Stay Safe Around Electricity, Water and Natural Gas
Teacher's Guide

Introduction
The *Stay Safe Around Electricity, Water and Natural Gas* activity booklet can be used as a follow-up to a utility presentation or as a stand-alone piece to teach electrical and natural gas safety concepts, water sports safety, and disaster preparedness. This guide provides background for teachers and includes ideas for classroom discussion and exploration.

Objective: To teach students the basic rules and principles of electrical, water and natural gas safety.

Students will be able to do the following:
- Describe how electricity is generated, distributed, and used.
- Practice water safety when swimming or boating anywhere, and especially in hydropower reservoirs.
- 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.
- Describe where natural gas comes from and how it is distributed and used.
- Explain why natural gas can be dangerous.
- Identify unsafe and safe behaviors around natural gas, and know how to recognize a natural gas leak and what to do if one is detected.
- Learn how to respond to electric and natural gas emergencies and prepare for disasters.

Key Principles of Electrical and Natural Gas 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 composed of 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.
5. Natural gas is pumped through underground pipes to our homes and businesses.
6. Natural gas is combustible, and we use it by burning it.

Pages 2-3: Uses, Production and Distribution of Electricity and Natural Gas

Teacher Background

Electricity is a form of energy that 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.

Natural gas is another form of energy. It is a colorless, odorless gas that is lighter than air. It is primarily methane gas that forms when organic material (plants and animals) decomposes under pressure. Methane gas that formed when ancient organisms decomposed was trapped under layers of solid rock and is found in the same underground areas where crude oil (petroleum) is found. Wells are drilled through the rock to bring natural gas to the earth's surface. The gas is pumped to a processing plant where it is cleaned, and then pumped through pipelines to towns.

A chemical called mercaptan is added to natural gas to make it smell like sulfur or rotten eggs. We use natural gas in appliances, such as clothes dryers, stoves and ovens, furnaces, air conditioners, water heaters, outdoor gas lights, pool or spa heaters, barbecue grills, and fireplace logs, and in motor vehicles.

Discussion/Activities

1. Electricity and natural gas are so much a part of our lives that we take them for granted. Put students in pairs or small groups and have them make a list or write a short story about how they would live for a day without electricity or natural gas. Ask them to include what they would use for cooking, lighting, and staying warm or cool.
2. Find out from your local utility whether they have any tours or resource materials on electricity and natural gas and on electrical and natural gas safety.
3. Natural gas is a fuel made by nature. How does it get buried under the earth?

Page 4: Water Safety

Teacher Background

Many reservoirs in central and northern California have multiple uses, including electricity production (hydropower). Your students may live near a hydropower reservoir, or travel to one to enjoy water sports. In either case, it is important that students be aware of the function of these reservoirs and practice basic water safety when enjoying their facilities.

Discussion/Activities

Ask students if they have ever gone swimming, boating, fishing, or camping near a hydropower reservoir. Ask them if they had known about the potential dangers of these reservoirs (such as very cold or swiftly flowing water, slippery canals, and flumes) and what types of precautions they or their family members took to stay safe.

Invite students to create a poster with important safety tips for play in and around water—whether a reservoir or any other body of water. If possible, invite a younger class in to the classroom to view the posters when they're finished, so older students can help educate younger students about water safety.

Page 5: Disaster Preparedness

Teacher Background

Floods, fires, earthquakes and tsunamis are rare, but being prepared for them is essential. Students who live downstream from a hydropower reservoir should be especially aware of flood preparedness measures, and should have an evacuation plan and a high-elevation meeting place for their families.

Discussion/Activities

Encourage students to share the tips about emergency kits and family evacuation planning with parents/guardians and siblings.

Page 6: Conductors and Insulators

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 or block the flow of electricity.

Discussion/Activities

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.

