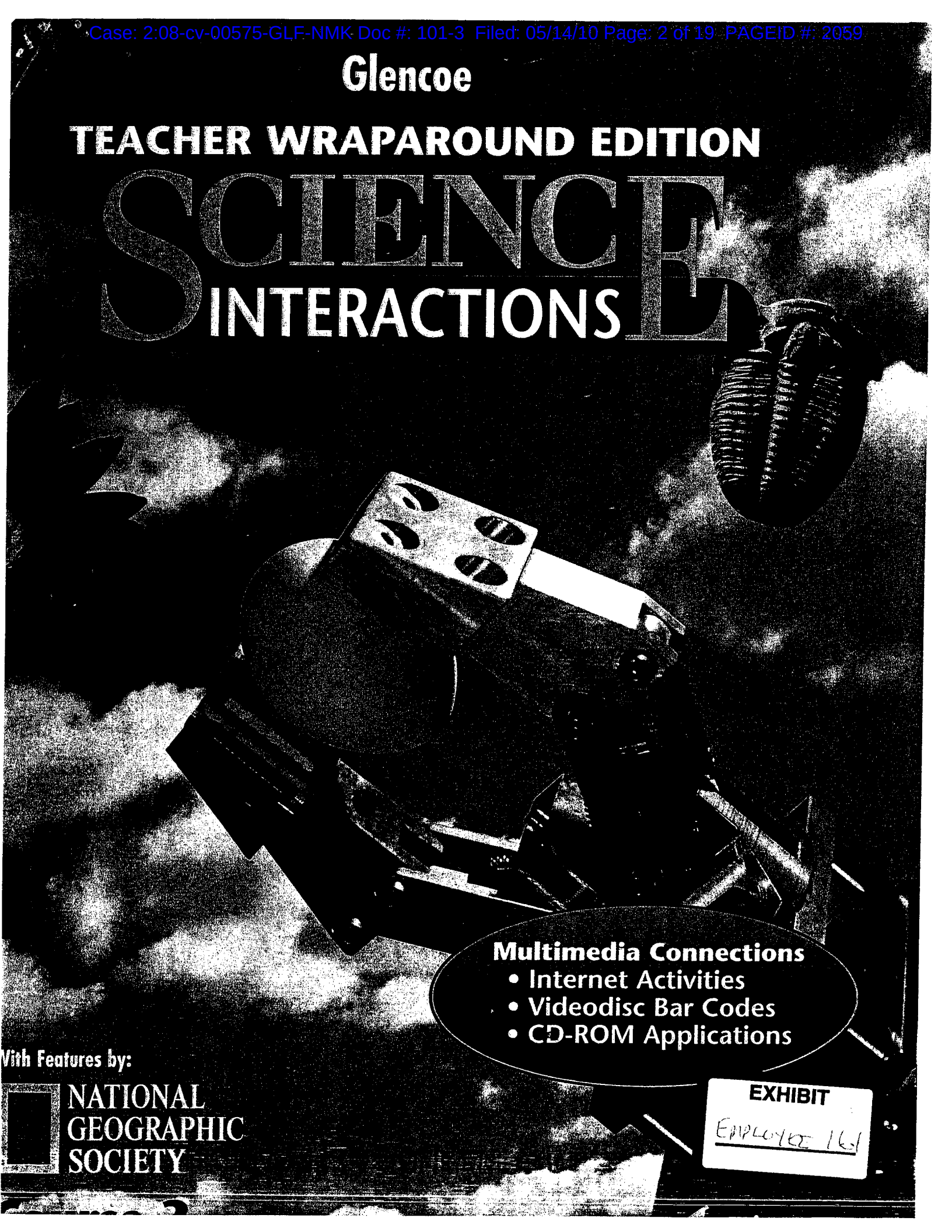
Exhibit B

Glencoe

TEACHER WRAPAROUND EDITION

SCIENCE INTERACTIONS



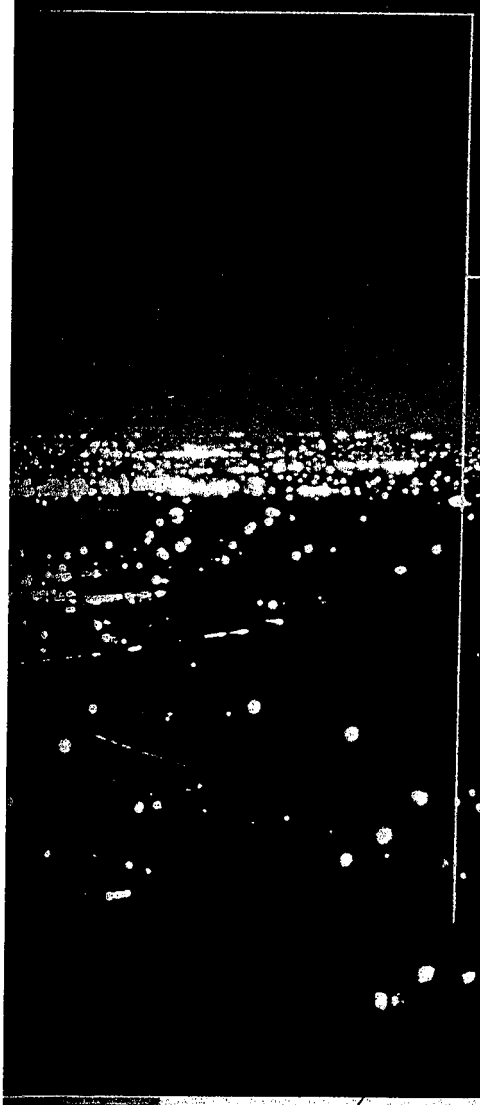
Multimedia Connections
- Internet Activities
- Videodisc Bar Codes
- CD-ROM Applications

With Features by:

NATIONAL GEOGRAPHIC SOCIETY

EXHIBIT
Employee 161

NATIONAL GEOGRAPHIC try it!



Bring a magnet near a refrigerator door and you feel a pull. Do you feel the same pull when you try to attach a magnet to a soft drink can? Both a refrigerator door and a soft drink can are made of metal. Why do the magnets act differently?

What To Do

1. Bring the magnet close to items such as paper clips, rubber bands, aluminum soft drink can tops, and paper. Based on your observations, write a general statement *in your Science Journal* describing what a magnet does.
2. Using the materials that were attracted by the magnet, place a sheet of paper between the magnet and materials. Do you notice any difference in the way the magnet works? *In your Science Journal,* describe what happens.

GETTING STARTED

Discussion Some questions you may want to ask your students are: BELLWORK

1. What things can you list that have to do with electricity? Students may identify a variety of electrical appliances. They may also say *lightning, electric sockets, wires,* and *transmission towers.*

2. Which of the things you listed are similar to each other? How? Students should find relationships among the items they listed in response to question 1.

3. Where is the safest place to be during an electrical storm? Why? Answers may vary. Students may be aware that out in the open, near a tall object such as a tree, or near water are hazardous places to be during an electrical storm. Students may suggest a car because the rubber tires act as insulators through which electric charge does not flow.

The way in which students answer these questions will help you to identify any misconceptions about electricity that they may have.

DO THIS

Answers to Questions

1. A magnet attracts certain metal objects and attracts or repels other magnets.

2. No. The magnet attracts the objects through the paper.

Try It Again Some explanations and predictions may change.

Try It!

(DO THIS)

Purpose To observe how a magnet affects different materials.

Background Information A magnet has two poles, designated *north* and *south.* Opposite poles attract each other, but like poles repel. The attractive force around a magnet, in its magnetic field, is most powerful at the poles.

Electrical currents can produce magnetic fields. This phenomenon is used in some kinds of switches and in doorbells.

Suggested Materials Magnets, a variety of items such as soft drink can tops, paper clips, rubber bands, paper, cloth, and screws.

Trouble Shooting Some refrigerator magnets may not be strong enough for use in this activity. Hardware stores often sell strong rectangular magnets you may find more suitable for use than refrigerator magnets.

Assessment

Process Have students make a data table and classify the objects according to whether or not they were attracted to the magnet. Use the Performance Task Assessment List for Data Table in **PASC,** p. 37.

L1 [redacted] MAY WANT TO USE

Chapter 1 Electricity

TEACHER CLASSROOM RESOURCES

Student Masters	Transparencies
Study Guide, p. 7 - HOMEWORK **Making Connections: Technology & Society,** p. 5 **Science Discovery Activities,** 1-1 **Laboratory Manual,** pp. 1–2, Electrical Charges **Activity Masters,** Design Your Own Investigation 1-1, pp. 7–8	**Teaching Transparency 1,** Like and Unlike Charges **Section Focus Transparency 1**
Study Guide, p. 8 **Critical Thinking/Problem Solving,** p. 9 **Take Home Activities,** p. 6 **How It Works,** p. 5	**Section Focus Transparency 2**
Study Guide, p. 9 **Multicultural Connections,** pp. 5,6 **Making Connections: Integrating Sciences,** p. 5 **Critical Thinking/Problem Solving,** p. 5 **Science Discovery Activities,** 1-2, 1-3 **Laboratory Manual,** pp. 3–4, Wet-cell Battery	**Teaching Transparency 2,** Series and Parallel Circuits **Section Focus Transparency 3**
Study Guide, p. 10 **Making Connections: Across the Curriculum,** p. 5 **Concept Mapping,** p. 9 **Activity Masters,** Investigate 1-2, pp. 9–10	**Section Focus Transparency 4**

ASSESSMENT RESOURCES	TEACHING & TECHNOLOGY
Review and Assessment, pp. 5–10 **Performance Assessment,** Ch. 1* **PASC*** **Mindjogger Videoquiz** **Alternate Assessment in the Science Classroom** **Computer Test Bank**	**Spanish Resources** **Cooperative Learning Resource Guide** **Lab and Safety Skills** **Science Interactions, Course 3, CD-ROM** **Computer Competency Activities**

*Performance Assessment in the Science Classroom

NATIONAL GEOGRAPHIC

TEACHER'S CORNER

Index to National Geographic Magazine

The following articles may be used for research relating to this chapter:

- "Lightning, Nature's High-Voltage Spectacle," by William R. Newcott, July 1993.

