It's a Wired World

Experiments in Electrical Safety

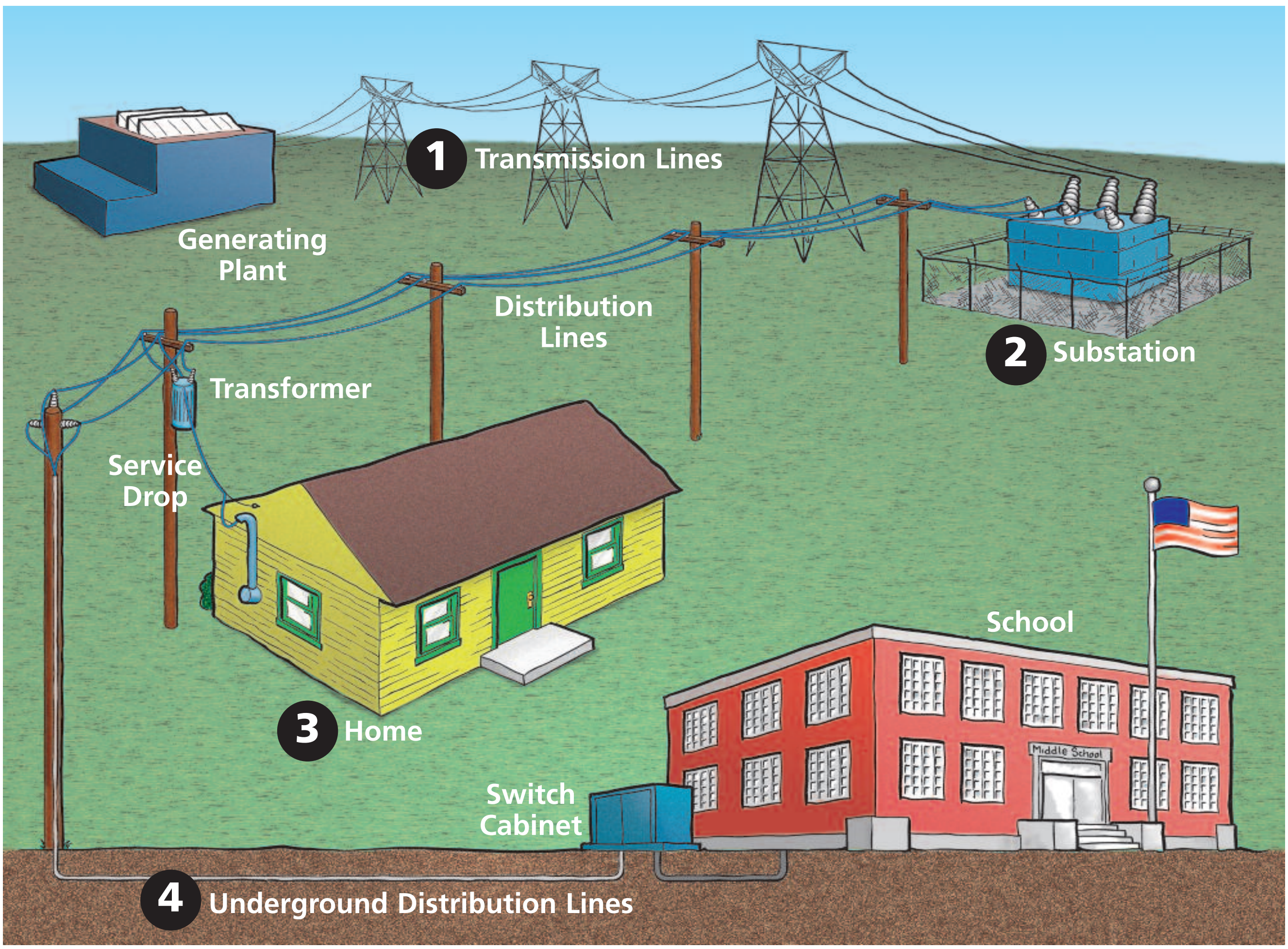
santee cooper

It's a Wired World

Electricity is everywhere. This book is about how electric circuits work. Once you know about circuits, you'll know how to stay safe around electricity. When you reach the end of this book, you'll be ready to teach other kids about electrical safety.

