Zap!

Primary Learning Objectives:
Students will:

- Understand that atoms are the building blocks of everything.
- Know that protons, neutrons, and electrons make up atoms and have positive, neutral, and negative charges.
- Recognize that static electricity is created when positive and negative charges aren't balanced.
- Distinguish that materials through which electricity flows very easily are conductors and things that block the flow of electricity are insulators.
- Be aware that static electricity can be used for practical purposes and be able to give examples.

Examples of TN State Standards to Incorporate:
Kindergarten:

- 7.11.1 Explore different ways that objects move.
- Inq.1 Use senses and simple tools to make observations.

1st Grade:

- 7.11.1 Investigate how forces (push, pull) can move an object or change its direction.
- 7.11.1 Use familiar objects to explore how the movement can be changed.
- Inq.3 Communicate understanding of simple data using age-appropriate vocabulary.

2nd Grade:

- 7.9.1 Use tools to observe the physical properties of objects.
- Inq.2 Ask questions, make logical predictions, plan investigations, and represent data.

3rd Grade:

- 7.9.1 Use physical properties to compare and contrast substances.
- 7.9.1 Describe a substance in terms of its physical properties.
- T/E.3 Identify appropriate materials, tools, and machines that can extend or enhance the ability to solve a specified problem.

4th Grade:

- 7.12.1 Explore the interactions between an electrically charged object and other materials.
- 7.12.2 Observe that electrically charged objects exert a pull on other materials.

5th Grade:

- 7.12.3 Provide examples of how forces can act at a distance.
- 0507.Inq.4 Analyze and communicate findings from multiple investigations of similar phenomena to reach a conclusion.

6th Grade:

- 7.12.3 Compare and contrast the characteristics of objects and materials that conduct electricity with those that are electrical insulators.
- 7.12.2 Identify materials that can conduct electricity.

7th Grade:

- Inq.5 Design a method to explain the results of an investigation using descriptions, explanations, or models.
- 0707.11.4 Identify and explain how Newton's laws of motion relate to the movement of (any) objects.

8th Grade:

- 7.9.1 Understand that all matter is made up of atoms.
- 7.9.1 Identify atoms as the fundamental particles that make up matter.
- Inq.4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.

High School: Physical World Concepts

- C.L.E. 7.4.2 Explore static and current electricity.
- 7.5.1 Identify the parts of an atom.
- 7.5.2 Describe the properties and location of subatomic particles.

High School: Physics

- CLE 3231.5.2 Explore the flow of electrical charges and electric currents.
- CLE 3231.6.1 Investigate the properties and structure of the atom.

High School: Physical Science

- CLE 3202.2.4 Probe the fundamental principles and applications of electricity.
- CLE 3202.1.2 Describe the structure and arrangement of atomic particles.
- CLE 3202.Inq.2 Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.

- Inq.2 Conduct scientific investigations that include testable questions, verifiable hypotheses, and appropriate variables to explore new phenomena or verify the experimental results of others.
- Inq.4 Determine if data supports or contradicts a hypothesis or conclusion.

Examples of Academic Vocabulary to Incorporate:

Kindergarten: beginning, ending, retell, difference, location, position, air, change, collect, observe, parts, senses, tools, job

1st Grade: question, reality, information, summarize, predict, sequence, classify, compare, data, digit, direction, even, greater than/less than, balance, classify, environment, investigate, location, matter, prediction, property, push/pull, technology

2nd Grade: discussion, predicting, distance, interpret, likely, unlikely, outcome, unknown, compare, contrast, depend, distance, energy, infer, investigate, observation, reasoning, scientific inquiry, scientist, similarities/differences, type, decision, conflict

3rd Grade: cause, effect, fact, possessive, sequential, summarize, supporting details, change, conclusion, reasonableness, orbit, conductor

4th Grade: prediction, make inferences, drawing conclusions, compare, contrast, analogy, range, relationship, convert, accuracy, electricity, friction, distribution

5th Grade: implied, main idea, visual image, data collection methods, edge, variable, dissipate,

6th Grade: inference, relevant, relevancy, sequential order, experimental probability, random, similarity, cause and effect, conductivity, control, criteria, electrical conductor, protocol, variable

7th Grade: inferences, paraphrase, phenomenon, speed

8th Grade: debate, elaborate, inferring, facilitator, rate, inductive reasoning, deductive reasoning, reliability, infinite, sequence, proton, neutron, electron, atom, neutral, particle motion, variation

9th Grade: questioning, research, paraphrase, catalyst, friction, energy, resistance

10th Grade: research, reasoning, shift, incongruity, ambiguity, deductive reasoning, inductive reasoning, independent and dependant events, catalyst, property

High School: Instructors, please note that though there are no specific Academic Vocabulary lists for upper grade high school students, they will be expected to be familiar with and understand the key scientific terms and concepts covered within the following lesson. Familiarize yourself with the proper terms for all of the following concepts and make sure that you use them with and explain them to your students.

Zap!

Have you ever been "shocked" when you touched a doorknob, a car-door handle, or a water fountain? Ouch! Well, then you already know something about the effects of **static electricity**.