Extension Activity/Experiment

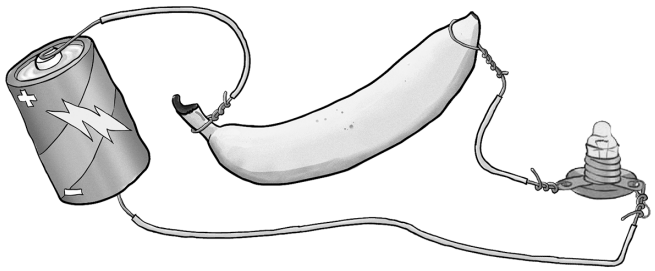
Testing conductors and insulators within an electrical circuit is a great opportunity to get students involved in the discovery process as promoted by the National Common Core standards. This experiment will encourage students' creativity and experiment-design skills as it asks them to work with independent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

Page 7: How Electricity Can Hurt You

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 percent 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 or 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. Ask students why it is unsafe to climb in or play around trees near power lines. *(If they contact a tree that is in contact with a power line, they could get shocked or even killed.)* Remind students to do a power line safety check before climbing any tree. A good way to do this is to walk all the way around the tree at the drip line, looking up for power lines.
3. 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.

Pages 8, 9 and 11: Power Line Safety

Teacher Background

Most overhead power lines are not insulated, and thus are located high above 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 of 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 or play in trees that 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 in pairs or small groups 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 or near it. When they work on or near 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 page 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. What could happen if you touch a power line or a tree that is in contact with a power line? *(Electricity will travel through you and you could be hurt or even killed.)*

Page 12: Electrical Equipment

Teacher Background

Substations, pole-mounted transformers, and pad-mounted transformers may attract students' curiosity. Substations and transformers contain equipment that can cause electrocution. Students should stay away from them and report any damaged or unlocked equipment to an adult.

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.

Pages 10, 14: Safety in and Around the Home

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, because it is a conductor, increases the risk of shock. Outdoors, it is important to stay aware of underground and overhead power lines, and underground gas pipelines. 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.

Discussion/Activities

1. Explore with students their experience with electricity's dangers at home. Have students work in pairs to make a list of home dangers and share these with the class. 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 what could happen if they start a digging project without first calling the utility locator service, accessible by dialing 811. *(You could strike an underground gas pipeline and cause a fire or explosion. You could strike an underground power line and get a shock.)*
4. Why is it important to plant trees where they will not grow to contact overhead power lines? *(Tree branches that contact high voltage power lines can cause outages, fires, and shock hazards.)*

Pages 13, 14 and 15: Natural Gas Leak Recognition, Response and Prevention

Teacher Background

Natural gas is a safe fuel when used properly. We use natural gas by burning it. To burn, natural gas must mix with the proper amount of oxygen and be ignited by a flame or spark. Burning natural gas without the proper amount of oxygen produces carbon monoxide, a deadly poison. When natural gas leaks, there is a risk of fire and explosion, and there is danger of fire if combustibles are stored or used too near gas appliances.

Discussion/Activities

1. What does natural gas smell like? *(Natural gas is odorless, but a chemical called mercaptan is added to make it smell like sulfur or rotten eggs.)* Why do we want natural gas to smell bad? *(So we know when it's leaking and can protect ourselves.)*
2. What are some other signs of an outdoor gas pipeline leak? *(A hissing or roaring sound, dirt spraying or blowing into the air, continual bubbling in water, vegetation that is dead or dying for no apparent reason.)*
3. Why should you tell an adult when you smell gas? Why leave the house if no adult is home? *(There is danger of fire or explosion from leaking gas. You could be seriously hurt.)*
4. Why shouldn't you use a light switch, candle, flashlight, TV, radio, garage door opener, or even a phone if you smell gas*? (Any of these things could cause a spark or flame that could ignite the gas and cause a fire or explosion.)*
5. What should you do if you suspect an outdoor gas pipeline leak*? (Do not use electricity or fire. Get far away from the area immediately and don't go back until safety officials say it's safe. Ask a trusted adult to report the leak to 911 and the local gas utility.)*
6. What should you do before starting a digging project? *(Call 81] to have underground utility lines located and marked, so you can dig a safe distance away from them.)*

Back Cover: Home Safety Inspection

Ask students to take this inspection checklist home and to do the inspection with their families. Ask students to report what hazards, if any, they found in their homes, and whether/how their family fixed the hazard.