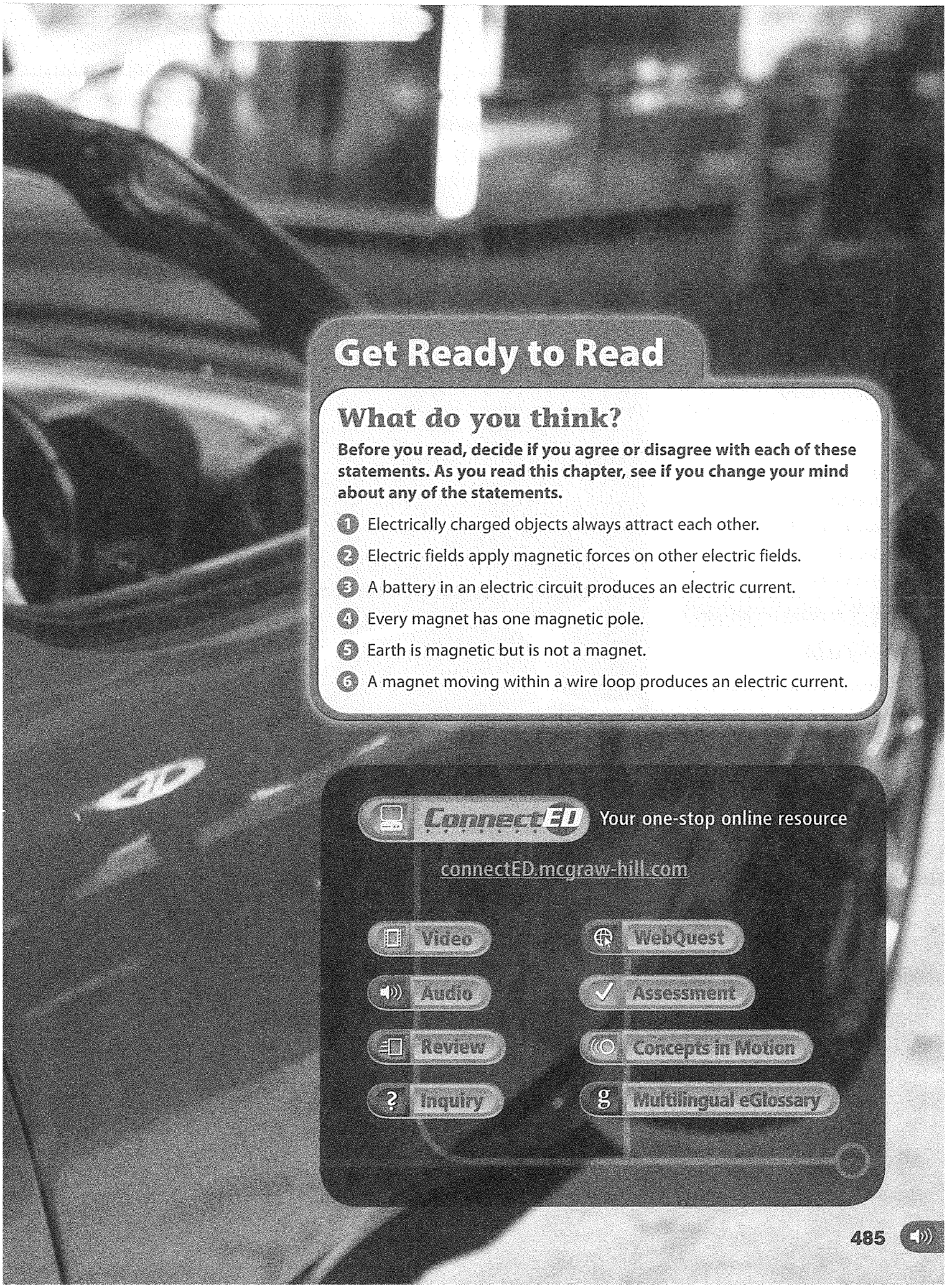

Get Ready to Read

What do you think?

Before you read, decide if you agree or disagree with each of these statements. As you read this chapter, see if you change your mind about any of the statements.

1. Electrically charged objects always attract each other.
2. Electric fields apply magnetic forces on other electric fields.
3. A battery in an electric circuit produces an electric current.
4. Every magnet has one magnetic pole.
5. Earth is magnetic but is not a magnet.
6. A magnet moving within a wire loop produces an electric current.

