Experiments to Explore

Electricity

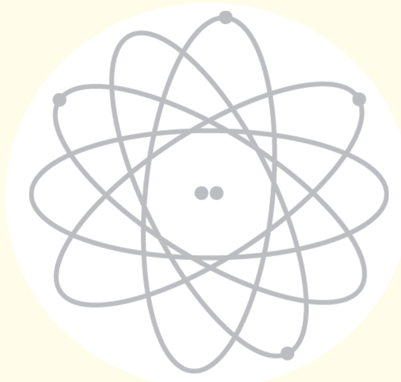
Understanding Electricity and Electrical Safety

santee cooper®

What Is Electricity?

We use electricity every day, but what is electricity? How does it work? Electricity is a form of energy that starts with atoms. Atoms are tiny particles that make up everything around us, but they are too small to see.

If we could see an atom,
it would look something like this:



The center of the atom has at least one proton and one neutron. At least one electron travels around the center of the atom at very great speed. An outside force, called voltage, can push electrons from atom to atom. This movement of electrons produces electricity. We have found a way to harness electricity's power and use it.

Atoms are so small that **12 trillion atoms** fit in a grain of sand.

How much is 12 trillion?

A stack of 12 trillion pennies would stretch back and forth across the United States 400 times!

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How Do We Use Electricity?

We use electricity
to cook our food;
to light our homes,
schools, and work places; to heat water;
and to heat and cool our homes.

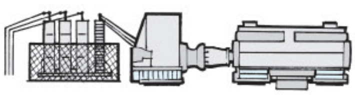
How does electricity help you have fun and get your work done? Brainstorm 25 ways that electricity helps you in your activities.

Going Further

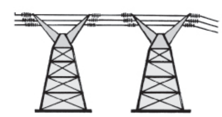
Americans have had electricity for about 100 years. In some parts of the world, people still live without it. What do you think would be the hardest thing about living without electricity?

Where Does Electricity Come From?

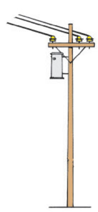
Electricity comes to us through the electrical distribution system. It begins with a generating plant that produces electricity and ends at the outlets in our homes, schools, and businesses. Use the words at the bottom of the page to complete this description of the system. The first letter of each word is provided to help you get started.



Electricity is produced at a g____________ p______________.



T_______________ l______ on tall towers carry very high voltages of electricity over long distances to a s__________ , where transformers reduce the voltage (strength).



Then electricity travels through smaller distribution lines to a t______________ on a power pole or on the ground, where the voltage is reduced again.

Finally, electricity flows through wires to o________ in our h_______ , s_______ , and businesses, where it waits to be used.

substation | generating plant | outlets | schools
transformer | homes | transmission lines

Find the Power Words

Circle the words and phrases related to electrical power and the electrical distribution system hidden in the puzzle below. They may be written horizontally, vertically, or diagonally.

BONUS: Find and circle these words on pages 2, 3, and 4.

Hidden Words

atom, distribution, electricity, electron, energy, generating plant, heat, home, light, neutron, power pole, proton, transformer, transmission, school, substation, voltage

Z	N	L	I	G	H	T	E	O	R	C	S	F	L
V	U	B	A	I	U	R	G	I	M	E	J	T	G
P	S	U	B	S	T	A	T	I	O	N	L	O	E
O	E	D	C	A	Z	N	E	U	T	R	O	N	N
W	R	Q	I	E	M	S	P	R	E	J	P	I	E
E	L	I	N	S	E	F	H	O	M	E	R	X	R
R	H	C	O	A	T	O	M	E	J	E	O	B	A
P	T	E	W	V	I	R	U	N	A	L	T	J	T
O	T	R	A	N	S	M	I	S	S	I	O	N	I
L	C	L	H	T	D	E	R	B	I	C	N	R	N
E	T	E	R	X	W	R	Y	S	U	P	L	S	G
F	I	N	U	O	J	O	E	F	D	T	E	C	P
E	L	E	C	T	R	I	C	I	T	Y	I	H	L
R	A	R	Y	V	O	L	T	A	G	E	M	O	A
V	I	G	H	M	U	E	L	E	C	T	R	O	N
A	J	Y	I	N	B	E	I	Z	R	E	O	L	T

Safety Tip

Remember, the voltage in any power line is strong enough to injure or even kill you. Never play around substations or transformers. Don't touch a power line or anything in contact with a power line.

