Electrical Safety World
Teacher's Guide

Introduction
Electrical Safety World uses articles, experiments, and activities to explain electricity-related science concepts, and how to use electricity safely in daily life. The content addresses many science and health education standards, both state and national, for grades 4-6.

This presentation guide provides the objective for each page spread, ideas for classroom discussion, activity and puzzle answers, and suggestions for experiment setup and completion.

Pages 2 & 3: Introduction to Energy Use and Vocabulary
Objective: To make students aware of how they use energy (*i.e., for light, heat, etc.)* and the sources of energy they use. To familiarize students with some new concepts and vocabulary.

Energy Use Chart: Help students complete the energy use chart. Ask them to consider whether they did any of the following things today: took a bath or shower, cooked food, watched a TV show or video, listened to music, were driven to school, enjoyed a warm (or cool) home, or played a computer game. Ask students what appliance or equipment they used for each activity, and have them record their answers in the first and second columns. If students are not aware of the energy sources that run the appliances and equipment they used, ask them to check with their families and fill out the third column at home. (*Tips for recognizing energy sources: Electrical appliances plug into a wall outlet and portable electric devices run on batteries. Appliances and equipment that use natural gas or other fuels have a flame inside when they are on.)*

What Do You Think? Students' answers will vary. Depending on your climate and season, keeping warm or cool without using energy may require a lot of ingenuity. Students may find it interesting to speculate about—or do some research on—how people native to your area kept warm or cool before the invention of modern heating and air conditioning systems.

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

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

Discussion: Review the vocabulary words in the word search. Preview the book by asking students to find the first time each of these words is used. *(Atoms – p. 4; Circuit—p. 6; Conductor—p. 8; Current—not used; Electricity—p. 2; Electron—p. 4; Energy—p. 2; Insulator—p. 8; Volts—p. 9; Watts—not used.)*

Pages 4 & 5: How Electricity Happens
Objective: To explain how electricity is generated, as well as to distinguish which generation methods are based on renewable energy and which on non-renewable energy.

Discussion: No matter what fuels produce the electricity you use, do your lights shine, does your radio play, and does your computer run in the same way? (*Yes.*) Which fuels on these two pages are used to generate most of the electricity used in the U.S? (*Fossil fuels including coal, oil and natural gas; followed by nuclear energy and hydropower.*)

Which Are Renewable?
Before doing this activity, discuss the meaning of the word "replenished." (*To make full or complete again by supplying what has been used up.*)

Fossil Fuels: Coal, oil, and natural gas were formed millions of years ago, when plants and tiny sea creatures were buried by sand and rock. Their structure and bodies decomposed, and as a result of the earth's heat and pressure, they turned into fossil fuels. The processes that formed them are no longer occurring, so fossil fuels are NON-RENEWABLE.

Nuclear Power: The uranium that runs nuclear power plants must be mined from the ground. Like fossil fuels, uranium supplies are finite and NON-RENEWABLE.

Hydropower: The most common form of hydropower uses dams on rivers to create large reservoirs. Water in rivers is continually replenished, so hydropower is RENEWABLE. In fact, hydropower is currently one of the largest sources of renewable power.

Biomass: Wood is the largest source of biomass energy, followed by corn, sugarcane wastes, straw, and other farming by-products. Because plants and trees need sunlight to grow, biomass is a form of stored solar energy. Although it is possible to use biomass faster than we produce it, more can be grown, so biomass is RENEWABLE.

Geothermal Energy: The term "geothermal" comes from "geo" for Earth, and "thermal" for heat. The hot molten rock inside the Earth isn't going away anytime soon, making geothermal energy RENEWABLE. Although it is renewable, geothermal energy has some limitations: people must be careful not to draw steam or hot water out of the Earth faster than it can be replenished.

Solar Energy: The sun's energy will never run out, so solar energy is RENEWABLE. It's true that sometimes the sun isn't shining, so photovoltaic cells cannot always make electricity. However, some solar power systems can store electricity in batteries for non-sunny days.

Wind Power: The wind will be around for as long as the Earth is, so wind power is RENEWABLE.

Fuel Cells: Fuel cells run on hydrogen. If the hydrogen comes from a renewable resource like landfill gas, fuel cells are RENEWABLE. However, if it comes from a nonrenewable resource like fossil fuels, fuel cells are considered NON-RENEWABLE.

Page 6: Go with the Flow
Objective: To explain how electricity flows in a home electrical system.

Discussion: Find out how much your students know about electrical safety. Ask students to select three of the numbered locations on the drawing. Have them describe behavior that could put someone in contact with electricity at each location, and a safety tip or safe practice to prevent this. For example, for #10, the electrical outlet, a dangerous behavior would be to poke a sharp object into the outlet. A safety tip to prevent this would be "Put only plugs into outlets."

Page 7: Which Bulbs Will Light?
Objective: To teach the characteristics of an electrical circuit.