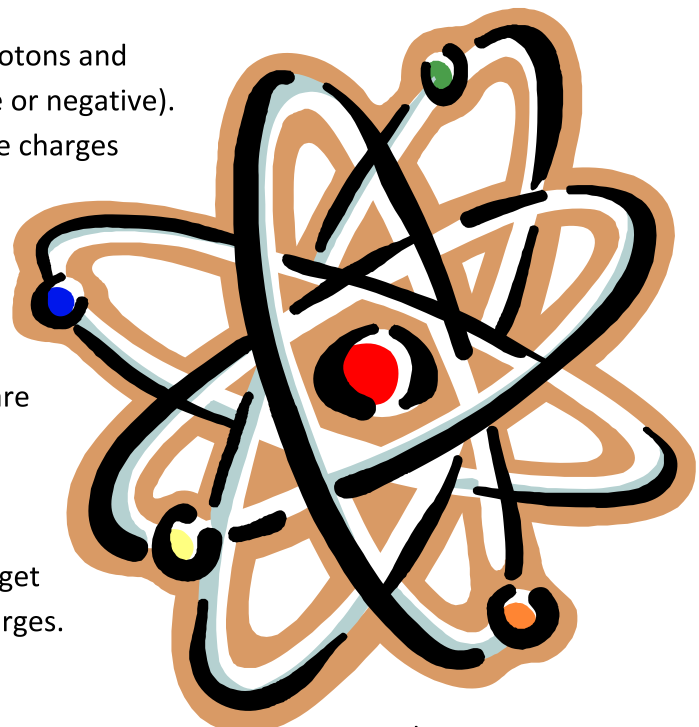
A Shocking Atom

What you might *not* know is how static electricity happens. It all starts with a tiny thing called an **atom** (say: **ah-**tum). Everything in the world is made up of atoms - from your pencil to your nose. An atom is so small you can't see it with your eyes - you'd need a special microscope. Imagine a pure gold ring. Divide it in half and give one of the halves away. Keep dividing and dividing and dividing. Soon you will have a piece so small you will not be able to see it without a microscope. It may be extremely small, but it is still a piece of gold. Now, ff you could keep going, dividing it into smaller and smaller pieces, you would finally get to the smallest piece of gold possible. The smallest possible piece you can get down to of something is called an atom. Think of atoms as the building blocks of all the stuff in the world.

Now take that tiny atom of gold, if you divided it into smaller pieces, it would no longer be gold. It would be broke down into its parts because each tiny atom is made up of even tinier things, the building blocks of atoms:

1. **protons** (say: **pro**-tahnz), which have a positive charge
2. **electrons** (say: ih-**lek-**trahnz), which have a negative charge
3. **neutrons** (say: **noo**-trahns), which have no charge

Most of the time, atoms have the same number of protons and electrons and the atom charge is neutral (not positive or negative). Static electricity is created when positive and negative charges aren't balanced. Protons and neutrons don't like to move around much, but electrons love to jump all over the place!



When an object (or person) has extra electrons, it has a negative charge. Things with opposite charges are always attracted to each other; they like to find each other. It's like a crazy invisible game of tag. Positive charges seek negative ones and negative ones seek positives. Whew! Got it? Don't worry; we're going to get lots of practice playing with positive and negative charges. You've probably even done it before.

When you rub a balloon on your hair the balloon picks up electrons from your hair, remember they're negatively charged, and that makes the balloon negatively charged. And since all those electrons left your hair, your hair is now positively charged because mostly protons are left. Opposite charges attract, so bringing the negatively charged balloon near the hair causes the positively charged hair to stand up to try and get closer to all those electrons.

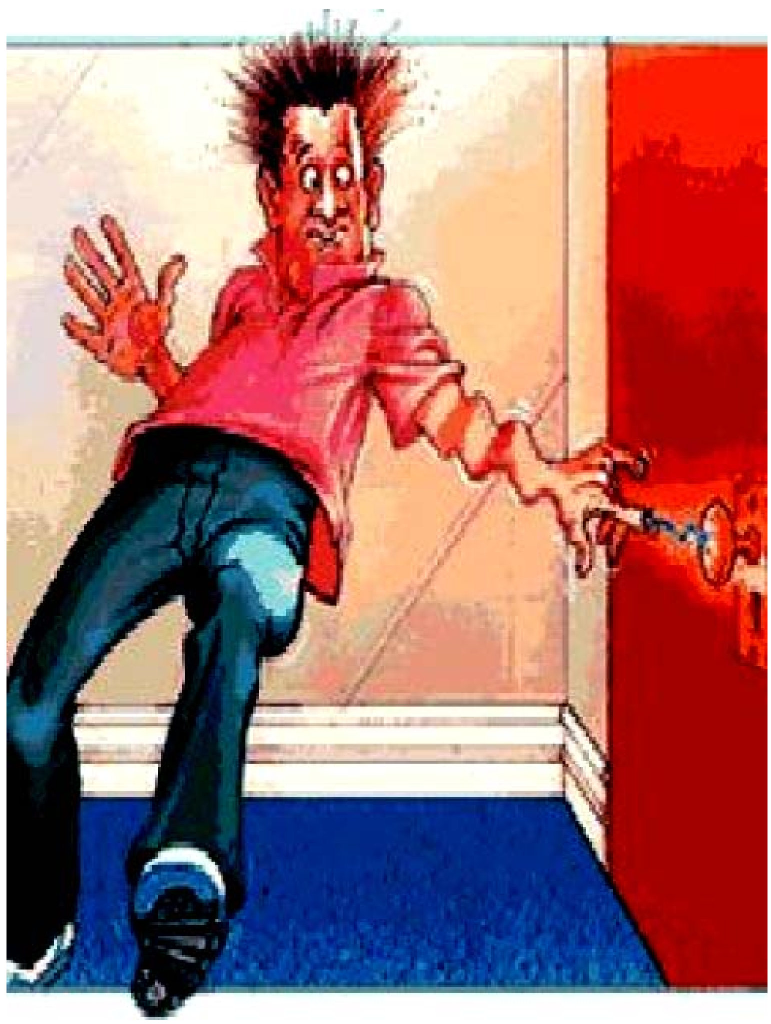
So, why is it called static?

When something is static that means it doesn't move. There are two types of electricity: static electricity and electrical currents. Static electricity stays in one place, like the charge on a doorknob that can zap your hand in the wintertime. Electrical current moves and flows, like the current in the wires in a lamp. So, static electricity is called static because the charges do not move from where they were made, unlike the electricity used to power electronic devices that flows back and forth from one pole of a battery or power source to the other. Most of the time static electricity is made when two objects come in contact or are rubbed together.

For a static charge to stay in an object, it has to have to be able to resist the flow of electricity. That is why plastic balloons and hair are great for static electricity and can stay charged, but they don't make very good conductors for electricity. Other materials, like aluminum, can get a static charge, but they don't stay charged for a long because they can't resist the flow of electrons. The electrons can move through very quickly.