Complete a Circuit

In order for electricity to travel to where we need it, there must be a complete circuit of electricity. A complete circuit is like a circle.

Electricity starts at a particular place, travels around the circuit, and returns to the same place.

Materials

- 1 D-cell battery
- 1 1.2-volt lightbulb
- 1 E-10 lightbulb base
- 2 12-inch pieces of insulated solid strand copper wire (18-22 gauge), with one inch of insulation removed at each end
- masking tape

Directions:

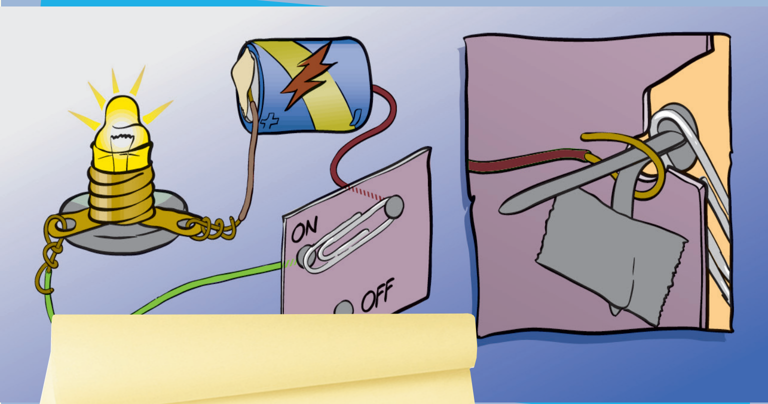
1. Connect one end of each wire to the lightbulb base (see illustration).
2. Tape one free wire end to each end of the battery.

   In this experiment, the complete circuit is something like the electrical distribution system that brings electricity to our homes. The battery produces the electricity like the generating plant does.

   What part of the distribution system is like the wires?

   What happens if you only tape one of the wires to the battery? Why does that happen?

Make a Simple Switch



In the previous experiment, we made a complete circuit and lit the lightbulb. How do we turn the bulb off? A switch creates an opening in the circuit. It stops the flow of electricity, which turns the light off. When the switch is on, it completes the circuit, and the electricity can flow again.

Materials
- circuit from the last experiment
- 3-inch by 3-inch square of cardboard
- large paper clip
- 1 12-inch insulated copper wire with stripped ends
- 3 brass fasteners
- masking tape
- hole punch

Directions:

1. Punch three holes in the cardboard about one inch apart.
2. Put fasteners through the three holes, inserting one through the paper clip also (as shown).
3. Disconnect one of the wires from the battery. Attach the new wire to the fastener with the paper clip (as shown) and then tape the other end to the battery. Attach the free wire end to one of the other fasteners.
4. Tape the ends of all the fasteners down. Be sure they aren't touching.
5. What do you think will happen if you move the paper clip to touch the top fastener? Write your prediction here: ____________________
6. What do you think will happen if you move the paper clip to touch the bottom fastener? Write your prediction here: ____________________
7. Move the paper clip to touch one fastener and then the other. What happened? Were your predictions correct? __________
8. Write "On" and "Off" by the correct fasteners.

(Don't leave the paper clip switch on too long. It may get HOT!)

Safety Tip

Never experiment with the electricity that comes from a wall outlet. It's much more powerful than the electricity made by small batteries and could seriously injure or even kill someone.

