McGraw-Hill Ryerson

DISCOVERING SCIENCE 9

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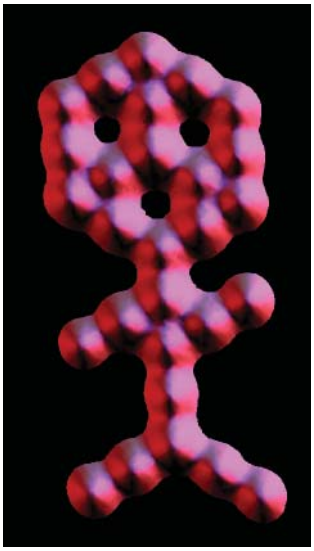
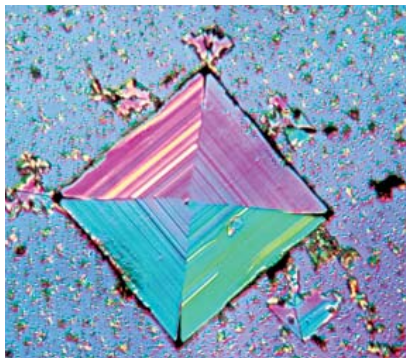
Contents





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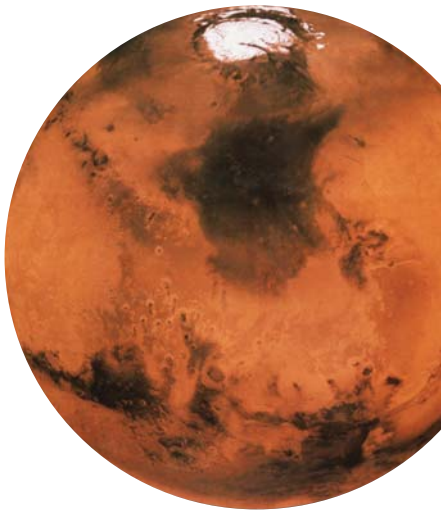
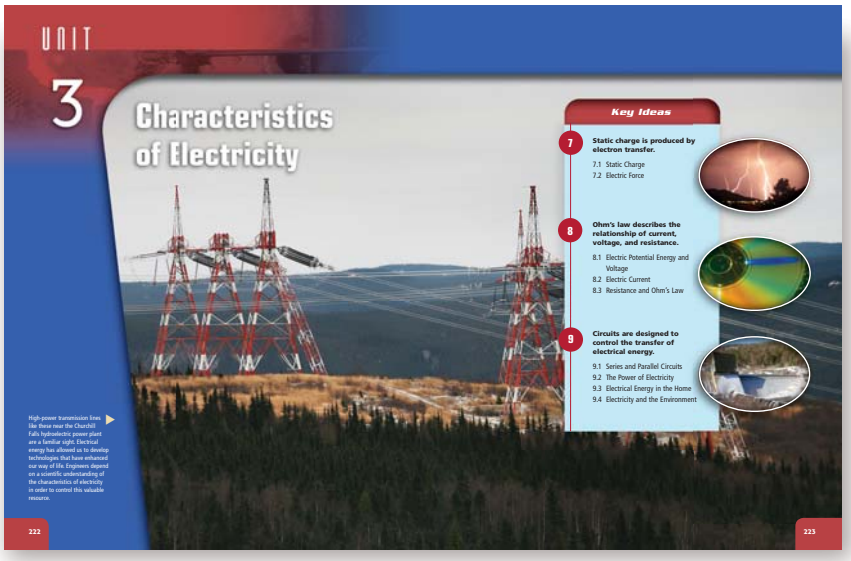


A Tour of Your Textbook

Welcome to ***Discovering Science 9***. This textbook introduces you to the wonders of chemistry, reproduction, electricity, and the structure of the universe. Take a brief tour of your textbook on the following pages. Then do the Scavenger Hunt on page xxi.