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Lesson 1

Electric Charges and Electric Forces

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

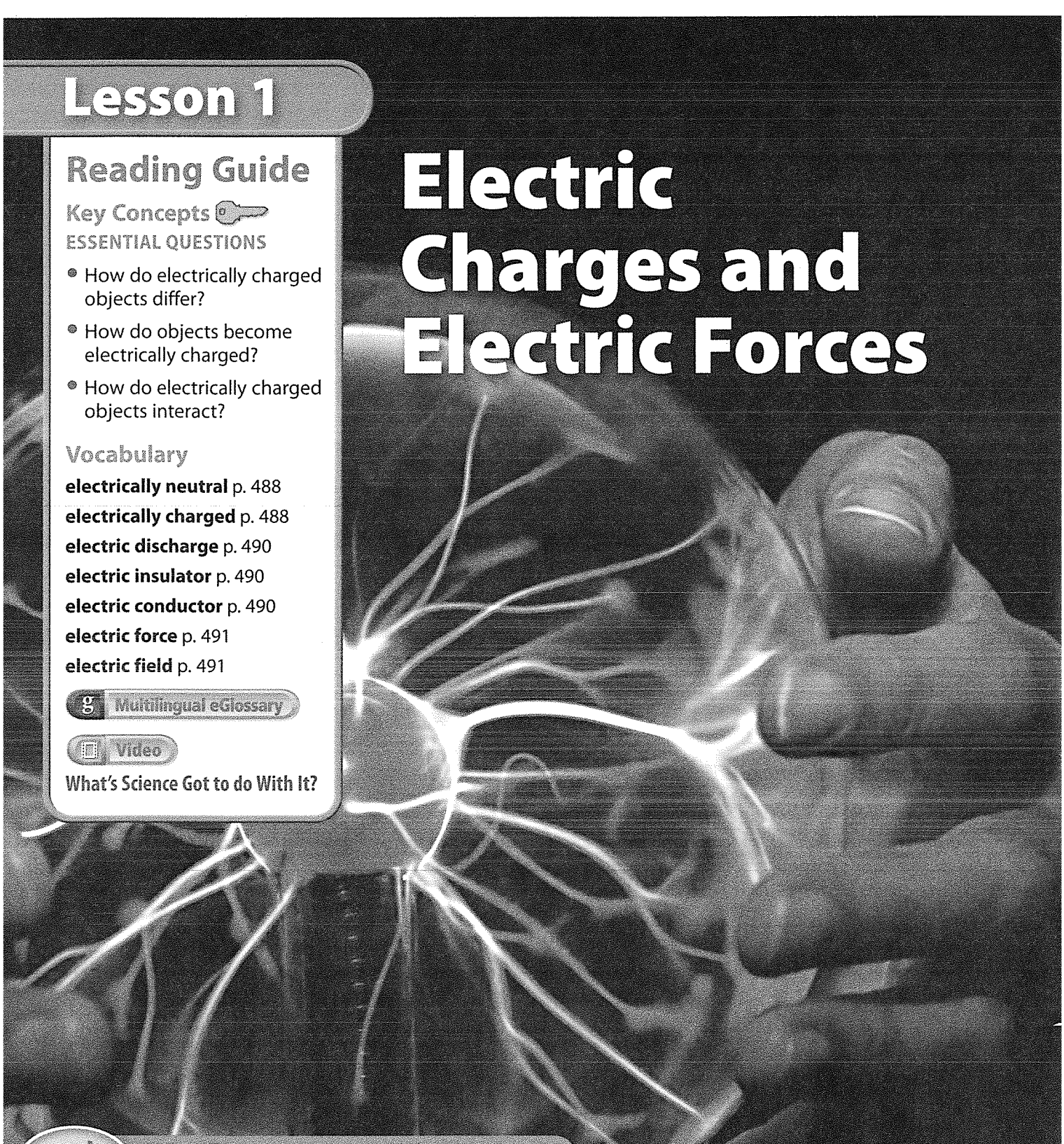
- How do electrically charged objects differ?
- How do objects become electrically charged?
- How do electrically charged objects interact?

Vocabulary

electrically neutral p. 488
electrically charged p. 488
electric discharge p. 490
electric insulator p. 490
electric conductor p. 490
electric force p. 491
electric field p. 491

Multilingual eGlossary

Video
What's Science Got to do With It?