Identifying Conductors and Insulators

Electricity can move easily through conductors, like metal and water. It can't move easily through insulators, like special rubber and glass.

Each number below the blank stands for a letter. Complete the sentences by filling in the missing letters. Then use the letters you filled in to decode the Secret Message at the bottom of the page.

1. Electricity can travel easily through some materials, like the copper

w ___ ___ ___ we've been using in these experiments. Materials that let
1 2 3

electricity travel e ___ ___ i ___ ___ are called CONDUCTORS.
4 5 6 7

2. INSULATORS do not allow electricity to pass easily through them.

The plastic coating on the ___ ___ p p ___ ___ wire is an insulator.
8 9 3 2

3. Metal and water are g ___ ___ ___ conductors.
9 9 10

4. Special r ___ ___ ___ ___ r and glass are good i ___ ___ ___ l ___ ___ ___ ___ ___ .
11 12 12 3 13 5 11 4 14 9 2 5

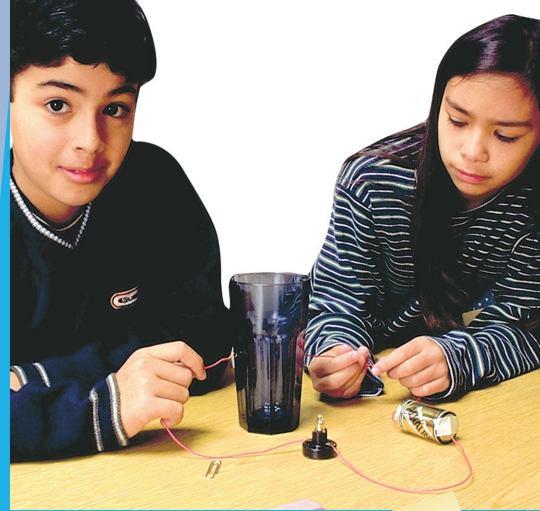
Secret Message

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
9 11 2 12 9 10 1 3 5 8 4 13

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
8 9 13 10 11 8 14 3 6 3 8 14 2 1 8 1 14 7

That's why it's important to be careful around electricity!

Find the Conductors and Insulators



Directions:

1. Disconnect the switch you made in the previous experiment. This leaves two wire ends free.
2. Predict which objects are conductors. List them here:

____

____

3. Predict which objects are insulators. List them here:

____

____

4. Test the objects one at a time by touching the free ends of the wires to the object. If the bulb lights, the object is a conductor. If it doesn't light, the object is an insulator. Show your results by putting a "C" by the conductors and an "I" by the insulators. Were your results different from your predictions?

Materials

- Gather these objects to test: steel wool, plastic, copper penny, rubber eraser, yarn, paper clip, glass

