Static Electricity

Through a series of experiments, students will learn about static electricity and how it explains lightning.

Grade Level: 5th-8th

Phenomena:
By conducting experiments, we can further understand static electricity and how it explains lightning.

Objectives:

- Students will act out and state the parts of an atom and their charges.
- Students will predict how objects will interact based on their charges.
- Students will investigate what causes static electricity.
- Students will explain how lightning forms.

Materials:

- Enough balloons for each student
- "George" balloon tied to a string.
- Masking tape
- Styrofoam packing peanuts or paper hole punch dots.
- Fur or fabric
- Signs for the atomic structure and charge activity
- Fluorescent light bulb and balloon for lightning experiment

Time Considerations:

Activity 1: 10 mins.
Activity 2: 10-15 mins.
Activity 3: 10-15 mins.
Activity 4: 10 mins.
Conclusion: 5-10 mins

Nevada Outdoor School . org

Next Generation Science Standards

MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Science and Engineering Practices:
Planning and Carrying out Investigations

Disciplinary Core Ideas:
Types of Interactions

Crosscutting Concepts:
Cause and Effect

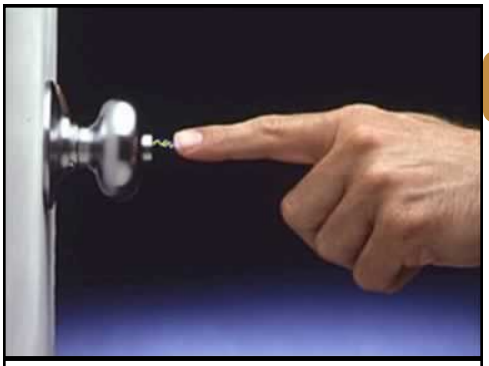
Excellence in Environmental Education Guidelines

Strand 2.1– The Earth as a Physical System C) Energy: Learners are familiar with the basic behavior of some different forms of energy.

Background

Static electricity is the buildup of electrical charges on the surface of an object. Static electricity is usually created when materials are pulled apart or rubbed together, causing negatively charged particles called electrons to be transferred from one material to the other.
As a result of having gained extra electrons one surface becomes negatively charged. Since it gave up electrons, the second material has an excess of positively charged particles, called protons, and therefore becomes positively charged. This charge build up can cause objects to attract or repel each other, sparks, and shocks. Some materials, like wool and plastic are easier to charge than others. Objects charged with static electricity will stay charged until they can either replace lost electrons or get rid of the extras that they picked up.
Static electricity is formed much better when the air is dry or the humidity is low. When the air is humid, water molecules can collect on the surface of various materials. This can prevent the buildup of electrical charges. Due to its shape, water is a polar molecule. Polar molecules have an unequal charge distribution that makes each molecule have two differently

charged poles much like a mini magnet. These poles can attract electrons and prevent them from building up and creating a static charge.
When the air is very dry, you can make static electricity by scuffing your feet on the carpet. When your feet scuff against the rug, they are actually picking up electrons from the floor. The electrons move all over your body, giving you a negative charge. Your new electrons spread out because they like to be as far apart as possible since like charges repel each other. Most objects, including your body, don't like to have extra charges and the electrons try to escape.
Metal objects like doorknobs are conductors and electrons move easily through them. If you touch a metal doorknob, the electrons on your body will leap into the metal trying to even out the charges. The transfer of electrons is actually a small electrical current, and produces the tiny electric shock you feel.
Lightning is static electricity except on a huge scale. Both lightning and getting shocked by a doorknob happen as charges balance themselves out. In storm clouds water, air, and dust molecules bump into each other causing electrons to be knocked free or transferred just like when you rub electrons off the carpet and onto your shoes. The positively charged particles rise to the top of the cloud while the negatively charged particles collect at the bottom of the cloud.
As more particles become charged, the bottom of the cloud builds up a massive negative charge. The charge is so big that it can repel electrons and negatively charged molecules on the earth leaving behind a huge positive charge on the Earth's surface.
When the difference in charges between the cloud and the ground gets too big the extra electrons jump between the cloud and the ground. This stream of electrons gives off its extra energy as light and heat which we see as lightning.



