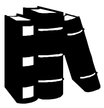
Static Electricity

THE BASICS



Grade Level: K-12

Estimated Time: 15-30 min. per part

THE TOOLBOX

There are several parts to the following activity on static electricity.

See below for a specific list of materials needed for each part of the activity.

EDUCATION STANDARDS	**Physical Science Content Standard:** Understanding the basic nature of static electricity and the law of electrostatics.
SAFETY CONCERNS	The amount of static electricity generated in these activities is not nearly enough to give anyone a harmful shock. Also be careful handling glassware.
FOR KIDS WITH DISABILITIES	Students with vision impairments may be able to "see" the effects produced in some of these activities with their hands. (See parts A, B, E, H, J, L, and M.)

What To Do

Educational Objective:

To demonstrate that matter, even in common, everyday forms, has an electrical nature, and that static electricity can be produced easily. To demonstrate the basic law of electrostatics—that like charges repel each other and unlike charges attract each other.

Note: Activities involving static electricity will work best on a cool, dry day, most likely in winter. When the air is humid, the extra electrons are attracted easily to water vapor particles in the air so that they do not build up a charge on other objects.

Materials Preparation:

There are several different parts to this activity on static electricity. You may want to do all parts of the activity, or maybe just one or two parts. Here is a list of what materials you will need for each 2 students for each part of this activity:

A. **Stuck-Up Balloon:** balloon; piece of fur or wool (or clean hair on someone's head); a blank space on a nearby wall.

B. **Dancing Balloon:** 2 balloons, 2 pieces of thread or lightweight string about 2 feet long (exact length is not critical); fur, wool, or hair as in part A.

C. **Gelatin Towers:** about 1 tablespoon of unflavored gelatin; flat plate.

D. **Dancing Water:** balloon or hard plastic/rubber comb; fur, wool, or hair as in part A; access to water faucet from which a thin, steady, continuous stream of water will flow.

E. **Dancing Ping-Pong Ball:** comb or balloon, as in part D; fur, wool, or hair as in part A; ping-pong ball; smooth, clear area on a tabletop or on the floor.

F. **Dancing Paper:** balloon; fur, wool, or hair as in part A; piece of paper about the size of a small fingernail. Enough pieces can be obtained by tearing up a small piece of notepaper about 2-3 inches square.

G. **Fun with Bubbles:** commercial bubble solution and blowing rings; balloon or comb as in part A; fur, wool, or hair, as in part A.

H. **Far-Out Hair:** comb or brush; your hair (clean and dry).

I. **Salt and Pepper:** salt and pepper, about one-half to one teaspoon of each; plate (optional); comb; fur, wool, or hair as in part A.

J. **Flying Newspaper:** strip of newspaper about 1 inch wide and 30 to 40 inches long.

K. **Snap, Crackle, Pop, and Hop:** clear plastic container, about 1-2 inches deep (a food storage container will work); sheet of aluminum foil larger than the opening of the container; pieces of dry puffed rice cereal, enough to make a layer 1 piece deep that covers about half of the bottom of the container.

L. **Invisible Leg:** an old nylon stocking; wool.

What to Do:

- Gather the necessary materials for the parts of the activity you have chosen to do.
- Arrange a place to do the activity where the students will have enough room.
- For parts D and G, have towels on hand to clean up wet hands and possible spills.

Questions to Ask Students As They Do This Activity:

- Have you ever been shocked after walking on a carpet or putting on a sweater? Combing your hair? Getting out of a car with cloth seats?
- What other experiences have you had with static electricity?
- What kinds of similarities are there between the static electricity in this activity and other experiences you have had?

Why It Happens:

In **part A**, the balloon should stick to the wall after being **charged** by rubbing. When you rub the balloon with wool, negatively charged particles called **electrons** are transferred from the wool to the balloon, giving the balloon an overall negative charge. When the charged balloon is brought near the wall, it repels some of the negatively charged electrons in that region of the wall (remember: negative charges repel other negative charges, and positive charges repel other positive charges). Therefore, that region of the wall is left repelled. Then, the negatively charged balloon and the positively charged section of the wall are attracted to each other, and the balloon sticks. The charged balloon may be made to stick to a wide variety of objects (even a person) because of the charge it receives after being rubbed.

