Static Electricity

FRAMEWORK
I. Scientific and Engineering Practices
II. Cross-Cutting Concepts
III. Physical Sciences

SKILLS/OBJECTIVES

The goal is to introduce children to the concept of static electricity, to show them how it works, and to give them a scientific background about why it happens and how it works. The developed skills include:

- Observation and Deduction – observing the results of hands-on experiments and making inferences/drawing conclusions.
- Understanding that physical forces such as electricity are ubiquitous and apply even to "superheroes" and "magicians".
- Creating and Designing – ability to assess given information, based on which to design an experiment.

MATERIALS

General: Several big pieces of wool cloth or fur (not smaller than a hand). (x20),

Movement game: 20 cards with a written – or + sign for introduction (10 of a kind).

Part I: Balloons with different sizes and shapes (x20)

Part II: a thin plexiglas sheet, a smooth surface; other surfaces(look around classroom – glass, wood, plastic).

Part III: **a sheet of acrylic plastic** or other clear plastic (about 1 foot [30 cm] square and 1/s inch [3 mm] thick), **4 supports** about 1 to 2 inches (2.5 to 5 cm) high (tuna cans, flat bowls, small cups), a **large piece of white paper,** 11 x 17 inches (28 x 43 cm), **tiny bits of "stuff"**: aluminized ceiling glitter, grains of rice, puffed rice cereal, spices (a spoonful of dill weed, basil, ground cloves, or nutmeg), bits of Styrofoam.

PartIV: PVC pipe, 2.5 cm diameter, ~60cm long; mylar tinsel (http://www.sciencebobstore.com/products/Levitating-Orb-Kit.html),

Note: a humid atmosphere provides a conducting path for the rapid neutralization of static charge; hence the following examples work best in dry, winter conditions.
You can split the class in smaller groups (by age) except for the first activity.

- For all activities and demos
- With needed amounts assuming 15-20 kids

BACKGROUND

- Start with questions. At the end of each experiment add some more background.

- What did we do last week? What is electricity? How does it work? Have they done some experiments on electricity and where do they find it in everyday life?

- What about **superheroes and magic** – do they and how use electricity? From there lead into the static electricity topic by saying that **"Today we'll discover a new type of electricity that is used both in everyday life but also quite often from our favorite superheroes such as Spiderman and Harry Potter. Have you heard of static electricity? "**

- *Note: Adjust the following paragraph depending on the level of the students and if they have been familiarized with atoms and molecules.*

Activity 0	**Movement Game**
Materials	20 cards with a written – or + sign for introduction (10 of a kind)
Worksheet	N

The materials we see and use in our life are consisting of very small particles (atoms) that are neutral because they have an equal amount of positive (protons) and negative (electrons) charges. Electrons can be exchanged during contact (friction, rubbing), making one surface positively charged and the other negative. The opposite charges attract themselves and the same repel each other. This is the main reason for static electricity. *Note, be sure to mention that any body contact is ok as long as they are comfortable with it.*

To illustrate the idea of positive attracting negative, let them **pick a random card** from your stack as if this is the "rubbing" process (you can rub the card on their hands or head before giving it).

- Then, ask them to show how negative attracts positive.
- What would happen if two negatives come together? Ask them to show with body interaction to exemplify this idea.
- What a small attraction would look like versus a big (i.e. touching a finger vs. a hug)? **Proceed to the activities, saying now some of the superhero secrets will be revealed.**

Activity 1	**Sticking balloons**
Materials	Balloons with different sizes and shapes (x20)
Worksheet	N

Say to the children that they will learn how Spiderman hooks onto building and this will be introduced with balloons. Mention that his costume is made of similar material.

- Distribute balloons to the children and ask them to blow them up.
- Rub a balloon with the wool cloth (in the winter you can usually just rub it on your hair). Notice the "pkpk" sound as you rub it. That is how we know there are positive and negative charges being transmitted from one surface to another.
- Stick the balloon on a wall or ceiling.

Notes: The balloon should be pretty full. Otherwise it would be too "heavy" and falls off easier.

Result: The balloon sticks for a while. The dryer the air is, the longer it will hang.

- Compare a charged versus non-charged balloon (2 similar ones). First show that the balloons are falling at the rate. Then charge them and compare.

- Follow-up, divide them in groups of 3 and let them try with different shaped/sized balloons. Ask them about their observations and how they correlate with the pre-activity talk. Tell them that now we are going to see how a bigger surface reacts to static electricity. Go to activity II.