___ steel wool

___ plastic

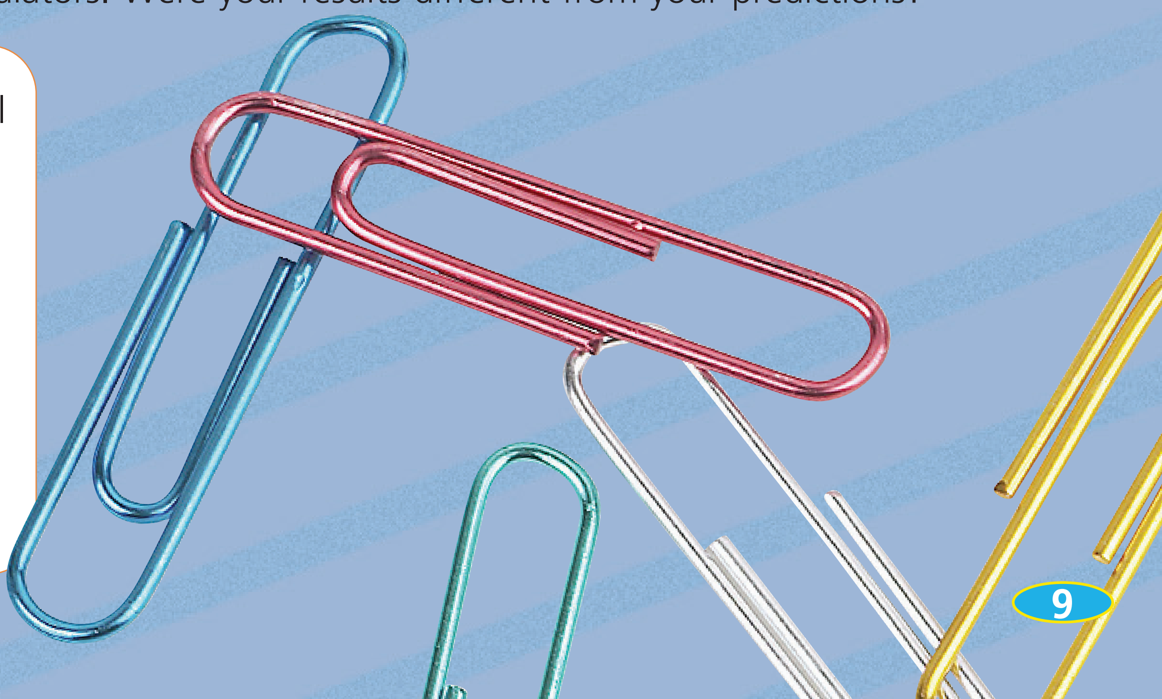
___ penny

___ eraser

___ yarn

___ paper clip

___ glass

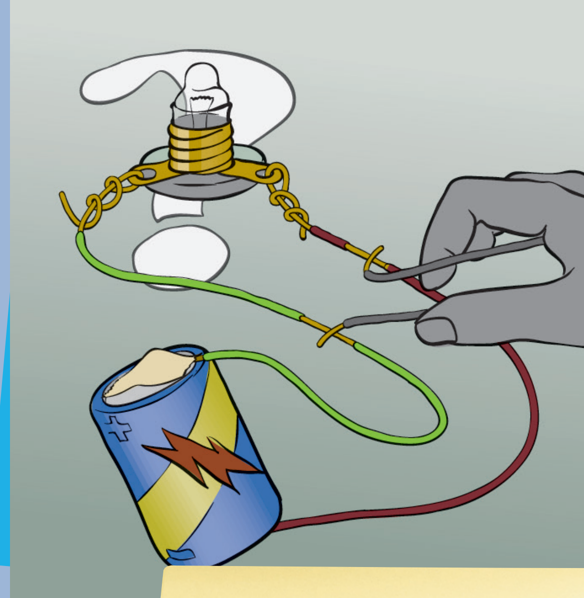


Short Circuits and Fuses

Unscramble the letters in the words below to learn about short circuits and fuses.

1. Electricity _ _ _ _ _ (e i l k s) to take shortcuts. If bare wires in a circuit _ _ _ _ _ (h c t u o) each other, the electricity takes the shortest path back to its starting _ _ _ _ _ (t i o n p).
2. When _ _ _ _ _ _ _ _ _ _ _ (r c i t t e e i y l c) takes a shortcut, called a short circuit, the circuit heats up. This could cause a _ _ _ _ (i r f e).
3. Fuses or circuit breakers are _ _ _ _ _ (t i u b l) into our electrical systems to prevent fires.
4. Inside a fuse is a delicate piece of _ _ _ _ _ (a t e m l) that is part of the circuit.
5. In a _ _ _ _ (s f e u), if a short circuit makes the circuit too _ _ _ (t h o), the tiny strip of metal melts and breaks the circuit.
6. A circuit breaker also makes an opening in the _ _ _ _ _ _ _ (u t c c i i r) when there is a short circuit.
7. When the circuit is broken, the electricity stops _ _ _ _ _ _ (n m g i v o) and the power goes out.

Short Circuits Get Hot!