Beware of Conductors!

Not train conductors, we're talking about when you scuff your feet on your living room rug, you pick up extra electrons and have a negative charge. Electrons move more easily through certain materials like metal, which scientists call **conductors**. Things through which electricity flows very easily are called "conductors," and things that block the flow of electricity are called "insulators." *(Can students think of any materials which block electrical flows? Rubber, etc)* When you touch a doorknob (or something else made of metal), which has a positive charge with few electrons, the extra electrons want to jump from you to the knob.



That tiny shock you feel is a result of the quick movement of these electrons. You can think of a shock as a river of millions of electrons flying through the air. Pretty cool, huh? Static electricity happens more often during the colder seasons because the air is usually drier, and it's easier to build up electrons on the skin's surface.

So, the next time you get a little shock from touching a doorknob, you'll know that it's just electrons jumping around. Think of it as putting a little spark in your life!

What other kinds of big sparks do we see? Lightning!

Did you know that lightning is a giant form of static electricity? It’s formed when air rubs against rain clouds.

The sky is filled with electric charge. In a calm sky, the positive and negative charges are evenly interspersed throughout the atmosphere. So, a calm sky has a neutral charge.

Inside a thunderstorm, electric charge is spread out differently. A thunderstorm consists of ice crystals and hailstones. The ice crystals have a positive charge, while the hailstones have a negative charge. The positively charged ice crystals are pushed to the top of the thunderstorm cloud by upward pushing wind (updraft). Meanwhile, the heavy negatively charged hailstones are pushed to the bottom of the thunderstorm clouds by its downdraft (downward pushing wind) and gravity. Thus, the thunderstorm's positive and negative charges are separated into two levels: the positive charge at the top and the negative charge at the bottom of the cloud.

During a thunderstorm, the Earth's surface has an overall positive charge. Because opposites attract, the negative charges at the bottom of the thunder cloud want to link up with the positive charges of the Earth's surface.

Once the negative charge at the bottom of the cloud gets big enough, a flow of negative charge rushes toward the earth. This river of electrons is called a stepped leader. The positive charges of the Earth are attracted to this stepped leader, so a flow of protons moves up through some high point, such as a tree or a telephone pole, and into the air, trying to meet the electrons flowing down from the cloud. (Sometimes it even happens through people!) When the stepped leader and the positive charge from the earth meet, a strong electric current carries the earth’s positive charge up into the cloud. This electric current is known as the return stroke of lightning and that is what we see when we see lightning during a storm. The back and forth of charges happens three or four times, all within a few seconds, but normally the human eye cannot distinguish between all of the return strokes.

So, we see lightning when a river of billions of moving electrons and protons race up or down between a cloud and the ground (or between two clouds).

Where does the thunder come from?

The speeding electrons bump into air molecules along the way, heating them to a temperature five times hotter than the surface of the sun. This hot air expands as a supersonic *(faster than the speed of sound, which is 340.29 meters per second or 761 miles per hour)* shock wave, which you hear as thunder.

Lightning can start fires and it is strong enough to hurt or kill people. Lightning also helps nature by putting nitrogen in the ground for plants to use.

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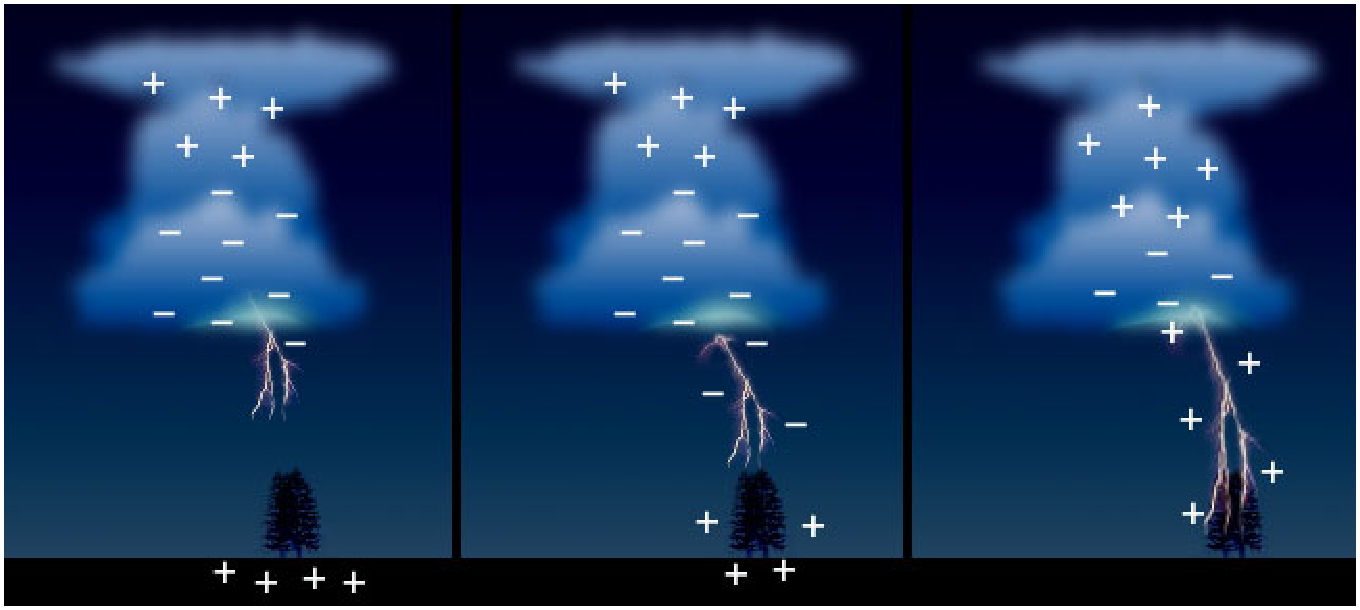
http://www.windows2universe.org/earth/Atmosphere/tstorm/lightning_formation.html&edu=high



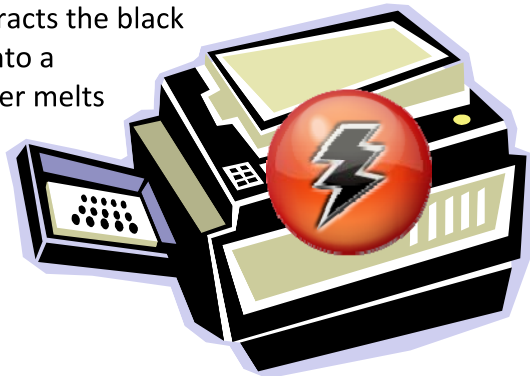
So, What Good Is It?

