Lesson 3

Magnetism

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- What causes a magnetic force?
- How are magnets and magnetic domains related?
- How are electric currents and magnetic fields related?

Vocabulary

magnet p. 506

magnetic material p. 506

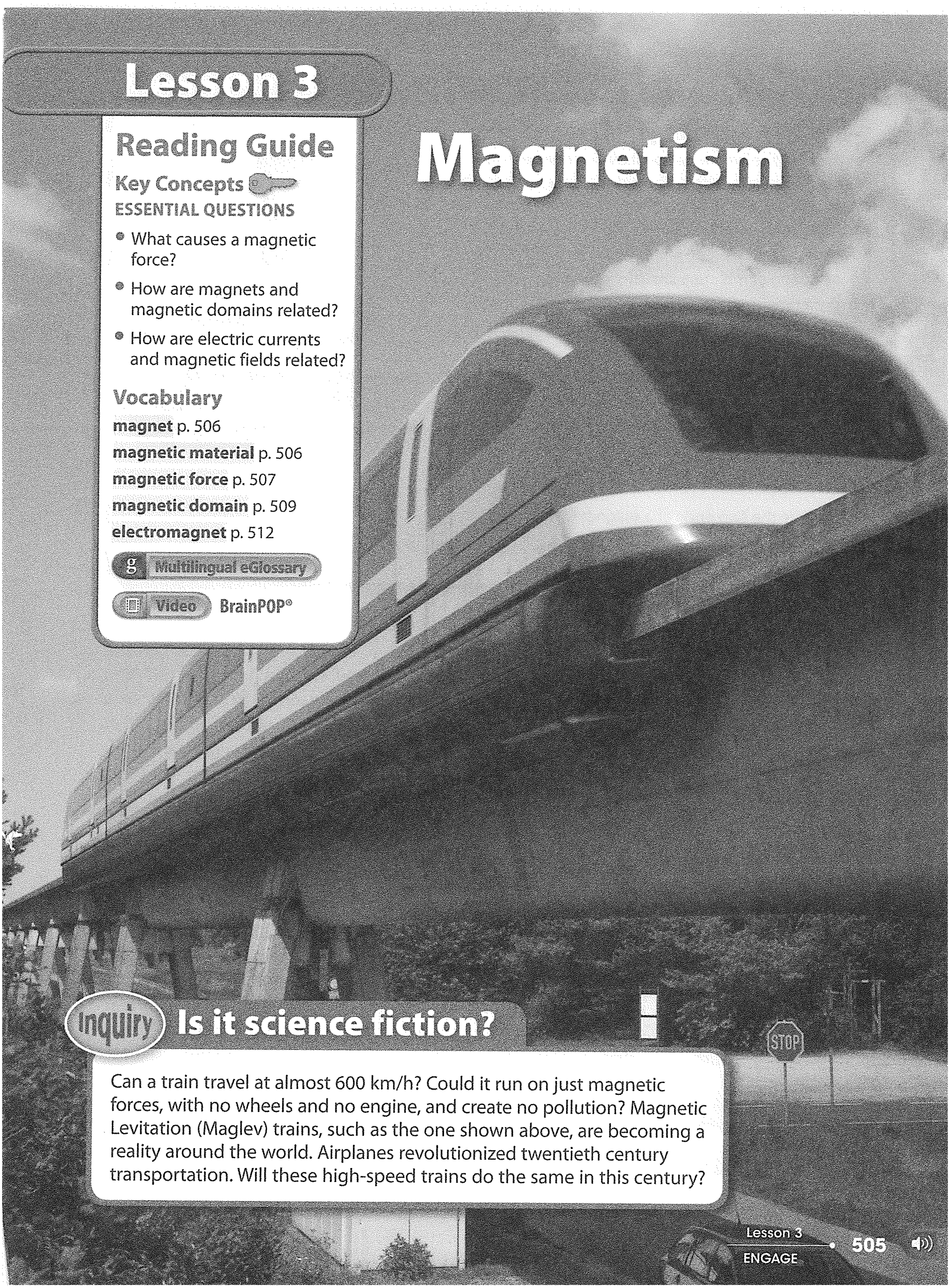
magnetic force p. 507

magnetic domain p. 509

electromagnet p. 512

g Multilingual eGlossary

Video BrainPOP®



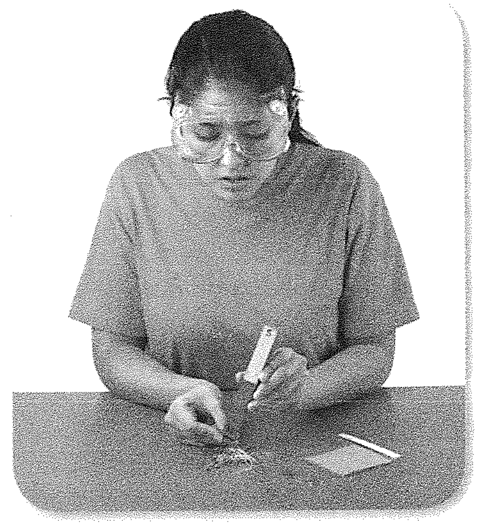
Inquiry Is it science fiction?

Can a train travel at almost 600 km/h? Could it run on just magnetic forces, with no wheels and no engine, and create no pollution? Magnetic Levitation (Maglev) trains, such as the one shown above, are becoming a reality around the world. Airplanes revolutionized twentieth century transportation. Will these high-speed trains do the same in this century?

Inquiry Launch Lab — 10 minutes

What is magnetic?

For thousands of years, people have recognized that some rocks attract others. The word *magnet* comes from the area of ancient Greece called Magnesia where magnetic rocks could be found. Now it is your turn! With what types of objects do magnets interact?



1. Read and complete a lab safety form.
2. Count the number of **paper clips** your **magnet** will pick up. Try both ends. Record your observations in your Science Journal.
3. Cover the end of the magnet with a **penny,** a **nickel,** a **craft stick,** and **two items of your choosing.** Test the number of paper clips the magnet will pick up each time. Record your observations in a data table.

