

Bay Area Scientists in Schools Presentation Plan

Lesson Name Zap, Crackle, & Pop: Static Electricity Everywhere

Presenter(s) _____

Grade Level 4 **Standards Connection(s)** Physical Science: Electricity/magnetism: behavior of electrically charged objects (repulsion, attraction).

Abstract: Electricity is everywhere – in your brain, hair, the paper on your desk, mountains, trees, clouds, & lakes. In this activity, students will experiment with balloons and cans – and “magic wands” and “flying saucers” – to learn about a special type of electricity, static electricity, and figure out how it’s created and why it behaves the way it does.

Background:

Electricity is the movement of electrons – tiny negatively charged particles – from atoms, the building blocks of all materials. An atom has a nucleus with positively charged protons and neutral (uncharged) neutrons. Surrounding this nucleus is a “cloud” of negatively charged electrons. Electrons like to be balanced by protons – the positive and negative charges like to “hug” each other. For every 100 protons, there are usually 100 “electrons” hugging them.

But electrons can be rubbed off of materials that are good conductors to create a charge imbalance. This can result in one material having extra electrons and the other being short on electrons (which is like having extra protons). Some materials are more likely to attract electrons and others are more likely to have them rubbed off. Because opposite charges attract, extra electrons will always want to get back to their protons, creating an attraction between materials that are oppositely charged. Electrons don’t like extra electrons and protons don’t like other protons. This is repulsion. Some of the behavior we will see in the lesson do not involve the direct transfer of electrons, but more of the effect of an induced charge.

When a large number of extra electrons build up, they will sometimes flow suddenly into a nearby object – a good example of this is the “static shock” you can receive when you touch a charged object. Lightning is a more dramatic demonstration of this charge neutralization as electrons flow from ice particles in storm clouds into the ground below.

Vocabulary/Definitions: 3 – 6 important (new) words

- Static: not moving
- Electrons: negatively charged (-) particles in the atom
- Protons: positively charged (+) particles in the atom
- Attract: pull together
- Repel: push apart
- Negative charge: extra electrons (-) on something
- Positive charge: more (+) protons than electrons on something
- Conductivity: the flow of electrons
- First rule of electricity: Like charges repel; opposite charges attract



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Materials:

What will you bring with you?

- Materials kit for each station
- Work sheets (unless run off by teacher)

What should students have ready (pencils, paper, scissors)?

- None

Classroom Set-up: *Student grouping, Power/Water, A/V, Light/Dark, set-up/clean-up time needed*

Desks or tables arranged to create three stations with corresponding bags of materials. Six pairs of books of equal height at station 2. Balloons will be blown up ahead of time at station 3. Overhead projector. Will need 5 minutes to set up, 5 minutes clean-up. Students in groups of 8 to 10 with each group divided into pairs of partners or 3's if necessary.

Classroom Visit

1. Personal Introduction & Topic Introductions: 10 Minutes

Who are you? What do you want to share with students and why? How will you connect this with students' interests and experiences?

(varies by presenter: my intro) I'm "Dr.J." I've had several careers – in Washington and embassies overseas, with phone company computers, and in schools with students of all ages. Science has always been a hobby – I've tinkered with electrical stuff all my life. Why my hat? ***Charge one balloon with wool cap, stick on wall.***

At your age I was living in Arizona where every summer we had exciting thunderstorms. How many of you have been in thunderstorms? I learned to count the seconds after each lightning flash: one-a-thousand, two-a-thousand... If thunder came in 5 seconds, how far away was it? (***Get ideas and explain***) 10 seconds? 20? 40? Never? If the lightning was less than a mile away my mother would call me to get inside! Has anyone been close enough to a lightning strike to hear the thunder instantly as a loud crash? (***Story of boy on lake***) There are more dangerous ways to feel it – 300 people are injured every year by lightning strike; about 60 are killed. Ben Franklin famously conducted a very dangerous experiment with kites and lightning – another scientist was killed trying to copy Franklin. (***OH from Ben & me***). But there are many safe things you can do with electricity.

Distribute worksheets for recording data.

(As one team member explains the key words, another team member writes them on the board with the definitions. The students can copy their answers onto the worksheet. The third team member may want to be blowing up 6 water balloons for station 3: Cans on roll).
Who has ever felt a spark when they rubbed their shoes on a carpet and then touched someone



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else? Where else have you felt it? How about: when you climbed out of a car, or went down a slide on the playground Petting a cat or removing a sweater? Then you've all experienced static electricity. (*Sketch on board: atom with protons (+), electrons (-).*)

Lightning is created by the neutralization of charged particles in the air. Thunder is caused by the resulting shock wave that is created as the superheated air expands explosively.

