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Stay Safe Around Electricity
Teacher's Guide

INTRODUCTION
The *Stay Safe Around Electricity* activity booklet can be used as a follow-up to an electric utility presentation or as a stand-alone piece to teach electrical safety concepts. This guide provides background for teachers on the electrical safety concepts contained in the booklet. It also includes ideas for further discussion and exploration.

OBJECTIVE
To teach students the basic rules and principles of electrical safety. Students will be able to:
- Describe how electricity is generated, distributed, and used.
- Explain why electricity can be dangerous.
- Predict what is likely to happen in common situations involving potential electrical contact and identify safe behaviors in each situation.

KEY PRINCIPLES OF ELECTRICAL SAFETY
Use these principles to help students understand the dangers represented in the activity book:
1. Electricity flows easily through ***conductors***, like metal and water. It does not flow easily through ***insulators***, like special rubber or glass.
2. Water is an excellent conductor of electricity. Because the human body is 60-70% water, people are also good conductors of electricity, which is why it is dangerous to us.
3. Electricity always takes the easiest path to the ground.
4. If you come between electricity and the ground, you become a conductor for electricity and can be shocked. An electrical shock can seriously injure you.

PRODUCTION, DISTRIBUTION, AND USE OF ELECTRICITY
Pages 2-3

Teacher Background
Electricity is made at a power plant. Power plants use some form of fuel (coal, oil, natural gas, nuclear, hydro, wind, or solar) to heat water into steam, which turns the blades of a turbine. The turbine spins magnets inside a generator, producing electricity.

Electricity travels through a grid of wires, including transmission lines (which carry high-voltage electricity over long distances) and distribution lines (which carry lower-voltage electricity for use in homes and businesses). Distribution lines run overhead or underground. Transformers change electricity's voltage and are found in substations, on power poles, or in large metal boxes on the ground, called pad-mounted transformers. From distribution lines, electricity enters buildings and flows through wires in the walls that lead to lights and electrical outlets.

Discussion/Activities

1. Electricity is so much a part of our lives that we take it for granted. Ask students to imagine a day without electricity. What would they use for cooking, lighting, and entertainment at home?
2. Find out from your local utility whether they have any tours or resource materials on electricity and electrical safety.

HOW ELECTRICITY CAN HURT YOU

Page 4

Teacher Background

Electricity seeks the easiest path to the ground, traveling through any conductive material available. Human beings conduct electricity because we are 60-70% water, and water is a great conductor. If a person gets between electricity and the ground or something touching the ground, electricity will flow through him/her. A person standing on a tree, a ladder, or the floor is connected to the ground and can still be shocked.

Emphasize to students that an electrical shock can be quite serious. It can lead to serious internal and external burns. It can stop a person's heart and kill him or her. And it hurts.

Discussion/Activities

1. What is the difference between a bird sitting on a power line and you touching a power line? *(The bird is not touching the ground or anything that is in contact with the ground, so electricity does not flow through it and it is not harmed.)*
2. Have students make signs listing all the ways they know to behave safely around electricity. Ask students to take their signs home to review with their families.

CONDUCTORS AND INSULATORS

Page 5

Potentially dangerous situations involving common electrical conductors (water and metal) appear on pages 8, 9, 13, and 14.

Teacher Background

Conductors, such as metal and water, allow electricity to flow through them. Water is such a good conductor that most insulators will not work if they are wet. Insulators, such as special rubber or glass, resist the flow of electricity.

Discussion

1. Ask students to name a few common conductors. *(Wires, cords, metal pipes, water, anything wet, paper clips, and fingers or any part of the human body.)*
2. Ask students to name a few common insulators. *(Glass, air, dry dirt, special ceramics, rubber, and plastics.)* Make sure students understand the difference between insulating safety gear such as rubber boots, and household products such as athletic shoes and latex gloves, which do not protect against shock. Remind students that they should never experiment with these household products and electricity.
3. Reiterate to students that water should never be squirted at a power line. The stream of water can conduct electricity and shock the person doing this.

Extension Activity/Experiment

Testing conductors and insulators within an electrical circuit is a great opportunity to get students involved in the discovery process as promoted by the National Common Core standards. This experiment will encourage students' creativity and experiment-design skills as it asks them to work with independent variables and draw conclusions from their observations.

Before beginning, explain to students that an electrical circuit is a complete loop that allows electricity to flow through it. They can design their own electrical circuit with a battery as the power supply; the lit or unlit light bulb will indicate whether electricity is flowing through the circuit. With the circuit they build, students can test whether certain materials can block (insulate against) or allow (conduct) the flow of electricity.

Materials needed for each setup:

- D-cell battery
- 1.2-volt light bulb
- E-10 light bulb base
- Two 12-inch pieces of insulated solid strand copper wire (18-22 gauge), with one inch of insulation removed at each end
- Masking tape
- Objects or materials to test as conductors and insulators such as steel wool, plastic, a penny, a rubber eraser, yarn, a paper clip, glass, dirt, food, etc.

If possible, procure enough battery/wire/bulb circuit setups for students to work in small groups. If only one setup is available, ask for a student volunteer to help you set up in front of the class.

Setup: Ask students to select a number of objects or materials to test in their circuit. These should include some they think are insulators and some they think are conductors. Students can use masking tape to attach the wires to the battery and possibly the object.