Think About This

1. How are the two ends of a magnet the same?
2. **Key Concept** What types of materials are magnetic?

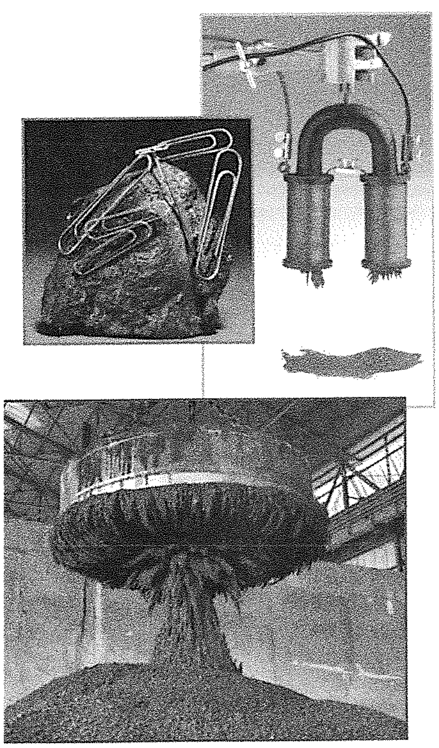


Figure 13 Many everyday devices contain magnets. Magnets come in many shapes and sizes.

What is a magnet?

How many magnets could you find in your house? You might think of the magnets holding notes and papers to a refrigerator. However, many magnets are not so obvious. For example, almost every item in your home entertainment center, including the television, the DVD player, and the computer, use magnets. Refrigerators, vacuum cleaners, and telephones use magnets too. ATM cards and credit cards use magnetized strips to hold personal information. Figure 13 shows that magnets often are found in factories, scientific laboratories, and even in nature. What is a magnet?

If you use magnets, you might know that magnets attract some objects, such as paper clips, but not other objects, such as pieces of paper. *A* **magnet** *is an object that attracts iron and other materials that have magnetic qualities similar to iron.* A magnet attracts paper clips and some nails because they contain iron. Magnets also attract other metals, such as nickel, cobalt, and alnico, which is an aluminum-nickel-cobalt alloy. *Any material that a magnet attracts is a* **magnetic material.**

Reading Check Why is the metal cobalt a magnetic material?

Magnetic Fields and Magnetic Forces

Recall from Lesson 1 that an invisible electric field surrounds an electrically charged object. In the same way, an invisible magnetic field surrounds a magnet and electric current. Even though magnetic fields are invisible, they can be detected by the forces they apply. *A* **magnetic force** *is a push or a pull a magnetic field applies to either a magnetic material or an electric current.* First, you will read about magnetic forces applied to magnetic materials. Later in this lesson, you will read about magnetic forces applied to electric currents.

WORD ORIGIN
magnetic
from Greek *magnēs*, means "stone from Magnesia," ancient city in Asia Minor

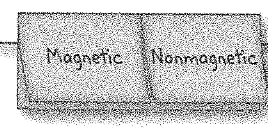
Seeing a Magnetic Field

A magnet's magnetic field applies a magnetic force to a magnetic material even if the magnet and magnetic material do not touch. A magnetic field and its force are stronger closer to the magnet and weaker farther away from the magnet.

Figure 14 helps you visualize a magnetic field. Because iron is a magnetic material, if you sprinkle iron filings around a magnet, they will line up with the magnet's magnetic field. These curved lines are called magnetic field lines.

FOLDABLES®

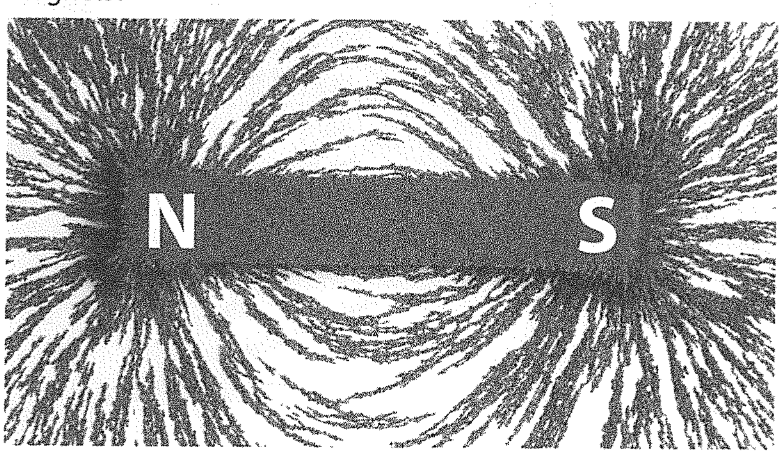
Create a horizontal two-tab book. Label it as shown. Use it to describe and to collect examples of magnetic and non-magnetic materials.



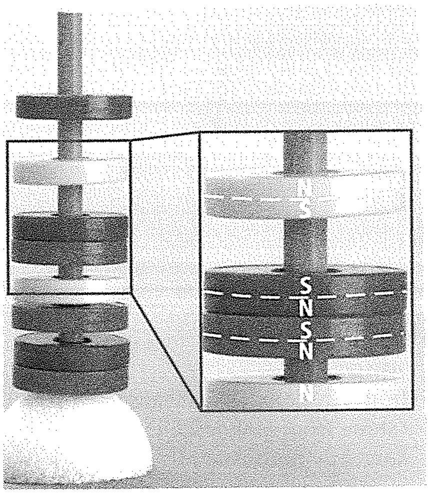
Magnetic Poles

Magnets are made in many sizes and shapes. However, all magnets have something in common—every magnet has two magnetic poles. One pole of a magnet is called the magnetic north pole. The other pole is called the magnetic south pole. The magnetic poles are the two places on a magnet where the magnetic field lines are closest together. This is also where the magnetic field applies the strongest force. Magnetic field lines point away from the magnet's magnetic north pole and toward the magnet's magnetic south pole. For a bar magnet, as shown in **Figure 14**, the ends of the magnet are the magnetic poles.

Key Concept Check What causes the forces applied by magnets?



◀ **Figure 14** An invisible magnetic field can be shown with iron filings.



▲ Figure 15 Similar, or like, magnetic poles repel; opposite magnetic poles attract.

Visual Check How do the disc magnets illustrate a magnetic attraction?

Concepts in Motion

Animation

Magnetic Poles and Magnetic Forces

The forces that magnets apply to each other depend on which magnetic poles are near each other. Figure 15 shows the interaction of the magnetic poles of several disc magnets that are near each other. If two magnetic south poles or two magnetic north poles are close to each other, the magnets repel, or push away from each other. This repulsion causes the one disc magnet to "float" on the invisible magnetic field. If a magnet's magnetic north pole is near another magnet's magnetic south pole, the magnets attract each other. In Figure 15, this attraction causes the magnets to come together. In other words, similar poles repel, opposite poles attract.

