolts



Included in this guide is follow-up information to encourage discussion about the topics covered during the program. You will also find experiments, worksheets, and recommended reading to use with your class at the end of this guide.

The formal definition of electricity is the flow of tiny charged particles, or electrons found in atoms. Some examples of electricity are lights, lightning and getting shocked. Atoms are the basic building blocks for everything in the universe, but they are too small to be seen with the naked eye, or even a microscope. The center of the atom is the nucleus. Neutrons, which have no charge, and protons, which are positively charged, remain within the nucleus. Electrons are negatively charged particles that move outside the nucleus.

STATIC ELECTRICITY

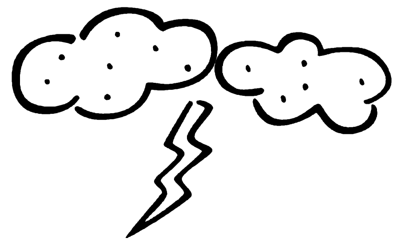
Definition: *Electricity involving a build up of charges that stay in one place until they jump to another object*

In the *Volts & Jolts* program we made static electricity by rubbing a balloon on a volunteer's head and noticed that the balloon stuck to his/her head or to the wall. This is due to the loss of electrons on the head, making it more positively charged, and the gain of electrons on the balloon – becoming more negative. Since we know that opposite charges attract one another, the balloon is held against the wall or head until the charge gradually decreases and the balloon falls.

An electric shock is produced or felt due to the difference in charges between one person and another. As negative charges build up they eventually jump or arc to something more positively charged to become neutral. The object/person with less electrical resistance is called the *conductor* because it allows the negative charge to flow through it more easily. Some examples are water, salt, our bodies and metal. However, the *insulator* is made of a material that does not allow electricity to flow through it. Examples are rubber, plastic, pottery and the ground. The Van de Graaff Electrostatic Generator, "Sparky", generates static electricity using a rubber band inside of it that rubs off electrons onto the metal dome. These electrons collect outside and build up a charge. Putting a conductor near it will allow the charge to jump to the metal in the form of a bolt of electricity. The purple sparks of static electricity are basically baby lightning bolts. Our hair

stands up when we put our hands on the dome because of the negatively charged particles from the Van de Graaff running through our bodies and repelling against other negatively charged particles in our hair/body. As your body is becoming more negatively charged, your hair is also. We know that like charges repel each other. Your hair stands up because your negative head will push your negatively charged hair away. To make your hair "dance", we move the metal conductor wand close to Sparky and then away from it. Moving the conductor close pulls some of the electric charge away from your body, making your hair fall; when we move the conductor away, the charge increases and the hair goes back up.

Lightning is caused by static electricity building up and being released. In a storm cloud dust and ice particles rub against water droplets and become statically charged. Positively charged particles rise to the top of a cloud and negative particles sink to the bottom. The negative charges leap from the cloud to meet the positive charges jumping off the ground, causing a bright flash.



The Leyden Jar is a capacitor, which means that it stores an electric charge. There is an activity within this guide that shows you how to easily create one. In the "shock circle" we use this device to demonstrate that people are good conductors of static electricity because we have a lot of water, salts and minerals in our bodies, which are all good conductors of electricity. Once the Leyden Jar has collected enough charge, the shock circle shows how fast and well it can move. It moves very fast, about 31,000 miles/second and can be very strong and dangerous depending on the source of the electricity. The muscles in our bodies need electric shocks to make them contract so that our hearts can pump blood and our muscles can make us move. Too much electricity can stop our hearts, but doctors can make them beat again using defibrillators.