Inquiry Lightning in a Bottle?

Whether you call them nebula spheres, plasma lamps, or lightning balls, these devices put on a fascinating display. Are you really looking at miniature bolts of lightning? This lesson will help you understand the electric charges that produce these mysterious streams of light. But, what are electric charges, and how can they be useful to you?

Inquiry Launch Lab

10 minutes

Why do they move?

Have you ever pulled a sweater out of a clothes dryer and found other items of clothing clinging to it? Maybe you heard a crackling sound or even saw sparks when you pulled the items apart. When different materials come into contact with each other, such as the clothes in the dryer, something happens to the materials. How do the materials interact? What causes their strange behaviors?

1. Read and complete a lab safety form.
2. Break a handful of **polystyrene packing pellets** into 2/3-cm pieces. Place the pieces in a **2-liter soda bottle,** and place the **cap** on the bottle.
3. Touch the bottle with a piece of **wool cloth.** Record your observations in your Science Journal.
4. Now, rub the sides of the bottle vigorously with the wool for 3 minutes. Record your observations.
5. Open and partially squeeze the bottle. Exhale into the bottle to return it to its original shape. Repeat several times to add moisture to the air in the bottle. Repeat step 4.

Think About This

1. How do the packing pellets act when you rub the bottle with the wool compared to when you simply touch the bottle with the wool?
2. How does adding moisture to the air in the bottle affect the behavior of the pellets?
3. **Key Concept** Hypothesize how the wool affects the packing pellets even though the wool does not touch the packing pellets.

Electric Charges

Have you ever walked across a carpeted floor, reached for a metal doorknob, and received a small shock? The shock comes from electric charges jumping between your fingers and the doorknob. What are electric charges? Where do they come from? Why do they jump from one object to another? In this lesson, you will learn the answers to these questions.

Recall that atoms are the tiny particles that make up all the matter around you. An atom has a **nucleus** made up of two kinds of smaller particles. These particles are protons and neutrons. An atom also is made up of electrons. Electrons move around the atom's nucleus, as shown in **Figure 1.** Protons and electrons have a property called electric charge. Neutrons do not have electric charge.

Reading Check What particles found in an atom have the property of electric charge?

Academic Vocabulary

nucleus
(noun) basic or essential part; core

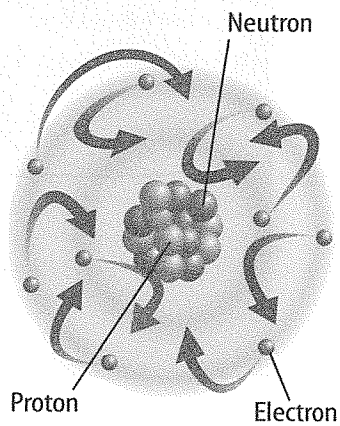
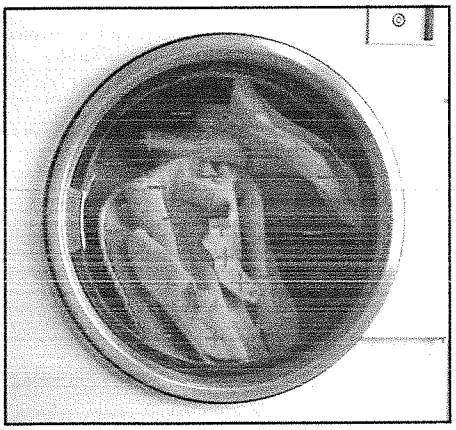


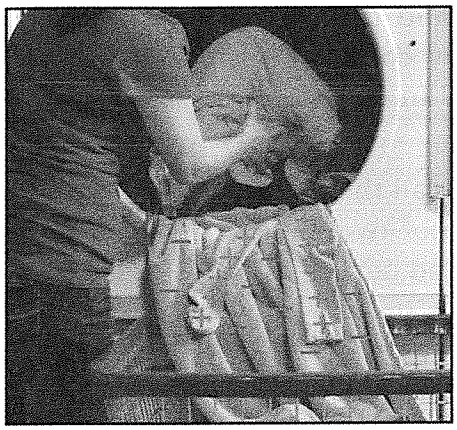
Figure 1 Atoms are made of protons, electrons, and neutrons.

Figure 2 An electrically neutral object becomes charged when it touches a different material.

