Electrical and Natural Gas Safety at Home and Work
Teacher's Guide

Introduction
The purpose of *Electrical and Natural Gas Safety at Home and Work* is to educate readers about the principles that will help them stay safe around electricity and natural gas, including dangerous and potentially life-threatening situations.

The text not only includes facts and safety tips, but also uses personal stories to get readers to realize that dangerous situations can happen to them. The content is appropriate for high school students and adults.

This teacher's guide provides objectives for each page spread, suggestions for relating information to readers' life experiences, and questions that can be used to assess learning or spark group discussion.

HOW SHOCK HAPPENS (page 3)
Objectives
- Describe the path of electricity from the source of current through a conductor to the ground.
- Name at least three conductors and three insulators.
- Understand that even a small amount of electric current can cause injury or fatality.

Real-World Applications
- After reading "A Lesson in the Tub," ask students to draw or describe the path electricity took from the source to the ground. Have students brainstorm what could be done to make sure the empty socket does not remain a hazard. *(Possible answers: Put a light bulb in the socket. Replace the socket with a new, safer fixture. Have an electrician remove the socket and/or deactivate the wiring to the socket.)*
- Ask students to generate a list of possible conductors and insulators. Collect a sample of some of the suggested materials and have students use a simple electrical circuit to check the accuracy of their predictions. Use one D-cell battery and one holiday mini-light cut from a string of lights. Be sure several inches of wire extend from each side of the bulb, and strip the ends of the wire to connect with the battery. Test each material. Conductors should allow the bulb to light; insulators should not allow the bulb to light. Do all insulators or all conductors have any characteristics in common? *(Most conductors are metal; insulators include plastic, rubber.)*
- Explore with students their own experiences with electricity. Has anyone in the class been shocked, burned, or injured in another way from electricity? Does anyone know someone who has? What happened? Why did it happen? What thoughts did the person have afterward? Was anyone with the person? What did the other person do? Did the experience have an effect on the safety measures these people take around electricity?

Exploration & Assessment

1. Toward what destination does electricity naturally travel? *(The ground.)*
2. How does electricity endanger human beings? *(If we contact electric current while we are touching the ground, the current will flow through our bodies and we will be injured or killed.)*
3. What is the difference in effect between contacting the amount of electricity in the power lines outside your house and in the socket of a night-light? *(None. Under the right conditions, both contacts are probably fatal.)*
4. Why is it important to avoid damaging the insulation of a power cord? *(A damaged cord could leave wire exposed to the surroundings. Electric current could flow from the wire to anything it touches, including people, pets, or other objects, and cause a harmful or fatal shock.)*

ELECTRICAL SAFETY BASICS (pages 4-5)

Objectives

- Remember at least five rules for safe behavior around power lines and electrical equipment.
- Generalize safe behavior from the rules given to new situations.
- List several protective actions to take when working or playing around power lines.

Real-World Applications

- Have students list at least five safety rules they would teach a group of younger children about how to stay safe around power lines and outdoor electrical equipment. *(1. Don't climb utility poles and don't climb trees growing near power lines. 2. Keep balloons and kites away from power lines; don't use metallic balloons outdoors. 3. Don't try to retrieve kites or other objects that have become tangled in power lines; ask an adult to report the hazard. 4. Stay clear of pad-mounted transformers and all other electrical equipment. 5. Stay away from power substations.)*
- Ask students why it would be dangerous for a gardener to use long-handled pruning shears to cut tree branches growing close to a power line. *(If the shears touch the power line, electricity has a path to ground through the gardener's body, resulting in a harmful or fatal shock.)*
- Ask students to try to imagine a hypothetical situation in which they could contact electricity without getting hurt. Have students present situations to the rest of the class for critique. For each strategy, identify the points of contact with electric current and with the ground. *(There aren't many situations where this is possible. Standing on an object such as a ladder, a chair, the roof, etc. are not acceptable alternatives because electricity could travel through the person and through the object to the ground. If students create some situations in which they may not be hurt, for example, being inside a car with a downed power line on it, emphasize that they still would be in a gravely dangerous situation. The point of this exercise is to have students practice thinking through how and where they become part of electricity's path to ground.)*

Exploration & Assessment

1. List at least three ways you can become part of the path to ground for electricity when you are outdoors. *(Possible answers: by touching the string of a kite or balloon caught in overhead lines; by entering or climbing utility installations and equipment; by touching power lines with poles, ladders, pruning shears, shovels, or other tools; by touching underground lines with a digging tool.)*
2. What is the difference between birds sitting on a power line and you touching a power line? *(The birds are not touching the ground, so they are not harmed. People have no way to touch a power line without touching the ground or something connected to the ground.)*

STORM SAFETY (pages 6-7)
Objectives

- Remember what to do if you are outdoors and there is the possibility of lightning.
- Demonstrate what to do if you are in a vehicle that comes in contact with power lines.
- Describe the proper action to take if you observe a fallen power line.