Static electricity on door knob:
http://www.school-for-champions.com/science/static_sparks.htm

Preparation

- Gather all lesson materials
- Tie a balloon to a string and hang it from the ceiling. Draw a face on the balloon and while the students aren't looking, charge the nose using a piece of fur.

Introduction:

Introduce the students to your friend "George" (or "Sue"). Tell them there are a few things they should know about George. First, he is nearsighted: (George can only see things up close) and second, he has a really big crush on you; whenever he can see you he can't keep his eyes off you. Show students that no matter where you are, George moves to be next to you. You can also have a few students come up and stand by George to determine if he's attracted to other people in the class.

Explain that today they will be doing some experiments and by the end of the lesson, they will be able to explain why George is so attracted to you.

Doing the Activity

Activity 1: Balloon Inquiry

Pass out one balloon per student.

Instruct the students to blow up and tie their balloons. Make sure to emphasize that the balloons are going to be used for scientific purposes.

Can you make a balloon stick to a wall without using tape or glue?

Tell the students to do different experiments around the classroom to see if they can find a way to stick their balloons to the wall.

Once they have done a few experiments or gotten their balloons to stick to the walls they should go back to their seats and record:

-What they did to make

the balloon stick
-Why they think the balloon sticks (or why it doesn't)
-Any observations or questions they have

Discuss the results with the students; Students should be able to conclude that they all in some way rubbed their balloons on another object in order to get it to stick to the wall. If they didn't get their balloon to stick, they should be able to come up with an explanation by the end of the lesson.

Ask students what they think will happen if they rub their balloons and hold them over a pile of packing peanuts or hole punch dots. Allow students to experiment with the peanuts or paper.

After conducting some experiments using the peanuts/ paper, draw conclusions as a class.

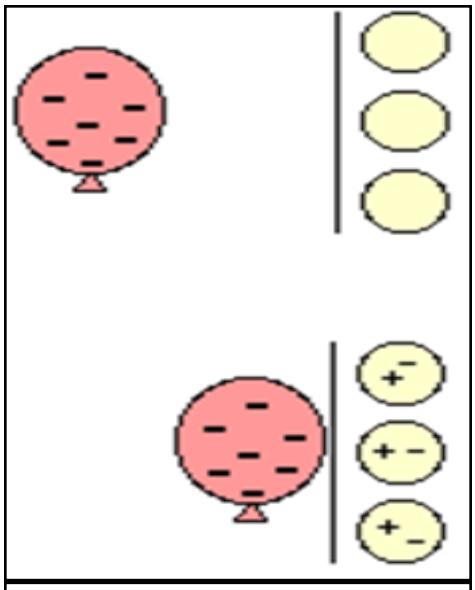
Students should be able to conclude that when you rub a balloon with another object like fur, hair, wool, etc. you can get it to attract or be attracted to other objects.

Write, "ATTRACTION" on the board.

Activity 2: Repulsion

Ask the students what they think would happen if two balloons were rubbed with hair or fabric and brought together.

Have each student rub their balloon then hold it by the knotted end and move it close to a partner's balloon. The two



Induced charge from a negatively charged balloon. Electrons in the wall are repelled causing a net positive charge.
http://www.sciencemadesimple.com/static.html

balloons should be repelling each other.

Discuss the results and draw conclusions with the students. When you rub both balloons they usually repel each other.

Write, "REPULSION" on the board.

Activity 3:
Atomic Charge and Structure

Discuss with the students that with magnets, two like charges repel each other and opposite charges attract. The same thing happens with charges on the balloon. Write (different) and (same) next to attraction and repulsion on the board.

Ask the students what the balloon is made of (rubber).

Now ask the students if they know what the rubber is made of. Tell them it is the basic building block of matter. It's what you, the students, their desks, and the wall are all made of

Give the students an analogy; ex. Gold analogy: ask the students to picture a gold ring and then imagine splitting that ring in half. Tell the students to picture splitting the gold ring down to the smallest piece of gold possible, so small you would need a microscope to see it. Picture breaking the ring down so much that if you broke it down anymore it would no longer be gold– this would be an atom of gold.

