Activity 2.3 Making Lightning

Teacher Background

Even on a balmy, sunny day warm air can rise, cool and condense into small, puffy cumulus clouds known as "fair weather clouds." An unstable atmosphere can cause air within the cloud to rise even higher and condense, forming a more deeply developed cloud. Due to this upward motion such clouds can extend from a few thousand feet above the ground to over 50,000 feet up into the atmosphere. It is in these towering cumulonimbus clouds that thunderstorms are born. Ice crystals and large water droplets begin to form at the top of the cloud. When they grow large enough to overcome the updraft, they begin falling and downdrafts form. During the time when both updrafts and downdrafts co-exist the storm is in its most violent stage. Downdrafts continue to grow and eventually choke the updrafts, cutting off the supply of humid air which feeds the storm. The storm tapers away.

Electrically charged water droplets and ice crystals are in constant motion within the cloud. In a process still not fully understood, the charges begin to separate, with positive charges migrating to the top of the cloud and negative charges moving to the base. Scientists are still trying to figure out exactly how the negative and positive charges build up in different places in the cloud.

Eventually the charges become sufficiently strong that a current begins to flow. Negatively charged electrons begin a zigzag path from the cloud to the surface of the Earth, which is positively charged. When the negative charge comes close enough to the ground it attracts the positive charges from the ground, usually conducted through a tall structure such as a tree, and a powerful electrical current begins flowing. A single flash of lightning contains enough power to light an entire town, even if only for a few seconds!

Lightning can reach temperatures of 28,000 degrees Celsius, about 4 times hotter than the surface of the Sun. The air around a bolt of lightning is heated rapidly and expands. After expanding the atmosphere quickly contracts. The expanding and contracting atmosphere produces sound waves which we know as thunder. (Students can walk through this process via an interactive animation in the WHY section of the LIVE FROM THE STORM website.)

Objectives

Students will observe how charges build up causing static electricity.
Students will safely observe how touching a conductor will release static electricity as a static discharge.
Students will compare static electricity to lightning (which is static discharge).
Students will review safety procedures recommended when encountering lightning and thunderstorms.

Vocabulary

conductor
discharge
negative charge
positive charge
static electricity

Materials
styrofoam plate
styrofoam cup
foil pie pan
masking tape
source to charge the styrofoam plate. (Fur pads work the best, but you can also use clear plastic wrap or other fabrics.)
Activity 2.3 Student Worksheet, Making Lightning

LFSTORM Standards Correlation sheet (for teacher reference)

Engage
Ask students to describe their previous experiences during thunderstorms. Do thunder and lightning make up some of their earliest memories? What safety rules should they follow during a thunderstorm. (Stay inside your house and don't bathe or shower until after the storm. Remember lightning can travel along telephone wires. If you're in a car or school bus, stay in the vehicle. If you are caught outside find the lowest spot: don't stay near something tall. [For a scientific explanation, see Teacher Background above.] If caught in the open, lean forward and hug your legs in a crouch position, making as little contact with the ground as possible: do *not* lie on the ground nor stand upright. Swimmers should get out of the water. Boaters need to find a safe place to anchor. See the "Safety Warning" and associated emergency preparedness URLs accessible via the LFSTORM home page.)

Explain the process which occurs in a cloud leading up to a thunderstorm. Can lightning strike twice in the same spot? (Yes, the Empire State Building has been hit many times during the same lightning storm.)

Explain/Explore
Procedure
Distribute Worksheet 2.3 and review the Objectives, Materials required and the procedure. Note that while fur pads work best, you can also use clear plastic wrap or other fabrics. Ensure students pay special attention to how they attach the styrofoam cup to the pan. The cup must be in complete contact with the pie pan. Make sure they do *not* simply place strips across the bottom of the cup and attach to the pie pan.

Using the steps on the student worksheet as your checklist, facilitate the experiment, encouraging students to follow the procedure carefully and to note results in their WEATHERlogs.

TEACHER TIP:

If you're going to do this Activity with more than one class on the same day, have plenty of materials on hand. By the end of the day the static electricity will build up in the room and the materials will become so charged that you will not get the desired results. While damage is relatively unlikely, you should also be sure that anyone using a classroom computer has discharged before typing. No need to risk a cyber-storm!

Note that you may need to get your room quite dark in order to actually see the sparks: one of our teacher reviewers found that while her students could easily feel and even hear the static electricity, they really wanted to see it.

Expand/Adapt/Connect
Discuss with students what they observed. How does this compare to what happens during a lightning storm? Discuss the materials used in this experiment and why it was important to use materials that conducted electricity and insulators. Could students stand on a rubber door mat and not get shocked? Why or why not?

Go online and research information about thunderstorms and other static electricity demonstrations which sound like fun, and report your results to the class.

Research the use of lightning rods, Ben Franklin's kite experiment (*not* to be repeated!) and early experiments with static electricity. (Start with the TIMELINE in the WHO section of the LFSTORM website.)

Use this Activity and the Emergency Preparedness information referenced in it as possible content for "The Great Emergency Preparedness PSA Contest." You can find full information online at the LIVE FROM THE STORM site. See CLASSROOM CONNECTION in the EDUCATORS section.

Suggested URLs
http://www.nssl.noaa.gov/edu/ltg/
NOAA's National Severe Storms Laboratory: information and Q&A on lightning.

http://www.coe.usouthal.edu/oar/html/lightning.html
NOAA/OAR: good background information, activities and links to additional resources.

http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/svr/home.rxml
How thunderstorms develop, types of thunderstorms and the dangers involved: comprehensive overview for older students.

http://www.azstarnet.com/anubis/zaphome.htm
"Kids' Lightning and Safety" pages. Sabrina and her parents survived being struck by lightning. She has created this page to warn others about being safe during storms.