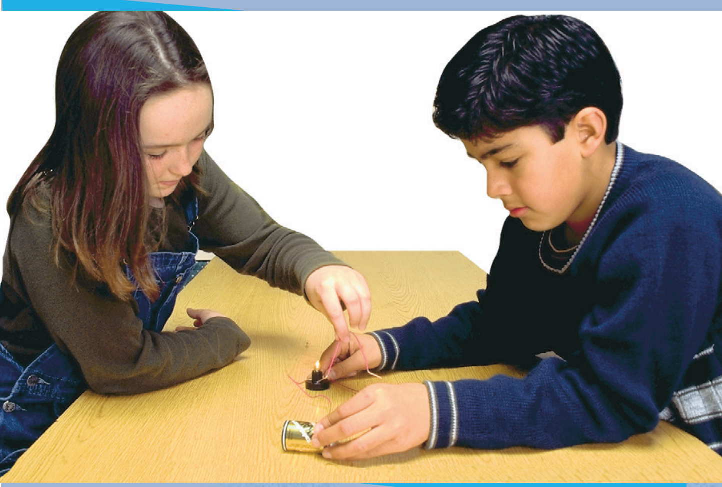


Directions:

1. Attach each of the prepared 12-inch wires to the lightbulb base.
2. Tape the other wire ends to the ends of the battery. The bulb should light.
3. Hold the 6-inch wire by the insulation and lay the bare ends of this wire across the two bare spots in the middle of the 12-inch wires as shown.

Materials

- 1 D-cell battery
- 1 1.2-volt lightbulb
- 1 E-10 type lightbulb base
- 2 12-inch pieces of insulated copper wire, with one inch of insulation removed at each end and an inch of insulation removed near the middle of each piece (as shown).
- 1 6-inch piece of insulated wire with ends stripped



Questions:

What happens to the lightbulb?

____

____

After a minute, lift the short wire off the circuit and carefully feel one of the ends. Is it warm or hot? Why do you think so?

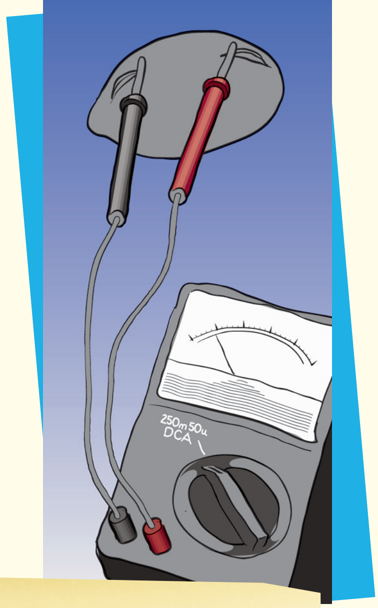
____

____

Safety Tip

Be sure an adult fixes or replaces frayed electrical cords. They can cause a short circuit in your home's electrical system.

Make a Wet-Cell Battery



The battery we have used in these experiments is called a dry-cell battery. Inside the battery, chemicals in paste form react with each other to produce just enough electricity to run small things like toys and flashlights.

Cars and boats use wet-cell batteries. These batteries have liquid chemicals inside, which can generate larger amounts of electricity.

Materials

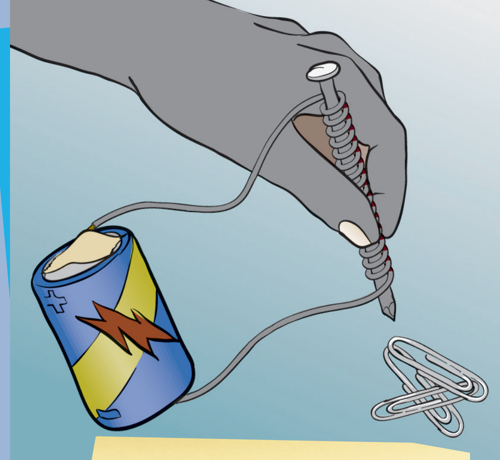
- 1 penny
- 1 nickel
- 1 lemon
- 1 multi-tester to measure the flow of electricity

Directions:

1. Your teacher has prepared a lemon by cutting a deep slit near each end.
2. Insert the penny into one slit and the nickel into the other.
3. Set the dial on the multitester at the lowest direct current voltage setting (DC A).
4. Touch the positive lead (red) from the multitester to the penny and the negative lead (black) to the nickel.
5. What does the multitester show?