Give each student a sign labeled proton, neutron, or electron. Have the protons and neutrons huddle together in the middle of the room and allow the electrons to stand wherever they want around the edges of the room.
Tell the students that they have just made an atom and have them look around the room.

Discuss the three main components of an atom:

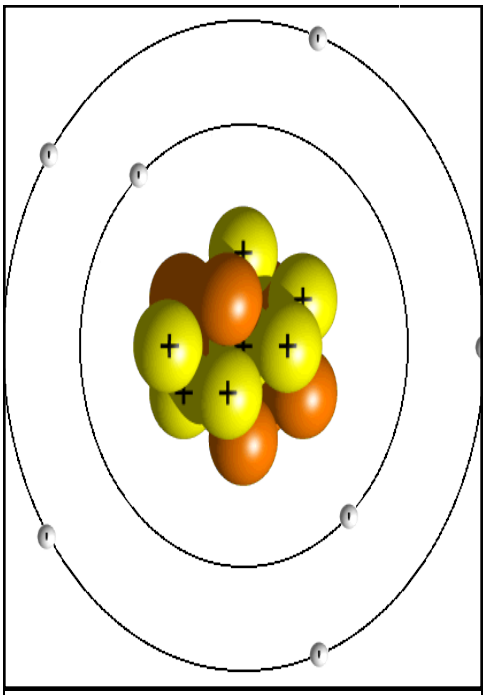
1. Protons: Are positively charged and are found in the nucleus.
2. Neutrons: Are neutral (meaning they do not have a

charge) and are found in the nucleus with the protons.

3. Electrons: Are negatively charged and can be found orbiting the nucleus in electron shells.

Ask the students in the nucleus if they feel squished or if it's easy to move around. They should be pretty cramped. Emphasize that in a real atom, the nucleus is heavy and hard to move too.

Now have the nucleus look around them at the electrons. They have space to go wherever they want in the room. Real electrons move easily too



Bohr model of an atom
http://education.jlab.org

and can even move between atoms. All electricity, from outlets, batteries, and static, is just electrons moving.

Explain that most atoms have an equal number of protons and electrons which make them neutrally charged. However, sometimes when objects bump into each other or are rubbed together or pulled apart, electrons are transferred.

When an atom loses an electron so that it has more protons than electrons, it becomes positively charged. When an atom gains an electron, so that it has more electrons than protons it becomes negatively charged.

At this point in the lesson, explain why the balloon stuck to the wall in the first experiment. When you rubbed it either with your hair or the fur you transferred electrons from the fur onto the balloon giving it a negative charge and the fur or your hair a positive charge.

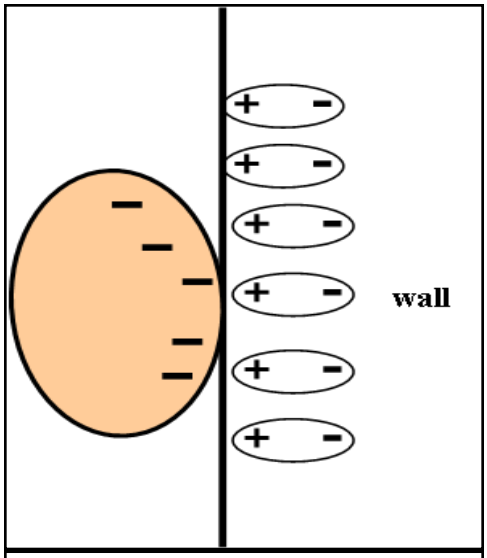
Define static electricity for the students; It is a buildup of electrons on an object.

Ask the students if they know how static electricity can explain the previous experiments.

Activity 4:
Lightning Experiment

For this experiment you will need a hard rubber comb or balloon, a dark room, and a fluorescent light bulb (not an incandescent bulb).

DO NOT use electricity from a wall outlet for this experiment. Handle the glass light bulb with care to avoid breakage.



Balloon to wall:
http://onlinephys.com/static1.html

Take the class into a dark room or corner of the classroom and have them gather around you.

Ask the students if they think the bulb will light using the balloon. You will have a mix of answers. Remind the students that all electricity is moving electrons and that in order for the bulb to light, it needs electrons from somewhere.