TEAMWORK

In this picture, electricity travels from a **generating plant** over **transmission lines** to a **substation** where the voltage is decreased. Then overhead and underground **distribution lines** carry it to homes and schools where we use it for lights, appliances, motors, and equipment. Work with a team or a partner to find out what you already know about electrical safety. For each of the numbered locations, describe a dangerous behavior and at least one way to stay safe. Write your ideas below.



1 ______________________________

2 ______________________________

3 ______________________________

4 ______________________________

Let It Shine

When you flip a light switch on the classroom wall, you're drawing electricity all the way from a power plant to your light bulb.

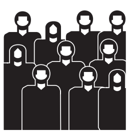
With just a battery, wire, and a bulb, you too can bring light to the classroom. The battery is like a power plant, and the wire carries electricity. Add the flashlight bulb, and you've got an electric circuit that is similar to the one that runs from the power plant to electricity customers and back.

SAFETY BASICS

The circuit you build is like the one from the power plant to your home or school. But the electric current in your home is much STRONGER than the current in your team's circuit.

NEVER EXPERIMENT WITH HOUSEHOLD ELECTRICITY. YOU COULD BE SERIOUSLY HURT OR KILLED.

Circuit: a closed path along which electricity can travel.



TEAMWORK

You've got a D battery, a flashlight bulb, and some copper wire stripped at the ends. Using these materials, see how many ways you can get the bulb to light. You may want to use tape to hold your circuit together.

Draw a diagram showing one of your successful circuits.

Draw a diagram showing an unsuccessful circuit.

What requirements must be met in order for the bulb to light?

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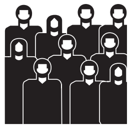
Go with the Flow

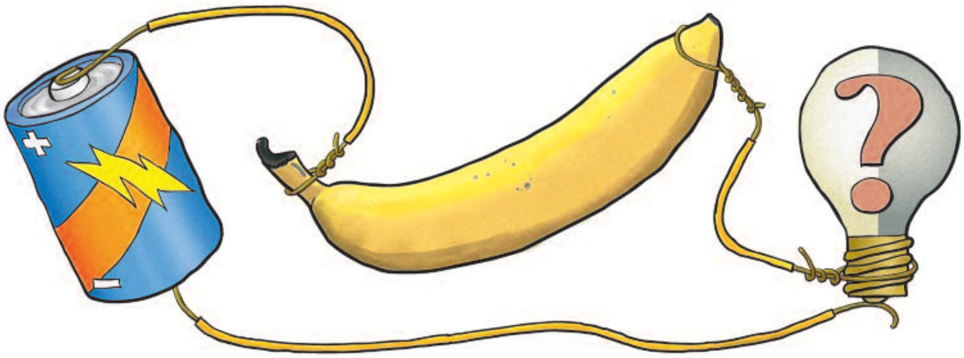
All the things in the world can be divided into conductors and insulators. Conductors are materials that allow electricity to flow easily through them. Insulators are materials through which electricity does not flow easily.



TEAMWORK

Collect these six objects, plus three others of your choosing. List your items below. Circle the ones you think will be the best conductors.

banana	**metal fork**	________________
metal paper clip	**wood pencil**	________________
rubber band	**penny**	________________



Now, set up the circuit shown above. Substitute your objects, one at a time, for the banana. Were any of the results different from your predictions? Do you know why they were different?

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SAFETY BASICS

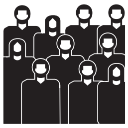
Some materials, such as water and metal, are really good conductors. That's why you should NEVER stick a fork into a toaster while it's plugged in. The fork could conduct electricity from the wires (that toast the bread) to you.

YOU COULD BE SERIOUSLY HURT OR KILLED.