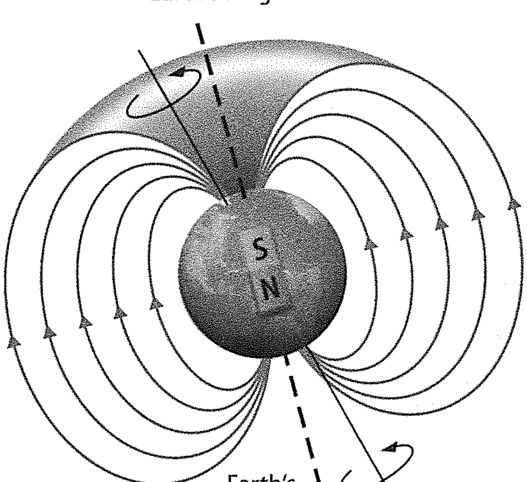
Earth as a Magnet

How does a magnetic compass help you find Earth's geographic North Pole? A compass needle is just a small bar magnet. As with all magnets, a magnetic field surrounds a compass needle.

Flowing molten iron and nickel in Earth's outer core create a magnetic field around Earth. Therefore, Earth has a magnetic north pole and a magnetic south pole, too. Recall that the opposite poles of two magnets attract each other. Thus, the compass needle's magnetic north pole points toward Earth's magnetic south pole, as shown in Figure 16. This means that Earth's magnetic south pole is actually near Earth's geographic North Pole.

Reading Check Which of Earth's geographic poles is about in the same location as Earth's magnetic south pole?

Figure 16 Earth is surrounded by a magnetic field. Earth's magnetic south pole is near Earth's geographic North Pole. ▼



Magnets

Why do magnets attract only some materials? Remember, all matter is made of atoms. A magnetic field surrounds each atom. In some materials, atoms are grouped in magnetic domains. *A* **magnetic domain** *is a region in a magnetic material in which the magnetic fields of the atoms all point in the same direction.* The magnetic fields of the atoms within a domain combine into a single field around the domain. Think of a magnetic domain as a tiny magnet within a material.

Nonmagnetic Materials

Most materials, including aluminum and plastic, do not have atoms grouped in magnetic domains. Part a) of **Figure 17** shows how the magnetic fields of the atoms of the plastic comb point in many different directions. The random magnetic fields cancel out the magnetic effects of each other. These nonmagnetic materials cannot be made into magnets.

Magnetic Materials

In some materials, such as iron and steel, atoms are grouped in magnetic domains. These materials are called magnetic materials. However, not all magnetic materials are magnets. As shown in part b) of **Figure 17**, the magnetic fields of the domains of the steel nail point in different directions. The magnetic fields of these domains cancel out the magnetic effects of each other. Here, the magnetic material is not a magnet.

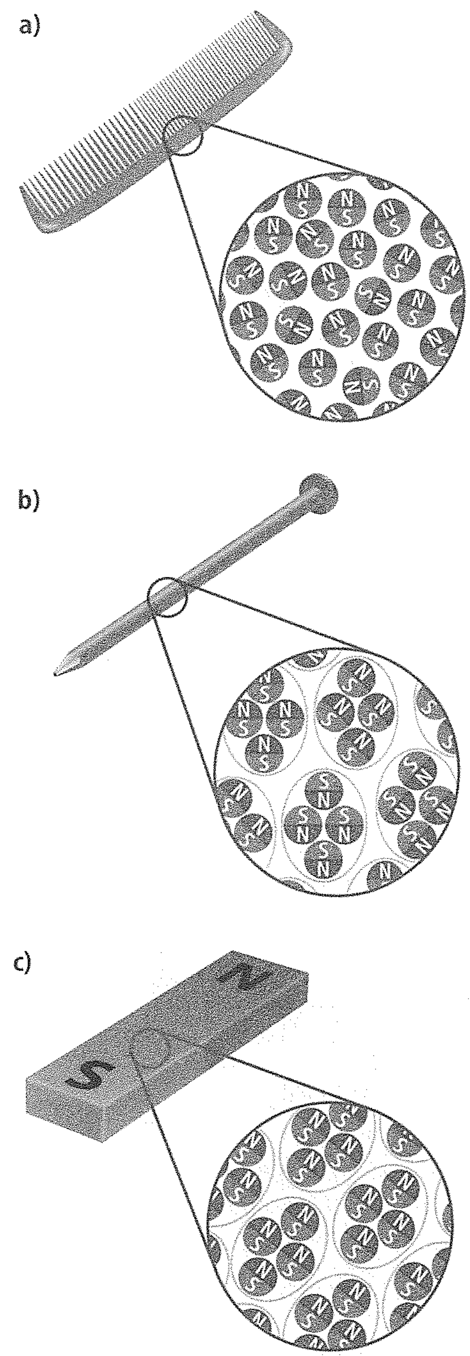
A magnetic material becomes a magnet as the magnetic fields of the material's magnetic domains line up to point in the same direction. Part c) of **Figure 17** shows the aligned magnetic fields of the magnetic domains of a bar magnet. The magnetic fields of the domains combine to form a single magnetic field around the entire object. In this case, the magnetic material is a magnet.

Key Concept Check How are magnets and magnetic domains related?

Magnetic Domains

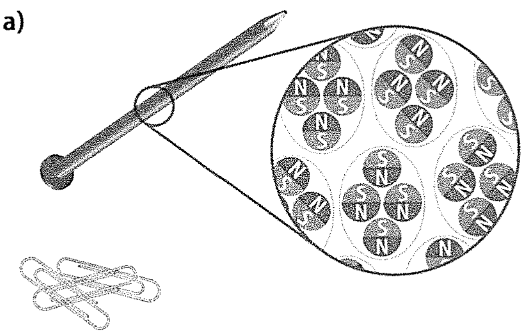
Figure 17 Atoms of magnetic materials are grouped in magnetic domains.

Concepts in Motion Animation



Visual Check How are magnetic domains and nonmagnetic materials related?

a)



b)