GET MAGIZINE FROM GRANDPA

National Geographic Society Products Available From Glencoe

To order the following products for use with this chapter, contact your local Glencoe sales representative or call Glencoe at 1-800-334-7344:

- *STV: Electricity and Simple Machines* (Videodisc)

Additional National Geographic Society Products

To order the following products for use with this chapter, call the National Geographic Society at 1-800-368-2728:

- *Everyday Science Explained* (Book)
- *Elementary Electricity* (Video)

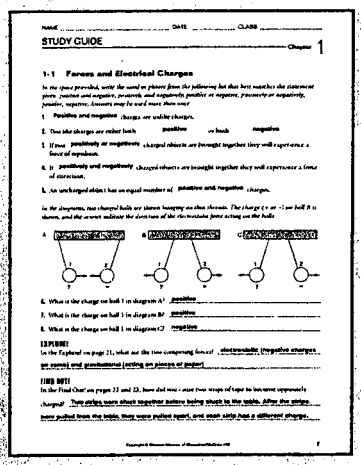
ALSO - LOOK AT - TV → COMPUTER - CD - "PHYSICAL SCIENCE VI" MATTER

(QUIZ FOLLOWING)

Chapter 1 Electricity

REVIEW AND REINFORCEMENT

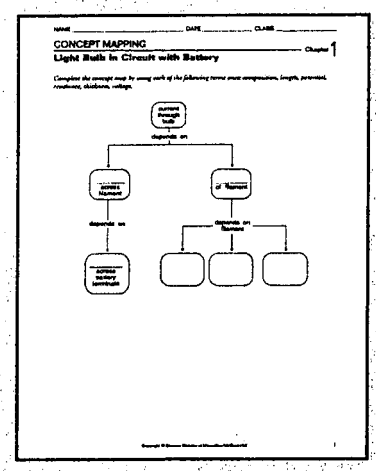
Study Guide*


STUDY GUIDE — Chapter 1

1-1 Forces and Electrical Charges

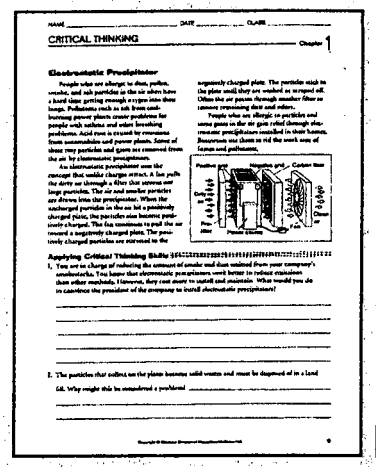
L1

Concept Mapping


CONCEPT MAPPING
Light Bulb in Circuit with Battery

L3

Critical Thinking/ Problem Solving

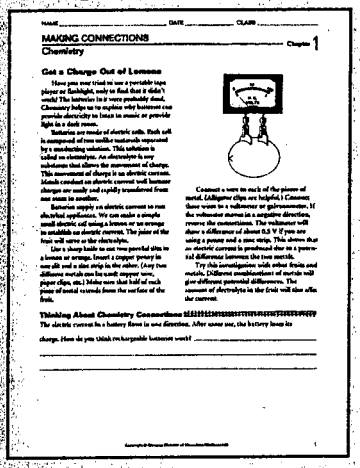

CRITICAL THINKING — Chapter 1

Electrostatic Precipitator

L3

ENRICHMENT AND APPLICATION

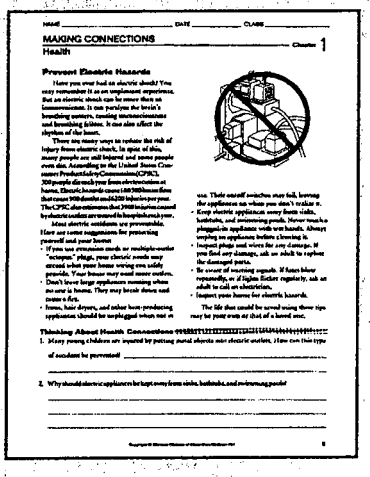
Integrating Sciences


MAKING CONNECTIONS
Chemistry — Chapter 1

Get a Charge Out of Lemons

L1

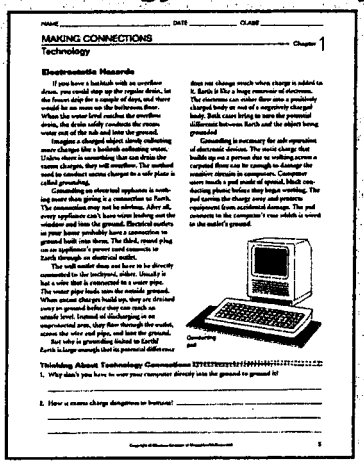
Across the Curriculum


MAKING CONNECTIONS
Health — Chapter 1

Prevent Electric Hazards

L1

Technology and Society

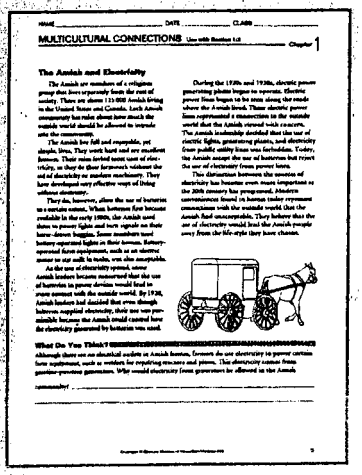

MAKING CONNECTIONS
Technology — Chapter 1

Electrostatic Hazards

L1

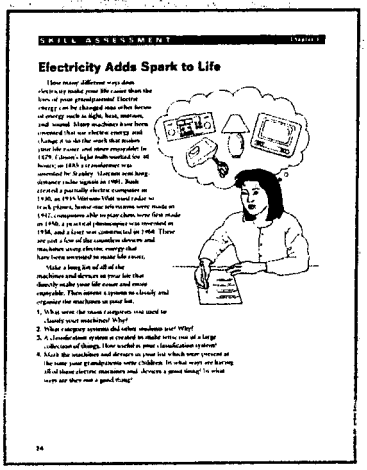
ASSESSMENT

Multicultural Connection**


MULTICULTURAL CONNECTIONS — Chapter 1

The Amish and Electricity

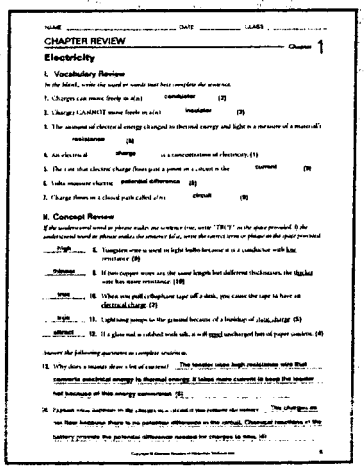
Performance Assessment


SKILL ASSESSMENT

Electricity Adds Spark to Life

L1

Review and Assessment


CHAPTER REVIEW — Chapter 1

Electricity

L1

Do THIS EXPERIMENT (HIGH SCHOOL STATIC MACHINE BORROW)

★ USE BOOK ELECTRICAL WIRING FUNDAMENTAL

Explore! ACTIVITY

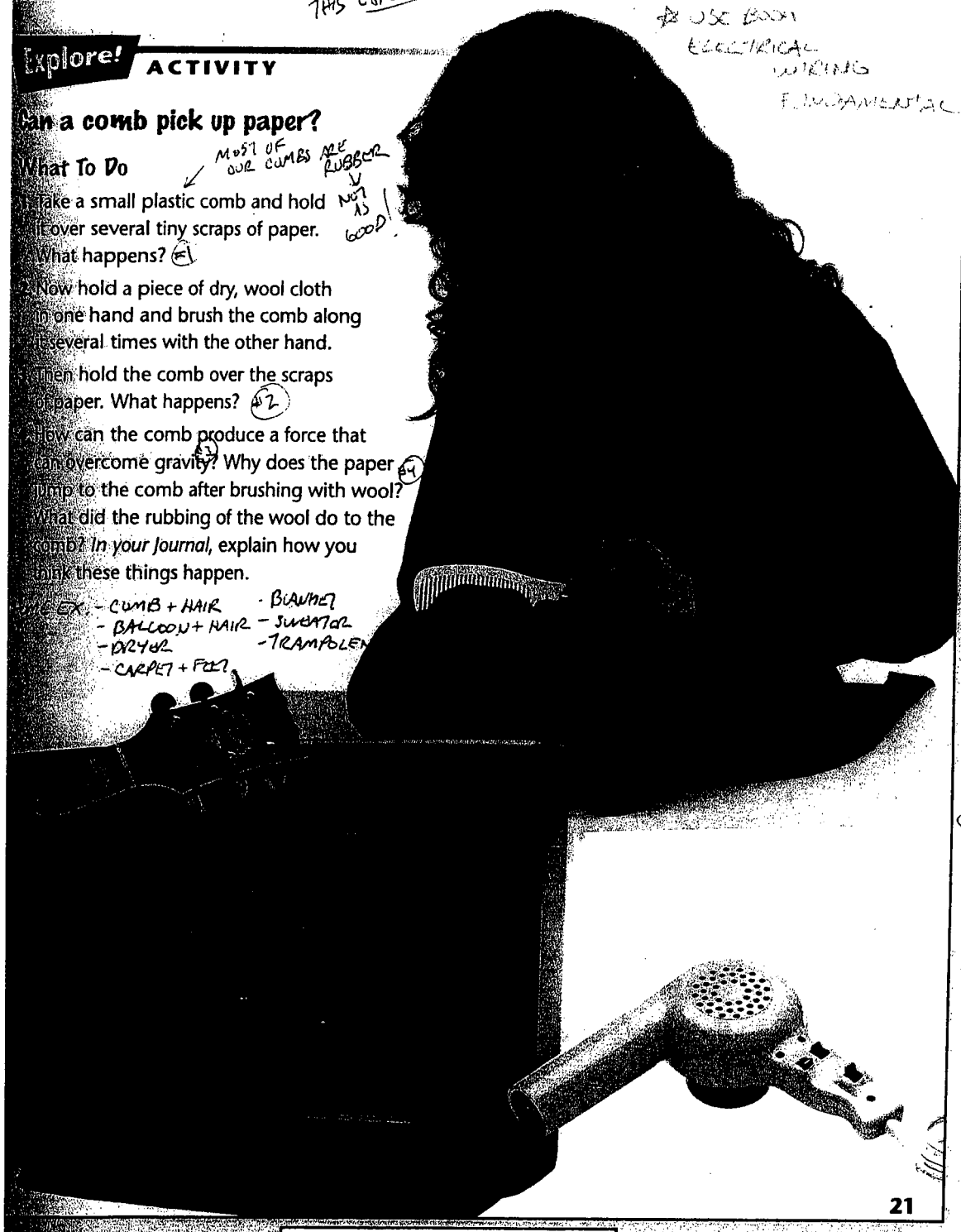
Can a comb pick up paper?

What To Do

MOST OF OUR COMBS ARE RUBBER ✓ NOT AS GOOD!