GOING FURTHER

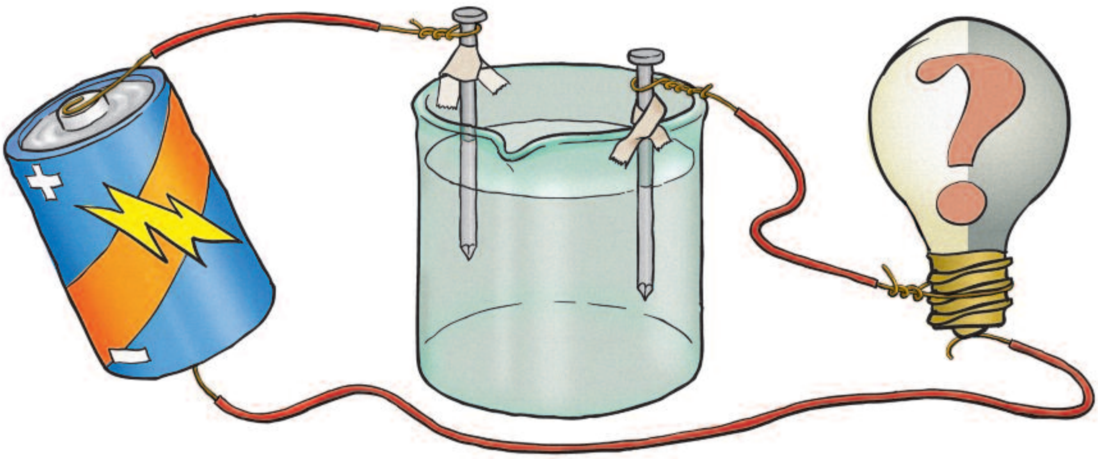
With an adult, check the appliance cords and plugs in your house. (First turn them off and unplug them.) If the insulation is cracked or frayed, you are in danger of touching electricity by mistake and getting hurt. Decide with your family if you should replace the cord or throw the item away. LEAVE ANY UNSAFE ITEM UNPLUGGED until repaired.

Electricity and Water



TEAMWORK

Do you think the bulb in this circuit will light? Discuss it first, then set up the circuit. Put plenty of salt in the water.



Write your observations here.

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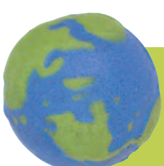
In this experiment, adding salt makes the water more conductive and allows the bulb to light. When a source of electricity has higher voltage than your D batteries, the electricity will travel through water with or without salt in it. So, if lightning struck a lake, or a blow-dryer fell in the sink, electricity would travel through the water. Anyone touching that water could be electrocuted. (Electrocution means fatal contact with electricity.)



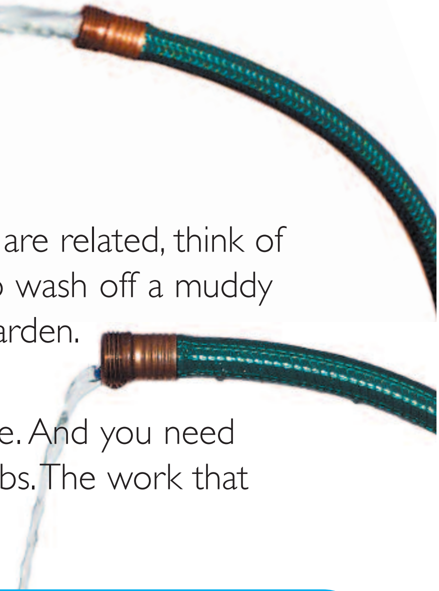
GOING FURTHER

Create a television spot or radio announcement that warns people about electrical hazards during storms and floods. You may target your announcement at children or adults. If it goes on the air, contact your local utility first to be sure it is accurate.

SAFETY BASICS

Your body is 60-70% water, so you are an excellent conductor of electricity. In fact, just about everything can become a conductor, if it is wet.

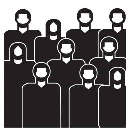
Current Affairs



Watts, volts, and amps measure electricity. To understand how they are related, think of water in a hose. You would use water that comes out really hard to wash off a muddy car. You would use water that comes out more slowly to water a garden.