Objects normally are electrically neutral. They have equal amounts of positive charge and negative charge.



When objects made of different materials come in contact with each other, negatively charged electrons move from one object to another.



Objects that lose electrons are positively charged. Objects that gain electrons are negatively charged. Oppositely charged objects attract each other.

Positive and Negative Charge

There are two types of electric charge—positive and negative. Here, *positive* and *negative* do not mean more or less. The terms are simply names scientists use to talk about the two types of electric charge.

Protons have positive charge. Electrons have negative charge. The amount of positive charge of a proton equals the amount of negative charge of an electron.

Atoms have equal numbers of positive protons and negative electrons. *A particle with equal amounts of positive charge and negative charge is* **electrically neutral.** Electrically neutral atoms make up all objects. Therefore, objects are normally electrically neutral, too. However, electrons sometimes transfer between objects. How does transferring electrons affect objects?

Reading Check Why are atoms electrically neutral?

When electrons transfer from one electrically neutral object to another, both objects become electrically charged. *An* **electrically charged** *object has an unbalanced amount of positive charge or negative charge.* Figure 2 shows that objects can be either positively charged or negatively charged.

Positively Charged An object that has lost one or more electrons has more protons than electrons. Thus, the object has more positive charge than negative charge. The object is positively charged.

Negatively Charged An object that has gained one or more electrons has more electrons than protons. Thus, the object has more negative charge than positive charge. The object is negatively charged.

Key Concept Check How do electrically charged objects differ?

Materials and Electric Charge

How do electrically neutral objects become electrically charged? The table in the MiniLab below lists some common materials in the order of how tightly they hold electrons. Wool is above rubber on the list. This means that wool does not hold electrons as tightly as rubber. Look at **Figure 3.** As the rubber balloon touches the wool toy, electrons transfer from the toy to the balloon. The balloon becomes negatively charged and the toy becomes positively charged.

On the other hand, glass is above wool on the table in the MiniLab. **Figure 3** shows that as a glass cup touches the toy, electrons transfer from the glass to the wool. In this case, the glass becomes positively charged, and the wool becomes negatively charged.

Key Concept Check How do the balloon and the stuffed toy become charged?

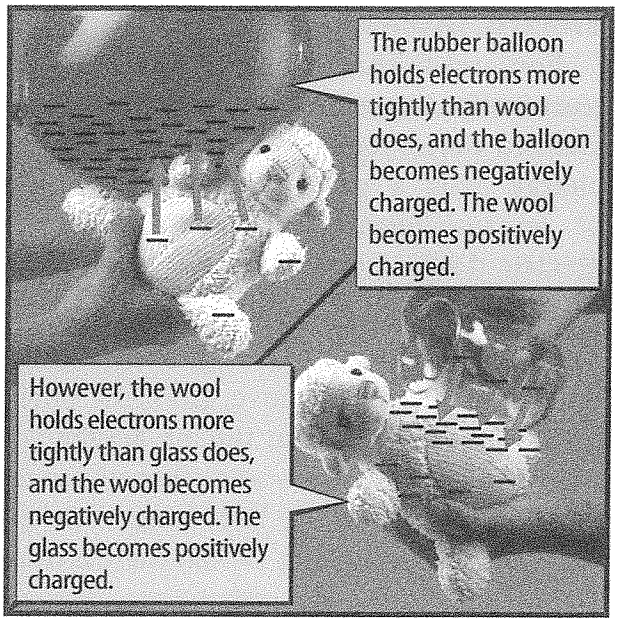


Figure 3 Whether an object becomes positively charged or negatively charged depends on the material it contacts.

Inquiry **MiniLab** 20 minutes

Can you create an electric charge?

In the table below, rubber is listed below nylon. This means that when a rubber object contacts a nylon object, electrons transfer from the nylon to the rubber. The rubber object becomes negatively charged, and the nylon becomes positively charged.

1. Read and complete a lab safety form.
2. Inflate and tie-off **two balloons.** Mark an *X* on both balloons with a **permanent marker.**
3. Select one **material** from the list above rubber and one **material** from the list below rubber.
4. Rub the marked area of each balloon on one of your materials.
5. Hold the balloons by their knots, and bring the two marked areas together. Record your observations in your Science Journal.
6. Now, rub the marked area of one of the balloons on one chosen material. Rub the marked area of the other balloon on the other chosen material. Repeat step 5.