In **part B**, each of the balloons acquires a negative charge as in part A. Because the two balloons have the same charge, they repel each other.

In **parts C and F**, the particles of gelatin (C) or pieces of paper (F) are attracted to the balloon or comb in the same way that the balloon is attracted to the wall in part A. Some of the particles may jump off the balloon or comb after coming into contact with it. This is because some of the electrons may be transferred to the particles of gelatin or paper after they come into contact with the charged balloon or comb. Then, since the gelatin or paper particles and the balloon or comb both have negative charges, the particles jump off the balloon or comb.

In **part D**, the charged balloon or comb attracts the water molecules falling in the stream of water, just as it attracted the positively charged section of the wall in part A. However, there is a slight difference. The water molecules are made up of the familiar H_2O. In each molecule of water, there is one atom of oxygen (O) that has two atoms of hydrogen (H) bonded to it. The overall structure looks sort of like a Mickey Mouse head—the oxygen atom makes the head and the two hydrogen atoms are in the place of the two big ears. This structure is naturally electrical because the oxygen end of the molecule has a slightly negative charge, and the two hydrogen molecules have slightly positive charges. When the negatively charged comb or balloon is held near the thin stream of water, it naturally attracts the positively charged (hydrogen) ends of the water molecules and naturally repels the negatively charged ends. Because of this, the stream of water can bend in response to the charged comb or balloon.

In **parts E and G**, again we have a separation of charges in the ping-pong ball (E) or bubbles (G) caused by the nearby charged comb. The charged comb repels the electrons in the side of the bubble or ball near it. The comb then attracts the remaining positively charged side. Because one side of the ping-pong ball or bubble becomes attracted to the comb, the comb can be used to **pull** the ball around the tabletop or to move the bubble. If the comb touches the ball, then the extra electrons from the comb will jump over to the ball until there is an even charge on both the comb and the ball. In that case, there will be no more force of attraction between the comb and the ball. The same thing will happen with the bubble, but of course, they can also break! The comb will have to be charged again with the wool in order to repeat the activity.

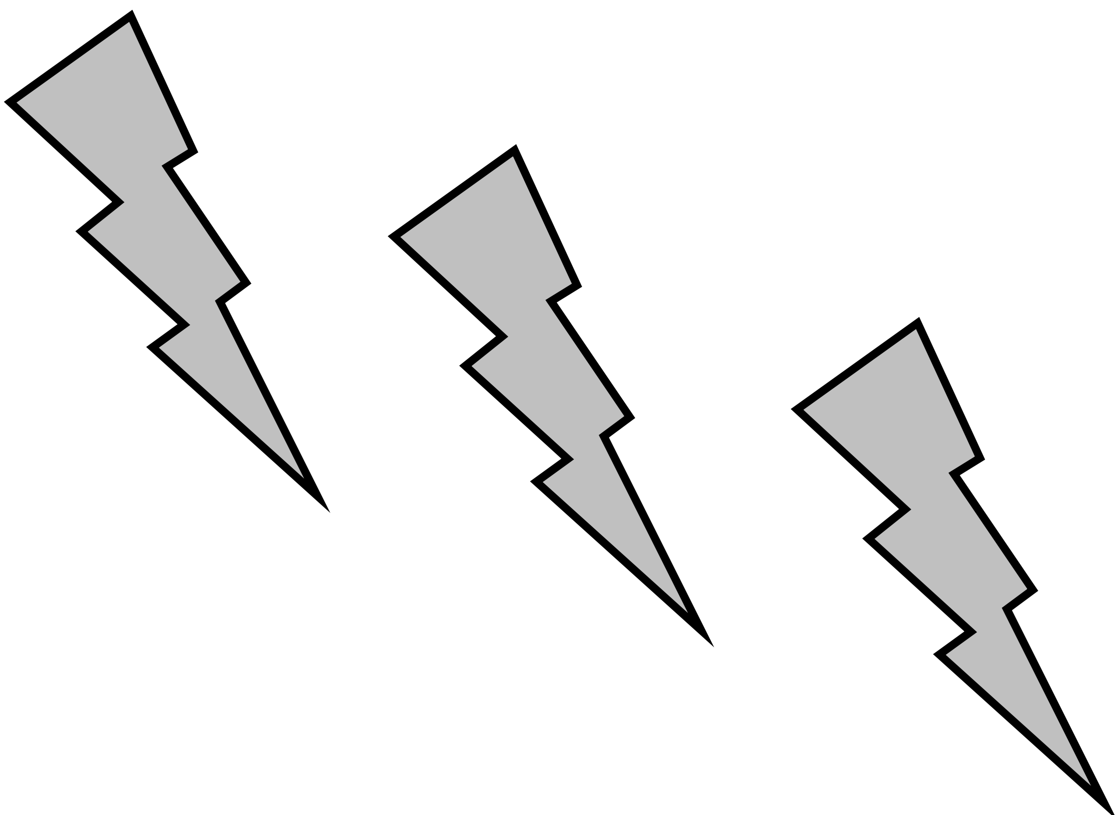
Many of us have probably experienced the situation in **part H**, especially in winter. When you run a comb through your hair, electrons are transferred from the comb to the hair, leaving the comb negatively charged and the strands of hair positively charged. Since they are opposites they attract. And, since each of the hair strands has the same kind of positive charge, the hairs repel each other, which is what gives you **flyaway hair**. This will occur more readily when the hair is straight, clean and dry.