Turning on the faucet supplies the force, which is like the voltage. The amount of water moving through the hose is like the amperage. And you need different combinations of volts and amps to do different kinds of jobs. The work that electricity does in a job is measured in watts.

1 watt = 1 amp x 1 volt *or* 1 amp = 1 watt ÷ 1 volt



TEAMWORK

Here's how watts, volts, and amps make a difference in a circuit. Let's say the circuit breaker for the living room has tripped, cutting off the electricity. The living room circuit can carry 15 amps. The living room is served by 120-volt household electricity. Use the wattage and voltage for the following appliances to find out why the living room circuit is overloaded.

(Amps = watts ÷ volts)

Device	Watts	Watts ÷ Volts	Amps
ceiling lamp	150	150 ÷ 120	1.25
table lamp	100	________	________
vacuum cleaner	900	________	________
color television	170	________	________
answering machine	6	________	________
space heater	1200	________	________
ceiling fan	20	________	________
computer	7	________	________

SAFETY BASICS

Touching as little as 60 milliamps (.06 amp) of electricity is probably fatal, and even 10 milliamps (.01 amp) could be fatal. That's why you should never play with a wall socket or hit the electric lines that feed your house.

If everything were on at once, how many amps would you need?

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If you turn on the portable space heater, can you leave on all the lights?

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What can't you use in the room when you're vacuuming?

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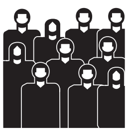
Ben Franklin Was Lucky!

Benjamin Franklin could have died from many of his electricity experiments. One year he wanted to use electricity to kill a turkey for Christmas dinner. While checking his equipment, he touched two parts at the same time and got a big shock. His whole body vibrated, and his arms were numb until the next morning. He was lucky he wasn't burned or electrocuted!

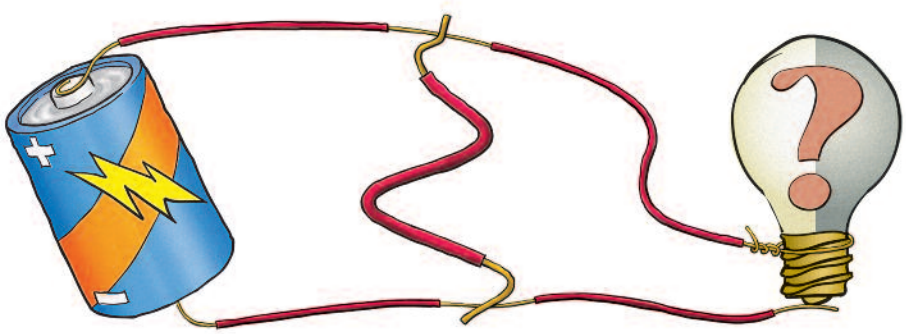


TEAMWORK

Can you figure out why Ben Franklin got shocked? Discuss what will happen to the light when you set up the circuit below. Record your prediction. Set up the circuit and then lay the thick wire between the two exposed wires. Observe what happens. Then IMMEDIATELY remove the thick wire and disconnect the battery.

SAFETY BASICS

An electric circuit is designed to be safe. A short circuit takes electricity outside the safe path and can shock or kill people or start fires.



1. Your prediction: ______________________________

2. What happened? ______________________________

3. You built a short circuit. Explain why it's called a short circuit.

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4. Based on your experiment, can you tell why Benjamin Franklin got shocked?

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Don't Get Grounded

Electricity is grounded when a conductor carries the electric current from its circuit to the ground. On its way to the ground, electricity will travel through any conductor in its path—including your body.

A ground fault circuit interrupter (GFCI) actually detects leaks in circuits. If it senses a leak, the GFCI is designed to cut off the circuit automatically

SAFETY BASICS

Electricity always takes the easiest path to the ground. Whenever you are touching the earth or something that contacts the earth (like a ladder), then you are grounded.