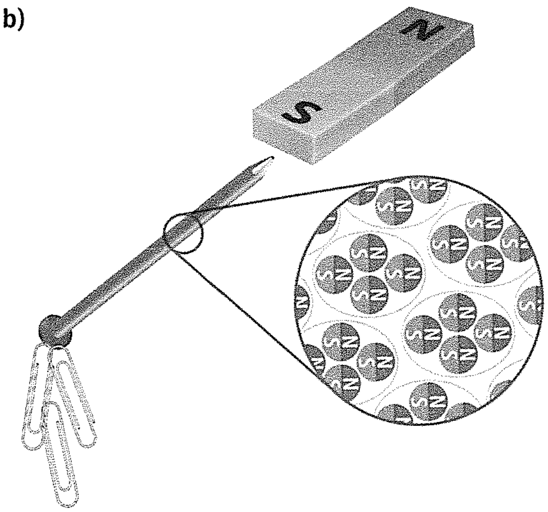
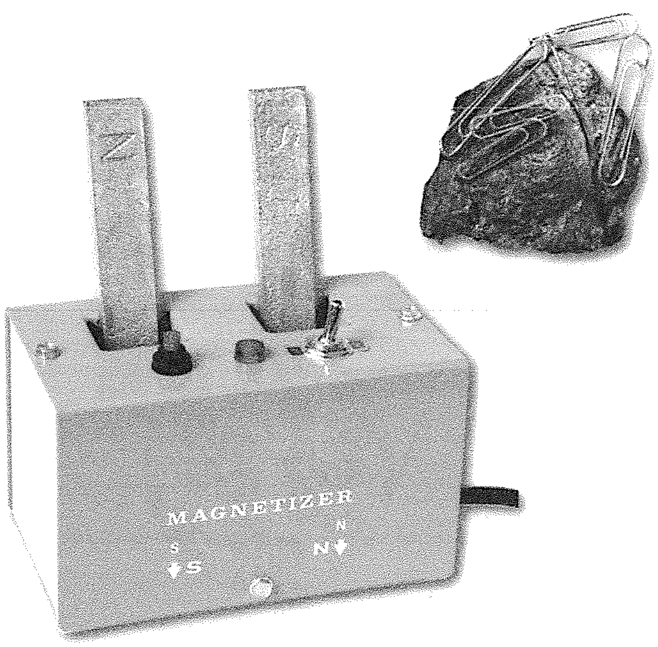


Figure 18 A nail becomes a temporary magnet when it is near a permanent magnet.



▲ Figure 19 Lodestone is a natural permanent magnet. A permanent magnet can be made in a laboratory with an electric magnetizer.

Temporary and Permanent Magnets

Some magnetic materials lose their magnetic fields quickly. Others keep their magnetic fields for a long time. How long a magnet remains a magnet depends partially on the material from which it is made. A soft magnetic material is not soft to the touch. It is called soft because it quickly loses its magnetic field. A material that keeps its magnetic field for long periods of time is called a hard magnetic material.

Temporary Magnets Placing a soft magnetic material, such as iron, in a strong magnetic field causes the material's magnetic domains to line up. This makes the material a magnet. When the object is moved away from the magnetic field, its domains return to their random positions, and the material is no longer a magnet. In part a) of Figure 18, the nail is not a magnet. However, in part b), the nail is a magnet. This is because the bar magnet's field causes the magnetic fields of the nail's domains to line up. Thus, the nail becomes a magnet. The nail is a temporary magnet because it attracts other magnetic materials only as long as it is within the magnetic field of another magnet.

Reading Check Why do soft magnetic materials make temporary magnets?

Permanent Magnets Hard magnetic materials are mixtures of iron, nickel, and cobalt combined with other elements. When placed in an extremely strong magnetic field, the magnetic domains of a hard magnetic material align and lock into place. Unlike a temporary magnet, when a magnet made this way is removed from the strong magnetic field, the object remains a magnet permanently. A naturally occurring permanent magnet called lodestone is found in Earth's crust. Other permanent magnets can be made with electric devices called magnetizers, as shown in Figure 19.

Combining Electricity and Magnetism

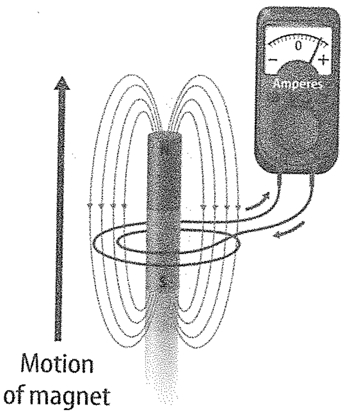
In 1820, the Danish scientist Hans Christian Ørsted noticed that a compass needle moved when a nearby electric current was switched on. He was convinced there was a relationship between electricity and magnetism. Today, we call this relationship electromagnetism. Almost all the electrical devices in your home—anything that uses an electric motor—depend on electromagnetism.

Magnetic fields produce electric currents.

Recall that a generator is a machine that produces an electric current. **Figure 20** shows how you can make a simple generator. All you need is a small wire coil connected in a circuit and a magnet. If you move the magnet through the center of the coil, the magnet's magnetic field moves over the loops of the coil. As the magnetic field moves over the coil, this forces an electric current to flow through the circuit. If the magnet stops moving, the current stops, too.

More complex generators use wire coils with more loops and stronger magnets that rotate in place. The students to the left in **Figure 21** are using a hand-cranked generator. Turning the crank rotates a magnet within a small wire coil. This produces enough electric current for them to complete their experiment. However, huge generators, such as the one shown to the right of **Figure 21**, use coils with several kilometers of wire and giant magnets to produce the electric current that is supplied to homes, buildings, and cities.

Key Concept Check How do electric currents and magnetic fields interact?

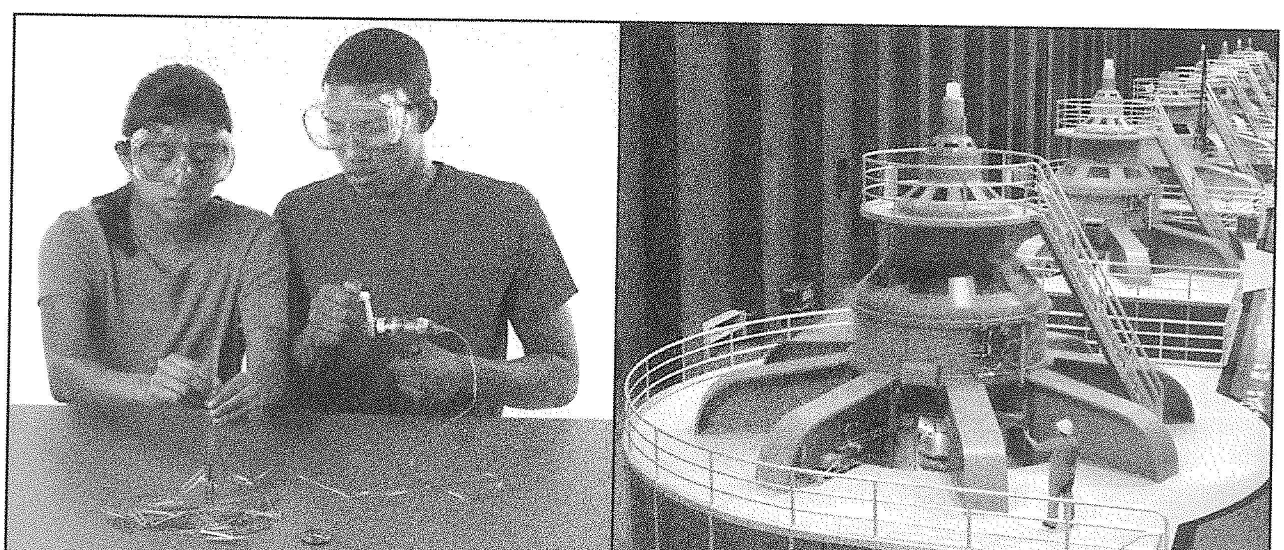


▲ **Figure 20** A magnetic field moving over a wire coil produces a current in a circuit.