Static electricity can be annoying, shocking, interesting, and fun to play with, but is it useful? Does it do more than make clothes stick together, dirty TV screens, shoot sparks, make lightning bolts, and shock our hands? Can we actually **do** anything with it, or is it just a fun but useless phenomenon?

Static electricity isn’t useless. In fact, static electricity is vital for painting the outside of your car or refrigerator. For example, when the factory is painting a car, the paint particles are given a negative charge, and the car frame is dipped in a substance that gives it a positive charge. Then, when the paint sprays out it sticks to the car, and is attracted to all the areas where it would be hard for a person to reach. This process ensures a perfectly even layer of paint, since when there is enough negative paint in the car the extra will be repelled (shoved away) by the paint already on the car. It also makes sure that the paint won't fall off easily, since the electrical attraction between the paint and the car is much stronger than if the paint was just sprayed on without being charged.

It also affects the quality of sandpaper, and, even more importantly, the cleaning of smoke from coal-fired power plants. In coal fired power station static electricity is used to stop the dust particles and pollution from reaching the atmosphere. Particles of ash pass through a charged grid, and become charged. They then stick to charged plates on either side of this grid, where they can be disposed of safely.

Without static electricity we wouldn’t be able to make copies. Why not? A Xerox machine uses static electricity to make copies. Remember, when you rub a balloon on your head, the balloon is charged with electricity. Inside a Xerox machine is a plastic drum that is also charged. When you put a piece of paper on the glass, a copy of it goes onto the drum. Where there were dark places on the paper, the static charge on the drum attracts the black plastic toner powder. Then the powdered places go onto a blank piece of paper, and the paper is heated. The toner melts and makes black letters on the new piece of paper.



Zap!

1. Protons have a _____________ charge.
2. Electrons have a ____________charge
3. _____________ have no charge.
4. Everything in the world is made up of _____________.
5. Things through which electricity flows very easily are called “_____________,” and things that block the flow of electricity are called “_____________.”
6. Lightning is a giant form of ______________.
7. Static electricity ___________________ and electrical current ____________________.
8. Static electricity isn’t ______________.
9. We see lightning when a river of billions of moving _____________ and ___________ race up or down between a ___________ and the ground (or between two clouds).
10. Thunder is a ______________ shockwave that moves faster than the speed of sound.
11. When you rub a ______________ on your head it picks up electrons.

Word Bank

Electrons	Positive	Stays in one place	
Supersonic	Useless	Protons	Balloon
Static electricity	Electrons	Conductors	
Insulators	Moves and flows	Atoms	
Negative	Neutrons	Cloud	

Static tubes

What do I need?

- Clear plastic tubes with end caps (or small completely dry water bottles)
- Styrofoam peas (filling from bean bag chairs) or tiny broken-up pieces of Styrofoam pellets
- Empty bowl, shoe box, or large can
- Wool cloth

Background

The plastic tube, or bottle, when rubbed with wool, picks up electrons and becomes negatively charged. This induces a positive charge in the Styrofoam peas which will cling to the plastic, pick up electrons, and later leap away.

When your finger approaches the negatively charged tube, the finger becomes positively charged by induction, just like the Styrofoam peas. Therefore, your finger and the Styrofoam have like charges, and you will find that you can chase the peas around inside the tube by moving your finger on the outside.

Option:

Giant Static Tube - Rinse out a 1-liter soda bottle and let it completely air dry. Fill the bottle with 1/4 cup of Styrofoam balls and seal the bottle with a cap. Rub the bottle on your head (or better yet, your friend's head) or on a wool sweater. Observe the effects of static electricity on the Styrofoam balls!

What do I do?

Your students will have a wonderful time making their own static tubes. You may find it works well to set up one corner of the room in which students will come to make their static tubes in small groups.

1. Give each student a clear plastic tube (or water bottle) and two end caps. If using tubes, have them insert one cap into one end of the tube.
2. Place all of the Styrofoam peas inside a large container such as a bowl, shoe box, or can. Challenge the students to get about two tablespoons of Styrofoam peas inside their static tubes through the end that they have left uncapped. This is not always easy, because the plastic tubes take on a charge with minimal handling and will attract and repel the Styrofoam peas.
3. When the students have placed their peas inside the tube, have them insert the other end cap, and remove any Styrofoam clinging to the exterior of the tube with a cupped hand. Rub the exterior of each tube with the wool cloth.
4. Let the students experiment with their closed static tubes. Can they pour all of the peas from one end to the other? How can they move any peas along that seem to be stuck? Using terms they have learned through other activities, such as attract, repel, static charge, and induction, can they describe what happens when they bring a finger close to the outside of the tube?

The following experiment is from The Exploratorium-At-Home Book, online.
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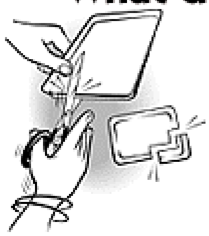
Super Sparker

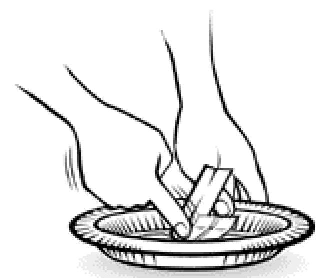
Make very, very, very tiny lightning, anytime you want!

