Science and Safety of Electricity, Water & Natural Gas
Teacher's Guide

Introduction
Science and Safety of Electricity, Water & Natural Gas uses articles, experiments, and puzzles to explain science concepts related to electricity and natural gas, and how to use these energy sources safely in daily life. It also covers water sports safety and disaster preparedness.

This presentation guide provides the objective for each page spread, suggestions for experiment setup and completion, and ideas for classroom discussion. Activities can be done with materials listed in the booklet; electrical components are available from electronics retailers.

Pages 2 & 3: Table of Contents, Word Search, and Fascinating Facts
Objective: To interest students in booklet contents, introduce relevant vocabulary words, and review electric and gas safety tips students already know. This page also helps identify which new safety tips students have learned from reading the booklet.

Word Search Key (The first letter of each word is underlined and italicized.)

	M	**R**	**E**	**H**	***T***				**N**			
E								**O**				
L	**N**	**A**	**T**	**P**	**A**	**C**	**R**	**E**	***M***			**M**
E					**I**	**T**					**O**	
C	**O**	**N**	**D**	**U**	**C**	**T**	***I***	**V**	**I**	**T**	**Y**	
T				**E**	**F**		**O**		***A***	**I**		
R			**L**		***G***		**N**			**U**		
O		***E***								**C**		
L										**R**		
Y	**S**	**R**	**O**	**T**	**A**	**L**	**U**	**S**	**N**	***I***		
T										***C***		
E		***M***	**E**	**T**	**H**	**A**	**N**	**E**				

Tips for Discussion
Review the vocabulary words in the word search. Ask students to read aloud the electric and natural gas safety rules they wrote on page 3 and then tally them on the board. Note which tip(s) recurred most often and discuss why that may be. (Perhaps the tips are easy to remember, or they refer to a situation in which students often find themselves, etc.) Be sure to bring students back to this page after they finish the booklet so they can list additional safety rules they've learned.

Pages 4 & 5: Dangerous Waters
Objective: To emphasize the dangers of using electricity near water, and how we protect ourselves from shock by the use of ground fault circuit interrupters (GFCIs). To learn about hydropower, and essential water safety tips.

Questions for Discussion
Why is it so dangerous to use electricity near water? *(Because water conducts electricity.)* What is the safest way to use electricity in areas near water? *(Use battery-powered appliances. If you must use corded appliances, make*

sure they are plugged into a ground fault circuit interrupter, also called a GFCI. These devices monitor the flow of electricity in a circuit and if any is escaping the circuit, they quickly shut off power to prevent serious shock.) Why should you use high-power water squirters away from power lines and electrical equipment? *(If you spray water at electrical facilities, electricity can travel down the stream of water and shock you.)* What are some ways to stay safe when enjoying water sports in reservoirs or anywhere else? *(Swim with adult supervision, check the water temperature before you go in, obey all warning signs, be alert for swiftly flowing water and changing conditions, always wear a U.S. Coast Guard-approved life jacket when boating, and stay out of canals and flumes.)*

Pages 6 & 7: The Body Electric
Objective: To explain what electricity is, how electric shock affects the body, and conductivity.

"Keep Your Ion the Bulb" Experiment
Setup: Make sure students strip enough insulation from the ends of the wires to allow for good contact with the battery and the beverages. Remind them to wipe off the tips of the wires between each test.
Answers: Students' answers to the questions will vary depending on the beverages they choose to test. Students may think that only salty-tasting beverages will contain enough salts to make the bulb light brightly, but this is not the case. Any beverages with sodium, potassium, magnesium, and/or calcium will make the bulb light. Beverages with a higher concentration of these substances (such as sports drinks) will conduct electricity better and should make the bulb light up more brightly than those with a lower concentration.

Questions for Discussion
Because the human body conducts electricity so well, you can be seriously hurt if you contact electricity from an appliance or power line. Ask students: What is likely to happen to you if you contact electricity from a household appliance? *(Heart attack, or muscle contractions that lock you to the source of electricity.)* What is likely to happen if you contact electricity from a power line? *(Fatal shock or fall.)* Ask students to tell about anyone they know or have read/heard about who survived an electric shock. How could the incident have been prevented/avoided? *(Answers will vary.)*

Pages 8 & 9: World of Wires
Objective: To teach about power lines and outdoor electrical safety, the characteristics of an electrical circuit, and the difference between conductors and insulators.

"Who Can Resist?" Experiment
Setup: Strip the wires ahead of time and make sure the batteries are fresh. Though the illustration does not show it, it's helpful to use tape to stick the wires to the ends of the battery. Students are likely to know that metals are good conductors, but they may be unaware that things with a lot of liquid in them also conduct well. Some things to have on hand include lemons, pickles, and potatoes. When testing these, make sure students stick wires into the wet part of the item.

Answers
#4: Students' answers will vary.

#5: If students choose an insulator that is porous enough to absorb water, such as a wooden stick, it will conduct electricity after being soaked overnight. However, an insulator that is not porous, such as a piece of plastic, will not absorb enough water to conduct electricity.