1. Take a small plastic comb and hold it over several tiny scraps of paper. What happens? #1
2. Now hold a piece of dry, wool cloth in one hand and brush the comb along it several times with the other hand.
3. Then hold the comb over the scraps of paper. What happens? #2
4. How can the comb produce a force that can overcome gravity? #3 Why does the paper jump to the comb after brushing with wool? #4
5. What did the rubbing of the wool do to the comb? *In your Journal*, explain how you think these things happen.

EX. - COMB + HAIR - BALLOON + HAIR - DRYER - CARPET + FEET - BLANKET - SWEATER - TRAMPOLEN



ASSESSMENT PLANNER

PORTFOLIO
Refer to page 47 for suggested items that students might select for their portfolios.

PERFORMANCE ASSESSMENT
Process, pp. 21, 22, 25, 33, 37, 39, 40
Skillbuilder, p. 30
Explore! Activities, pp. 21, 29
Find Out! Activities, pp. 22, 27, 32, 35, 37, 40
Investigate, pp. 24–25, 38–39

CONTENT ASSESSMENT
Oral, pp. 27, 29
Check Your Understanding, pp. 26, 30, 35, 41
Reviewing Main Ideas, p. 45
Chapter Review, pp. 46–47

GROUP ASSESSMENT
Opportunities for group assessment occur with Cooperative Learning Strategies.

Explore!

Can a comb pick up paper?

Time needed 15 minutes

Materials plastic comb, scraps of paper, wool cloth

Thinking Processes observing and inferring, recognizing cause and effect, concept mapping

Purpose To observe the attraction between opposite charges.

Teaching the Activity

Troubleshooting This activity works best on days with low relative humidity. Make sure that the wool cloth is dry. Have students move the cloth vigorously along the comb.

Science Journal Students may relate their observations to other instances in which static electricity caused an attraction between objects. L1

Expected Outcome

Students will observe that when rubbed, the comb attracts scraps of paper.

Answers to Questions

1. Nothing happens.

3. The paper scraps are attracted to the comb.

4. Comb exerts force that attracts the paper. The paper is attracted by charges on the comb. Rubbing charged the comb. CRKTW

Assessment

Do THIS

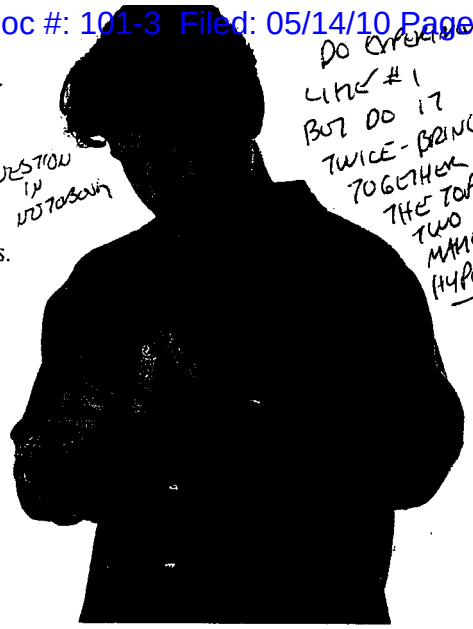
Process Students can learn to better recognize cause and effect by thinking of other ways of producing static electricity. *By rubbing your feet on a carpet; by clothes rubbing together in a drier; by combing your hair on a very dry day, and so on.* Ask students to note if the result is an attraction between objects, repulsion, or a spark. Students could then make a concept map including this information. Use the Performance Task Assessment List for Concept Map in **PASC**, p. 89. L1 P

COPY PAGE #5 - PASS OUT PASCULS

What To Do

1. Fold over about 5 mm on the end of the tape for a handle. Then tear off a strip 8 to 10 cm long. Stick the strip on a dry, smooth surface, such as your desktop. Make a second strip and stick it on top of the first.
2. Quickly pull both pieces off the desk and pull them apart. Then bring the tapes close together. Observe what happens.
3. Now make two new strips of tape, but this time press each one onto the desk. Then pull them off and bring the two strips close together. What happens?

AT THIS POINT – MAKE A HYPOTHESIS – WRITE DOWN



DO EXPERIMENT LINE #1 BUT DO IT TWICE – BRING TOGETHER THE TOP TWO MAKE HYPOTHESIS

QUESTION IN NOTEBOOK

Conclude and Apply

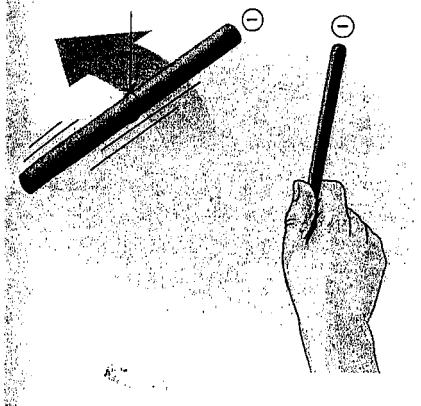
1. What happened when you brought the first pair of tapes close together? What happened when you brought the second pair together?
2. What did you do that might have caused the two different reactions?

When you pulled the strips of tape from the desk, you caused them to have an electrical charge. An **electrical charge** is a concentration of electricity. By sticking one strip on top of the other, you treated the two strips differently. Each strip had an excess of different charges. **Unlike charges** attract one another. When you prepared the strips the same way, they received like charges. **Like charges** repel one another.

You can learn more about different types of charge produced by various materials in the Investigate activity on the next page.

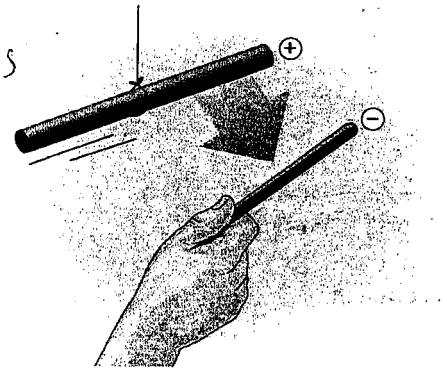
OVERHEAD VOC. WORDS

STOP HERE



Like charges on rods

USE BAR MAGNETS FOR THIS



Unlike charges on rods

GOOD TIME FOR TESLA COIL DEMO.

Figure 1-2

The two effects you saw in the Find Out activity showed you that there must be at least two different kinds of charge. Like the tape strips you prepared, the rods with like charges repel one another and those with unlike charges attract one another.

1 MOTIVATE

Bellringer SHOW THIS

Before presenting the lesson, display **Section Focus Transparency 1** on an overhead projector. Assign the accompanying **Focus Activity** worksheet. L1

DO THIS / ASK OCE

Demonstration Play the song "Opposites Attract" by Paula Abdul as students come into the room. Ask students to relate the main phrase of the song to the information in this section. L1

2 TEACH

Tying to Previous Knowledge

Have students recall past observations by describing what can happen if you touch a doorknob after walking across a carpet. They may reply that you get a shock. Explain that friction between the carpet and shoes induces a net charge. The electric shock is a *static discharge*, or "loss" of static electricity.

Theme Connection In their study of this section, students will be exposed to the theme of scale and structure. Students will experiment with charged objects to see how charges interact. This macroscopic scale is appropriate for students who have not yet studied atomic structure. You may wish to point out, however, that it is also possible to study charge on a much smaller scale, that of individually charged particles.

Content Background EXPLAIN TO CLASS

Objects become charged through the transfer of negatively charged particles (electrons). If an object gains these particles, it becomes negatively charged. If it loses these particles, it becomes positively charged. (Because students have not yet learned about atomic structure, refer to the movement of "particles" rather than "electrons.")

Program Resources

Study Guide, p. 7
Teaching Transparency 1 L1
Section Focus Transparency 1

DESIGN YOUR OWN INVESTIGATION

PLACE MATERIALS

GROUPS - 6 - DIFFERENT SITES

Plan the Experiment

1 Prepare a data table *in your Science Journal* or in a database on the computer for the objects and fabrics you will test.

2 Will you test more than one kind of object? Will you use more than one fabric? YES OBJECT PLASTIC GLASS CERAMIC FABRIC WOOL COTTON FAKE FUR SILK

Check the Plan

1 How will you make the cellophane tape charge detectors? How will you distinguish between the two detectors?

2 How will you charge the objects? FRICTION - RUB THEM

BRING CLOSE TO How will you use the tape detector to check for charge? Will you use both pieces of tape? YES

3 Watch for the strength of the attraction. Does one combination of fabric and object make a stronger charge? Are the detectors attracted to the objects or fabrics if they are not rubbed together?

4 Write out your plan and check it with your teacher. Make any suggested changes and carry out your experiment.

Analyze and Conclude

Analyze How many different kinds of charge did you differentiate?

Compare Compare the charges on the object and the fabric. Are they alike or different? Was your hypothesis accurate?

3. **Identify** Was there any material that did not become charged? If so, identify the material. Why was it not charged?

4. **Conclude** When an electrical charge is produced by rubbing, are the charges always opposite?

DO THIS

Going Further

A plastic comb is rubbed with a piece of wool and is suspended from a string. What will happen if a glass object that has been rubbed with silk is brought near the comb?

Analyze and Conclude

1. The rubbing produces two kinds of charges.

2. The charges on the object and fabric are different. When the fabric and object are rubbed together, negatively charged particles move from one to the other. One becomes positively charged, and the other becomes negatively charged, resulting in attraction between the two. A

3. No, all the materials became charged with rubbing.

4. Yes

Going Further

The comb will turn away from the glass.

Assessment

COULD DO

Process Students can practice classifying additional objects by observing how these objects interact with the strips of tape. Students should expand their data table to include these observations. Use the Performance Task Assessment List for Data Table in **PASC**, p. 37. L1

GLENCOE TECHNOLOGY

CD-ROM
Science Interactions, Course 3, CD-ROM
Chapter 1

DIFFERENT AUDIENCE THAN IN ACTIVITY MASTER "COMB WILL TURN TOWARDS THE GLASS"

Van de Graaf - DO WITH H2O (WATER) ATTRACTS BECAUSE OF IONIC BONDS
ZY WITH A CHARGED COMB - IT SHOULD ATTRACT THE H_2O
Van de Graaf - IS LIKE A "CLOUD" OF NEG. CHARGES ON THE OUTSIDE OF YOUR BODY

AND ON WOODEN CHAIR - HAIR WILL STAND UP

ENRICHMENT

Research Have students work in groups and use reference materials to investigate Coulomb's law—the relationship among the electric force, charge, and distance between two charged objects. Coulomb's law is an inverse square law similar to Newton's law of gravitation. L3

PEER TEACHING

1-2 Electrical Charge Carriers

Electrical Charges

In the last section, you observed that electrical charges may be positive (+) or negative (-). What type of material moves charges from one place to another? Do all materials move charges in the same way? Do electrical charges stay put on some materials? You can answer this question by combining and expanding two activities from Section 1-1.