Becomes Positive
Glass
Human hair
Nylon
Wool
Silk
Aluminum
Paper
Cotton
Wood
Rubber
Copper
Polyester
Polystyrene
Polyvinyl chloride
Becomes Negative

Analyze and Conclude

1. **Compare** the behavior of the balloons after they rub against the same material and when they rub against different materials.
2. **Key Concept** Explain how you can tell when the balloons receive the same charge and when they receive different charges.

Electric Discharge

You read that objects can become electrically charged. However, an electrically charged object tends to lose its unbalanced charge after a period of time. *The loss of an unbalanced electric charge is an* **electric discharge.**

Some electric discharges happen slowly. For example, electrons on negatively charged objects discharge, or move, from the object onto water molecules in the air. Maybe you have noticed that the static cling of electrically charged clothing lasts longer on dry days than on humid days when there is more water vapor in the air.

Some electric discharges happen quickly. For example, lightning is the sudden loss of unbalanced electric charges that build up in thunderstorm clouds. Figure 4 describes other examples of electric discharges.

Electric Insulators and Conductors

Different materials become electrically charged as they come in contact. With some materials, charges remain where the materials touched. With other materials, the charges evenly spread out over the object.

For example, after a balloon touches a sweater, charges from the sweater stay in the area of the balloon that touched the sweater. However, after you walk across a carpet, charges from the carpet spread over your entire body. Your hand receives an electric shock as you reach for a metal doorknob.

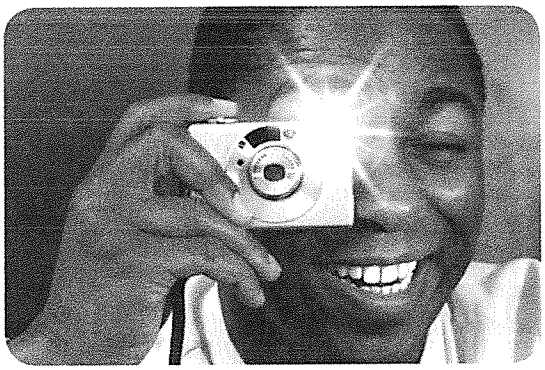
Electric charges do not spread over the balloon because electric charges cannot easily move in rubber. *A material in which electric charges cannot easily move is an* **electric insulator.** Plastic, wood, and glass are examples of electric insulators.

A material in which electric charges easily move is an **electric conductor.** Some of the best conductors are metals, such as copper.

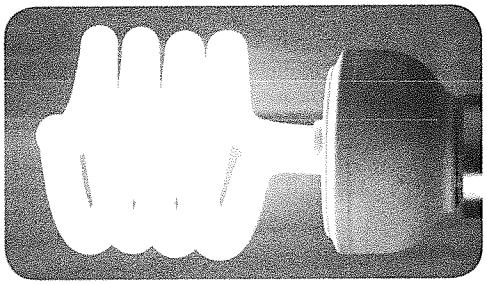
Review Personal Tutor

Figure 4 Electric discharges occur all around you.

A sudden electric discharge through the gas-filled tube of the camera flash causes the gas to produce a burst of light. ▶



◀ A steady electric discharge between the metal rod and the steel plates produces enough thermal energy to melt the metals.



A continual electric discharge through the fluorescent light causes a powder inside the tube to glow brightly. ▶

Visual Check What are some careers that use an electric discharge?