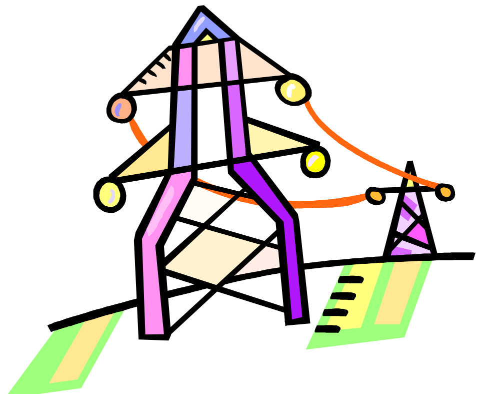
CURRENT ELECTRICITY

Definition: *Electricity where the charges are moving in a large-scale, organized way*

We do not use static electricity in our homes because it is very unstable and unreliable. Instead, we use current electricity that flows through wires. The movement of electrons around a circuit is called an electric current. Two kinds are direct current (DC) and alternating current (AC).

Direct current electricity comes right from the source, like a battery. The electrons flow from the positive to the negative pole causing a current of electricity. It is easy to make a battery at home using a lemon or potato, an unwound paperclip and a piece of copper wire. By placing the wires in the lemon or potato, crossing them, and then sticking them on your tongue, an electric current is made and you get a little shock – harmless! Another activity for building a battery is included at the end.

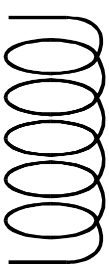
Electricity generation in a power station, like JEA's, yields alternating current. This comes from wires and the direction it flows in alternates at 60 cycles/second – it travels in one direction, stops, and travels in the opposite direction. We use AC electricity in our homes because of its convenience and reliability- electrical outlets in the walls of our homes allow us to plug in many things at once for unlimited amounts of time. But, where does the electricity come from? JEA produces electricity through the heating of coal. The hot coals give off steam that rises to make the generators move. The turbine spins a magnet inside of a wire coil, which transfers the electrons from the wire out to power lines. From the power plant the electricity goes to a step up transformer, where it is strengthened. It can then travel long distances over power lines called transmission lines. From there the electricity goes to a step down transformer, which lowers the voltage for home use, and finally to distribution lines which bring it into our homes.



The C*ircuit Board* used in the *Volts & Jolts* program shows that all wires need to be complete in order for the circuit to work properly; if one wire was snipped, the light would not go on when the turbine was moving. Attaching volunteers to the circuit board shows that humans are good conductors of current electricity, but too much *resistance* or a broken circle would stop the current and the light would not go on. Most electrical equipment uses high power from household current. This is very dangerous and you should never play with electricity from sockets.

BRADCAST ELECTRICITY

Definition: High-frequency electric power transmitted wirelessly



In 1891, Nikola Tesla invented the *Tesla Coil*, a 50-foot electric generator that broadcasted electricity into the air. The Tesla Coil is a special transformer that takes small amounts of electric power and rapidly boosts it to a great deal of power. As we demonstrated in *Volts & Jolts*, the high-frequency output of the small Tesla Coil (8 inches high) can light a fluorescent tube from several feet away without wire connections. It seemed like a brilliant idea since no wires are involved; however, the problems associated with it were that it was very loud, dangerous due to traveling sparks, and it only worked for a 22 mile radius. Although we do not continue to use the Tesla Coil, Tesla's high-frequency electric power ideas and inventions did lead to neon and fluorescent lighting, radio transmission, remote control electronics, computers and wireless internet, fax machines and microwaves.

The Leyden Jar

A device for collecting and storing charges

BACKGROUND:
The Leyden Jar was invented independently by EG Von Kleist and Professor van Musschenbroek of Leyden University in 1745. At that time it was believed that electricity was an invisible fluid. Kleist attempted to get a glass of electricity by connecting a static generator to a wire that ran into an empty glass. After running the generator, Kleist disconnected the glass and found that it was still empty. He then thought that perhaps electricity dissolved in water and so he repeated the experiment with the glass filled with water. Once again he did not achieve the desired results and considered the experiment a failure. When he went to remove the wire from the glass, there was a spark and he received a large shock. The idea was born.