Ask the class who has extra electrons. Choose a volunteer and rub the balloon on their head for several seconds to transfer their "extra" electrons to the balloon.

Touch the charged part of the balloon to the bottom part of the light bulb and watch very carefully. You should be able to see small sparks or areas lighting up. Experiment with touching different parts of the bulb.

So, what happened? Explain to the students that when the charged comb touched the bulb, electrons moved from it to the bulb, which in turn caused the small sparks of light inside.

Show the students a small incandescent bulb and ask whether the balloon will make it glow. Most students will believe that the smaller bulb will glow brighter.

Chose another volunteer for "extra" electrons and repeat the experiment using the small bulb. The bulb will not light but sparks will be visible between the balloon and the bulb's base.

Discuss the results with the students; When a big enough charge is built up, electrons can and will jump from one surface to another causing a shock and sometimes a spark.

The little bulb does not light because incandescent bulbs produce light using a filament that glows white hot from the current passing through it. The few electrons added to the balloon don't provide near enough energy to heat the filament.

Ask the students if they can think of other sparks they have seen that are much bigger. (Lightning)
Have the students think about and make a guess as to how lightning might be explained through static electricity.

After the students have made guesses, explain that during a storm, wind and air movement causes friction which leads to a charge buildup just like rubbing a balloon on their hair.

Eventually too much electricity builds up and the electrons jump to the ground in order to help even out the charges. When the electrons jump the spark they create is like the spark you see when you get shocked by a doorknob, except this is on a much bigger scale.

Lightning Storm:
http://www.nssl.noaa.gov/faq/faq_ltg.php

Conclusion

Ask the students to try to explain why "George" is so attracted to you, keeping in mind everything that has been found/concluded during the lesson and experiments. **Assess how many students raise their hands and how many have the correct answer.

The students should be able to tell you that "George" has obtained a negative charge from being rubbed with fur and you are more positively charged than he is, therefore your positive charge and "George's" negative charge cause you to attract each other.

Assessment

Assess students on conduction of experiments and responses throughout the lesson.

Extensions

Create a kinesthetic model of lightning using the students in your classroom:

Have 3-5 students hold hands and act as the bottom of a cloud.

Have the cloud "pick up" and stand in front of several students who have been designated electrons.
When no more students can be held back by the cloud, point out how squished the electron students are and explain that this is what happens in a real cloud. The electrons build up until there is more energy than the cloud can handle and the electrons jump back to the earth.

Allow the electrons trapped by the cloud to break free and return to the other side of the classroom.

Compare static electricity to electric current. Static electricity is caused by an unmoving

buildup of electrons, while moving electrons result in an electric current. Electric current is the rate at which electrons flow through a conductor like copper wire. Batteries, outlets, and solar panels all create electric currents that we use for power.

Teach the students the "Atom Rap":

The neutron is in the nucleus,
And the proton is its pal.
Electrons make electricity,
They want OUT of the atom corral.

Vocabulary

Engineer: someone who is trained to design and build machines, vehicles, bridges, roads, or other structures

Extract: to get, pull, or draw out, usually with special effort, skill, or force

Geologist: a person who studies the earth's layers of soil and rock

Mineral: a substance found in nature that is not an animal or a plant

Mining: the process of extracting minerals or ore from the ground

Mining Environmental Scientist: a scientist in charge of reclamation when a mine is done with production

Nonrenewable Resource: a natural resource which cannot be produced, grown, generated or used on a scale which can sustain its consumption rate

Reclamation: to return the land as close to it's natural state as possible once mined from

Renewable Resource: any natural resource that can replenish itself naturally over time

Sources

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- Nevada Mining. (2010). *Nevada Mining Association 2010 Sustainability Report*. Retrieved Dec. 13, 2010, from http://www.nevadamining.org/issues_policy/pdfs/NVMA_2010_Sustainability_Report.pdf
- Sierra Nevada Journeys. *Gold Cookie Mining.* Retrieved Nov. 19, 2010, from http://www.sierranevadajourneys.org/wp-content/uploads/Gold-Cookie-Mining.pdf

Images:

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