The lemon works like a battery to generate enough electricity for the multitester to measure. This isn't enough electricity to light the bulb.

Build an Electromagnet



Electricity can help you make a magnet. When you send electricity through a piece of metal, it becomes magnetized. We call it an electromagnet.

Electromagnets can be very, very strong. They are often used in manufacturing and to help lift heavy loads.

Materials

- 1 D-cell battery
- 1 4-inch iron nail
- 1 24-inch piece of insulated wire with the ends stripped
- paper clips, other small metal objects

Directions:

1. Leaving about six inches of wire at each end, tightly wrap the wire around the nail about twenty times.
2. Tape each wire end to the battery (as shown). Handle it carefully; the wire will get hot!
3. Touch the electromagnet to one of the metal objects. What happens?

   ____

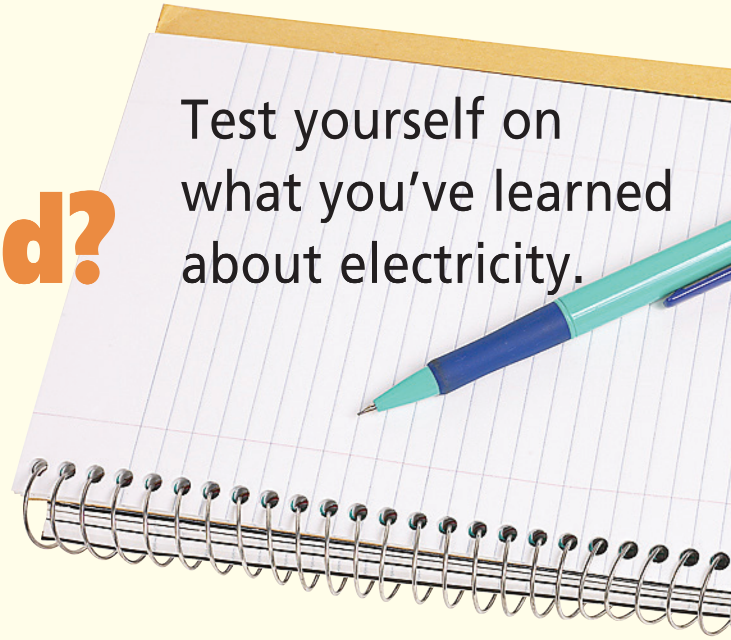
4. Disconnect one of the wires from the battery. What happens?

   ____

Going Further

Look up electromagnets in your class encyclopedia or in reference sources on the Internet. Find three ways people use electromagnets every day.

What Have You Learned?



Test yourself on what you've learned about electricity.

Fill in the Blanks

1. Electricity is a form of ____________ (page 2).
2. In a complete ___________, electricity travels along a path that takes it back to where it started (page 6).
3. High voltage electricity travels on transmission lines to the _______________________, where transformers lower the voltage (page 4).
4. Materials called ____________ allow electricity to travel easily through them (page 8).
5. ______________ , such as the plastic coating on electrical cords, protect us from electric shock (page 8).
6. When there is a short circuit, a thin strip of metal in a _________ melts to prevent a fire (page 10).