In Holland, Professor van Musschenbroek was trying to do the same thing. After repeated failures, his assistant Cuneus tried charging the water while holding the glass in his hand. This also led to a spark and a large shock. Professor van Musschenbroek wrote of the experiment and was given credit for the invention of the Leyden Jar, the forerunner of the modern capacitor.

Leyden Jars played a large part in early experiments with electricity, including many done by Benjamin Franklin. He used them for a variety of experiments, including his famous experiment using a kite to show that lightning was actually static electricity.

Make Your Own Leyden Jar:
Materials needed: glass or plastic drinking glass, aluminum foil, charging device (television)

Procedure:
1. Cut two squares of foil, each a little taller than your glass and long enough to reach around it with about an inch of overlap.
2. Take one piece and wrap it around the glass, leaving about half an inch of the glass bare above the foil
3. Crush the bottom of the foil to cover the bottom of the glass
4. Shape and smooth the foil until it fits around the glass as smoothly as possible.
5. After smoothing the foil, carefully remove it from the outside of the glass and place it inside. There should still be a bare gap above the top of the foil.

6. Repeat steps 1-4 with the second piece of foil, making the foil as smooth as possible. Don't worry about small tears, just push the foil back together and smooth it down.
7. Cut a third strip of foil about an inch wide and 10-12 inches long. Crumple one end into a ball.
8. Remove the inner foil from the glass and insert the small foil strip with the ball above the edge of the glass.
9. Place the inner foil back into place making sure that the ball of foil is still above the edge of the glass. Your Leyden Jar is now complete.

To charge your Leyden Jar, turn on your television, hold the jar in your hand and move the ball of foil back and forth across the screen to collect the charge. You could also rub a balloon on your hair and bring the charged balloon close to the top of the jar. After 30-40 repetitions, you should be able to get a spark to be felt easily.

WHY?? As the spark jumps to the ball, it tries to spread evenly over the foil. Due to the "skin effect", all of the charge moves to the outer surface of the inner foil and the top of the foil ball, leaving the inner side with no charge. The buildup of charge next to the non-conducting glass has a polarizing effect. Like charges are pushed away, and opposite charges are attracted. Excess charges on the outside of the glass are drained away by the outer foil and conducted to the ground by way of the hand and body. If the outside foil is not grounded, very little charge will accumulate in the jar.

Because the foil ball extends beyond the foil liner, it will have a charge equal to the outer surface of the inner foil. As you bring your knuckle close to the ball, a spark will jump. This drains the charge from the ball and the foil.

Problems?? If you have problems getting a spark from your Leyden Jar, try drying it with a hair dryer. You may need to collect several sparks before trying to draw a spark to your knuckle. Also check to be sure that the foil liners are as smooth as possible. Be sure that there is at least a one inch gap between the foil and the top of the glass on the inside and outside. This will prevent the charge from arching over the top.

Adapted from "The Science Education Book of the Van de Graaff" by Robert Kramph. 1991. The Science Education Company.

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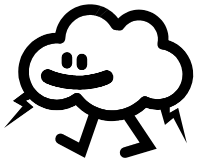
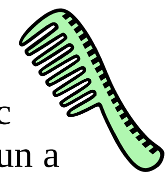


Static Activities

Make your own static

Place a tin tray on a polyethylene bag and use clay as a handle to rub the tray around. Don't touch the tray-use the handle to lift it. Hold a fork near the edge. A spark of static electricity will jump from the tray to the fork.



Making static electricity

You do not need a laboratory or special equipment to make static electricity. Your experiment can be as simple as combing your hair. Run a plastic comb through your hair a few times or rub it hard with a piece of woolen fabric. Then hold the comb near some tiny scraps of tissue paper. Rubbing the plastic builds up a static charge in the comb that attracts the tissue scraps. Try the same experiment with different plastic items. It works with pens, straws, and balloons.