Concepts in Motion **Animation**

Figure 21 An electric generator uses a magnet and wire coil to produce an electric current.

Review **Personal Tutor**



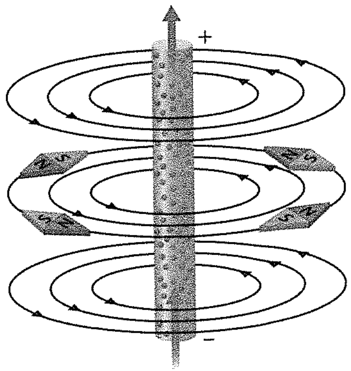


Figure 22 The magnetic field around the current-carrying wire is shown as a series of circles.

Electric currents produce magnetic fields.

You read that some magnetic materials become temporary magnets when placed in the magnetic field of another magnet. There is another type of temporary magnet that is very common and useful.

Hans Ørsted discovered that a magnetic field surrounds a current-carrying wire, as shown in Figure 22. If a current-carrying wire is wound into a coil, the magnetic field becomes stronger. If you place a soft magnetic material within the coil, the magnetic field becomes even stronger. *A temporary magnet made with a current-carrying wire coil wrapped around a magnetic core is an* **electromagnet.**

Electromagnets are useful because they can be controlled in ways other magnets cannot. First, an electromagnet's magnetic field can be turned off and on. Turning off the electric current in the coil turns off the magnetic field. Second, the north and south poles of the electromagnet reverse if the current reverses. And finally, the strength of an electromagnet can be controlled with the number of loops in the coil and the amount of electric current in the coil.

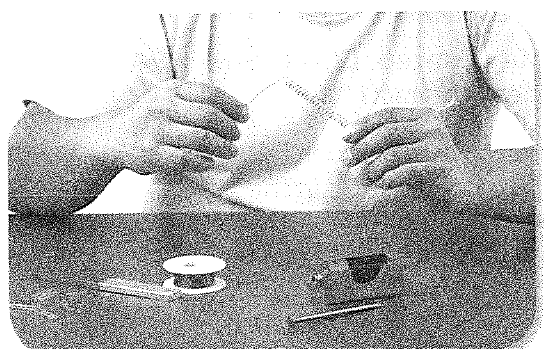
Inquiry MiniLab

20 minutes

What determines the strength of an electromagnet?

Electromagnets do things that permanent magnets cannot. They can be turned off and on, and their strength can be changed. As a result, many modern electrical devices use electromagnets.

1. Read and complete a lab safety form.
2. Wrap half of 150 cm of **enamel-coated magnet wire** around a **straw.** Leave a short tail at each end of the wire.
3. How many **paper clips** can the coil pick up? How does it interact with another magnet? Record your observations in your Science Journal.
4. With **sandpaper,** scrape the insulation off the ends of the wire.
5. Connect the wire to a **D-cell battery.**
6. Now, how many paper clips can the coil pick up? How does it interact with another magnet? Disconnect the battery.
7. Write a plan to test the effect of the following on your electromagnet: amount of current in the coil, number of loops in the coil, and the direction in which the battery is connected. Record your plan.



8. When your teacher has approved your plan, conduct your tests.

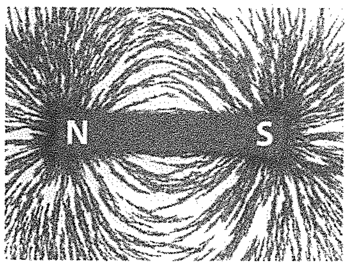
Analyze and Conclude

1. Critique your plans for testing your electromagnet.
2. **Key Concept** Explain the relationship between electric current and the strength of the magnetic field.

Lesson 3 Review

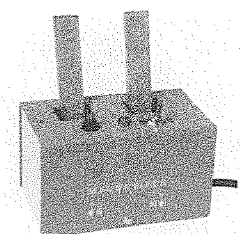
Assessment Online Quiz

Visual Summary



An invisible magnetic field can be shown with iron filings.

An electromagnet is a current-carrying wire coil wrapped around a magnetic core.



Magnets occur in nature. They also can be made from magnetic materials.

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.

5. Earth is magnetic but is not a magnet.

6. A magnet moving within a wire loop produces an electric current.

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

Use Vocabulary

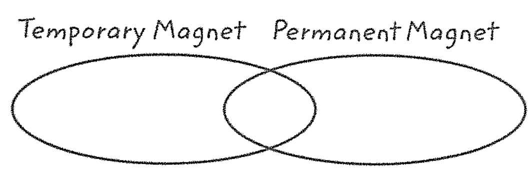
1. An object that attracts iron is a(n) ________.
2. **Distinguish** between magnetic materials and nonmagnetic materials.
3. **State** in a sentence the relationship between an electric current and an electromagnet.

Understand Key Concepts

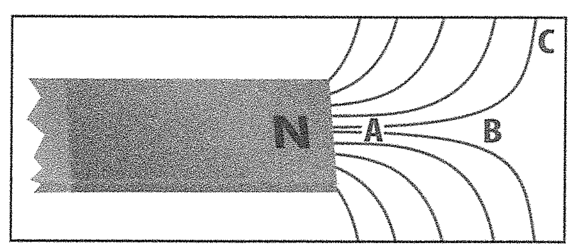
4. **Explain** what causes a magnetic force.
5. **State** the relationship between magnetic domains and magnetic materials.
6. An electric current produces
   - **A.** a magnetic field.
   - **B.** electric charges.
   - **C.** magnetic domains.
   - **D.** magnetic materials.

Interpret Graphics

7. **Organize** Copy and fill in the graphic organizer below to compare and contrast temporary and permanent magnets.



8. **Describe** the strength of the magnetic field at points A, B, and C in the image below. Explain your answer in terms of the magnetic field lines.

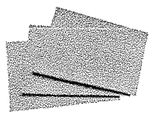


Critical Thinking

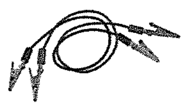
9. **Infer** why soft magnetic materials are used as cores in electromagnets.