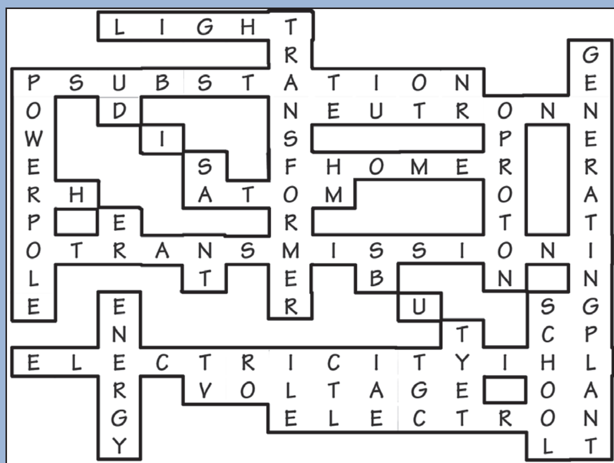
Circle True or False

7. Our bodies conduct electricity (page 8).	True	False
8. Electricity from the wall outlet is strong enough to kill you (page 7).	True	False
9. Insulators allow electricity to flow easily through them (page 8).	True	False
10. If a circuit breaker breaks the circuit, the power comes on (page 10).	True	False

Puzzle Solutions

PAGE 4: GENERATING PLANT, TRANSMISSION LINES, SUBSTATION, TRANSFORMER, OUTLETS, HOMES, SCHOOLS.

PAGE 5:



BONUS—PAGE 2: ATOM, ELECTRICITY, ELECTRON, ENERGY, NEUTRON, PROTON, VOLTAGE; PAGE 3: LIGHT, HEAT, HOME; PAGE 4: DISTRIBUTION, GENERATING PLANT, POWER POLE, TRANSFORMER, TRANSMISSION, SCHOOL, SUBSTATION.

PAGE 6: 1. POWER LINES; 2. THE BULB DOESN'T LIGHT BECAUSE THE CIRCUIT IS NOT COMPLETE.

PAGE 8: 1. WIRE, EASILY; 2. COPPER; 3. GOOD; 4. RUBBER, INSULATORS. SECRET MESSAGE: "OUR BODIES CAN CONDUCT ELECTRICITY."

PAGE 9: CONDUCTORS: STEEL WOOL, PENNY, PAPER CLIP. INSULATORS: PLASTIC, ERASER, YARN, GLASS.

PAGE 10: 1. LIKES, TOUCH, POINT; 2. ELECTRICITY, FIRE; 3. BUILT; 4. METAL; 5. FUSE, HOT; 6. CIRCUIT; 7. MOVING.

PAGE 11: THE ELECTRICITY TAKES THE SHORTCUT BACK TO THE BATTERY AND NO LONGER LIGHTS THE BULB. THE WIRE GETS HOT.

PAGE 12: ACID IN THE LEMON REACTS WITH THE COINS TO PRODUCE A SMALL AMOUNT OF ELECTRICITY, WHICH THE MULTITESTER SHOWS.

PAGE 13: 3. THE ELECTROMAGNET ATTRACTS THE PAPER CLIP. 4. EVEN THOUGH THE CIRCUIT IS BROKEN, THE NAIL REMAINS MAGNETIZED FOR A TIME.

PAGE 14: 1. ENERGY; 2. CIRCUIT; 3. SUBSTATION; 4. CONDUCTORS; 5. INSULATORS; 6. FUSE; 7. TRUE; 8. TRUE; 9. FALSE; 10. FALSE.

Home Safety Checklist

DIRECTIONS: Ask an adult in your family to help you complete this checklist by inspecting the inside and outside of your home. Check yes or no for each answer. **Any "yes" answers need correcting to be sure your home is safe.**

		YES	NO
1. Are electrical outlets overloaded with too many plugs?	**1.**		
2. Do the cords of appliances and power tools have bare wires or worn areas?	**2.**		
3. Do electric cords run under rugs or furniture?	**3.**		
4. Are electric appliances near water where they could get splashed or fall in?	**4.**		
5. Are fire extinguishers outdated or missing?	**5.**		
6. Are electric heaters close to anything that can burn?	**6.**		