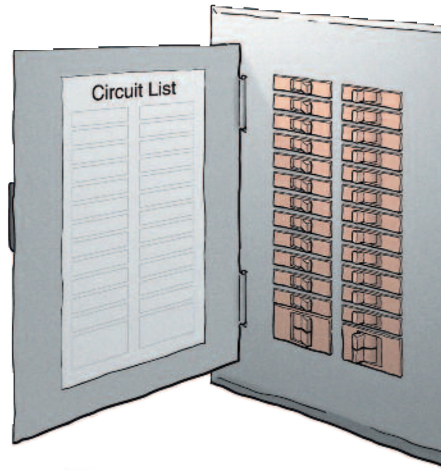
TEAMWORK

Discuss why there is danger from electric shock in each of these pictures.

GOING FURTHER

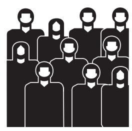
Figure out why a bird sitting on a wire does not get hurt. Compare your answer with other teams. Ask your teacher to help you understand which answers are right.

Switch Play



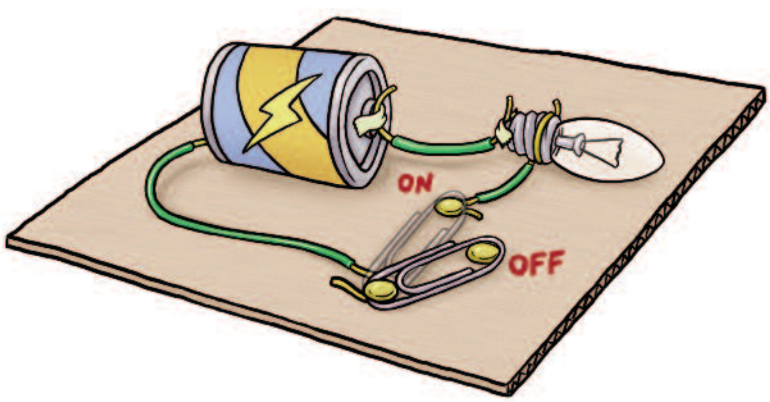
In your home or school, electric circuits run from the main circuit box to outlets or appliances and back. A circuit stays on if electricity can flow in a continuous circle.

If a circuit draws more electricity than is safe, circuit breakers flip to the off position and "break" the circuit so electricity stops flowing before insulation can overheat and cause a fire. Fuses do the same job as circuit breakers.



TEAMWORK

Circuit breakers are switches. Using classroom materials (cardboard, brass fasteners, paper clips), make a switch for your circuit so that it can be easily turned off and on. It goes off if the circle is broken or opened. Explain how it works below.



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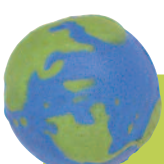
SAFETY BASICS

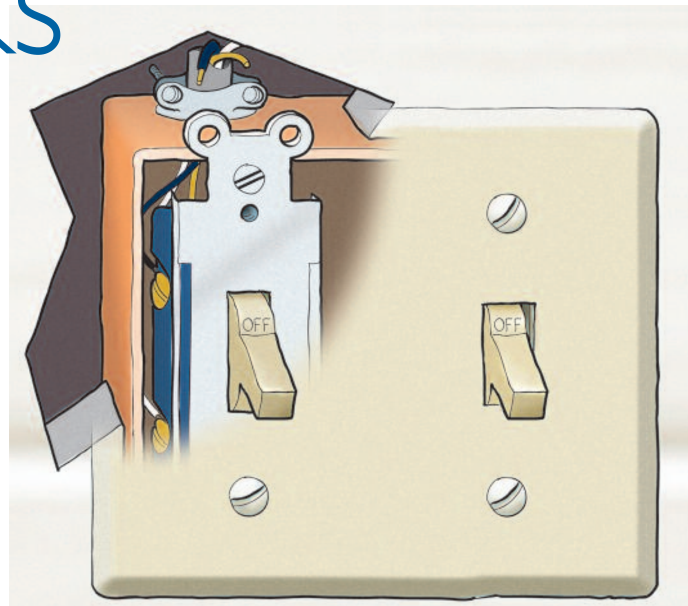
Circuits are limited. If fuses blow or circuit breakers trip often at your home, you might have an overloaded circuit. Ask an adult to investigate.