Real-World Applications

- Ask students to describe any experiences they have had regarding lightning. Were they outdoors or indoors? What did they do to stay safe?
- Role-play safe procedures if caught outdoors when lightning is possible.
- Role-play safe procedures if caught in a car that is in contact with live power lines and with a person touching a fallen line. What happens to the person who touches the line? *(They become immobilized by the current passing through them.)* What should bystanders do and not do? *(Call emergency services for help, but DO NOT touch the person who is in contact with the power lines. A would-be rescuer who touches the victim becomes a part of the current's path to ground.)*
- Explain to students that the majority of power outages are caused by storms. Ask students if they have ever experienced a power outage and if so, how long it lasted. Discuss as a class what items would be useful to have on hand if the power were to go out. Review the list of items below, which are recommended for a basic home outage kit by the American Red Cross. Encourage students to work with their families to assemble outage kits with these items:

    1. Water: One gallon per person, per day
    2. Food: Nonperishable, easily prepared
    3. Flashlight
    4. Battery-powered or hand-crank radio
    5. Extra batteries
    6. First aid kit
    7. Medications (seven-day supply)
    8. Multipurpose tool
    9. Sanitation and personal hygiene items
    10. Copies of personal documents
    11. Cell phone, chargers
    12. Family and emergency contact information
    13. Extra cash
    14. Emergency blanket
    15. Map of the area

Exploration & Assessment

1. What should you do if you are in a vehicle that comes into contact with a power line? *(Stay in the vehicle, if at all possible.)* Why? *(Because the risk of shock when leaving the vehicle is greater than the risk while you're inside, as long as there is not a fire or other reason that makes it necessary to leave.)*
2. Why are you not part of the path to ground if you are in a car with a downed line on it, but if you are on a ladder, you are part of the path to ground? *(The vehicle's tires hold a layer of air*

between you and the ground. The ladder will conduct electricity, even if it is wood, so if you are touching the ladder, you become part of the path to ground.)

3. If you must leave an energized vehicle, how do you do it? *(Jump, do not step, from the vehicle. Then roll or shuffle away, keeping your feet together.)* Why? *(Jump to avoid becoming part of electricity's path to ground. Shuffle away to avoid becoming a bridge for electricity from an area of high voltage to an area of lower voltage.)*

INDOOR PROJECTS (pages 8-9)

Objectives

- Explain why plain metal conductors should not be substituted for fuses.
- Explain how to appropriately assist someone who has contacted electricity.
- Identify appropriate actions to take when a fuse blows or a circuit breaker trips.

Real-World Applications

- Point out to students that using adapters and extension cords to plug several appliances into the same electrical outlet could be dangerous. If the items plugged into the outlet draw more electric current than the wiring can handle, the circuit could get so hot it could start a fire.
- Have students examine a fuse and draw its components. Identify the component that regulates the amount of current. Ask students to explain why substituting a penny or aluminum foil for a fuse would cause a fire. *(The parts of a fuse include a screw-in point of contact like a light bulb and a wire strip through which current flows, insulated by a glass housing. The wire strip is rated to conduct only a certain amount of electricity. A fuse will only carry the amount of electricity for which it is rated. A plain metal conductor will carry unlimited amounts of electricity to wiring that can carry only limited amounts, which can cause the wires to overheat and start a fire.)*
- Ask students why a ground wire would be connected to a water pipe in a house. Explain that pipes are laid in the ground, so they can be used to give electric current a path to the ground. Ask students: Would it be safe to touch a pipe and an electrical appliance at the same time? *(No, because you could become part of the path to ground.)*
- Ask students what any of these four situations might indicate about a home: Fuses blow or circuit breakers trip often; appliances that heat (irons or toasters, for example) do not get as hot as they should; TV picture shrinks when appliances go on; not enough wall outlets for the number of appliances in use. *(Home wiring is inadequate. Additional circuits need to be installed by a qualified electrician.)*
- Have students brainstorm ways in which a person can become part of the path to ground for electricity inside the home. *(By touching appliances with wet hands, by placing appliances so that there is the risk of them falling into water (tub, sink, etc.); by putting objects or fingers in appliances or outlets; by ignoring malfunctioning appliances; by forgetting to examine the power cords before plugging in appliances, etc.)*

Exploration & Assessment

1. Where can you control the flow of current into a home or other building? *(At the service panel.)*
2. What could go wrong with the insulation that coats the wiring inside the walls of a building? *(It could melt from the heat from overloaded circuits, it could fray from wear, or it could be cut accidentally.)*
3. What happens if the insulation is broken in some way? *(Electricity will escape from the circuit and find a path to ground.)*
4. What are the appropriate steps to take to assist someone who has been shocked or burned by electricity? *(If possible, unplug the source of electricity or interrupt power at the main switch. Do not touch the victim until you are sure there is no danger of electrical contact. Call for emergency help and give first aid if you know how.)*
5. What makes appliances potentially dangerous? *(They are a hazard around water; their cords can become worn without being noticed; and the inside parts can malfunction without anyone being able to tell that there's a problem.)*

YOUR HOME WORKSHOP (pages 10-11)

Objectives

- List at least three areas of potential hazard when using power tools.
- Identify the role of personal attitude in working safely.
- Define a ground fault and identify appropriate placement for GFCIs.