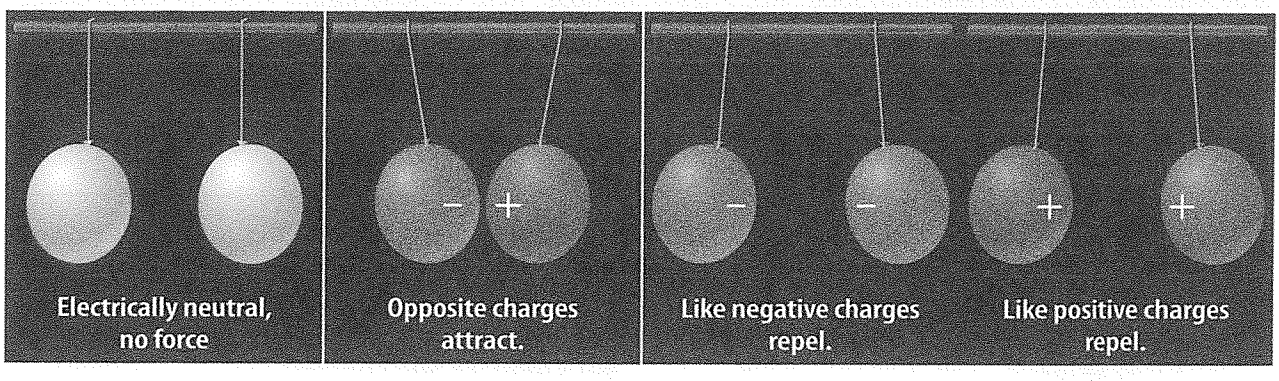


Figure 5 Charged objects push or pull on other charged objects.

Visual Check In the figure above, why do the green and red balloons attract each other?

Electric Fields and Electric Forces

Suppose you rub two balloons on a wool sweater. Electrons transfer from the sweater to the balloons. Both balloons become negatively charged. The sweater becomes positively charged. You notice that the sweater attracts, or applies a pulling force on, the balloons. However, the balloons repel, or apply a pushing force to each other. *The force that two electrically charged objects apply to each other is an* **electric force.**

Electric fields surround charged objects.

To open a door, your hand must touch the door to apply a force to it. However, an electrically charged object does not have to touch another charged object to apply an electric force to it. For example, the two charged balloons in the example above repel each other even though they do not touch.

How do charged objects apply electric forces to each other without touching? The answer is a bit of a mystery. However, scientists know there is a region around a charged object that applies an electric force to other charged objects. *This invisible region around any charged object where an electric force is applied is an* **electric field.**

Electric force depends on the types of charge.

Whether an electric force is a push or a pull depends on the types of charge on the objects, as shown in Figure 5. If both objects are positively charged or if both objects are negatively charged, the two objects push each other away. In other words, objects with the same type of electric charge repel each other.

If one object is positively charged and the other object is negatively charged, the two objects pull each other together. In other words, objects with opposite types of electric charge attract each other.

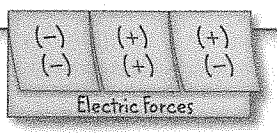
Key Concept Check How do electrically charged objects interact?

WORD ORIGIN

force
from Latin *fortis,* means "strong"

FOLDABLES®

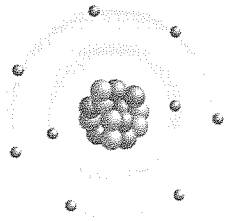
Make a horizontal three-tab book with an extended tab for the title. Label it as shown. Use it to organize your notes on the relationships between electric forces.



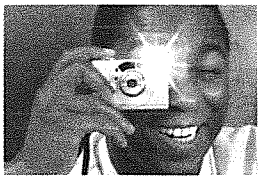
Lesson 1 Review

Assessment Online Quiz

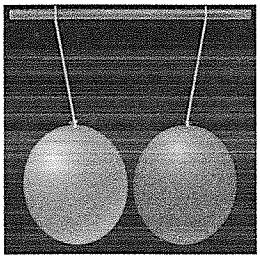
Visual Summary



Atoms are the source of all electric charge.



Electric discharges occur all around you.



The electric force between two charged objects depends on the type of charge on each object.

FOLDABLES

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

1. Electrically charged objects always attract each other.
2. Electric fields apply magnetic forces on other electric fields.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

1. **Define** *electric discharge.*
2. **Utilize** the terms *electric force* and *electric field* in a single sentence.
3. **Compare and contrast** electric insulator and electric conductor.

Understand Key Concepts

4. **Name** What are the two types of electric charge?
5. **Explain** two ways an object can become electrically charged.
6. Cotton holds electrons more tightly than wool. If a wool sweater touches a cotton shirt, the electric charge of the shirt will be

   A. negative. **C.** polarized.
   B. neutral. **D.** positive.

Interpret Graphics

7. **Organize** Copy and fill in the table below describing whether the particles in the left column will attract, repel, or exert no force on each other.

Particles	Type of Electric Force
Proton and proton	
Electron and electron	
Electron and proton	

Critical Thinking

8. **Infer** A rubber balloon and a glass cup are each rubbed with a polyester shirt. Will the cup and the balloon attract or repel each other? Explain your thinking.
9. **Assess** Is the following statement true or false? Write a short paragraph supporting your opinion. "An object with an excess of neutrons has no electric charge."