GOOD BELL WORK QUESTION

(CONDUCTORS) (NO) (YES-INSULATOR)

Section Objectives

- Distinguish electrical conductors from insulators.
- Describe how a charged object attracts an uncharged one.
- Demonstrate a variety of effects of static electricity.

Key Terms

insulator, conductor

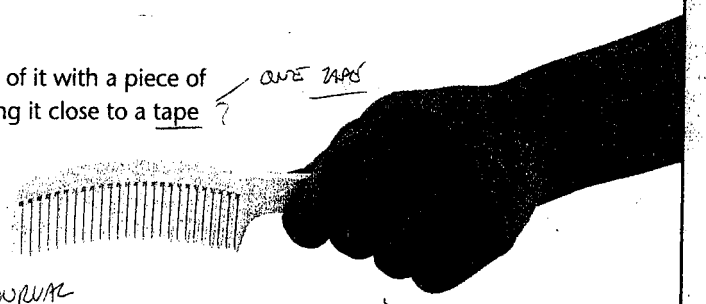
Find Out! ACTIVITY

Do electrical charges stay put?

As you've observed, electrical charges move to and from objects. What controls that movement?

What To Do

1. Charge a plastic comb by rubbing one end of it with a piece of wool while holding it by the other end. Bring it close to a tape charge detector. ONE TAPE ?
2. Now, with your finger, touch the comb on the end you charged. Bring the comb near the charge detector again. ?



Conclude and Apply WRITE DOWN-JOURNAL

1. *In your Journal,* describe what happened the first time you brought the comb near the charge detector.
2. What happened the second time you brought the comb to the charge detector?
3. What happened to the electrical charge?

THIS EXP. DIDN'T WORK SO WELL

In the Find Out activity above, you observed that the comb held a charge until you touched the charged end. Electrical charges don't move freely from one place to another through some materials such as plastic. If the charges had been able to move in the comb, you wouldn't have had to touch its other end to remove the charges. A material in which electrical charges do not move freely from place to place is called an **insulator**.

USE-OVERHEAD OF "TRAFFIC FLOW"

1-2 PREPARATION

Planning the Lesson

Refer to the Chapter Organizer on pages 20A–D.

Concepts Developed

Students observe how charges move freely through conductors, but not through insulators.

1 MOTIVATE

Bellringer

Before presenting the lesson, display **Section Focus Transparency 2** on an overhead projector. Assign the accompanying **Focus Activity** worksheet. L1

Student Text Questions

What types of material move charges from one place to another? *conductor* **Do all materials move charges in the same way?** *no* **Do electrical charges stay put on some materials?** *yes*

Conclude and Apply

1. The tape charge detector was attracted to the comb.
2. nothing
3. Somehow, touching the comb neutralized the charge.

Assessment

Oral Ask students to relate the properties of insulators to their importance to safety. *Insulators help prevent accidents by preventing the free movement of electrical charge.* Students could then write public service announcements warning of the dangers of using appliances with frayed wires. Use the Performance Task Assessment List for Oral Presentation in **PASC**, p. 71. L1 P

Find Out!

Do electrical charges stay put?

Time needed 10 minutes

Materials charge detector, comb, piece of wool

Thinking Processes recognizing cause and effect, comparing and contrasting, modeling

Purpose To infer that electric charges do not move freely through insulators.

Teaching the Activity

Troubleshooting Experiments with static electricity work best on dry, cool days.

Science Journal Ask students to write predictions of what will happen. L1

Expected Outcome

Students should observe that the comb held the charge until they touched the charged end.

Explore! ACTIVITY

Do conductors hold a charge?

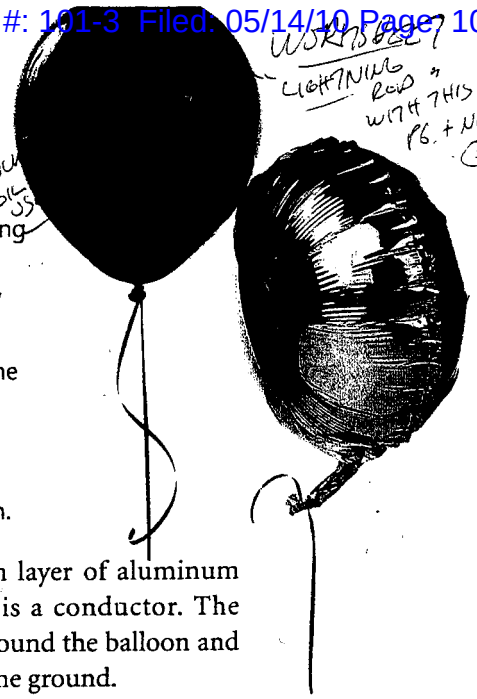
DO AS A DEMO

DO THIS OUT BALLOONS OR ALUMINUM FOIL

WORKSHEET LIGHTNING ROD WITH THIS PG. + NEXT (30)

What To Do

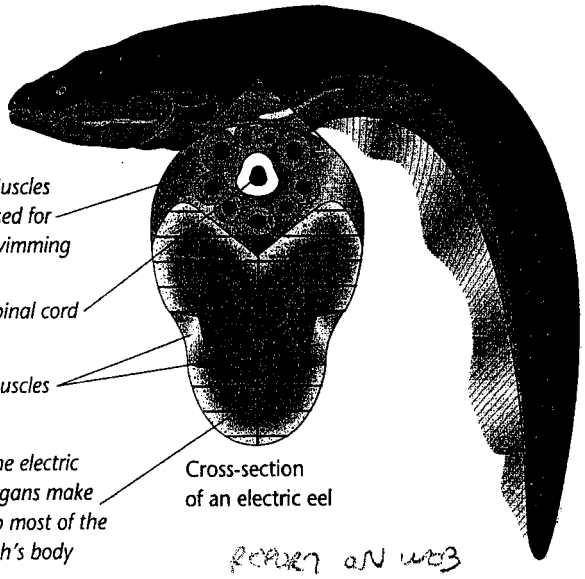
1. Hold a balloon that has been given a negative charge by being rubbed with wool over a few small (less than 1 cm x 1 cm) scraps of aluminum foil. Is the foil attracted to the negatively charged balloon? WORKS WELL
2. Hold the positively charged wool over the foil. Is the result the same? Can you explain why? THIS DIDN'T WORK
3. Now, try the same experiment with a charged shiny metallic balloon like the one shown. What happens? *In your Journal,* draw what you think happened and write a brief explanation.



The Explore activity showed that conductors are attracted to both positive and negative charges. The shiny balloon didn't hold a static charge because the thin layer of aluminum on the balloon is a conductor. The charge flowed around the balloon and through you to the ground.

impulse to stun their prey, fend off predators, and detect underwater objects.

The shock of an electric eel is large enough to kill an animal as large as a horse. When an animal is stunned by an electric shock, it stops breathing and drowns. Usually the electricity from electric eels stuns small prey, such as fish or frogs.



Cross-section of an electric eel

READ ON WEB ON ELECTRIC EEL + RAYS

What Do You Think?

Besides the electric eel, other animals that live in water—the electric ray, for example—use electric impulses to stun their prey and protect themselves. ASK

1. Why do you think water animals use electricity in this way, while animals that live on land do not? DISCUSS - PURE H_2O ELECTRICAL CURRENT MORE
2. Why might it matter where the electrical impulses enter the body of an electric eel's prey?

Explore!

Teaching the Activity

Science Journal Encourage students to draw diagrams showing the transfer of charge between the wool and balloon and the foil. L1 P BELL WORK OVERHEAD

Expected Outcome

Students should observe that the pieces of foil move toward the charged balloon and wool and conclude that the foil experienced a net attractive force. The metallic balloon does not attract the foil.

Answers to Questions

1. Yes.

2. Yes. In both cases, the bits of foil are attracted to the object because the opposite charges are closer than the like charges.

3. The shiny balloon did not attract the foil because the charge flowed around the balloon, through the person, and into the ground.

Assessment

TRY

Oral Ask students to propose a method for preventing the charge from flowing from the shiny balloon to the ground. *The person could wear a rubber glove on the hand holding the balloon.* Have students make a drawing showing how they think the balloon would interact with the foil. *The balloon would hold the charge and attract the foil.* Select the appropriate Performance Task Assessment List in **PASC.** L1

2 TEACH

TALK ABOUT

Tying to Previous Knowledge

Ask students if they have ever shuffled across a carpet or removed a sweater and then received a shock when they touched a doorknob. Did they get a second shock if they touched the doorknob again? *no* What might have happened to the static charge? *After the first shock, the body no longer carried a charge.*

Answers to What Do You Think?

INSULATOR

1. Answers may include the fact that impure water conducts electricity, while air does not.

2. The prey is more vulnerable in certain parts of its body such as the brain and less fatty areas. The prey might not be sufficiently stunned if the electrical impulses entered its body in a less vulnerable spot.

Program Resources

Study Guide, p. 8

Critical Thinking/Problem Solving, p. 9, Electrostatic Precipitator L2

Take Home Activities, p. 6, Conducting an Experiment L1 DO THIS

How It Works, p. 5, Lightning Rods L1

Section Focus Transparency 2

1-3 Making Electricity Flow

Moving Electrical Charges

During a thunderstorm, the charge jumping from cloud to cloud or striking Earth produces a flash of light. Could you light a lamp this way? Probably not. The spark occurs for only an instant. A lamp needs energy from a continuous flow of charge to stay lit.

It takes energy to separate positive and negative charges. Till now, you've provided that energy either by rubbing or pulling tape away from a desk top. There are more convenient ways to store that energy for use later. After you study the diagrams below, try making charges flow by doing the activity on the next page.

Section Objectives

- State the function of a battery in a circuit.
- Light a bulb using a battery.
- Explain the effect of resistance on the current in a circuit.