Real-World Applications

- Invite students to observe workers on a construction or maintenance job and note the things they do to stay safe on the job. What is their attitude? If you were a safety inspector, what would you recommend they do differently? To which worker would you give a safety award? Why?
- Make a safety sign listing safe ways to handle tools and appliances. Make the sign attractive and eye-catching so people will want to pay attention to it. Post your sign in the classroom, shop, lab, or at home in the workshop or utility room.

Exploration & Assessment

1. Of the safety rules you already know, which might be especially applicable in a home workshop? *(Power cords: Check for wear. Use suitable cords outside or in wet places. Look for GFCIs. Unplug by pulling on the plug, not the cord. Unused cords should be coiled loosely and stored in a dry place. Tools: Do not carry by the cord. Keep switch in OFF position when not in use. Check for wear or damage. Discard any tool the first time it delivers a shock.)*
2. How could emotions and attitudes affect workplace safety? *(Hurrying, distraction, carelessness, frustration, anger, taking shortcuts, and not following directions can cause a person to ignore procedures that ensure safety on the job.)*
3. What does GFCI stand for? Locate GFCIs in your classroom or school or home. What conclusions can you draw about where GFCIs should be placed? *(GFCI stands for ground fault circuit interrupter. GFCIs are used outdoors and indoors near water because those are the areas of greatest risk of contact.)*

OUTDOOR PROJECTS (pages 12-13)

Objectives

- Remember that a person holding a ladder, pipe, or other long conductor can contact power lines far above his or her head.
- Identify appropriate actions to take when planning to dig underground in any area where power lines might be buried.
- List several protective actions to take when working around power lines.

Real-World Applications

- Have students calculate what their safety margin would be if they were using a ladder to work near power lines 25 feet above the ground. *(Student's height, plus ladder height, minus 10 feet for clearance.)*
- After reading "Olympic Competitor's Shocking Story," ask students what Cliff or his work supervisor could have done to avoid the accident. *(Call the local utility to locate underground power lines near the work site.)*
- Have students look outdoors at nearby overhead utility lines. Point out how difficult it can be to distinguish power lines, which pose a shock threat, from telephone or cable lines.

Exploration & Assessment

1. How many feet of clearance are required for safety when working around power lines? *(At least 10 feet for most power lines; even more for high-voltage lines or when working with cranes or derricks in construction.)*
2. Why would you never use water to extinguish electrical fires? *(Because water is a conductor, using it on an electrical fire could conduct electric current through the stream of water to the person fighting the fire.)*
3. What protective actions should you take when working around power lines? *(Keep yourself and your equipment at a distance from overhead lines. Call the power company and ask what safety measures should be taken before you begin work. Call to check the location of underground lines before you dig. On farms, keep irrigation pipe at least 10 feet from power lines and store irrigation equipment at least 100 feet from lines. Make sure the water stream breaks up into droplets before contacting a line.)*

NATURAL GAS SAFETY (pages 14-15)

Objectives

- Describe the precautions to be taken when you smell gas.
- Recognize the health risks posed by undetected carbon monoxide gas.

Real-World Applications

- Encourage students to do a natural gas safety check at school and at home. Have them locate natural gas appliances, such as water heaters and wall heaters, and ensure that flammable materials are kept a safe distance from the flame.
- If your school uses a gas furnace, water heater, or other equipment, have the building maintenance engineer explain to students the rules he or she follows to ensure safety.
- Have students role-play what they would do if they smelled leaking gas in different situations: at home, at school, in a public building such as a store or office building.

- Explain to students that gas pipeline leaks may not always be detectable by their odor, so people need to be alert for other warning signs. These signs include a hissing or roaring sound; dirt spraying or blowing into the air; continual bubbling in water; and grass/plants dead or dying for no apparent reason.
- Ask students to describe how carbon monoxide is produced. *(By the combustion of natural gas, wood, coal, charcoal, gasoline, kerosene, or any other fuel.)*

Exploration & Assessment

1. Compare the dangers posed by leaking natural gas with the dangers posed by leaking carbon monoxide. *(Natural gas is a fire risk. Carbon monoxide is a poisoning risk.)*
2. Why would it be dangerous to turn off lights in a building if you are leaving because you smell gas? *(The switch might create an electrical spark that could ignite gas in the air around it. An explosion could result.)*
3. What are the symptoms of carbon monoxide poisoning? *(Fatigue, flu-like symptoms, headaches, cherry-red skin, rapid heartbeat.)*
4. A family is stuck on a snow-covered road at night in the middle of winter. They close the car windows and leave the motor running so they can use the car heater to stay warm. Why is this dangerous? *(Carbon monoxide produced by the combustion of gas in the car motor could leak into the car and poison the occupants.)*