GOING FURTHER

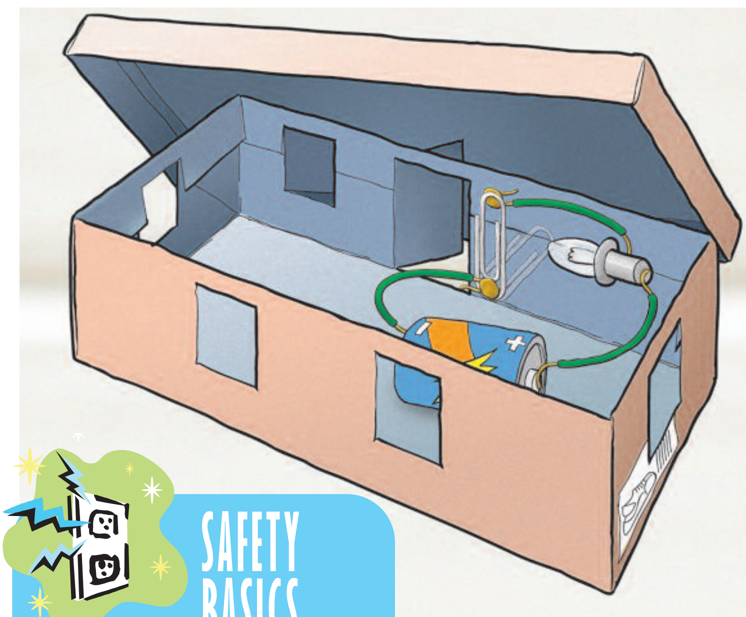
With an adult, go to your home circuit breaker or fuse box and find out which outlets and appliances are connected to which breakers or fuses. Note these connections in a chart mounted near the circuit box.

What Lurks Behind the Walls?



Someone designed the electric circuits in your home so that your family could put lights and appliances where you want them without overloading the circuit.

Now it's your turn to design an electric circuit for a house.



SAFETY BASICS

Never overload an outlet. The wires could overheat or be damaged and cause a fire. More people die as a result of fires that start with an electrical problem than from electric shock in the home.

TEAMWORK

Make a shoe box cabin, complete with windows and doors. There should be one working circuit with a light and switch.

1. Draw your idea on paper first. Show where doors, windows, a light, and a switch will be placed. Then draw your plan on the shoe box cabin walls.

2. Cut your wire, leaving extra wire at the ends for the connections with bulbs and switches.

3. Construct a working electrical system for the cabin.

GOING FURTHER

Add more lights to the circuit in your shoe box cabin. Or add another switch so the light can be controlled from two places. What could you add to your cabin to make it safer?

Back to the Source

Electricity travels through wire—lots of it. Every time you turn on a light or appliance, you make a request for electricity from a power plant. Thousands of miles of transmission lines carry the electricity instantaneously from the power plant to the local substation. Then, overhead and underground distribution lines bring it to neighborhood transformers and to homes, schools, and businesses.

SAFETY BASICS

Never try to enter a substation. The voltage is so high that you might get shocked or hurt without actually touching anything. If something of yours gets into a substation, call your electric utility.

TEAMWORK

1. Work together to make a transmission and distribution network for your shoe box cabins. Disconnect your shoe box cabin from its battery. Collect four of the batteries and connect them in a row (like in a flashlight). Put them in a box to represent the power plant. Mark the power plant with the name of an energy source that is used to make electricity.