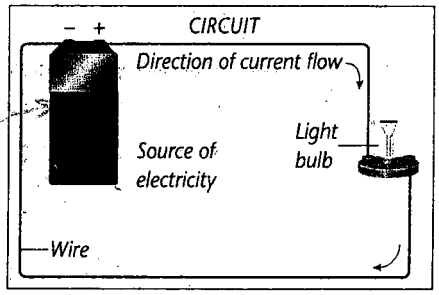
Key Terms

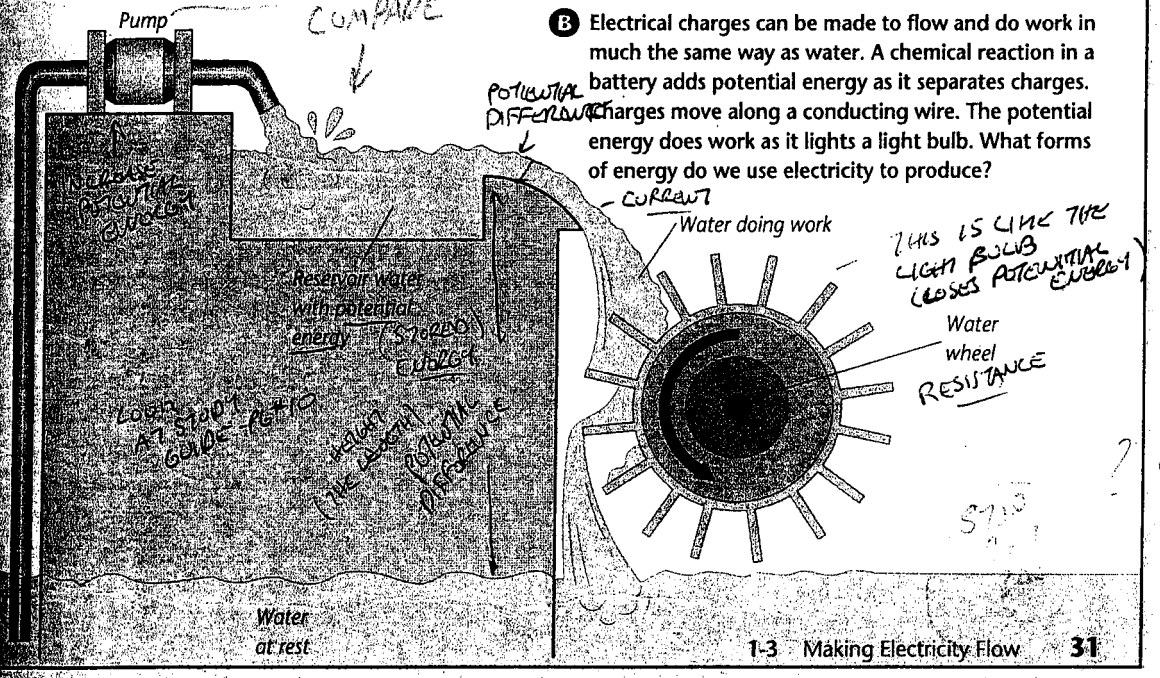
potential difference
circuit
current
resistance

Figure 1-6

Water Wheel

A continuous flow of electrical charge can be maintained in the same way that water in the diagram below is made to flow.





A The water pump works against gravity, lifting water into the reservoir. The potential energy added by the pump does work as the water escapes and turns the water wheel.

B Electrical charges can be made to flow and do work in much the same way as water. A chemical reaction in a battery adds potential energy as it separates charges. Charges move along a conducting wire. The potential energy does work as it lights a light bulb. What forms of energy do we use electricity to produce?

Program Resources

Study Guide, p. 9 + 10
Teaching Transparency 2 L1
Laboratory Manual, pp. 3–4, Wet-Cell Battery L2
Science Discovery Activities, 1-2, Getting a Reaction
Section Focus Transparency 3

Visual Learning

Figure 1-6 What forms of energy do we use electricity to produce? *Thermal, kinetic, light, mechanical, sound.*

1-3 PREPARATION

Planning the Lesson

Refer to the Chapter Organizer on pages 20A-D.

Concepts Developed

In this section, students will learn about the conducting paths through which current electricity flows. Students will make circuits using light bulbs, wire, and a D-cell.

1 MOTIVATE

Bellringer

Before presenting the lesson, display **Section Focus Transparency 3** on an overhead projector. Assign the accompanying **Focus Activity** worksheet. L1

Demonstration Encourage the development of observation skills. Obtain a fresh lemon, a new penny, and a silver dime (one minted before 1965). Attach an alligator clip to each coin and insert the coins into the lemon about 2 cm apart. Use the leads from the coins to connect an LED to complete the circuit. Ask students what makes the LED light. (LEDs are available from scientific supply houses and electronics supply houses.) L1

2 TEACH

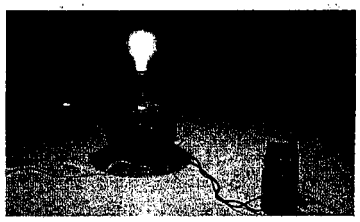
Content Background In circuit diagrams, positive charges are often shown flowing through a circuit. This is called conventional current, which cannot be distinguished from real current in which electrons flow in the opposite direction.

When you made the battery light the bulb, you created a complete path through which charge flowed. Such a complete, or closed, path is called a **circuit**.

The rate at which charges flow through the lamp and wires is called electric current. **Current** is how much electric charge flows past a point in a circuit during a given time. It's measured in amperes (A). MATHMATIC (I)

The electric potential energy is the total stored energy of all the charges. The change in potential energy divided by the total charge is called the electric potential difference, or **potential difference**. The potential differ-

EXPLAIN - POTENTIAL ENERGY
EXAMPLE - RETEACH - PAGE 35



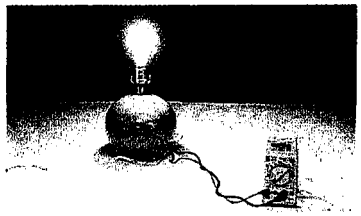


Figure 1-7

A You can use an instrument called an ammeter to measure the rate of current flowing through this three-way bulb. When the switch is at the lowest setting, the current is small.

B At the medium setting, an ammeter shows that the current is greater. How can you tell?

C The current is greatest at the highest setting. What does this tell you about the effect of the switch on the current?

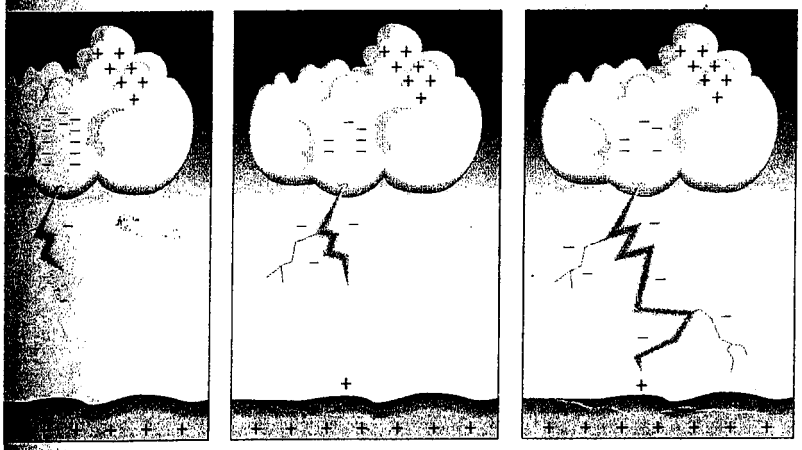
IT BEGINS WITH A UPWARD STROKE FROM GROUND TO CLOUD (YOU SEE) BUT (-) CHARGES ARE BEING ATTRACT DOWN FROM CLOUD TO GROUND → YOU DO NOT SEE

When Lightning Strikes

Lightning begins with a weak, downward discharge in which large numbers of negative charges flow toward the ground. This is followed immediately by a bright flash, or return stroke, from the ground to the cloud along the same path.

The shorter the distance from the ground to the cloud, the easier it is for the electrical discharge to take place. It's not a good idea to run under a tree during an electrical storm. The lightning seeks the shortest path to the ground, and the tree provides that path.

People can sometimes have a warning of a nearby lightning strike. They feel their skin tingling and their hair standing on end. A person in this situation should fall to the ground to reduce the chance of being struck by a lightning bolt.



What Do You Think?

Buildings, particularly farm buildings in open areas, have lightning rods atop their roofs. How are these rods used? How can these rods help avoid a fire due to lightning?

VIDEO DISH - PHYSIC - 3 MIN LONG - NO#17 SIDE#1

WORKSHEET - HOW IT WORKS

Answers to What Do You Think?

The rods prevent lightning from striking the buildings and starting fires. The rods extend above buildings, they are the most likely objects to be struck by lightning. The rods conduct charges to the ground. The building is, thus, not exposed to the discharge, so a fire is not likely to start.

Going Further

Students can work in small groups to make posters that show what causes lightning. Display the finished posters on a bulletin board titled *What Causes Lightning?* Select the appropriate Performance Task Assessment List in **PASC.** L1

STORY - FIRE TOWER + STORM
SHARP POINTS ARE MORE ATTRACTING THE CHARGE + IT

Visual Learning

Figure 1-7 How can you tell? *The light is brighter.* **What does this tell you about the effect of the switch on the current?** *Each of the three "On" positions of the switch allows more current to flow through the bulb.*

Find Out!

Troubleshooting Tell students that the terminals of the battery are very important in this activity. Have one volunteer from each group point to the terminals while the rest of the group checks to make sure that the terminals have been identified correctly.

Science Journal Have students diagram the circuit showing where it has its greatest electrical potential. L1

Expected Outcome

Students should complete the circuit so that the bulb lights.

Conclude and Apply

1. Diagrams should include all items in the circuit, and should show negative charges leaving the battery and flowing through the circuit to light the bulb.

2. Like the pump, the battery maintains a difference in potential. The water does the work of turning the wheel as it flows down. The electric current does the work of lighting the bulb as the current moves through the circuit.

OK - DO EXAMPLE ON WHITEBOARD

Assessment

Process Ask students to draw a diagram in their journals showing the energy changes that happen in the electrical circuit. *Diagrams should show chemical energy in the battery changing to electrical potential energy which changes to light and heat energy in the bulb.* Use the Performance Task Assessment List for Scientific Drawing in **PASC**, p. 55. L1 P

Find Out! ACTIVITY

How does electric current depend on the resistance in a circuit?

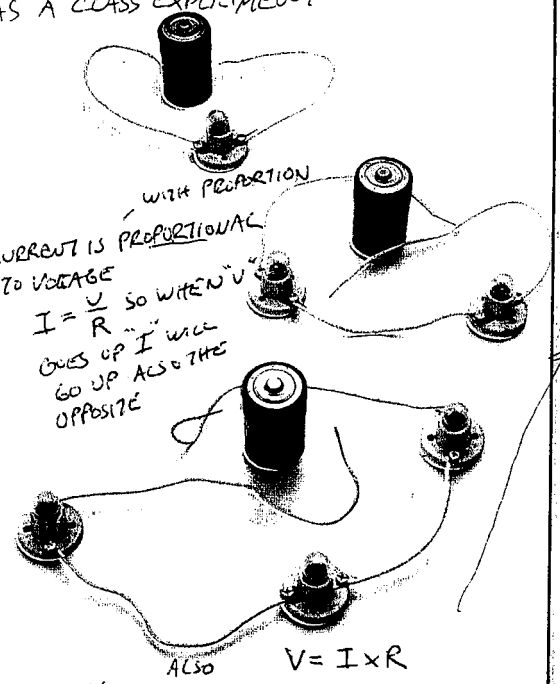
Examining changes in a simple working circuit will help you understand how resistance and current are related.

