



Electricity and Magnetism, Part 1

Rationale: According to the California State Science Content Standards, electricity and magnetism are important concepts for 4th grade students.

Disclaimer: Some of the procedures for the activities contained in the lessons have been adapted from various resources listed throughout the module.

Part 1A: Electric Current

introduces ideas of electric current from the microscopic and macroscopic points of view

Activity Summary:

- Introduction Part 1 Worksheet Item 1
- Parts of the atom Part 1 Worksheet Item 2
- Simple series circuit Part 1 Worksheet Item 3
- Microscopic view of circuit Part 1 Worksheet Items 4 and 5
- Conductors and insulators Part 1 Worksheet Item 6
- Conductivity test Part 1 Worksheet Items 6 and 7
- Experimental conclusions
- Special materials

Part 1B: Static Electricity

introduces idea of static electricity

Activity Summary:

- Electroscope
- Charging balloon
- Balloon/string experiment
- Balloon/electroscope experiment
- Review

File Summary:

- E&M_1a_doc
- E&M_1a_teachers
- E&M_1a_wksht
- E&M_1a_wksht_key
- E&M_1b_doc
- E&M_1b_teachers



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Part 1B: Static Electricity

Objectives:

After participating in the program *Electricity and Magnetism, Part 1B*, students will be able to:

- relate static electricity to the parts of the atom
- express the difference between static electricity and electric current
- explain that electrons may be removed from an atom and transferred to another object, leaving that object charged
- describe how a discharge or spark is created when electrons jump from one object to another to re-establish charge neutrality
- recognize that like charges repel
- recognize that opposite charges attract
- name several types of static electricity

Vocabulary:

electroscope - an instrument for detecting very small charges of electricity

static electricity - stationary electrical charges, as those resulting from friction

Lesson Plan:

Materials:

For each group:

- aluminum foil – one 6" x 6" piece
- aluminum foil – two 1/2" x 3 1/2" strips (length may vary depending on cup size)
- clear plastic cup (or other plastic cups with a view window cut)
- small paper clip
- tape

For each student:

- balloon
- piece of wool cloth (approximately 12" x 12")
- string
- worksheet

Teacher/Volunteer Preparation:

1. Electroscope construction preparation: Cut the aluminum foil pieces (two 1/2" x 3 1/2" strips and one 6" x 6" piece per group). The length of the strips may vary depending on the cups used. When hung on the paper clip, the two strips should not touch the table. To make it easier for students to insert the paper clips, pre-punch holes in the bottoms of the plastic cups. A large safety pin tip will work well here. If the cups are translucent, cut out a "window" in one side of the cup so that the hanging strips may be clearly seen. Leave enough of the cup so that it can support itself on a table top.

Time:

- activity 1: 10 minutes
- activity 2: 10 minutes
- activity 3: 5 minutes
- activity 4: 5 minutes
- activity 5: 10 minutes



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Activities:

1. (10 minutes)

- Each group should make an electroscope^{1,13} to demonstrate that like charges repel.
- Refer to Figure E&M_1_1 as the electroscope is constructed.
- Fold out the inner loop of the paper clip and straighten it.
- Hang the two aluminum foil strips ($\frac{1}{2}$ " x $3\frac{1}{2}$ ") on the hook still left in the paper clip.
- Push the straightened end of the paper clip through the hole from inside the cup.
- When the cup is placed on a table bottom-side up, the two strips should hang beneath the cup without touching the table. Make sure the strips hang straight and are fairly close to one another.
- Secure the paper clip to the cup with tape. This works best when taping on the outside of the cup where the straight part of the paper clip comes through.
- Wad up the square piece of aluminum foil in a ball and press it onto the top of the paper clip. Do not wad the foil up too tightly before pressing it onto the paper clip.
- Students have now built an electroscope. Put this aside for a later experiment.

2. (10 minutes)

- Give a balloon to each student and ask them to blow it up.
- Have the students rub a piece of wool on the balloon several times and try to stick it to the wall or their shirt, etc. Let them play with this a bit to see what else the charged balloon will do.
- After a few minutes, ask the students to stop and describe what they experienced. (Students should report things such as being able to stick the balloon to something, making their hair stand up, hearing sparks, etc.)
- Does anyone know what causes these things to happen? (static electricity)
- Ask the students to think of other examples of static electricity. (walking across a carpet and touching a metal object, getting out of a car that has cloth seats, pulling two socks apart right out of the dryer, lightning, spark plugs, etc.)

3. (5 minutes)

- Now give each student a string and ask them to tie it to their balloon.
- Work in pairs for this. Have the two students in each pair charge their balloon and hold it by the end of the string.
- By holding the balloons by the strings, ask students to try to bring the two balloons together (you can also tape the two strings together in a doorway with the two balloons hanging at the same level).
- What do students observe? (Students should report that the two balloons do not want to be near each other; that the two balloons push each other away → repel each other.)
- What is happening? Can anyone explain what happened to the balloon when you rubbed it with the wool cloth? (When the balloon was rubbed with the wool cloth, electrons were removed from the wool by friction and were transferred to the balloon.)