Discussion: Before doing the activity, introduce the concept of a closed path. Explain that a closed path is like a continuous loop with no breaks or obstacles in it. Ask students to name some shapes that are closed paths and some that are open. Some examples of closed paths are a circle, square, rectangle, and triangle. Examples of open paths are a spiral, a line and a U-shape. For electricity to flow, it needs to travel on wires that are a closed path with no breaks or obstacles.

Answer Key:
Top Left: OPEN. The bottom wire touches the base of the light bulb, but the top wire does not. The top wire is touching the top of the light bulb, but because the glass of the light bulb does not conduct electricity, it is an obstacle that prevents electricity from flowing along the wires.
Top Right: CLOSED. Bending the wire does not affect whether the circuit is open or closed.
Middle Left: OPEN. Electricity cannot flow because the wire only goes from the battery to the bulb (or vice versa). There is no return path.
Middle Right: BOTH ANSWERS CAN BE CORRECT. This picture can be read in two ways. If students think it is showing the metal base of the bulb directly touching the bump on the battery, then the circuit is CLOSED. If they think the metal base of the bulb is not directly touching the bump on the battery, then the circuit is OPEN.
Bottom Left: OPEN. Although the loop is closed, electricity cannot travel through the glass top of the light bulb, so in truth there is not a continuous path for electricity to travel.
Bottom Right: CLOSED. There are actually two closed loops in this example.

Did You Guess Right? Setup: If you are doing this in class with batteries and bulbs, strip the wires ahead of time and make sure the batteries are fresh. Although the illustrations do not show it, it's helpful to twist the wire around the base of the bulb and tape the wires to the battery.

Going Further: Ask students to create an alternate way to set up a closed circuit that is not pictured on this page. After completion of this activity, have them explain the alternate circuits they created and why they did or did not light the bulb.

Page 8: Conductors & Insulators
Objective: To teach students to recognize materials that conduct electricity. To explain that water, metal, and the human body can conduct electricity, making people vulnerable to electrical shock.

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 non-conductive 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 electrical shock? (*They use specially tested insulating gloves, tools, and equipment, and are specially trained.*)

Activity: Ladders: People who work around power lines would be more likely to use the fiberglass ladder, the work gloves and the safety goggles. Why? The metal ladder is a conductor, while fiberglass is an insulator. Gloves: The work gloves are specially tested rubber, while the kitchen gloves are very thin rubber and not designed to insulate from electricity. Goggles: The goggles do not have any metal on them, while the glasses do, and metal conducts electricity.

A Safety Note: If insulators are wet, damaged or dirty, or if the voltage is high enough, materials that are insulators can conduct electricity. Teach students never to assume that an insulator will block electricity.

Experiment: If you have a battery/wire/bulb circuit setup, use it to test a variety of materials to see how these allow or block the flow of electricity (e.g. conductors: penny, metal paper clip, metal barrette; insulators: eraser, rubber band, glass button). Have students predict which objects will conduct and which will insulate against electricity. Attach one of the wires from the battery to one end of the material being tested, and one of the wires from the light bulb to the other end of the material being tested. Have students observe whether the bulb lights up to see if their predictions were correct.

What Do You Think? *The characteristic properties of a substance are independent of the amount of the substance, so metal scissors will conduct electricity just as easily as a metal ladder.*

Page 9: Struck by Lightning
Objective: For students to understand that high-voltage shock can come from lightning as well as wires, and to learn how to avoid a lightning strike.

Discussion: About 100 people are killed and more than 1,000 are injured by lightning strikes in the U.S. each year. Carissa was quite lucky. Most people who survive lightning strikes have much worse and longer-lasting injuries than Carissa's.

Ask students: Have you ever been on a golf course, sports field, or near water when a storm was approaching? What did you do? If you stayed outdoors, did you realize that you risked being struck by lightning?

Emphasize to students that if a storm is approaching or under way, they must immediately follow these precautions: Get indoors. Stay away from windows. Lightning can travel through plumbing pipes and electrical and telephone wiring, so stay away from tubs, sinks, or anything electrical such as corded phones.

What Do You Think? *The electricity from one lightning bolt could light up 250,000 homes. (30,000,000 volts/120 volts = 250,000.)*

Page 10: Shocking Scene
Objective: To counteract a misleading movie scene, and to teach students to never contact or throw anything at power lines.

Discussion: Electricity always takes the easiest path to the ground. It will stay in a circuit unless it can find a path to the ground. If you touch a circuit and the ground at the same time, you can become electricity's easiest path to the ground. Electricity can flow through water, and because your body is 60-70% water, electricity can flow through you!

Emphasize to students that if they touch a power line while standing on a ladder or a roof, electricity would travel through them. And if their kite or balloon got tangled in a power line and they touched the string, electricity could travel down the string and into them on its way to the ground. Both situations would mean a serious (and possibly fatal) electric shock!

Now that students know a little about electrical safety, they can notice electrical safety errors in movies, books, TV shows, etc. Ask students if they have seen examples of people doing unsafe things around electricity in movies or TV programs. Did the person get a shock? Encourage students to write up their examples and/or do an oral presentation.