What To Do

1. Make a complete circuit containing a battery and a single bulb. Observe how brightly the bulb glows.
2. Next, add a second bulb as shown in the photograph. Note the brightness of the bulbs.
3. Finally, add another bulb to the circuit as shown. Observe the brightness of the bulbs.

Conclude and Apply

1. What happened when you added the second bulb to the circuit? When you added the third?
2. *In your Journal,* explain what you observed.



Each added bulb, or added resistance, decreased the brightness of all the bulbs. You could infer that less bright means less current was flowing. When the voltage remains the same, the current decreases as the resistance increases.

Instead of static charges, you have seen dynamic charges in an electric circuit made of a complete path, a resistance, and a source of potential difference. These simple circuits are part of electric appliances and tools you use every day.

check your UNDERSTANDING

1. Draw a circuit using a 6-V battery and a bulb that would cause the bulb to glow.
2. What keeps the charges flowing in a circuit? What happens to the potential energy when the charges pass through the bulb?
3. **Apply** Suppose you replaced the bulb in the circuit you drew in Question 1 with one of higher resistance. Describe the change in the current through the bulb. How would the new bulb's brightness compare with that of the bulb you replaced?

3 ASSESS

Check for Understanding

Assign questions 1 and 2 under Check Your Understanding. To help students answer question 3, have a volunteer state the relationship between current and resistance. *Current and resistance are inversely related.*

Reteach

Discussion To help students understand the concept of potential energy, use the analogy of an eraser on a desk. We say the eraser has potential energy because of its height. The potential energy changes when the eraser falls. The potential energy is being changed into other forms of energy such as the energy of motion as it falls and sound energy when it hits the floor.

In a battery, the potential energy at one terminal is greater than at the other. This makes it possible for electrons to move, or fall, through the circuit. L1

Extension

Discussion Have students describe parts of the human circulatory system. They will probably list *heart, blood vessels,* and *blood.* Ask them what is similar about the function of the heart in the circulatory system and the function of the battery in the circuits that they made. *Each is a pump. The heart pumps blood. The battery "pumps" charge.* L2

4 CLOSE

Discussion

Inform students that, in 1800, an Italian physicist named Alessandro Volta observed that two metals connected by a conducting liquid produced a continuous transfer of charges. Ask students how this phenomenon is different from static electricity. *Static electricity does not move in a continuous flow; electric current does.* L1

Program Resources

Critical Thinking/Problem Solving, p. 5, Flex Your Brain

Multicultural Connections, p. 5, The Amish and Electricity L1; p. 6, Electricity from Sunlight L1

Making Connections: Integrating Sciences, p. 5, Get a Charge Out of Lemons L2

Science Discovery Activities, 1-3, A Copper Topper

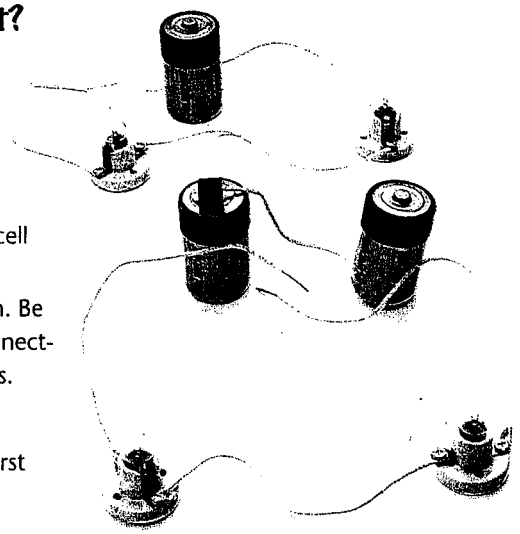
check your UNDERSTANDING

1. Students should draw a schematic diagram to represent Figure 1-8.
2. A chemical reaction in the battery maintains the flow. Potential energy decreases as current passes through the bulb.
3. The current in the bulb would decrease. The bulb would be less bright.

Find Out! ACTIVITY

How does increasing voltage affect current?

Why do some flashlights have more D-cells than others? To find out, you'll need two D-cells, wire, and two bulbs.



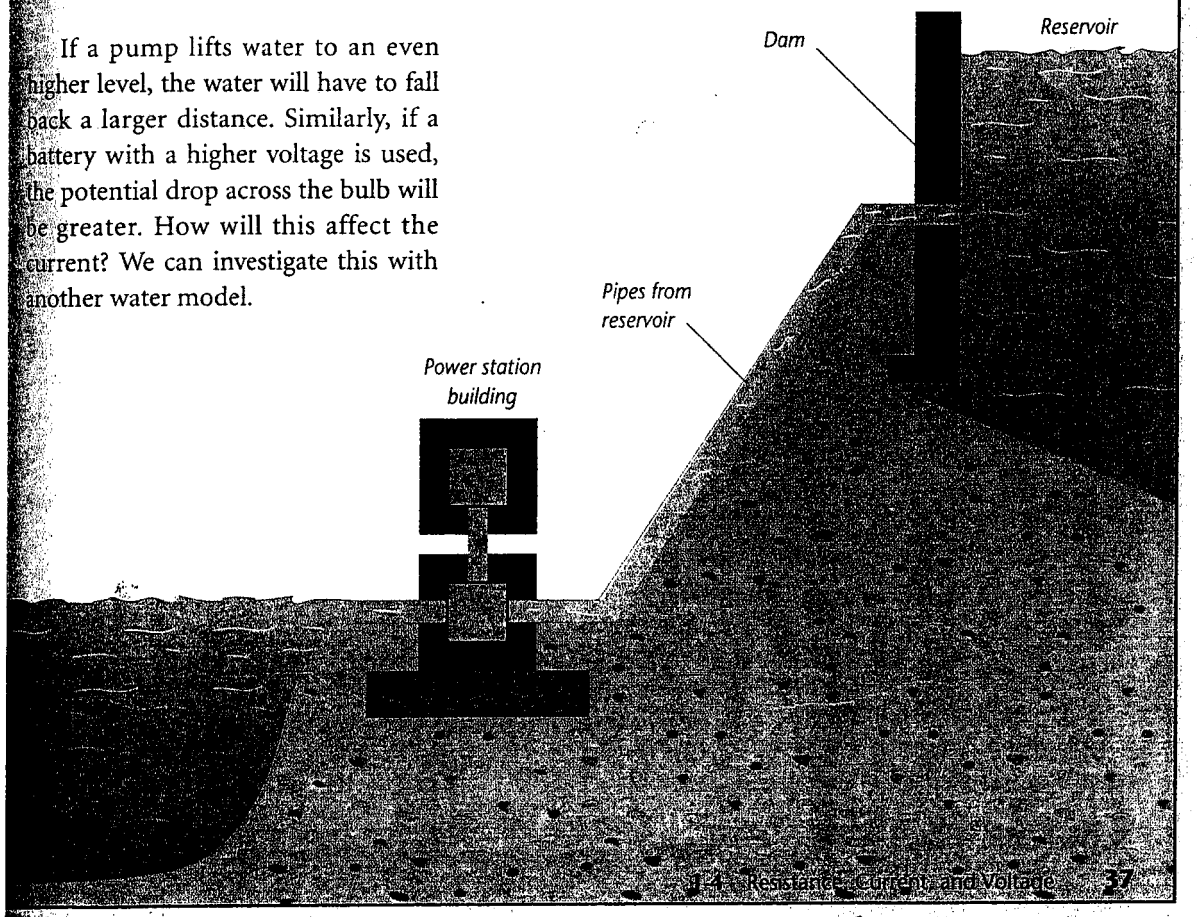
What To Do

1. Make a complete circuit with the two bulbs and one D-cell as shown. Observe the brightness of the bulbs.
2. Disconnect the circuit and add a second D-cell as shown. Be sure the D-cell connections match the photo before connecting the bulbs. Again, observe the brightness of the bulbs.

Conclude and Apply

In your Journal, write to explain how the brightness in the first circuit compares with the brightness in the second circuit. Explain any differences.

If a pump lifts water to an even higher level, the water will have to fall back a larger distance. Similarly, if a battery with a higher voltage is used, the potential drop across the bulb will be greater. How will this affect the current? We can investigate this with another water model.



Find Out!

How does increasing voltage affect current?

Time needed one class period

Materials two D-cells, two bulbs rated at 3 volts, two sockets, connecting wires

Thinking Processes comparing and contrasting, observing, interpreting scientific illustrations, recognizing cause and effect

Purpose To observe that as potential difference or voltage increases, current increases.

Preparation Three to four students can work in one group. Assign tasks, such as disconnecting and connecting bulbs, connecting batteries, and checking the circuits against the diagrams. COOP LEARN

Teaching the Activity

Science Journal Before beginning the activity, ask students to predict what will happen if they add another D-cell to a circuit that contains one D-cell. Ask students to write their predictions in their journals. After the activity, students can compare their predictions to their findings. L1

Expected Outcome

Students should observe that increasing the voltage increases the current.

Conclude and Apply

The bulbs in the second circuit shine more brightly because adding a second battery increased the potential, thereby increasing the current.

Assessment

Process Ask students to draw a diagram in their journals comparing the brightness of the bulb before and after adding the second battery. Ask students to show the relationship between voltage and current. Use the Performance Task Assessment List for Scientific Drawing in **PASC**, p. 55. L1 P

Program Resources

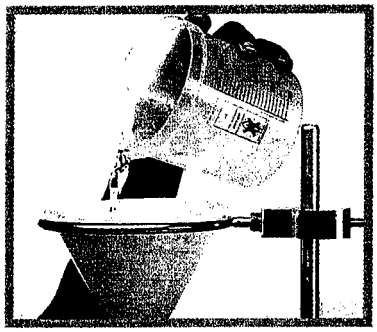
Study Guide, p. 10
Making Connections: Across the Curriculum, p. 5, Prevent Electrical Hazards L1
Section Focus Transparency 4

Multicultural Perspectives

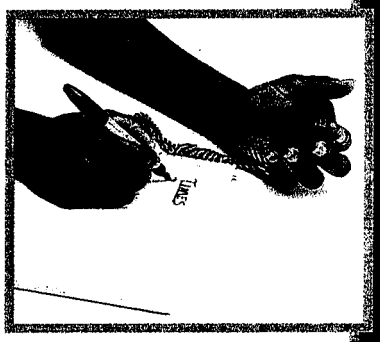
Innovations in Science

Meredith Gourdine, an African-American scientist, conducted research on producing high-voltage electricity from natural gas. His research may be applied to preserving foods, burning coal more efficiently, and desalinization. He also won a silver medal in track at the 1952 Olympic Games.