What do I need?

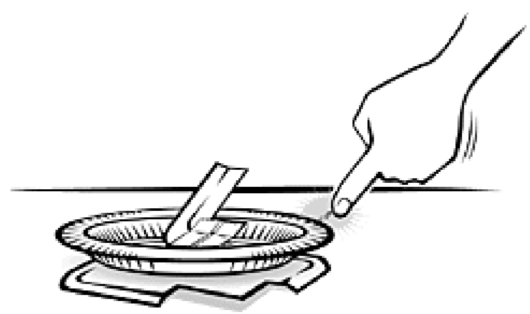
- scissors
- Styrofoam tray from your supermarket (ask at the meat or bakery counter for a clean, unused tray)
- masking tape
- wool cloth
- aluminum pie tin

What do I do?

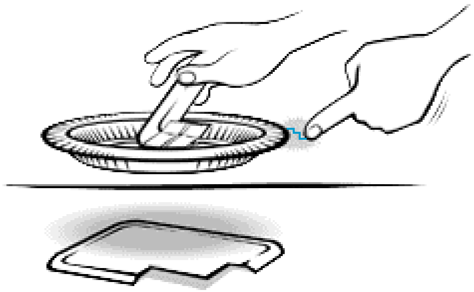




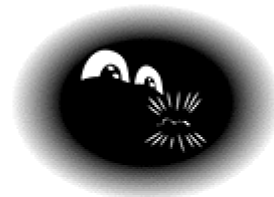
1. Cut a piece off one corner of the Styrofoam tray, as the picture shows. You'll have a long bent piece that looks a little like a hockey stick.
2. Tape the bent piece to the center of the pie tin. **Now you have a handle!**
3. Rub the bottom of the Styrofoam tray on your hair or the piece of wool cloth. Rub it all over, really fast.
4. Put the tray upside down on a table or on the floor.
5. Use the handle to pick up the pie tin. Hold it about a foot over the Styrofoam tray and drop it.
6. Now--very slowly--touch the tip of your finger to the pie tin. Wow! What a spark! (Be careful. DON'T touch the Styrofoam tray.



If you do, you won't get a spark.)



7. Use the handle to pick up the pie tin again. Touch the tin with the tip of your finger. Wow! You get another great spark.
8. Drop the pie tin onto the Styrofoam tray again. Touch the pie tin. Another spark! Use the handle to pick up the pie tin. More sparks!
9. You can do this over and over for a long time. If the pie tin stops giving you a spark, just rub the Styrofoam tray on your head again, and start over.



10. Try using your Super Sparker in the dark. Can you see the tiny lightning bolts you make? What color are they?

So, what makes the Super Sparker spark?

Remember, how when you rub a balloon on your head the balloon picks up electrons from you? Well, when you rub Styrofoam on your hair, you pull electrons off your hair and pile them up on the Styrofoam. When you put an aluminum (which is a metal, and what do metals do? Conduct!) pie tin on the Styrofoam, the electrons on the Styrofoam pull on the electrons. Some of the electrons in metals are free electrons --they can move around inside the metal. These free electrons try to move as far away from the Styrofoam as they can. When you touch the pie tin, those free electrons leap to your hand, making a spark.

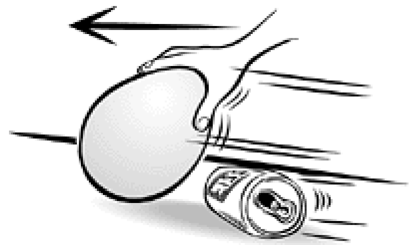
After the electrons jump to your hand, the pie tin is short some electrons and needs more. When you lift the pie tin away from the Styrofoam plate, you've got a pie tin that attracts any and all nearby electrons. If you hold your finger close to the metal, electrons jump from your finger back to the pie tin, making another spark. When you put the pie tin back on the Styrofoam plate, you start the whole process over again.

The following experiment is from The Exploratorium-At-Home Book, online.
http://www.exploratorium.edu/science_explorer/roller.htmll © 1998 The Exploratorium. All rights reserved.

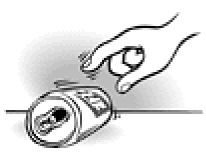
Remote Control Roller

Rub a balloon on your head, then watch a soda can race across the floor!

What do I need?

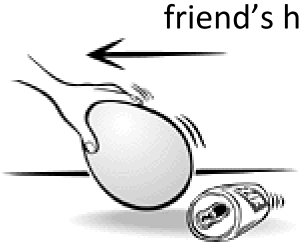


- empty soda can
- blown-up balloon
- your hair or a piece of wool cloth

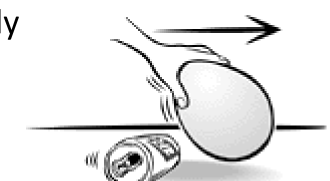


1. Put the can on its side on a table or the floor -- anyplace that's flat and smooth. Hold it with your finger until it stays still.

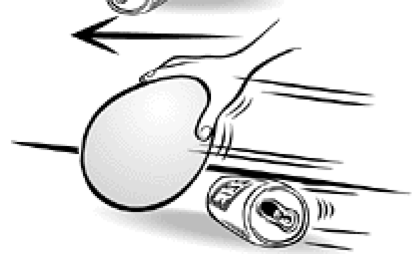
2. Rub the balloon back and forth on your hair (or a friend's head) really fast.



3. Hold the balloon about an inch in front of the can. The can will start to roll, even though you're not touching it!
4. Move the balloon away from the can -- slowly -- and the can will follow the balloon.



5. If you move the balloon to the other side of the can, the can will roll in the other direction.



6. How fast will the can roll? How far can you roll it before the can stops? Will it roll uphill? If you have multiple students with cans and balloons, you can have a race across the room or down the sidewalk.

Rub a Balloon on Your Head and You Can...

Bend Water

Turn on the faucet in your bathroom or kitchen. Don't run the water too hard, but more than a little trickle. Now rub a balloon on your head and hold the balloon near the water. The stream of water will bend toward the balloon!