In **part I**, again we have the situation where a charged comb causes the evenly distributed charges in the salt grains to separate, leaving a charged side that is attracted to the comb. As in parts C and F, some of the salt grains may jump off the comb after they receive some of the negative charges from the comb. When the charged comb is brought near the mixture of salt and pepper, the pepper grains are probably more easily attracted to the comb because they are lighter. They can be attracted to the comb from a greater distance than the salt.

In **part J**, rubbing both strips of newspaper causes them to receive the same kind of electric charge. Therefore, they repel each other. It may be necessary to stroke the paper strips more than once (in the same direction each time) in order to build up enough charge to cause them to fly apart.

By rubbing the plastic container in **part K**, it is given a negative charge. The lightweight pieces of cereal are attracted to the charged cover of the box, so they jump up to the top. When they touch the box, they receive some of the negative charge, and so they are repelled back down. Then, when they land on the aluminum foil, the metal foil conducts the charge away from each piece of cereal, leaving the cereal uncharged again. In that condition, each piece of cereal is free to be attracted again to the charged top of the box. And so, there is a cycle that can be repeated as long as you keep rubbing and charging the box! This **electrostatic attraction** is used in many industrial processes such as electrostatic coating in painting, making sandpaper, and making imitation velvet and suede. It is also the basis of photocopier technology.

By rubbing the nylon stocking with the wool in **part L**, the entire surface of the stocking receives the same charge. Since like charges repel each other, all sides of the stocking spread as far away from each other as possible, making the stocking appear to **inflate** with an invisible leg.



Web Sites

- **What Is Static Electricity?**
  http://www.sciencemadesimple.com/static.html
  (Grades 3-8)
- **The Energy Story Chapter 2: What is Electricity?**
  http://www.energy.ca.gov/education/story/story-html/chapter02.html
  (Grades 5-10)

Software

- **PowerLab Electricity**
  PowerLab Studios, Inc., 1997.
  (Grades 3-6)
- **I Love Science!**
  DK Interactive Learning, 1999.
  (Grades 2-5)

Reading Room

- Lunis, Natalie. **Discovering Electricity**. Newbridge, 1997.
  (Grades 2-6)
- Parker, Steve. **Thomas Edison and Electricity**. Chelsea House, 1995.
  (Grades 2-6)
- Snedden, Robert. **The History of Electricity**. Thomson Learning, 1995.
  (Grades 2-6)

Career Connections

Several occupations require a knowledge of static electricity, including electricians and electrical engineers. Even computer technicians need to be aware of static electricity to prevent "frying" the motherboard or other sensitive computer components.