A



B



C

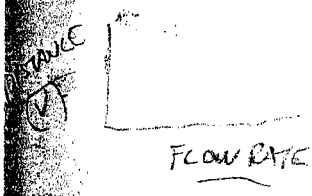
5 ***Design an experiment*** to explore the effect of higher and lower potential differences, and the effect of larger and smaller resistance on the flow of water. Show your design to your teacher. If you are advised to revise your design, be sure to check with your teacher again before you begin.

TAKES A FULL PERIOD TO DO DEMO.

DEMO - USE A CHAIR IN MIDDLE OF FLOOR
- 4-TIMERS - THROW OUT HIGH + LOW
- TAPE ON - 8mm + 10mm TUBES

Analyzing

1. Organize your data in a table. 500
2. ***Calculate*** the rate of flow of ~~100~~ mL of water at each height of the funnel.
3. ***Make a graph*** to compare funnel height and the rate of water flow. PASS OUT GRAPH PAPER
4. At what height is the rate of flow the greatest? What effect does the diameter of the tube have on the rate of water flow?



Concluding and Applying

5. If the water in this model is similar to electrical charges in a circuit, which trial corresponds to the circuit with the highest voltage? What electrical property does the hose diameter represent?
6. ***Going Further*** If the smaller diameter hose corresponds to a greater electrical resistance, what do you think will happen to the electric current if resistance is increased while the voltage remains constant? If the resistance in a circuit remains constant, what happens to the current when the voltage is increased?

Possible Procedures After measuring the height of the apparatus, students can measure the time needed for 100 mL of water to flow into the lower beaker. Students should complete several trials, lowering the funnel for each trial. Students can also complete several trials using tubing of a smaller diameter. Students should record their measurements in a data table and write their observations in their journals. COOPERATIVE LEARNING

Science Journal Ask students to write a hypothesis in their journals about the effect of potential difference and resistance on the flow of water. Students should make sure that the experiments they design test their hypotheses. L2

Expected Outcome

By observing the model, students should infer that, with a constant voltage, increasing the resistance will decrease the current.

Answers to Analyzing/ Concluding and Applying

1. Tables should organize funnel height, tube diameter, and measured time.
2. rate of flow = 100 mL ÷ measured time
3. Graph should show that a large funnel height corresponds to a high rate of flow.
4. The trial with the greatest funnel height. As the diameter decreases, the rate of water flow decreases.
5. The trial with greatest funnel height; resistance
6. The current should decrease. The current should increase.

✓ Assessment

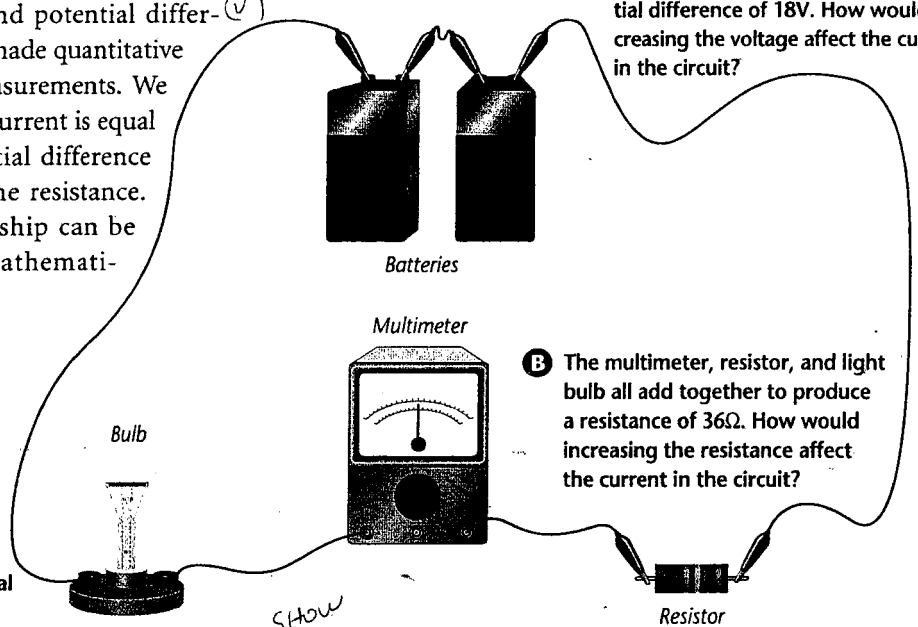
Process Have students imagine making a model using copper or steel wire, D-batteries, and a light bulb. Students should draw diagrams showing how current could be maximized by using these materials. *Using more batteries and copper wire will maximize current. Additional batteries increase the voltage, and copper wire is a better conductor and therefore has less resistance than steel wire.* Select the appropriate Performance Task Assessment List in **PASC.** L1 P

Ohm's Law

(I) Good

The relationship among current, (V) resistance, and potential difference can be made quantitative by using measurements. We can say that current is equal to the potential difference divided by the resistance. The relationship can be expressed mathematically: V/R=I.

Figure 1-11



A These two batteries produce a potential difference of 18V. How would increasing the voltage affect the current in the circuit?

B The multimeter, resistor, and light bulb all add together to produce a resistance of 36Ω. How would increasing the resistance affect the current in the circuit?

C Using the mathematical expression, V/R=I, the current in the circuit is 18V/36Ω, or 0.5A. Try calculating the current using two or three different values for voltage and resistance.

SHOW THIS

You have discovered that there is more to electricity than simply plugging something into a wall outlet. Batteries are a source of potential energy waiting to do work in a flashlight or tape player. Lights and appliances use the properties of resistance, voltage, and current.

Q+A
-VOLATE IS PROPORTIONAL TO CURRENT
-CURRENT AND RESISTANCE ARE INVERSELY RELATED

check your UNDERSTANDING

1. Two flashlight bulbs are powered by separate, identical 9-volt batteries. One bulb is dimmer. What does that imply about the resistance of the bulbs? How do the currents in the two circuits compare?
2. A piece of carbon, resistance 18Ω, is connected to a 12-V battery. Find the current in the carbon. What would be the current if a 6-V battery were used?
3. **Apply** A length of wire is cut in half, forming two shorter wires. How does the resistance of each half compare to that of the original wire? If the two short wires are placed side by side and twisted together, how does the resistance of the combination compare to the resistance of one short wire? How could you test your answers to these questions?

GLENCOE TECHNOLOGY

Software
Computer Competency Activities
Chapter 1

3 ASSESS

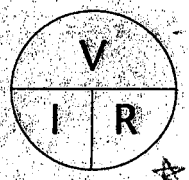
Check for Understanding

Three copper wires of unequal length were connected—one at a time—to a 1.5-V dry cell and an ammeter. Copy and complete the table using $R = \_\_$ L2

Wire	Current (A)	Resistance (Ω)
1	1.2	1.3
2	1.4	1.1
3	1.1	1.4

Reteach

Using Numbers Students often have trouble rearranging the equation V = IR. Show them the diagram below. When the desired variable is covered, the other two variables are in appropriate mathematical order. L1



PAGE 11 ELECTRICAL WIRING FUNDAMENTALS

Extension

Demonstration To help students relate current, potential difference, and resistance, set up a simple circuit by connecting a dry cell (or power source), a variable resistor, and a small light bulb. Have students explain what happens to the current and potential difference as you vary the resistance. L2

4 CLOSE

Explain that there are two main ways the parts of a circuit can be connected. Ask students to suggest different ways to arrange the elements of a circuit. L1

ENRICHMENT

Discussion To help students recognize some effects of resistors, ask them why it is desirable to have resistors in some circuits, even though the resistors appear not to do any work, such as lighting a bulb or turning a motor. To help students answer this question, adjust the volume of a portable radio, or use a dimmer switch to adjust lights. *Resistors are used to regulate current in radios, televisions, and other electrical devices.* L3

check your UNDERSTANDING

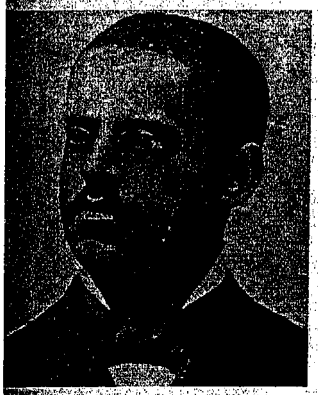
1. The resistance of the brighter bulb is lower than that of the dimmer bulb. Current is lower in the dimmer bulb.
2. Current = 0.666 A. Current = 0.333 A.
3. The resistance is less. The resistance of the two wires is less than that of one short wire. Use an ammeter.

? IS THIS CORRECT

Technology Connection Latimer's Light

Ever since Thomas Edison patented the light bulb, people have been trying to improve it.

One of the first to improve the light bulb was Lewis Howard Latimer. Latimer, a self-taught draftsman, worked for Alexander Graham Bell in the 1870s. Latimer's ability to draw detailed diagrams of complex electrical devices was invaluable. He drew the plans for Bell that resulted in the 1876 patent of the telephone.



Latimer first became associated with Thomas Edison when Edison patented the first incandescent bulb in 1879. Latimer set about making it better. His improved method for securing the carbon filament to metal wires inside the vacuum bulb was patented in 1881. Latimer continued to work on the incandescent bulb and in 1882 received what he considered his most important patent. He improved the process for producing the carbon filaments used in light bulbs.

Latimer was the only African American invited to join the Edison Pioneers, a group of scientists and inventors who worked for Edison. He was asked to supervise the installation of electrical streetlights in New York City, Philadelphia, and London.

Making Better Light Bulbs

The part of a modern light bulb that lights up is the thin tungsten wire, the filament, in the center. When an electric current passes through it, it glows. Unfortunately, some of the tungsten molecules get so hot that they vaporize, leaving the wire and adhering to the glass bulb. When enough tungsten has left the filament, the light bulb dies.

In newer bulbs, krypton gas may be used. A light bulb full of krypton gas stays relatively cool, so less tungsten gets hot enough to leave the filament. This makes the light bulb last longer at the same brightness.

If brightness is more important than long life, the krypton-filled bulb can be operated at higher filament temperatures to give a brighter light more efficiently than non-krypton-filled bulbs. Brighter krypton bulbs are used in slide and movie projectors.

One vital use for krypton light bulbs is illuminating airport runways at night. Electric-arc lights filled with krypton pierce fog for 300 meters (1000 feet) or more.