Materials

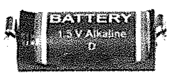
large paper clips



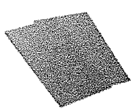
fine sand paper



alligator clip wires

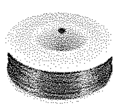


D-cell battery in holder

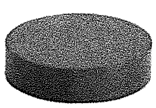


foam board

pushpins



magnet wire



strong magnet

Safety

How can you control the speed of an electric motor?

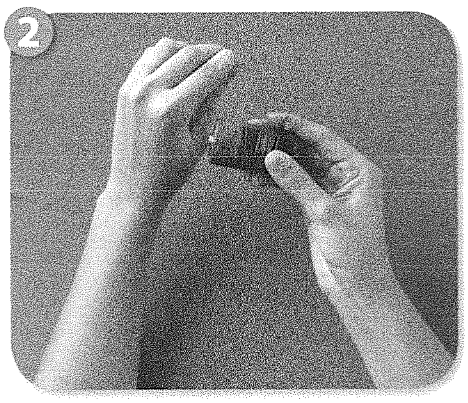
Electric motors are everywhere! They convert electric energy to motion. In most electric motors, magnetic forces between the fields of a permanent magnet and a rotating electromagnet make the electromagnet turn. Fans, hair dryers, and many battery-operated toys use electric motors. What other examples can you think of?

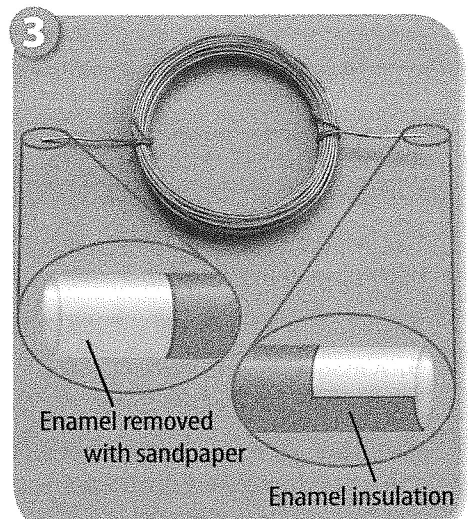
Question

How do the different parts of an electric motor affect its performance?

Procedure

1. Read and complete a lab safety form.
2. Wrap the magnet wire around a D-cell battery. Leave 5-cm tails at each end of the coil. Remove the coil from the battery.
3. Wrap the tails once around the coil so that the coil is held together and the wires stick straight out perpendicular to the coil.
4. Lay the coil flat on the table. Using sand paper, scrape the insulation off the visible side of the tails. Flip the coil over and scrape the insulation off one of the two tails.
5. Unfold each paper clip to form two S shapes. Using pushpins, attach the paper clips to the board, as shown in the photograph on the next page.
6. Place the magnet on the board, between the paper clips.
7. Suspend the coil by its tails in the hooks formed in the paper clips.
8. Using alligator clip wires, connect the paper clips to the terminals of the D-cell's holder. Give the coil a twist, and watch it spin rapidly.





Form a Hypothesis

9. After observing the behavior of your motor, formulate a hypothesis about how you could alter the speed of your motor.

Test Your Hypothesis

10. Develop a plan to alter the speed of your motor. Record your plans in your Science Journal.
11. Have your teacher approve your plans and procedure.
12. Test your hypothesis and record your results.

Analyze and Conclude

13. **Create** a flow chart showing the transfer of energy in this system.
14. **Explain** how you altered the speed of the motor.
15. THE BIG IDEA **The Big Idea** How are moving electric charges and magnetic fields related in a motor?

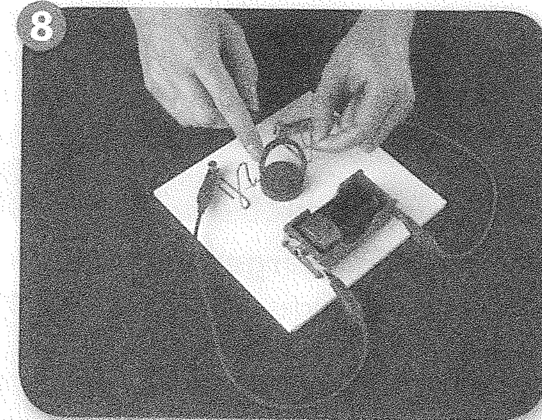
Communicate Your Results

Imagine you are an entrepreneur living in the time shortly after electric motors were invented. You want people to give you money so you can invent and sell a device that contains an electric motor. Create a brochure that explains to your investors how motors work and what you plan to do with motors.

Inquiry Extension

There are a number of factors that might be important in the design of an electric motor. For example, does it matter if the coil is round? How does the number of loops affect the motor? Will an electromagnet work in place of a permanent magnet? Write a short report that lists some possible variables that could affect the performance of an electric motor. Include your predictions of the effects of changing those variables.

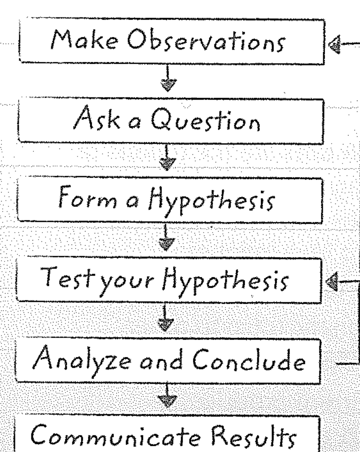
8



Lab Tips

- ☑ Hold the tails and spin the coil between your fingers. It should spin easily and not feel lopsided.
- ☑ Do not scrape the insulation off the coil!
- ☑ If your motor does not spin, be sure that the insulation has been scraped completely off one of the coil tails and half off the other tail.
- ☑ If your motor spins haphazardly, be sure that the tails are centered on the coil.

Remember to use scientific methods.



Chapter 15 Study Guide

WebQuest

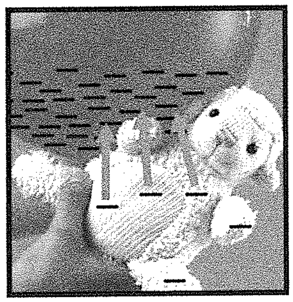
Electromagnetism is the term that describes the relationship between electricity and magnetism. An electric current produces a magnetic field, and a magnet's magnetic field can cause an electric current.

THE BIG IDEA

Key Concepts Summary

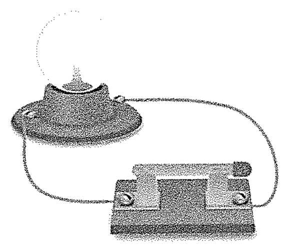
Lesson 1: Electric Charges and Electric Forces

- **Electrically charged** particles can be negatively charged or positively charged.
- When different materials touch, negatively charged electrons will move from one of the objects to the other.
- Electrically charged objects apply an **electric force** to each other. Objects with similar charges repel each other and objects with opposite charges attract each other.