Explain how + & - charges are attracted to each other, so they usually hug closely. But sometimes electrons (-) can rub off onto something – this results in **static electricity**: the buildup of extra + or – charges on a surface. Today we'll be playing with static electricity and paying close attention to what's happening to try to figure out where the electrons are moving. If you listen and observe carefully and think about it, you should be able to explain what's happening in each activity.

Initial demo: Soda cans on a roll. Charge a balloon again (with wool or hair) and hold it close to a soda can. Students sketch results on worksheets and write down what happened. Why did this happen? How did the first rule of static electricity apply? Draw a diagram on a board. (Electrons are transferred from the wool to the balloon, creating negative charge on the balloon. The protons in the can are then attracted to the negative charge on the balloon.)

All of our activities today will involve pieces of wool fabric. This is because wool easily gives up electrons. Our experiments will help us discover which things like to give electrons and which like to gain electrons.

Materials that gain a (+) charge by giving up electrons	Materials that gain a (-) charge by receiving electrons	Materials that are affected by an induced charge
Wool (pieces of wool fabric, wool yarn)	Plastic (styrofoam plates, plexiglass, vinyl table cloth)	Aluminum can, table surface, wall surface, bits of paper

Put the students into three groups (if they aren't already) to begin to begin the activities at stations.

2. Learning Experience(s): _____ **45** Minutes

What will you do, what will kids do? Demonstrations, hands-on activities, images, games, discussion, writing, measuring... Describe in order, including instructions to kids.

Ask the students to diagram their observations on the worksheet with + or – signs when they can. At the end of the time at each station, use the station materials list to have the kids put their materials back into the Ziploc bags.

Station One:

1. Magic Wands (Attraction experiment). Each pair of students gets a bag of materials.

Ask the students to rub the “magic wands” (pen, rubber tubing, plastic rod) with the



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wool. Have them tear the scraps of paper into small bits and sprinkle them over a surface. What happens to the scrap paper when they wave their magic wand over it? Let them experiment with the other types of fabric to see what happens. Tell them to trade wands with their partner to see if some work better than others. Ask: the wands aren't really magic – what is happening? Where do you think the electrons are moving to and from?

2. **Active Plates & Launching Pads (Repulsion experiment).** Take the plate with the aluminum “launch pad” and rub it with the wool cloth for 1 minute. Sprinkle bits of paper on the plate. What happened? Sprinkle bits of metal confetti on it. What happened? Slowly lift the plate off the desk. What happened? Where do you think the electrons moved to and from?

Station Two:

1. **Flying Saucer (Repulsion experiment).** Take the plastic plate labeled “flying saucer” and the plate labeled “rub me.” Rub both with the wool cloth until they stick to your desk. Place the “rub me side down onto the other plate on your desk. Now carefully pick up the bigger plate. What happened?
2. **Dancing Bits (Attraction experiment).** Place the plexiglass over two books of equal height. Place bits of paper under the plexiglass. One partner holds the plexiglass in place while the other partner rubs the top with wool. What happened?

Station Three:

1. **Cans on a Roll (Attraction experiment).** Put the soda can on its side on the desk. Rub all sides of the balloon with the wool cloth. What happens when you put the balloon close to the can? How far can you get the can to move without touching it?
2. **Hanging Yarn (Repulsion experiment).** Give each student one short piece of yarn. Have them hold the yarn from the middle so each side hangs down and rub each side separately with the square of plastic table cloth.
 - a. Pinch the yarn at the top and see if you can get the two sides to touch.
 - b. What happens when you put your hand between hanging yarn ends?
 - c. What happens when you and your partner bring your two pieces of yarn close to each other?

Prediction challenge at the front of the class: Ask for two volunteers. Hand one a long piece of yarn and square of wool. What will happen if each rubs their hanging material with their cloth material? Same or different results? (Same) Congratulate those who got it right. Now what will happen when we bring the hanging strips together (The strips hug each other.) Why?

3. Wrap-up: Sharing Experiences

10 Minutes

Putting the pieces together – how will students share learning, interpret experience, build vocabulary?