Make Your Hair Stand on Tiptoe

Rub the balloon on your head, then pull it away. Your hair will stick out and look really funny. (This can also happen when you comb your hair with a plastic comb.) What if you hold the balloon near your arm? Can you feel the hairs on your arm move? Will it work on doll hair? How about animal fur?

Make Super Sticky Balloons

Once you've rubbed the balloon on your head, it will stick to other things -- with no glue. You can stick it to the wall, to the TV, or even to your face!

Why does the soda can roll?

With Remote Control Roller, basically, you pile up electrons on one thing and use them to attract the protons in something else. When you rub a balloon on your hair, it ends up loaded with electrons. Those electrons can attract the protons in a soda can, the protons in a trickle of water, the protons in your hair, or the protons in a wall.

Why do clothes stick together in the dryer?

The attraction between protons and electrons can also make clothes stick together in the dryer.

When you dry clothes in the dryer, different fabrics rub together, and electrons from a cotton sock (for instance) may rub off onto a polyester shirt. That's why clothes sometimes stick together and make sparks when you pull them apart. You may have used antistatic sheets in your dryer. As these sheets bounce around with your clothes, they add a uniform antistatic coating to the fabric. Rather than cotton rubbing against polyester, you've got the antistatic coating on the cotton rubbing against the antistatic coating on the polyester. No electrons rub off-and you don't get any static cling.

Charge and Carry

A Spark Leyden Jar! Store up an electric charge, then make sparks.

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This experiment will produce a spark that you can feel, see, and hear. You rub a Styrofoam plate with wool to give it a large electric charge. Then you use the charged Styrofoam to charge the aluminum pie pan from your other experiment. The entire apparatus for charging the aluminum plate is called an electrophorus, which is Greek for charge carrier. An even larger charge can be stored up in a device called a Leyden jar, made from a plastic film canister.

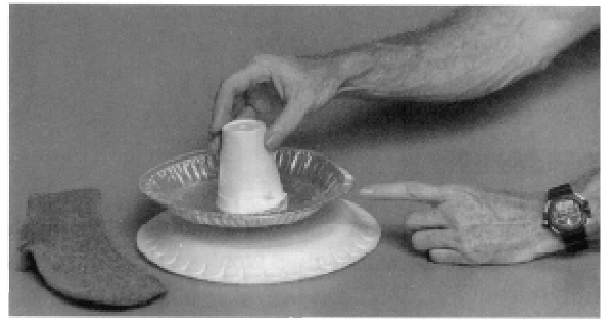
What do I need?

For the Electrophorus:

- A Styrofoam dinner plate (Acrylic plastic sheets also work well, as will old LP records)
- A piece of wool cloth (Other fabrics may work, but wool will definitely work.)
- Your pie pan with a Styrofoam handle from the other experiment

For the Leyden jar:

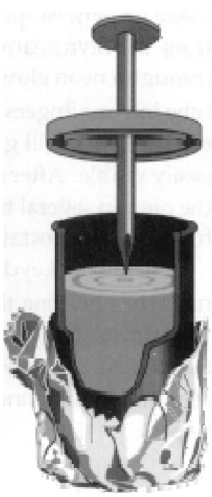
- A plastic 35 mm film can
- A nail slightly longer than the film can
- Some aluminum foil.
- Tap water
- Optional: A neon glow tube (available from Radio Shack)



What do I do?

Electrophorus:

Place your pie pan with its Styrofoam handle on top of the upside-down Styrofoam plate or a piece of acrylic plastic.



Leyden Jar:

Push the nail through the center of the lid of the film can. Wrap aluminum foil around the bottom two-thirds of the outside of the film can. You may tape the aluminum foil in place. Fill the film can almost full with water. Snap the lid onto the can. The nail should touch the water.

What do I do?

Rub the Styrofoam plate with the wool cloth. If this is the first time you are using the Styrofoam in an electrostatic experiment, rub it for a full minute.

To charge the pie pan follow the next steps exactly:

1. Place the pie pan on top of the charged Styrofoam plate.

2. Briefly touch the pie pan with your finger. You may hear a snap and feel a shock.

3. Remove the pie pan using only the insulating Styrofoam cup (see photo). You may have to hold the Styrofoam plate down with your other hand.

The pan is now charged.

Discharge the pan by touching it with your finger. You will hear a snap, feel a shock, and, if the room is dark, see a spark. To make the largest spark, have the pie plate at least one foot away from the Styrofoam plate. You can also discharge the pie pan through a neon glow tube. Hold one of the two metal leads of the tube in your fingers and touch the other lead to the pie pan. The electric spark will go through the neon and make a flash that is easily visible. After charging the Styrofoam once, you can charge the pie pan several times. The pie pan is portable and can be used for many electrostatic experiments.

Charge the Leyden jar by touching the charged pie pan to the nail while holding the Leyden jar by its aluminum foil covering. You can make several charge deliveries by recharging the pan before touching it to the nail. Discharge the jar by touching the aluminum foil with one finger and the nail with another. Watch for a spark.

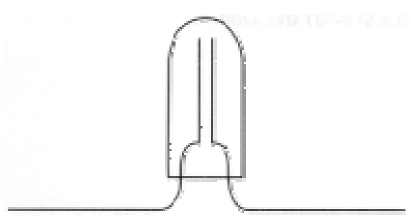
What's going on?

When you rub the Styrofoam plate with a wool cloth, you charge it negatively. That's because the Styrofoam attracts electrons from the cloth. Often, a plate fresh from the package will start with a positive charge. If it does, you will have to rub the plate long enough to cancel this initial charge before you can begin building a sizable negative charge. By using an electroscope, you can determine whether the Styrofoam is positively or negatively charged. Styrofoam is an insulator; it will hold its charge until it is discharged by current leaking into the air or along a moisture film on the surface of the Styrofoam

When you place the pie pan on the Styrofoam, the electrons on the Styrofoam repel the electrons on the pan. Since the electrons can't leave the pie pan because it is completely surrounded by insulating air and Styrofoam, the pan retains its neutral charge. If you touch the pie pan while it is near the Styrofoam, the mobile electrons will be pushed off the pan and onto you. The electrons make a spark as they jump a few millimeters through the air to reach your finger. The air in the spark is ionized as the moving electrons knock other electrons off air molecules. The ionized air emits light and sound. You can also feel the flow of electrons though your finger.