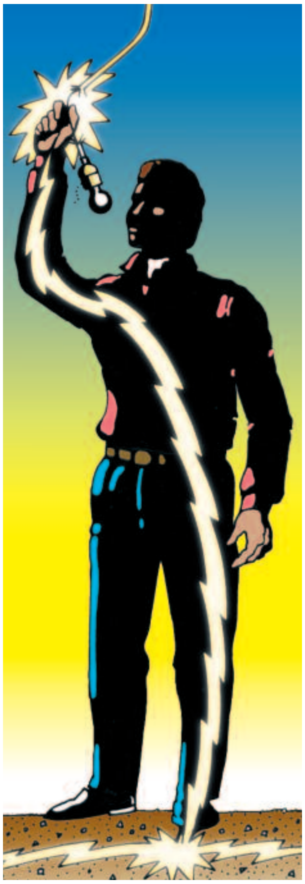
2. Run a wire from each end of the row of batteries to a spot that is central to all the shoe box cabins. Create another box to represent a substation.

3. Run a wire from each end of each cabin to the substation. Connect the cabin wires to the wires from the power plant so that you have an individual circuit from each cabin's circuit to the substation.

4. Be sure the bulbs are plugged in before the circuits are connected.

GOING FURTHER

What would you do to keep people from going into a substation in your neighborhood? Put those protective measures on the substation in your shoe box cabin network.



Shocks Happen

You're an electrical conductor. If you weren't, your heart wouldn't beat.

Tiny electrochemical nerve pulses with a current of .001 amp cause your heart to beat rhythmically. If an outside electrical current—as small as .01 amp—runs through your body, it can interrupt your heart, cause muscle spasms, and put your life at risk.

The effect of electric shock depends on

1. The amperage of the current
2. The duration of contact with the current
3. The path that the current takes through the body

SAFETY BASICS

You can never tell when contact with electricity will be fatal, but you can be sure it will always hurt. Electric shock can cause muscle spasms, weakness, shallow breathing, rapid pulse, severe burns, unconsciousness, or death.

Burns Happen, Too

In a shock incident, the path that electric current takes through the body gets very hot. Burns occur all along that path, including the places on the skin where the current enters and leaves the body.

TEAMWORK

Research electrical accidents.

- You may do your research through the Internet, through oral research (interview an EMT or emergency room doctor or nurse), or at your public library or newspaper office.
- As you read about or hear the stories, try to find out how the accidents happened and how the electricity affected the body.
- Select one story to present to the class through a written or an oral report. Include how the accident could have been prevented.

GOING FURTHER

Summarize as a class how each accident victim was changed by his or her accident.

What Would You Do?

If Someone Has Been Shocked or Burned by Electricity

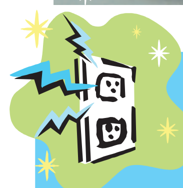
- Do not touch the person or anything they are touching. You could be shocked or even killed.
- Call 911 and tell them it is an electrical accident.
- When the victim is not in contact with electricity and you're sure there is no danger, tell an adult to give first aid and CPR if needed.
- Make sure the person is taken to a doctor.

If There Is an Electrical Fire

- Do not use water.
- Tell an adult right away. If the fire can be put out safely, the adult should use a proper chemical fire extinguisher. If the fire cannot be put out safely, LEAVE THE HOUSE.
- Call 911 to get help.

If a Power Line Is Down

- Avoid it. Always assume that it is carrying electricity, even if there are no sparks. Do not even get close to anything that is touching the line.
- If you are in a car when a power line falls on it, STAY IN THE CAR and wait for rescue and utility workers. If people come near the car to help you, warn them to stay way. Then ask them to phone for help.
- If you MUST leave the car because of fire or other danger, JUMP as far as you can with both feet together. If you step out while touching any part of the car, you will become a path for electricity. After you jump, shuffle away. Be sure that you NEVER touch the car and the ground at the same time.



SAFETY BASICS

Once you jump from a car with an electric wire on it, the danger may not be over. Electricity can spread out through the ground in a circle from the downed line. The voltage drops as you move away. If one part of your body touches a high-voltage zone while another part of your body touches a low-voltage one, you will become a conductor for electricity. This is why you should shuffle away from the car.

GOING FURTHER

Practice the car jump. Can you do it perfectly ten times in a row? Now try shuffling when you're scared and in a hurry.

Keep Your Family Safe

Before someone begins selling a new product, they usually try to learn about the people who might buy it. If you want to sell your family on the idea of electrical safety, first you need to find out what they know.