Were they surprised by anything they saw? What did they think of the experiments? Where else do remember experiencing static charge? How might you design an experiment to figure



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out where the electrons are moving from and to in these scenarios? Was there anything that you had noticed about the materials that we used and the effects they had?

4. Connections & Close:

5 **Minutes**

What else might kids relate this to from their real-life experience? How can they learn more?

Thanks and good-bye! Clean-up.

Total 75 Minutes



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"Zap, Crackle & Pop: Static Electricity Everywhere"

Materials Checklist

Station 1: "Magic Wands" and "Active Plates & Launching Pads":

- 1 9" Styrofoam plate w/ small adhesive aluminum "launching pad"
- 1 container of aluminum foil scraps
- Pieces of scrap paper
- 2 pieces of wool/felt/flannel fabric
- 2 other types of fabric
- 4 types of "magic wands", w/ a variety of types across the bags

Station 2: "Flying Saucer" and "Dancing Bits" – 6 bags containing:

- 1 larger Styrofoam disk labeled 'Launch Pad'
- 1 smaller Styrofoam disk-- one side labeled 'Flying Saucer', one labeled 'rub me'
- 2 pieces of wool/felt/flannel fabric
- 1 rectangular Plexiglass pane
- Pieces of scrap paper

Station 3: "Cans on a Roll" and "Hanging Yarn" – 6 bags containing:

- 1 empty soda can
- 1 balloon
- 2 squares of wool/felt/flannel fabric
- 2 strips of yarn
- 2 squares of soft vinyl tablecloth

For front-of-the-room demos, extra materials:

- 1 empty soda can
- 1 wool hat
- A bunch of balloons
- A bunch of sheets of scrap paper
- An extra container of aluminum foil bits
- Overhead from "Ben & Me"



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Follow-up – After Presentation

Suggest students write a letter explaining “How we learned about static electricity?”

- Students could look in their science books to see how the static electricity activities fit in.
- Student could write letter to the presenter about what they learned about static electricity.
- I will leave some Exploratorium handouts about things students could try at home and report back on.
- I will leave some sheets of suggestions the teacher could try in the classroom on a really dry day.
- Here’s a list of websites for further exploration:
 - <http://www.d70.k12.il.us/adler/4thelec.htm>
 - <http://www.sciencemadesimple.com/static.html>
 - <http://www.school-for-champions.com/science/static.htm>
 - <http://www.explainthatstuff.com/electricity.html>
- Here’s a short list of things for googling (in addition to all the new terms from the activities so far):
 - Lightning
 - Ball lightning
 - St. Elmo’s fire
 - Lightning rods
 - Plasma
 - Coronal discharge
 - Leyden jars
 - Electroscopes
 - Super-capacitors
 - Induced charges
- Students could read (or have the teacher read aloud) the book *Ben & Me* by Robert Lawson.
- Advanced readers could read *The Kite that Won the Revolution* by Isaac Asimov.

Also, for a bunch of other cool static electricity experiments/reading, see <http://www.sciencemadesimple.com/static.html>

Static Electricity Series (Children’s Museum of Houston) – In these hands-on activities, learners explore static electricity through the use of common household products. The activity webpage includes a fun how-to video for learners and educators.

<http://www.cmhoustonblog.org/2011/01/29/static-shock/>

<http://www.cmhoustonblog.org/2011/02/07/static-cling/>

<http://www.cmhoustonblog.org/2011/02/14/static-repulsion/>

<http://www.cmhoustonblog.org/2011/02/17/static-repulsion-bonus-experiment/>



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Reading Connections:

- Electricity by Darlene Lauw - Explains static electricity, magnetism, and how electricity travels. Highlights leading scientists, Earth-friendly facts, and important vocabulary. <http://books.google.com/books/about/Electricity.html?id=fRwJcaLDrcQC>
- Electricity: A Question and Answer Book by Adele Richardson - Have you ever shocked someone after rubbing your feet on the carpet? The shock is electricity jumping from you to another person. Look in this book for a dozen questions that will get you thinking about how electricity powers your world. <http://books.google.com/books/about/Electricity.html?id=uCl8x3qb4LAC>
- Sources of Forces: Science Fun with Force Fields by Vicki Cobb - With this book, you take ordinary objects and test different properties of force fields. Make an electric field detector out of a film can, a plastic drinking straw, tape, and a pencil. Build a device that measures electric current using a compass, a soda can, some string, and some tape. <http://www.amazon.com/Sources-Forces-Science-Force-Fields/dp/0822570238>