What Do You Think?

Think of several other places on Earth or in the solar system where krypton bulbs' greater brightness or longer life might be useful. NEED BATTERY, CHARGER, GENERATOR

MAKE A LIGHT BULB - CARBON (GRAPHITE PENCIL)

DEMO. - ELECTRICAL CHARGE

THE BULBS OF NEON, KRYPTON, ETC

Going Further

Help students learn to communicate their research by working in small groups to research and report on Thomas Edison's invention of the light bulb or on Edison's research group, The Edison Pioneers. Assign two group members the task of doing research. Assign one or two other students in each group the task of organizing the research, and one student per group the task of making an oral presentation to the class.

Students can work in small groups to make a chart that shows how light bulbs can be improved with bromine and krypton. Have students use both words and drawings in their charts. Display the finished charts on a bulletin board titled *Making a Better Bulb.* Select the appropriate Performance Task Assessment List in PASC. L2 GOOGLEAD

USE COMPUTER LAB FOR RESEARCH - IN ADVANCE TELL STUDENTS

EXPAND YOUR VIEW

Technology Connection

Purpose

Technology Connection extends Section 1-4, in which electric current is discussed. Lewis Latimer's invention improved the way electric current was used to produce light.

Content Background

Lewis Latimer (1848-1928), the son of a former slave, grew up in Boston. After serving in the navy during the civil war, he began his career as a draftsman. In addition to being an inventor and patent holder, Latimer was an author. His book, *Incandescent Electric Lighting,* was published in 1890.

Teaching Strategies Point out that Latimer's carbon-filament light bulb was an improvement over Edison's in that it had a better connection between the filament and the wires leading in and out of the bulb. Ask students why a weak connection would be a problem. *A weak connection might melt or break when heated, and the bulb would burn out.* L2

What Do You Think?

Answers may include the ocean bottom, an underground cave, or a planet far from the sun. L1

GLENCOE TECHNOLOGY

Videodisc

The Infinite Voyage: Miracles by Design

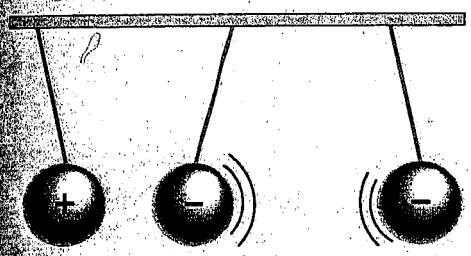
Chapter 6
New Ceramics: New Uses

Chapter 7
Ceramic Superconductors: Rapid Transportation

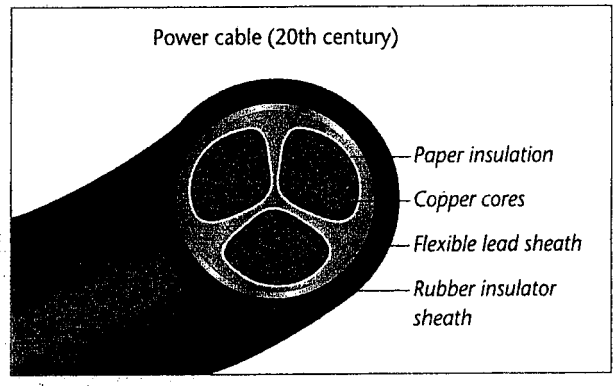
Science Journal

Review the statements below about the big ideas presented in this chapter, and answer the questions. Then, reread your answers to the Did You Ever Wonder questions at the beginning of the chapter.

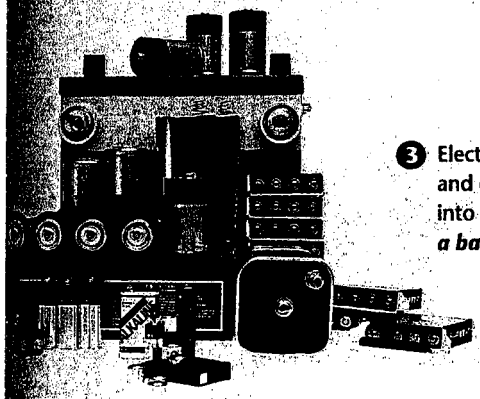
In your *Science Journal*, write a paragraph about how your understanding of the big ideas in the chapter has changed.



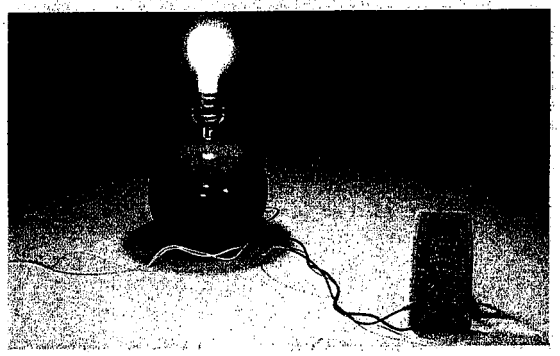
1. There are two kinds of electrical charges, positive and negative. ***How could you tell if a charge was positive or negative?***



2. Electric charges can move easily through conductors, but not through insulators. ***How could you tell if an object is an insulator or a conductor?***



3. Electrical charges flow through a circuit and do work by changing potential energy into other forms of energy. ***What role does a battery play in an electrical circuit?***



4. The three requirements of a circuit are a complete path, a source of potential difference, and resistance. Resistance depends on the material of the conductor as well as its length and thickness. ***What does resistance describe?***

chapter 1
REVIEWING MAIN IDEAS

Have students look at the illustrations and read the statements that go with each.

Teaching Strategies

Have students work in groups of four to answer the question that goes with each main idea and illustration. Tell groups to explain the concept that their photograph or diagram illustrates by suggesting another way that the same concept could be illustrated.

Students can also work in pairs to select one of the images and create a poster from it. Encourage students to recreate the drawing or photograph as a picture and add a paragraph of explanation. LOOK AHEAD

Answers to Questions

1. One could find out by comparing the unknown charge to a charge of known sign. How the unknown interacts with the known charge reveals what sign it is. Unlike charges attract one another and like charges repel one another.

2. If an object closes a gap in a circuit and current then flows through the circuit, the object is a conductor.

3. A battery is a source of potential energy. It separates positive and negative charges by a chemical reaction.

4. Resistance is a measure of how much potential energy is lost as current flows through a material. Very low resistance indicates a good conductor, and very high resistance indicates a poor conductor.

Science Journal

Did you ever wonder...

- Static cling is the attraction of opposite charges on two pieces of clothes that have just been dried in a dryer. (p. 24)
- Chemical reactions, similar to those produced in a battery, make electric eels electric. (pp. 28–29)
- One safe place to be is inside a car, because the charge would flow over the outside and to the ground. (pp. 28–29, 33)

Project

Have students use reference materials to research the origin and history of lightning rods. Tell them to relate their findings in a poster or written report. Display completed reports on a bulletin board titled *Safe Inside*. Select the appropriate Performance Task Assessment List in PASC. L1

GLENCOE TECHNOLOGY

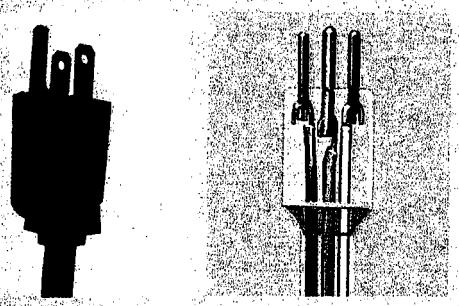
MindJogger Videoquiz

Chapter 1 Have students work in groups as they play the Videoquiz game to review key chapter concepts.

Critical Thinking

In your Journal, *answer each of the following questions.*

1. A bird can sit on a single power line wire without harm. Why? What would happen if the bird was to touch another wire of lower potential at the same time?
2. Signs often say "Danger - High Voltage." Why don't they say "Danger - High Current"?
3. Electrical cords attached to a household appliance are constructed as shown in the diagram. Explain the materials used in this construction.



4. How does turning a dimmer light switch adjust current flow?
5. If a circuit containing 1 meter of wire and three light bulbs was changed to 0.75 meter of wire and two light bulbs, what would happen to the current if the power supply was kept the same?

Problem Solving

Read the following problem and discuss your answers in a brief paragraph.

You are playing with your friends in a field. Suddenly, there is a bright flash of light. You know that a thunderstorm is coming and you had better take shelter. Nearby there is a metal building, a car, and a tree.

Which would be safe places to wait out the storm? Why? Which would be the most hazardous? Why?

CONNECTING IDEAS

Discuss each of the following in a brief paragraph.

1. **Theme—Energy** After you receive a shock from a doorknob, touching it right away a second time probably will not produce a second shock. Why? What could you do to give yourself a shock a second time?
2. **Theme—Systems and Interactions** Many times a car will not start if one of its battery terminals is covered with corrosion. Why won't the car start? How could it be fixed? What electrical property of the corrosion causes this problem?
3. **A Closer Look** Describe the role negatively charged particles play in producing lightning.
4. **Science and Society** What are two actions that you can take to decrease the hazard caused by discarded batteries?

chapter 1
CHAPTER REVIEW

3. Wire is a conductor. Rubber is an insulator to protect whomever touches it.
4. It increases or decreases the resistance by changing the length of a resistor.
5. Current would increase slightly.

Problem Solving

Inside a car or building is best because the charge stays on the outer surface of the structure. The tree would be the most hazardous place. Because it is higher than the car or the shed, it would be struck first. Electricity would then move through the tree to Earth.

Connecting Ideas

1. The body loses its charge in the first shock. Rub your feet again to gain another charge.
2. There is not enough contact on the battery terminal to complete the circuit because corrosion is an insulator. To correct it, clean off the corrosion.
3. Students should include the information that heavier negative particles form at the bottom of clouds. The bottom of the cloud repels negative charges from the ground beneath it, and this results in the ground becoming positively charged. In a discharge, large numbers of negative charges move toward Earth.
4. Students should mention using rechargeable batteries. Students should also recognize that they can take button batteries to a jewelry store to be recycled.

Assessment

Portfolio Review the portfolio options that are provided throughout the chapter. Encourage students to select one product that demonstrates their best work for the chapter. Have students explain what they learned and why they chose this example for placement into their portfolios.

Additional portfolio options can be found in the following **Teacher Classroom Resources:**

Making Connections: Integrating Sciences, p. 5
Multicultural Connections, pp. 5–6
Making Connections: Across the Curriculum, p. 5
Concept Mapping, p. 9
Critical Thinking/Problem Solving, p. 9
Take Home Activities, p. 6
Laboratory Manual, pp. 1–2; 3–4
Performance Assessment P