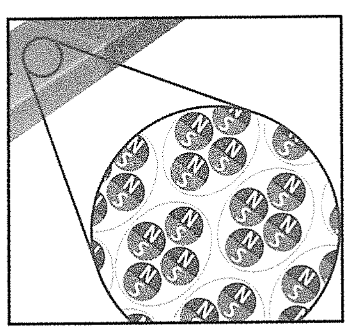
Lesson 2: Electric Current and Electric Circuits

- An **electric current** is the flow of electric charges.
- Most **electric circuits** contain the following basic components: a source of electric energy, a useful device, a closed path, a switch, and a safety cutoff.
- A series circuit has only one conducting path for all devices in the circuit. A parallel circuit has a separate path, or branch, for each device.



Lesson 3: Magnetism

- **Magnetic domains** are the groups of atoms in a magnetic material whose magnetic poles must be aligned for the material to be a magnet.
- The magnetic field around a magnet applies a magnetic force to other **magnetic materials.**
- An electric current produces a magnetic field, and a magnetic field can produce an electric current.



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

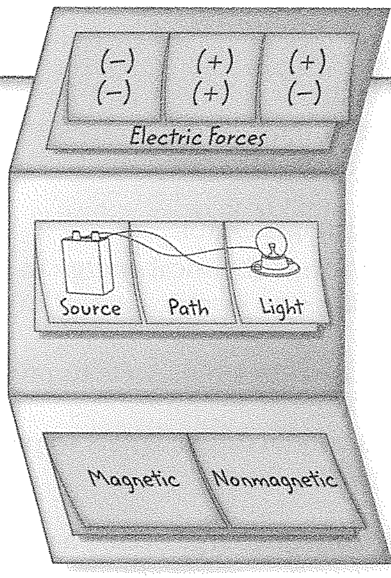
electric current p. 495
electric circuit p. 497
generator p. 498
electric resistance p. 499
voltage p. 501

magnet p. 506
magnetic material p. 506
magnetic force p. 507
magnetic domain p. 509
electromagnet p. 512

Review
- Personal Tutor
- Vocabulary eGames
- Vocabulary eFlashcards

FOLDABLES® Chapter Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.



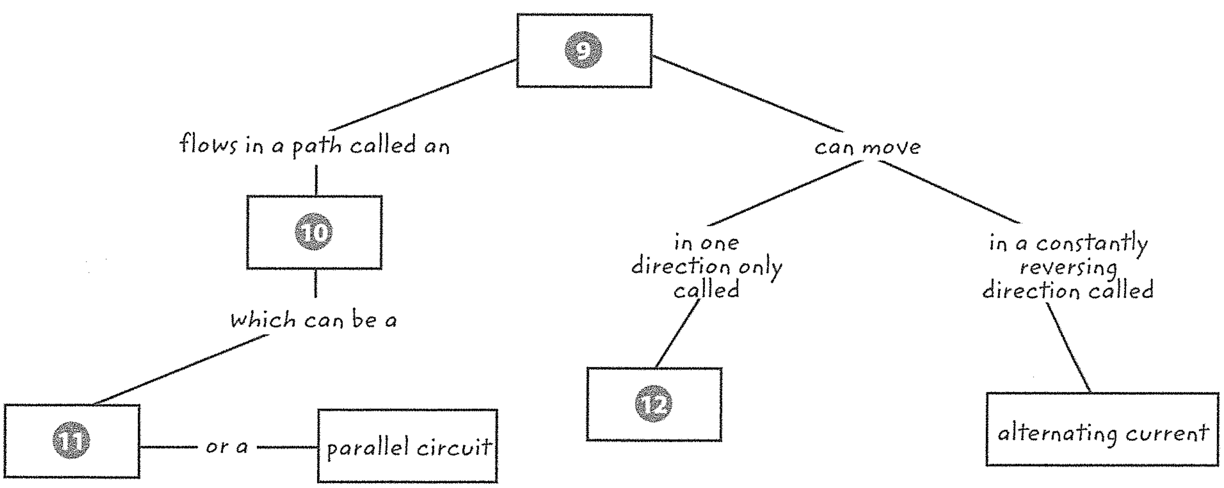
Use Vocabulary

1. A(n) ________ object has balanced positive and negative charges.
2. Define the term *electric insulator* in your own words.
3. Distinguish between electrically charged and electrically neutral.
4. A measure of the energy transferred by the flow of one coulomb of electrons in a circuit is ________.
5. Use the terms *generator* and *magnet* in one complete sentence.
6. Describe the effect of electric resistance on an electric current.
7. A closed path in which electric charges can flow is a(n) ________.
8. Explain two ways an electromagnet can be controlled.

Link Vocabulary and Key Concepts

Concepts in Motion Interactive Concept Map

Copy this concept map, and then use vocabulary terms from the previous page and other terms from the chapter to complete the concept map.



Chapter 15 Review

Understand Key Concepts

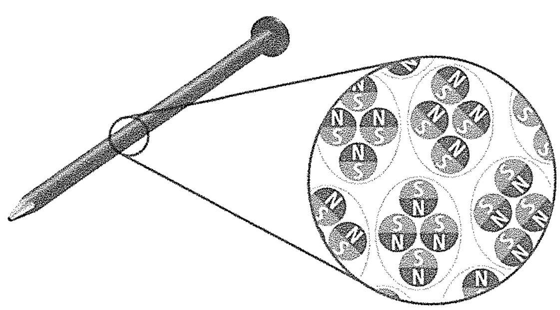
1. Which is a measure of the electric energy a coulomb of electric charge transforms by flowing through a circuit?
   - A. voltage
   - B. resistance
   - C. electric force
   - D. electric current

2. When the switch in a circuit opens, which of the following stops?
   - A. current
   - B. resistance
   - C. static charge
   - D. total charge

3. A magnet sticks to a refrigerator door. Therefore, the door must be
   - A. a magnet.
   - B. electrically charged.
   - C. made of a magnetic material.
   - D. probably not electrically grounded.

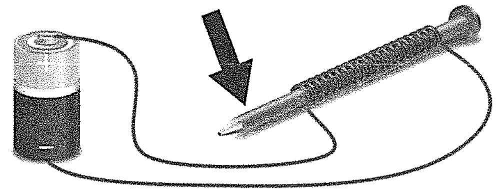
4. An electric current
   - A. flows easily in an insulator.
   - B. flows through an open switch.
   - C. is produced by a generator.
   - D. is produced by an electric motor.