Activity 2	**Sticking plastic**
Materials	A thin plexiglas sheet, a smooth surface; other surfaces(look around classroom – glass, wood, plastic)
Worksheet	N

- Put a Plexiglas sheet on the table and rub it against the table with both hands.
- Notice how it sticks to the table. Lift up a corner of the plastic and see what happens. Compare how far the sheet moves if you do not rub it and if you do it.
- Rub the plastic with a pencil or different pieces of cloth and see what happens.

Result: The plastic glues on the table.

- Follow-up, let the children choose and try with different surfaces. Provide big plastic pieve from exp.3.

- If they find a vertical smooth wood or glass surface(window), they could observe the sheet not only falling slowly, but sticking to the wall shortly before and as it falls. If it is not charged it would just fall in a second.

Ask them share their observations. Connect the last two experiments to the shape of the hand of Spiderman and that it would be **more difficult to attach with tip of fingers than with bigger surfaces** (balloons vs. plastic sheet). Ask the kids what **type of buildings** would Spiderman find most easy to climb– wooden smooth or glass skyscrapers (ask the children to name a couple of famous buildings made of glass; where are they?). Ask the kids also **what type of material Spiderman should be looking for for his costume**.

Activity 3	**Doing magic, making objects fly and jump around**
Materials	**a sheet of acrylic plastic** or other clear plastic (about 1 foot [30 cm] square and 1/s inch [3 mm] thick), **4 supports** about 1 to 2 inches (2.5 to 5 cm) high (tuna cans, flat bowls, small cups), a **large piece of white paper,** 11 x 17 inches (28 x 43 cm), **tiny bits of "stuff"**: aluminized ceiling glitter, grains of rice, puffed rice cereal, spices (a spoonful of dill weed, basil, ground cloves, or nutmeg), bits of Styrofoam.
Worksheet	N

Introduce with a small talk about Harry Potter and flying on brooms, that objects flying are obeying the static electricity principle.

- Put the piece of paper on the table. Place the supports on the paper beneath the four corners of the plastic, and scatter the tiny bits of Styrofoam, spices, ceiling glitter, or puffy rice on the paper.

- Charge the plastic by rubbing it vigorously with the piece of wool cloth or fur. Accompany with some “magic” words while putting on the supports above the paper.

Result: Watch the "fleas" dance (So cool!)!

- Follow-up: Try **rubbing on top of the plastic**. You'd see increased jumping even though you rub on the opposite site of the plastic.

- Try also **different types of material** for charging the plastic, including **a hand**, and experiment with **other materials for fleas**.

- Try the plastic at **different heights** by removing the support and inclining it. Notice how they stop moving. **Push the plastic to the paper and lift it.** Notice the "fleas" escape far away.

Tips: While the fleas are dancing, put your ear on the plastic plate. Listen to the tapping of the fleas as they hit the plastic. The tapping rate slowly decreases as the charge on the plastic is depleted. The dance of the fleas sounds like the clicking.

Explanations: The attraction between the negative plastic and the positive charge concentrated on the top of the fleas makes the fleas jump up to the underside of the plastic. When a flea actually touches the plastic, some of the plastic's negative charge flows to the flea. The top of the flea becomes electrically neutral. But since the whole flea was originally neutral, the flea now has some excess negative charge. The negatively charged flea and the negatively charged plastic repel each other strongly, which causes the flea to jump quickly back to the table. As the flea's excess negative charge slowly drains away to the tabletop, or to the air, the flea again becomes neutral and is ready to jump up to the plastic once more.

Activity 4	**Let's be Harry Potter!**
Materials	PVC pipe, 2.5 cm diameter, ~60cm long; mylar tinsel (http://www.sciencebobstore.com/products/Levitating-Orb-Kit.html),
Worksheet	N

- Take 6 strands of mylar tensil, and tie them together twice at 15 cm distance. Cut off excessive edges. This is our magical "object".

- Charge the stick with wool/hair. Take the "object" at one end and put it close to the stick, drop it over it. Observe the "object" fly around – real magic!

- Give the kids the opportunity to be magicians too.

CONCLUSIONS

Ask the kids what they learned for the day and what they found most fascinating. Static electricity is thought to be a particular **hazard for astronauts on planned missions to the Moon and Mars**. Walking over the extremely dry terrain could cause them to accumulate a significant amount of charge; reaching out to open the airlock on their return could cause a large static discharge, potentially **damaging sensitive electronics.**

Static electricity can build up and discharge into fuel. If the voltage of the discharge is high enough, it can actually **ignite the fuel or vapor**. This is a present **danger at gas stations**. It is one of the reasons why one should not leave their car running while fueling. This type of accident has occurred in the past at gas stations. **Fires have also been started at airports while refueling aircraft**.