STATIC ELECTRICITY ACTIVITY SHEET

Have you ever walked across a rug and then been shocked when you reached to touch a doorknob? If so, then you have experienced static electricity. There are many easy and fun demonstrations of static electricity that can be done with simple materials. However, most of these activities work best only on days when the humidity is very low, such as in winter on a cold day inside a warm room. Here are some things to try. See if you can think of others after you do some of these.

In activities that call for rubbing wool, you can use a sweater, sock, scarf, rug, or anything else you have that is made of wool. In the activities that call for a balloon, you can usually substitute a comb with the same results, and vice versa.

A. Stuck-Up Balloon

Blow up a balloon and tire the end so that the balloon stays inflated. Without doing anything else, hold the balloon against the wall and see if it will stick. What happens? Briskly rub the balloon across a piece of fur or wool or even your hair (works best if your hair is clean and dry). For wool, you can use a sweater, sock, scarf, or rug. Does the balloon stay? Can you explain what happened?

B. Dancing Balloon

Blow up 2 balloons and tie each one closed. Tie a long thread or string onto the end of each balloon. Give each balloon a static charge by rubbing it with fur, wool, or you hair as in part A. Hold each balloon by the end of the thread and try to bring the balloons close to each other. What happens?

C. Gelatin Towers

Spread some unflavored gelatin powder evenly onto a flat plate. Blow up a balloon, tie it, and charge it as you did in parts A and B. Touch the charged area of the balloon to the dish of gelatin. Gently raise the balloon straight up. What happens?

D. Dancing Water

Rub an inflated balloon or a comb (hard rubber or plastic) with fur, wool, or your hair to charge the balloon as you did in parts A, B, and C. Turn on a faucet so a thin, steady stream of water comes out. Bring the balloon or comb near the stream of water. What do you see happening? Can you explain why?

E. Dancing Ping-Pong Ball

Charge a comb or balloon as in parts A, B, C, or D. Place a ping-pong ball on a level surface such as a tabletop or smooth, bare floor. Bring the charged comb or balloon near the ball. What happens?

F. Dancing Paper

Tear a sheet of paper into small pieces about the size of the fingernail on your pinky. Place the pieces of paper on the table. Charge a comb or a balloon as in part E. Bring the charged comb or balloon near the pieces of paper. What happens?

G. Fun With Bubbles

Blow a bubble, and then catch it on your bubble blower. Move a charged balloon or comb around near the bubble. What happens? Or, blow the bubble into the air, and then bring the charged balloon or comb near the bubble. What happens? Can you get the bubble to follow your comb or balloon around in the air?

H. Far-Out Hair

Run a comb or brush through your hair on a cold, dry winter day. What happens to your hair when you hold the comb or brush near it? Can you explain why?

I. Salt and Pepper

Sprinkle some salt onto a plate or tabletop. Bring a charged comb near the salt. What happens? Then, sprinkle some pepper onto the table so that you have a mixture of salt and pepper. How do you think you might be able to separate the salt from the pepper? Bring your charged comb near the pile of salt and pepper particles. What happens? Which pieces were picked up more easily? Is this a good way to separate salt and pepper if they accidentally get mixed?

J. Flying Newspaper

Starting at the fold, tear across the bottom edge of a full sheet of newspaper so that you have a strip about 1 inch wide and 30-40 inches long. Hang the newspaper strip over one finger at the fold, with the two ends dangling freely. Quickly pull the newspaper strip up between two fingers of the other hand. Watch the dangling strips of newspaper. What do they do?

K. Snap, Crackle, Pop, and Hop!

Place a thin layer of dry puffed rice breakfast cereal on a sheet of aluminum foil. Then put a clear plastic container (about 1-2 inches deep) upside down over the cereal. Vigorously rub the upper outside surface of the container (the bottom of the container, since it's upside down) with a piece of wool or nylon. What happens to the cereal underneath the container?

L. Invisible Leg

Get a ladies nylon stocking (not the kind with elastic in it). Hold the toe of the stocking in one hand. Place a piece of wool (a scarf, sweater, or sock will work) in your other hand and wrap it around the stocking near the hand that is holding the stocking. Pull the stocking quickly through the wool several times, all in the same direction. Then put the wool down and hold the opening of the stocking in the hand that was holding the wool. What happens to the stocking?