What Do You Think? *Electricity doesn't travel down metal utility poles because specially designed insulators hold the electrical wires away from the poles. That's why it's so important to never shoot at or throw things at insulators. If they break, wires can touch the utility pole, and electricity can travel down it to the ground.*

Page 11: Outdoor Safety Tips
Objective: To teach students how to be safe around overhead lines and underground utilities.

Discussion: Why is it so dangerous to fly kites near power lines? *(Kites in power lines can cause outages or fires. If you touch the string of a kite that's caught in a power line, you could be shocked.)* 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 never take metallic balloons outside? *(Metallic balloons conduct electricity. If they get tangled in a power line or substation, they could cause an outage or a fire. If this happens, it's important to stay away and have an adult report it to the local electric utility.)* What can happen if someone uses digging equipment without knowing the location of underground utilities? (*They could damage underground gas pipelines and cause a fire or an explosion, or they could contact underground electric power lines and get a serious shock. Even if the person digging does not get hurt, the damage to the utilities could interrupt electric or gas service to lots of people. Before beginning a digging project call the underground utility locator service at 811 several days in advance.*) Why are fallen power lines so dangerous? (*They could be carrying electricity, and if you contact them or something they are touching, you could be shocked*.)

Get Creative: Make sure students' creations include both a safety tip about electricity, and what could happen if people don't follow it.

Activity: Have students practice how they would get out of a car with a power line on it. Emphasize that they must shuffle away from the car, keeping their feet close together and on the ground at all times. If they lift their feet off the ground and take steps instead of shuffling, their feet could make a circuit for electricity to travel. Ask them what would be the hardest part of doing this in a real accident situation, and have them practice it so it becomes second nature.

Page 12: Indoor Electrical Safety
Objective: To help students apply what they have learned about conductors and insulators to some indoor electrical safety situations.
Answers:
1.First unplug the toaster; Don't use a frayed cord; Use a battery-powered radio near water.
2.Toaster: fork; Cord: wire; Radio: water
3.GIRL: The girl could contact a live electrical part of the toaster. Electricity would travel through the fork into her and she would be shocked. CORD: The frayed cord is dangerous. Anyone who touches the exposed wires will be shocked. BOY: If the boy gets the radio wet or it falls into the sink, water could conduct electricity to him and he would be shocked. The same thing could happen if the insulation on the radio cord is worn or damaged.

Safety Tips: Students' answers will vary. Some possibilities include: "Don't put power cords under rugs or furniture legs. The cords could get damaged without anyone knowing." "Keep electrical heaters away from anything that can burn. Heaters get hot and can set flammable objects on fire." "Don't stick anything in an outlet but a plug, or you could get shocked." "Don't touch anything electrical with wet hands or when standing in water. Water conducts electricity and you could be shocked."

Page 13: Everyone Wants to Know
Objective: To address some of students' frequently asked questions about how electricity behaves.

Discussion: Assign each question to a small group of students and ask them to 1) cover the answers with a sheet of paper, 2) use what they know about electricity to brainstorm some possible answers to their assigned question. Students can then try to figure out the answers using the internet and the library before checking the answer key.

Page 14: Olympic Kayaker's Shocking Tale
Objective: To make students aware of the dangers of contacting underground power lines and the need to call the underground utility locator service at 811 several days before digging to locate buried utilities.

Discussion: Ask students whether they do odd jobs around the house that could involve overhead or underground power line contact. Ask them how they can take personal responsibility for avoiding power lines and other electrical equipment. Students' answers may vary, but should include the following:

- Call the underground utility locator service at 811 so they can mark lines before you start a digging project.
- Keep ladders, paint rollers, and other tall equipment away from power lines.
- Keep power tools away from water.
- Plug power tools, lawn mowers, etc. into GFCI outlets.

Page 15: In Case of Emergency!
Objective: To teach students critical skills for responding to electrical emergencies.

Discussion: Ask students if they have ever witnessed an electrical fire or someone being shocked by electricity. What did they do? Would they do anything differently if the same situation happened today, based on what they now know about electricity and the proper way to respond to electrical emergencies? A fun way to reinforce the safety tips on this page is to ask students to develop a skit to demonstrate how to respond to electrical fire or shock. The skit should have two scenes: one showing an unsafe response and the consequences, and the other showing the safe response described on this page.

Back Cover
Objective: To encourage students to share important hazard prevention tips with their families.

Discussion: Explain each of the hazards on this list. Ask students if they can explain why it is a hazard. (*1. Overloaded outlets can overheat and cause a fire. 2. Worn or frayed cords mean insulation can't do its job, so anyone who touches the cord could be shocked. 3. Cords under rugs or furniture can become worn or frayed without anyone's knowledge and can overheat or become a shock hazard. 4. Heaters close to anything that can burn can cause a fire. 5. People who dig without calling the underground utility locator service at 811 could hit a buried gas or electric line and damage the line or be hurt. 6. Water conducts electricity, so electrical devices used near water can be a shock hazard.)*

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