Sticky balloons

This is a very easy investigation that shows static electricity in action. Blow up some balloons and rub them hard on a wool sweater. Hold the balloons against a wall. The balloons seem to stick on the wall as if by magic. What is happening is that the static charges on the balloons is different from the static charge on the wall, and opposite charges attract one another. The balloons are held against the wall until the charge gradually leaks away and the balloons slip to the floor.

Bending water

Use you balloon once more, but this time charge up your balloon by rubbing it hard on a wool sweater, then hold it near a running tap. The water is attracted towards the charged balloon and you can see the flow of water bending towards it.

Log Rolling

Put some drinking straws on a table. Charge a plastic pen with static by rubbing it with a wool cloth. Hold the pen close to the straws and watch them roll away. The straws and pen are both plastic and have the same static charge. Things with the same charge repel each other, so the pen pushes the straws away.

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Recommended Reading

Allen, Dorothea. *Hands on Science*. The Center for Applied Research in Education: West Nyack, 1991.

*Challoner, Jack. *Eyewitness Books: Energy*. Dorling Kindersley: New York, 2000.

Gibson, Gary. *Understanding Electricity*. Copper Beech Books: Brookfield, 1995.

Kramph, Robert. *The Science Education Book of the Van de Graaff*. The Science Education Company, 1991.

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*Parker, Steve. *Eyewitness Books: Electricity*. Dorling Kindersley: New York, 2000.

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VanCleave, Janice. *Scientists through the Ages*. John Wiley & Sons, Inc.: New Jersey, 2004.

Walker, Pam & Elaine Wood. *Hands-On General Science Activities with Real Life Science Applications*. The Center for Applied Research in Education: West Nyack, 1994.

Whalley, Margaret. *Experiment with Magnetism & Electricity*. Two-Can: Princeton, 2002.

Websites

http://tonto.eia.doe.gov/kids/energy.cfm?page=electrcity_home-basics
www.historyforkids.org/scienceforkids/physics/electricity
http://scifiles.larc.nasa.gov/text/kids/D_Lab/acts_electric.html

Eyewitness Books may be available at the MOSH gift shop

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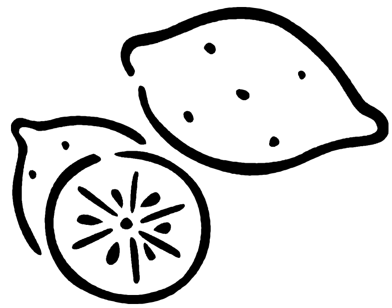
Power Up!

Make your own Battery

Here is a simple way to make your own battery and feel an electric shock using a lemon!



Materials:

1 lemon

1 knife (to cut slits in the lemon)

1 penny (or bare copper wire)

1 dime (you can also use a galvanized nail, paper clip, or bare zinc wire)

Try It:

1. Roll the lemon on a table or hard surface to loosen the juices in the lemon.
2. If you are using a dime & penny, cut two slits in the lemon, about an inch apart. Insert the penny and dime into the slots. If you are using wire, stick one end of the copper wire into the lemon. About an inch apart, stick the nail, paper clip, or zinc wire into the lemon.
3. Touch your tongue to the dime and penny (or both wires/nail) at the same time. You will feel a small tingly shock, like licking the end of a battery!

Why?

The lemon contains acid which reacts differently with the two metals. One of the coins/wires contains positive electric charges, while the other contains negative electric charges. These charges create current, which will flow if the battery circuit is complete. Your tongue acts like a wire and conducts the charges, making the circuit complete. The complete electric circuit creates a small electrical flow, which causes the sensation on your tongue. Regular batteries are very similar to your lemon battery.

Source:
http://www.ushistory.org/franklin/fun/lemon.htm

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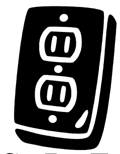
Name ____ Date_________________________

Volts & Jolts Word Find



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battery
static
power plant
electrons
Leyden jar
broadcast
Tesla coil
capacitor

transformer
charge
insulator
electricity
generator
current
conductor
circuit