Predict: Have students predict which objects will function as conductors and which as insulators, and state why they think so.

Test Variables: Have students test each object by attaching one of the wires from the battery to one end of the object, and one of the wires from the light bulb to the other end of the object or material. (See the illustration.) Have students observe whether or not the bulb lights for each item.

Conclude: Based on their results, have students conclude which materials are conductors and which are insulators, and record this in a data chart.

Extrapolate: Ask students to draw conclusions about what characteristics their insulator materials have in common and what their conductors have in common. (For example, conductors may be made of water or metal and insulators made of rubber or glass.) Encourage students to share their findings with the class.

POWER LINE SAFETY
Pages 4, 8-12

Teacher Background
Most overhead power lines are not insulated, and thus are located high off the ground to prevent accidental contact. The rubber coating on some overhead power lines should not be confused with insulation; it is there to protect the power line from the effects of the weather and is not meant to protect people from shock. Even if a line is insulated, the tiniest pinhole or break in the insulation puts you at risk. Stress to students that they should never touch power lines.

Discussion/Activities
1. Why does electricity stay in overhead lines instead of flowing down the pole? *(Insulators made of special glass, ceramic, or plastic are between the wire and the pole.)*
2. Ask students to brainstorm how electric line workers can touch power lines safely. Remind them about insulators and how they might be useful in this situation. *(Sometimes workers turn off the electricity in the power line before working on it. When they work on live lines, they use insulated tools, wear special insulating work boots with rubber soles [not athletic shoes], and use insulating gloves.)* Emphasize that these workers take special measures that students should never try to duplicate.
3. Remind students that if they are in a vehicle that contacts a downed power line (see p. 11), they are safe from electrical shock as long as they stay in the vehicle, and should wait there until help arrives. If they absolutely must leave the vehicle due to fire, ask students what they would do and why. *(Jump clear, being careful not to touch the vehicle and the ground at the same time, so your body doesn't create a path for electricity to flow from the vehicle to the ground.)*
4. Ask students what could happen if you start a digging project without first calling the utility locator service. *(You could strike an underground power line and get a shock.)*

ELECTRICAL EQUIPMENT
Pages 6-7

Teacher Background
Substations, pole-mounted transformers, and pad-mounted transformers may attract students' curiosity. Substation fences may look fun to climb, but the danger of shock is high. Pad-mounted transformer boxes contain equipment that can cause electrocution. The boxes are usually locked; students should stay away from them and report any damaged or unlocked boxes to an adult. Pole-mounted transformers do not pose as great a threat as pad-mounted transformers because they are much less accessible. However, the risk of shock is the same.

Discussion/Activities
1. Take students outside the school building and locate lines, transformers, and the entrance of electrical lines into buildings. What other equipment can they see? *(Possibly the electric meter.)* What is it used for? *(To measure how much electricity is used in the building.)*
2. Ask students to draw a map of their route to school, showing the places where they see electrical equipment. Include overhead lines, transformers, and substations.

HOME APPLIANCE SAFETY
Pages 13-14

Teacher Background
Home appliances are potentially dangerous because they are accessible to young children, their cords can become worn without being noticed, and the inside parts can malfunction without showing something is wrong. Appliances are commonly used around water, which increases the risk of shock.

Discussion/Activities

1. Explore with students their experience with electricity's dangers at home. Has anyone in the class been shocked, burned, or injured from an electrical appliance or other home use of electricity? Does anyone know someone who has? What happened? How did it happen? What thoughts did the person have afterward? Did the experience have any effect on the safety measures these people take around electricity?
2. Ask students to look around the classroom or their homes for special electrical outlets called GFCIs (ground fault circuit interrupters), which are designed to quickly shut off power to prevent serious shock. Where are GFCIs placed? (*GFCIs are used outdoors and inside near water because those are the areas of greatest risk of electrical shock.*)
3. Ask students to suggest other items to add to the safety inspection on the back cover.

WHAT TO DO IN AN ELECTRICAL EMERGENCY
Page 15

Teacher Background:
Electrical fires are different than other fires because they have a source of electricity that is still conducting electric current. This is why you should never use water on an electrical fire. Putting water on an electrical fire gives electricity a way to travel to the rescuer, through the stream of water. Instead of water, an adult should use a multipurpose fire extinguisher (designed for electrical fires, wood/paper fires, and flammable liquids).

In case of electrical shock, never touch the victim! Students may think that if a person is already shocked or burned, the danger is over. But if the source of electricity is still live and near or touching the victim, the situation could be deadly for someone who approaches too closely. Instead, an adult should unplug the source of electricity (if it is safe to do so) or turn off power at the main switch.

Discussion/Activities

1. Ask students to explain why we don't use water on electrical fires. (The electricity could travel through the water and shock you.)
2. Ask students to describe the dangers to the rescuer in an electrical emergency. (If a would-be rescuer were to touch a person still in contact with the source of electricity that shocked him/her, the electricity flowing through the injured person would flow through the rescuer, too. The rescuer would become another victim.)

BACK COVER
The back cover encourages students to conduct a home safety inspection with their parents.

Discussion/Activities

1. Conduct a full-class brainstorm about the types of electrical hazards that might occur in or outside students' homes.
2. Encourage students to share the electrical safety inspection on the back cover with family members.