SAFETY BASICS

Flying kites or model airplanes can be dangerous. Be sure to fly them in open fields, away from power lines. And NEVER fly kites or model airplanes in thunderstorms.

- Think of three questions to ask family members about electrical safety. Don't try to stump them. The idea is to see whether they know 1) what happens if they contact electricity; 2) what they can do to avoid electrical accidents; and 3) what to do if they see an accident. Each person on the team should interview at least one person in their family.
- After people have given their responses, give them the right answers.
- Discuss the results of your survey as a team and as a class. How could people's lack of knowledge or confusion about electricity cause them trouble? What do you think are the most important things to teach them?

Question: ______________________________

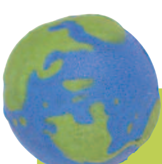
Response: ______________________________

Question: ______________________________

Response: ______________________________

Question: ______________________________

Response: ______________________________



GOING FURTHER

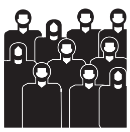
Make a note of the number of correct answers compared to the age of each person responding to your questions. As a class, make a graph to show this data.

Act It Out

Here's your chance to teach some younger kids about electrical safety. Have fun and remember that what you do may save someone's life.

SAFETY BASICS When people dig they must be careful not to damage underground electrical lines. Digging into these lines can be dangerous! Several days before digging, adults should call 811 to have underground utility lines located and marked.

811 Know what's below. Call before you dig.



TEAMWORK

1. Put on a skit to teach younger kids at your school about electrical safety. Choose from one of the scenes below or write one of your own.
2. Get or make any props, signs, or sound effects you will need for the scene.
3. Practice the scene. Not everyone has to act, but everyone should participate in some way.
4. Write down a script, so that everyone remembers how the scene goes.
5. Present the scene to an adult to make sure the safety message is correct.
6. Perform your scene for a younger class.
7. Answer any questions that students or their teacher may have about your safety message.

Scenes

1. Act out the scene from Winnie the Pooh where Pooh floats up to the honeybee tree to get honey, but in this version Tigger jumps and catches Pooh before he gets too close to a power line. Tigger explains to Pooh about the dangers of power lines and trees, balloons, and kites.
2. Relatives are visiting. They have a very curious toddler who goes from one dangerous situation to another (for example, tries to put an extension cord in his mouth, tries to put a fork in an outlet, almost knocks a plugged-in blow-dryer into the sink, and so on). Older kids stop him just in time, unplugging appliances, putting socket covers in outlets, and so forth.
3. Spiderman (or some other superhero) touches a damaged wire and gets shocked by electricity. A kid sees the accident and yells to an adult to turn off the main circuit breaker. Someone calls 911 and gives information to the emergency operator, while the adult gives first aid to the electric shock victim.

GOING FURTHER

Talk with the younger kids after the performance and find out what they learned from the scenes you acted out.

Electrical Safety at Home

See how many of these electrical safety actions you and your family can do this month. With an adult, fill in the checklist below.

	OK	Needs Work	Completed
Check for damaged appliance cords and plugs. Make sure outlets are not overloaded. (p. 4, 10)			
Make sure extension cords are rated to carry the current needed for appliances they serve. (p. 6, 9)			
Discuss safety rules about appliance use. (p. 4, 5, 8, 9)			
Move electrical appliances away from water sources. (p. 5)			
Put childproof outlet covers on electric outlets if any young children will be in the house. (p. 15)			
With an adult, go to your home circuit breaker or fuse box and find out which outlets and appliances are connected to which breakers and fuses. (p. 9)			
Talk with an adult about the dangers of ladders, TV antennas, tree climbing, and kites around electric lines. (p. 6, 8, 14)			
Practice what to do if someone has an electrical accident. (p. 13)			
Practice what to do if there is an electrical fire. (p. 13)			
Practice what to do if you are in a car with a power line on it. (p. 13)			
Practice how to communicate information to an emergency operator. (p.13)			

811
Know what's below.
Call before you dig.