After the electrons leap to your finger, the pan has a positive charge. Physicists say the pan has been charged by induction. You can carry the positively charged pan around by its handle and carry the positive charge to other objects. If you bring the positive pan near your finger again, or near any object that can be a source of electrons, the pan will attract electrons, creating a second spark.

The low-pressure neon gas in a neon glow tube is easier to ionize than air that is at atmospheric pressure. If you discharge the pan through a neon glow tube, the spark will make a bigger flash of light.



When you touch a positively charged pie pan to the nail on the Leyden jar, electrons from the nail flow onto the pie pan. The resulting positive charge on the nail attracts electrons from your body through your hand onto the aluminum foil of the jar. The Leyden jar will then have a positive center separated from a negative foil outside by the insulating plastic of the film can. If you touch one finger to the foil and bring another finger near the nail at the center of the Leyden jar, a spark will jump as the negative charges are attracted through you to the positive nail. The beauty of the

Leyden jar is that it can store charges from several charged pie pans, thus building up to a larger, more visible, more powerful (and more painful) spark.

Etcetera

The Leyden jar is the forerunner of the modern-day capacitor. It was invented in 1745 at the University of Leyden by Pieter Van Musschenbroeck. Early Leyden jars were larger than a plastic film can and could hold more charge. The inventor discharged one through himself and wrote, "My whole body was shaken as though by a thunderbolt." At another time, a Leyden jar was discharged through 700 monks who were holding hands. The charge caused them to simultaneously jump slightly off the ground.

Extensions:

To give the Styrofoam plate a positive charge, try rubbing it with a plastic bread bag. Try rubbing it with other cloths, too. Try charging the Leyden jar in reverse. That is, while holding the nail, touch the aluminum foil with the pan

Electroscope

What's your (electrical) sign?

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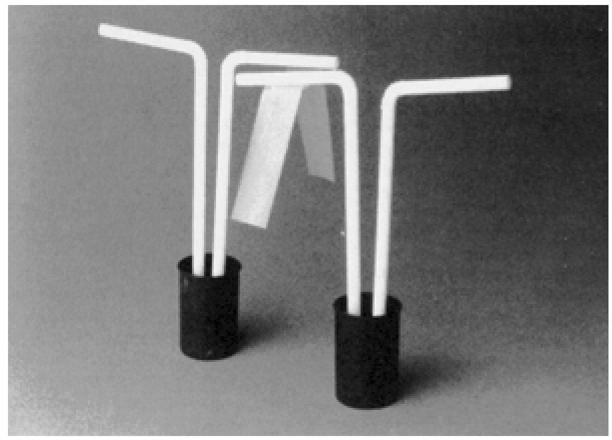


A commonly available brand of plastic tape can gain or lose negatively charged electrons when you stick it to a surface and rip it off. By suspending pieces of tape from a straw, you can build an electroscope, a device that detects electrical charge. A plastic comb will enable you to identify whether the pieces of tape are positively or negatively charged.

What do I need?

4 plastic drinking straws with flexible ends.
2 plastic 35 mm film cans.
Enough modeling clay to fill the film cans halfway.
A roll of 3-M Scotch Magic™ Tape, 3/4 inch (2 cm) width. (Don't substitute other brands of tape the first time you try this Snack. Once you know what to expect, you can experiment with other tapes.)
A plastic comb and hair or a piece of wool cloth.

What do I do?

(5 minutes or less)

Press enough modeling clay into both film cans to fill them halfway to the top. Press the inflexible ends of two drinking straws into the clay in each can, and bend the flexible ends to form horizontal arms that extend in opposite directions. The heights of the straws should be the same.

What do I do?

(15 minutes or more)

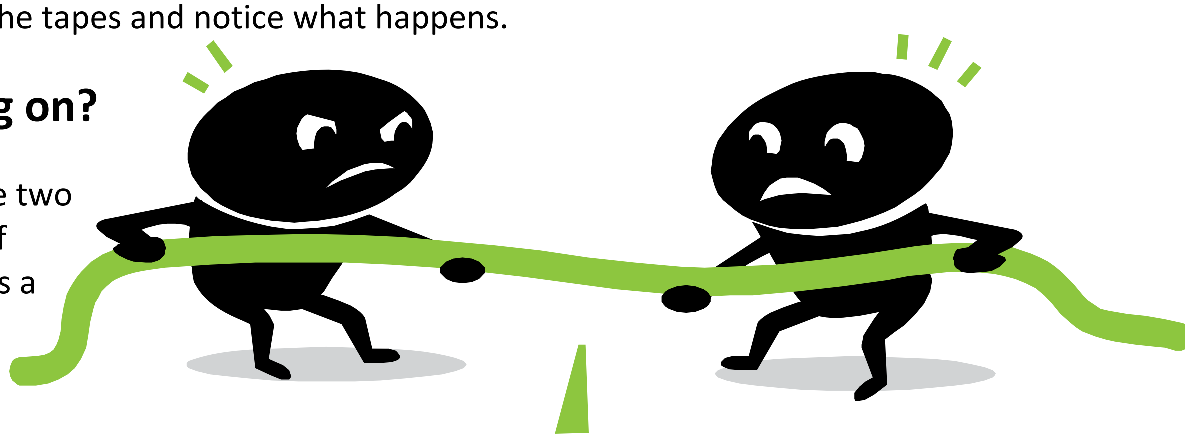
Tear off two, 4 inch (10 cm) pieces of tape. Press each piece firmly to a tabletop or other flat surface, leaving one end of each tape sticking up as a handle. Quickly pull the tapes from the table and stick one piece on an arm of a straw in one film can, and the other piece on an arm of a straw in the other film can. Move the cans so that the two tapes are face to face, about 6 inches (15 cm) apart. Then move the cans closer together. Notice that the two tapes repel each other.