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- What charge does the balloon now carry? (The electrons cannot easily get off the balloon, so the balloon is charged negatively.)
 - How does this help the balloon to stick to the wall? (An uncharged object attracts a charged object. When the negatively charged balloon comes close the wall, the part of the wall nearest to the balloon becomes positively charged – electrons in the wall just move over a bit. Then the negative balloon can stick to the positive part of the wall. Oppositely charged objects are attracted to each other.)
 - Why did the two negatively charged balloons push each other away? (Two negatively charged balloons repel each other. Similarly charged objects repel each other.)
4. (5 minutes)
- Charge up the balloon and bring it near the aluminum foil ball of the electroscope¹³. As the balloon approaches the ball, the two leaves hanging below should start to move apart. If the ball is touched, the strips will jump apart.
 - Observe the strips as the balloon is moved towards and away from the ball. (As long as the balloon still retains some charge, the strips should come back towards one another when the balloon is moved away. Sometimes the strips will be permanently deformed by the moving apart so that the electroscope will not work again until the strips are restraightened and made to hang close together. Also, if the balloon touches the electroscope, some charge will be transferred. In that case, when the balloon is moved away, the strips will stay far apart. You can briefly touch the Al ball with your finger to remove excess charge from the electroscope and the strips will fall back together.)
 - What happened? (As the negatively charged balloon is brought near the electroscope, electrons in the ball will travel down the paper clip and crowd onto the foil leaves. The Al strips now have a net negative charge. They will repel each other and move apart. As the balloon is moved away, the electrons flow back to the ball from the strips and the neutral foil leaves can now come back to their original position. If the balloon touches the ball of the electroscope, electrons will jump suddenly from the balloon onto the electroscope. The resulting negative charge on the foil leaves will cause them to jump apart as well. A net negative charge can be left on the electroscope. As mentioned above, the extra electrons may be removed by touching the ball with your finger.)
5. (10 minutes)
- Go over things learned. (Objects can be charged by friction. When this happens, electrons are removed from one object and are collected on another object (protons do not move). Similarly charged objects repel each other; oppositely charged objects attract one another. When a charged object is brought near a neutral object or an oppositely charged object, electrons can jump from the neutral object to the positive object, or from the negative object to the neutral object, or from the negative object to the positive object in order to equalize the charges. This movement of charge takes place instantaneously and is called static electricity. Static electricity discharges can do work



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(lighting up neon glow tube, setting a tree on fire during lightning strike, etc.).)

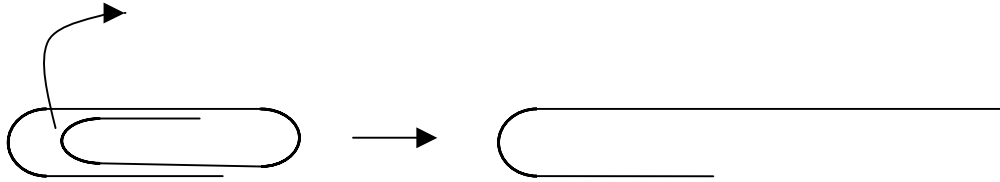
References and Extension Ideas:

The following resources were used in developing this lesson plan. Some of the activities were adapted from these sources. Many ideas for extension activities can be found in them as well.

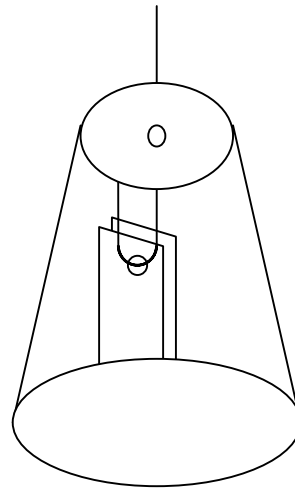
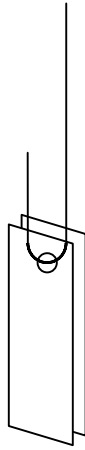
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2. www.beakman.com
3. Foss *Magnetism and Electricity* Module
4. www.freeweb.pdq.net/headstrong/mag.htm
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8. *Exploratorium Science Snackbook* or www.exploratorium.edu/snacks/
9. www.pbs.org/ktca/newtons/12/electric.html
10. www.pbs.org/wgbh/nova/teachersguide/lightning/lightning_sp1.html
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14. www.pgs.org/saf/4_class/45_pguides/pguide_602/4542_storm.html
15. www.chss.montclair.edu/~pererat/pertel.html
16. www.chss.montclair.edu/~peretat/perbuild.html
17. www.chss.montclair.edu/~pererat/perwirls.html
18. *The Science Teacher*, October 1999, "Electromagnetic/Mechanical Resonator", pp. 56-58.

E&M_1_1. Illustration of electroscope construction.

a) Fold out inner loop of paper clip:



b) Hang aluminum foil strips on hook: c) Push paper clip through hole in cup:



d) Tape paper clip in place:

e) Press aluminum foil onto top of paper clip (optional view window shown):