Questions for Discussion
Why is it important to know the difference between conductors and insulators? *(If you know about some common objects that are conductors, you might be more likely to keep these objects out of electricity's path, i.e., you would know not to stick a metal fork into an outlet or toaster or touch a power line with a metal ladder.)* Do you ever use ladders or long tools when working outside around your home? What precautions should you take to stay safe? *(Answers may include: use nonconductive fiberglass ladders and tools; keep all tools and equipment at least*

10 feet away from any power line.) What precautions do you think utility line workers take to avoid electric shock? *(They use nonconductive gloves, tools, and equipment, and are specially trained.)* What should you do if your family plans to dig or move earth around your home? *(Call 811 several days beforehand. They can come mark underground power lines and natural gas pipelines so you can dig a safe distance away.)*

Pages 10 & 11: It's a Gas
Objective: To explain the origins of natural gas, where geologists find it, how it behaves underground, and how it travels through underground pipes to homes and businesses. To teach students what to do if they smell a natural gas leak, and how to be safe around gas appliances and pipelines.

"Do the Reservoir Rock" Experiment
Setup: When students pour the water in, remind them to do it very slowly.
#1: After students fill the jar to the top with sand, it will appear full. Some students will know that the jar is actually full of both sand and air. If students maintain the jar is full of sand only, do not correct them. Students will have varying predictions of how much water they will be able to add to the jar without it overflowing.
#2: The amount of water students can fit into the jar without overflowing will vary, depending on the size of the jar and the coarseness of the sand.
#3: The water went in between the grains of sand.
#4: It replaced the air that was there.
#5: The air came bubbling up when the water was poured in.
#6: The sand in the jar is like the reservoir rock in a gas trap. The water in the jar models the water in the trap, and the oil is like the crude oil in the trap, which floats on top of the water. The air is like the natural gas in the trap, which rises above both the water and oil. However, while the air escaped from the jar in this experiment, in a gas trap there is an impermeable rock seal that keeps the gas from escaping.

Questions for Discussion
Have you ever smelled a gas leak in your home? What did you do? What is the right thing to do? *(Tell an adult, or if none is home, get everyone outside quickly, and call 911 and your local natural gas utility from a safe location.)* Why is it important to not light a match or use a light switch, candle, flashlight, TV, radio, garage door opener, or even a phone around a natural gas leak? *(Because the flame of the match or a spark from anything electrical could ignite the gas and cause an explosion.)* How do you recognize an outdoor gas pipeline leak? *(A smell of rotten eggs, a hissing sound, dirt blowing or spraying into the air, continual bubbling in water, or grass or plants that are dead or dying for no apparent reason.)* What should you do if you detect a gas pipeline leak? *(Do not use electricity or fire. Go far away from the area immediately, and don't go back until safety officials say it is safe. From a safe location, call 911 and the local gas utility to report the leak.)* Why is it important to not store flammable liquids or books and papers near gas-burning appliances? *(Because these appliances have a flame, which could ignite the flammable materials or their fumes.)*

Pages 12 & 13: You've Got the Power
Objective: To make students aware of how electricity and natural gas are used in their homes today and how they might be used differently in the future. To explain that people pay for the electricity and natural gas they use. And finally, to encourage students to identify and test the GFCI's in their home, and bring to their parent's attention any that are not functioning properly.

"Does your home have GFCIs?" Activity
Setup: Some new homes may have GFCI-protected circuit breakers, rather than GFCIs in individual outlets. In this case, students should not attempt the activity.

Answers
#2: Students should notice that GFCIs are placed in areas near sinks or outdoors. If their home is older, they may find many outlets that should have GFCIs but don't. Appliances with GFCIs in their cords are typically those appliances used near water, such as hair dryers.

Questions for Discussion
Have you ever done an electric/gas safety inspection of your home? Use the Home Safety Inspection list on page 13 to do this with an adult in your family, and report your findings to the class. *(Answers will vary.)*

Page 14: Fire in the Sky
Objective: To learn how to avoid a lightning strike. This spread also teaches about disaster preparedness.

"Disastrous Definitions" Activity Answers

Hurricane	C
Flood	D
Landslide	B
Blizzard	G
Tsunami	E
Tornado	A
Earthquake	F

Questions for Discussion
Find out about someone who has been struck by lightning. What were the circumstances? How was the person affected? How could the strike have been prevented? What's the best way to stay safe when lightning is approaching? *(Get indoors. Stay away from windows. Because lightning can travel through plumbing pipes and electrical and telephone wiring, stay away from tubs, sinks, anything electrical, and corded phones.)* Discuss the three disaster preparedness steps on page 15. Ask students share this page with family members. If any students live downstream from a hydropower reservoir or near waterway that has the potential to flood, emphasize the need for an escape route and a family meeting place at a higher elevation.

Page 15: Prepare for Disasters
Objective: To help students and their families be prepared in advance should a flood or other natural disaster strike.

Discussion: Ask students if they have ever experienced a serious storm that involved a long-term power outage or an evacuation, or if they know someone who has. Have them share their stories with the class. Explain that being prepared ahead of time can make the stress of enduring such an event a lot easier and safer.

Follow-up: Encourage students to take these lists home and share them with their families. Ask students to report on their progress in assembling their emergency kits, family exit maps, and contact lists.

Back Cover: Trees + Power Lines = Danger
Objective: To inform students of the potential hazards of trees near power lines, and of safe procedures for planting trees with respect to overhead and underground power lines.

Tips for Discussion
Emphasize that students should look around for nearby power lines before climbing any trees. Contacting a power line while up in a tree can be extremely dangerous! Ask students to name other outdoor activities that are unsafe to pursue around power lines. *(Possible answers include: shooting high-power water guns; having metallic balloons outside where they could get tangled in power lines; flying kites or remote-controlled toys.)* Remind students of the need to call 811 to have utility lines located and marked before planting a tree or embarking on any other digging project.