Tear off two more pieces of tape and press the sticky side of one against the smooth side of the other, leaving one end of each tape sticking out as a handle. Quickly pull the tapes apart and stick them to the two remaining arms. Bring the arms close together. Notice that these two tapes attract each other.

Run the comb through your hair, or rub the comb with the wool cloth. Then hold the comb near the dangling tapes. Notice that the comb repels the piece of tape whose smooth side was in the middle of the "sandwich" and attracts the tape whose sticky side was in the middle. When you hold the comb near the tapes pulled from the flat surface, the comb will repel both tapes if they were pulled from a Formica™ surface; the comb may attract tapes pulled from other surfaces.

Try pulling other kinds of tape from various surfaces, or rubbing various objects together, and then bringing the tape or objects near the tapes on the arms. Bring your hand near the tapes and notice what happens.

What's going on?

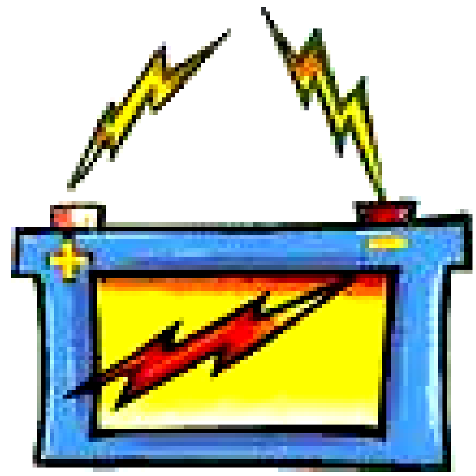


When you rip the two pieces of tape off the table, there is a tug-of-war for electric charges between each tape and the table. The tape either steals negative charges (electrons) from the table or leaves some of its own negative charges behind, depending on what the table is made of (a positive charge doesn't move in this situation). In any case, both pieces of tape end up with the same kind of charge, either positive or negative. Since like charges repel, the pieces of tape repel each other.

When the tape sandwich is pulled apart, one piece rips negative charges from the other. One piece of tape therefore has extra negative charges. The other piece, which has lost some negative charges, now has an overall positive charge. Since opposite charges attract, the two tapes attract each other.

When you run a plastic comb through your hair, the comb becomes negatively charged. Tapes repelled by the comb have net negative charge, and tapes attracted by the comb either have net positive charge or are uncharged.

You may have found that your hand attracts both positively and negatively charged tapes. Your body is usually uncharged, unless you have acquired a charge -- by walking across a carpet, for example. An uncharged object attracts charged objects. When you hold your hand near a positively charged tape, the tape attracts electrons in your body. The part of your body nearest the tape becomes negatively charged, while a positive charge remains behind on the rest of your body. The positive tape is attracted to the nearby negative charges more strongly than it is repelled by the more distant positive charges, and the tape moves toward your hand.



Etcetera

Since some table surfaces will not charge the tape, be sure to test your surfaces before trying this Snack with an audience.

Charge leaks slowly off the tape into the air or along the surface of the tape, so you may have to recharge your tapes after a few minutes of use.

You can use your electroscope to test whether an object is electrically charged. First use the comb to determine the charge on a piece of tape, and then see whether an object whose charge is unknown repels the tape. If the tape is negatively charged and an object repels it, then the object is negatively charged. Don't use attraction to judge whether an object is charged: A charged object may attract an uncharged one. If tape is attracted to an object, the tape and the object may have opposite charges, or the tape may be charged and the object uncharged, or the object may be charged and the tape uncharged. But if the tape is repelled by the object, the tape and the object must have the same charge. The only way that tape and an object will neither repel nor attract is if both are uncharged.

Static Detectives!

Uncover those mysterious static makers before they strike!

Have your students become static detectives as they uncover sources of energy with the glowing neon light. Just scrape your feet across the floor and watch the neon light flicker. It's a human powered light that is both safe and inexpensive.

Note:
The Static Powered Neon Lights work best in drier climates. Humidity helps to prevent static electricity from forming (it leaks off), so you might have work a little harder to build up a charge if you are in a high humidity area.

What do I need?

- 1 static powered neon light for each student (http://www.stevespanglerscience.com/product/1405)
- Activity Guide

How does it work?

The lamp contains a tiny amount of **neon gas**. The wires attached to the lamp are attached to two tiny electrodes inside the lamp. When a high voltage electrical current passes through certain gasses like neon, the gas gets excited and begins to glow. Many advertising signs use glass tubes filled with various gasses that produce light of different colors. For example, an orange glow is almost always produced by neon. When the glass tubes are filled with argon instead of neon, a pale blue glow is produced.

What do I do?

Consider making this a discovery session. Remind the students that static electricity is generated by friction (things rubbing together). Discuss the crackling sound that static electricity produces when you brush your hair, or when you rub a balloon against your hair. Contrast the subtle sound created by these man-made static sparks with the sound produced by lightning.

What do I do?

Now, give each of your students one of the neon lights and tell them that the light is supposed to flash when it detects a static spark. Allow the kids a few minutes to experiment on their own. See if anybody discovers how to make the lamp flash. If there are no successes after 3 to 5 minutes, give them some clues about how to hold the lamp (see presentation tips) for best results, and let them try again.

Remember, things through which electricity flows very easily are called “conductors,” and things that block the flow of electricity are called “insulators.” The bare wires are good conductors, but if you cover them with an insulator, the sparks will be harder to produce. Many non-metal things will work well as an insulator. Try materials such as tape, paper straws, a rubber eraser, and etcetera.

Have them record their results as they progress. Get them started with the following questions. What did you see? What color was the flash? How bright was it? How long did it last? What happened when you covered one of the wires with an insulator? What happened if you tried to produce flashes while holding onto both wires at the same time?