5. The picture below shows the magnetic domains of a(n)



   - A. insulator.
   - B. magnet.
   - C. magnetic material.
   - D. nonmagnetic material.

6. In the diagram below, the arrow points to the electromagnet's

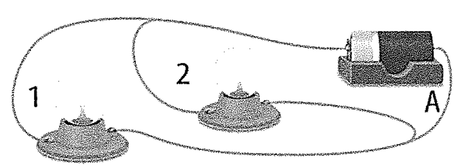


   - A. coil.
   - B. domain.
   - C. hard magnetic core.
   - D. soft magnetic core.

7. An electric generator
   - A. transforms chemical energy to motion.
   - B. produces an electric current in a wire coil.
   - C. uses two electromagnets to produce motion.
   - D. uses conducting magnets to produce a current.

8. An electric discharge occurs as
   - A. electrically neutral objects repel each other.
   - B. negative electric charges move onto a negatively charged object.
   - C. positive electric charges move onto a positively charged object.
   - D. unbalanced electric charges become balanced.

9. Which lightbulb(s) in the diagram below will remain lit if the wire breaks at point A?



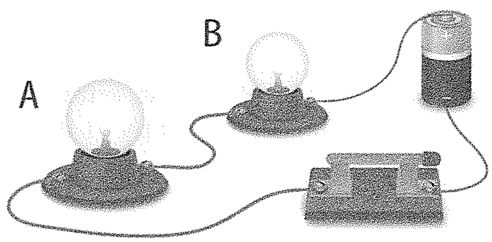
   - A. both
   - B. bulb 1 only
   - C. bulb 2 only
   - D. neither

Critical Thinking

10 **Create** Design a graphic organizer that compares and contrasts electric charges and magnetic poles.

11 **Evaluate** Dry air is a better electric insulator than humid air. Would the electric discharge from a charged balloon happen more slowly in dry air or humid air? Explain your answer.

12 **Modify** How could you change the electric circuit shown below to allow lightbulb A to stay lit even if lightbulb B is removed from its base?



13 **Hypothesize** Both soft magnetic materials and hard magnetic materials are hard to the touch. What then is the difference between these two types of materials?

14 **Solve** Suppose all the lights in a room go out when you plug an electric heater into a wall outlet. What would you do to get the lights back on? Explain your thinking.

15 **Assess** Suppose lightbulb A and lightbulb B are connected in a series circuit. The voltage across lightbulb A is greater than the voltage across lightbulb B. Which lightbulb would you expect to be brighter? Explain your answer.

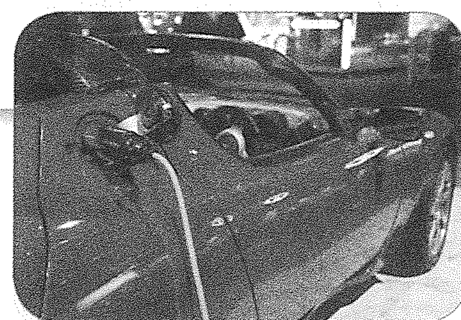
Writing in Science

16 **Write** Picture yourself as an electric charge flowing through an electric circuit. Write a three-paragraph story describing your trip through the entire circuit. Use as many Lesson 2 vocabulary words as possible.

REVIEW THE BIG IDEA

17 How are electricity and magnetism related?

18 How are electricity and magnetism used together in this sports car?



Math Skills

Review
Math Practice

Using Fractions

19 Four identical lightbulbs are connected in series to a 30-V battery. What is the voltage across each lamp?

20 An electric motor and a lightbulb are connected in a series circuit that is plugged into a 120-V wall outlet. The voltage across the motor is 100 V.

a. What is the voltage across the lightbulb?

b. What fraction of the energy from the wall outlet transforms in the electric motor?

c. What fraction of the energy coming from the wall outlet transforms in the lightbulb?

21 Three lights connected to a battery in a series circuit have voltage of 3 V, 4 V, and 5 V.

a. What is the voltage of the battery?

b. What portion of the battery's energy is transformed in each of the lights?

Standardized Test Practice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Multiple Choice

1 Which statement best describes how a balloon could become positively charged?

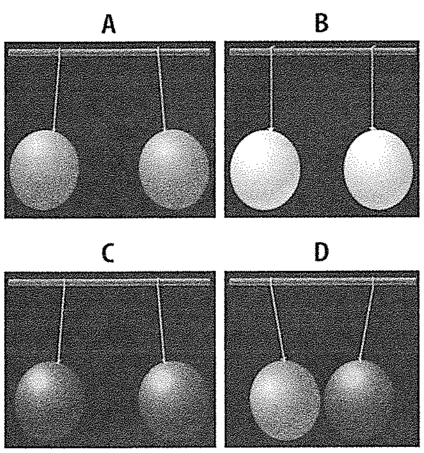
A Positive electrons are rubbed off the balloon and onto another object.

B Negative electrons are rubbed off the balloon and onto another object.

C Positive electrons are rubbed off another object and onto the balloon.

D Negative electrons are rubbed off another object and onto the balloon.

Use the figure below to answer question 2.



2 Which balloons have opposite charges?

A the pair in figure B

B the pair in figure D

C the pairs in figures A and C

D the pairs in figures B and C

3 Octavio pulls a sock from the clothes dryer. It is electrically charged. What must be true of the sock?

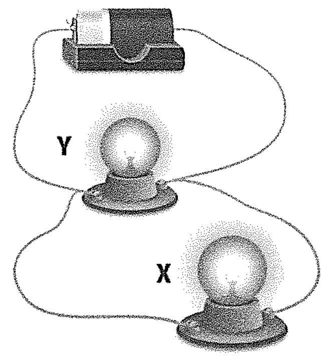
A It has lost all of its electrons.

B It can never again become electrically neutral.

C It would not interact with other charged objects.

D It has unequal amounts of positive and negative charges.

Use the figure below to answer questions 4 and 5.



4 How would removing lightbulb X affect the circuit?

A Lightbulb Y would stay lit, but there would be no current in any of the wires.

B Lightbulb Y would stay lit because there still would be current through it.

C Lightbulb Y would go out because there would be current in the smaller loop.

D Lightbulb Y would go out because there would be no current in any of the wires.

5 Which best describes lightbulb Y?

A It is an electric insulator.

B It is a source of electric energy.

C It is a device that transforms light energy to electric energy.

D It is a device that transforms electric energy to light energy.

6 How does a battery generate electric current in a circuit?

A It moves the negative electric charges that are already in the circuit.

B It creates positive electric charges and pushes them into the circuit.

C It creates negative electric charges and pushes them into the circuit.

D It destroys positive electric charges, which it pulls from the circuit.