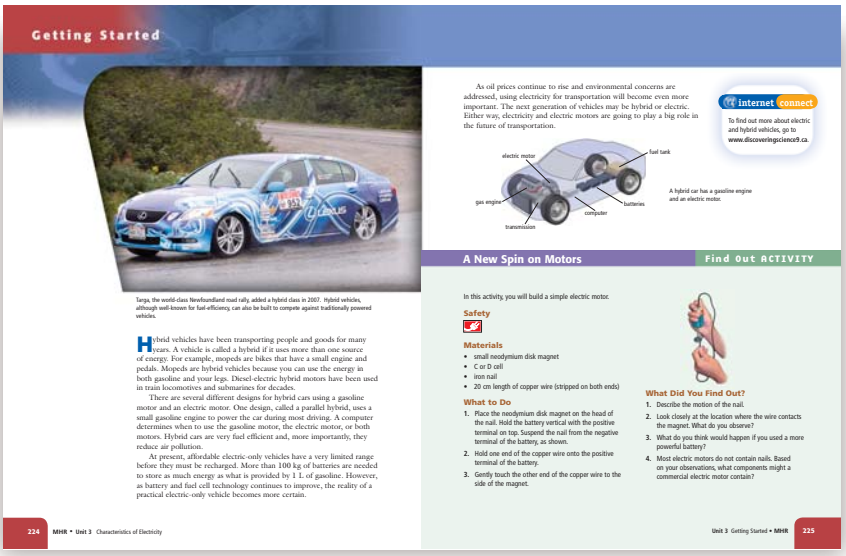
Unit Opener

- ***Discovering Science 9*** has four major units: Atoms, Elements, and Compounds; Reproduction; Characteristics of Electricity, and Space Exploration.
- Each unit opener photo is a window into the world of the Key Ideas you will study in the units. The caption explains the photo.
- The unit opener identifies each of the unit's Key Ideas. These are the chapter titles.
- The small photos next to the Key Ideas are from the beginning of each chapter.



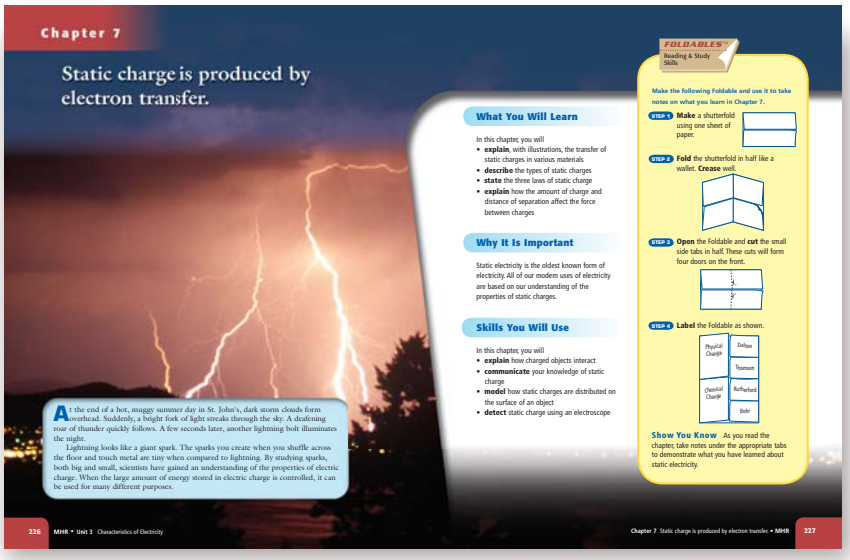
Getting Started

- Getting Started helps you recall what you already know about the Key Ideas in the unit.
- It helps you prepare for studying the unit by giving you the following:
  - — a short reading about an interesting topic related to the unit
  - — a short **Find Out Activity** so you can explore an idea related to the unit



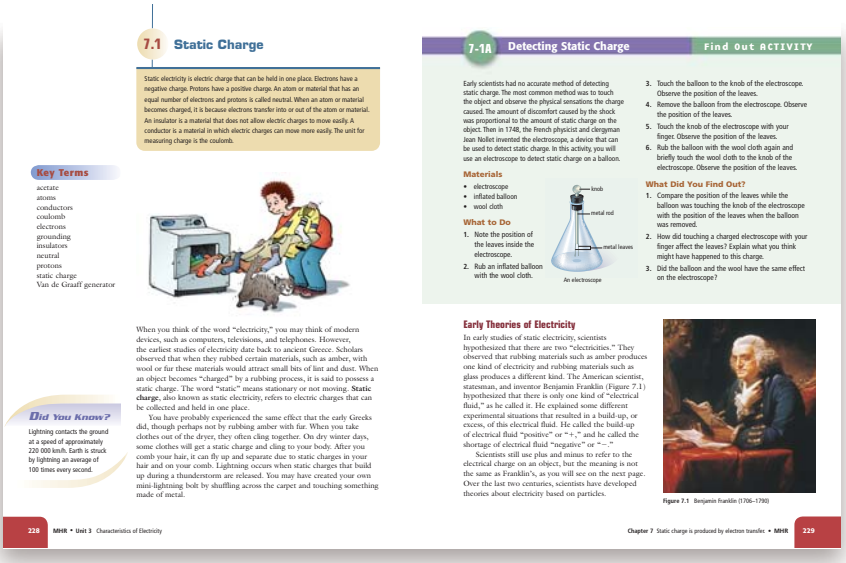
Chapter Opener

- The chapter title sentence is the Key Idea that you will study in this chapter.
- The chapter opener outlines What You Will Learn, Why It Is Important, and Skills You Will Use in the chapter.
- The **Foldables** exercise is a fun way to develop your study skills. Look for a Foldables exercise at the beginning of every chapter.



Section Opener

- Each new section in a chapter begins with a new number and a short title.
- The shaded light brown box below the section title contains a summary of the science concepts you will study in the section.
- The list of Key Terms in the margin identifies important new science terms that you will learn in the section.
- The **Did You Know?** margin feature, which appears in some section openers, is an interesting bit of information related to the section's topic.
- Some section openers include a **Find Out Activity** or a **Think About It**.



Find Out Activity

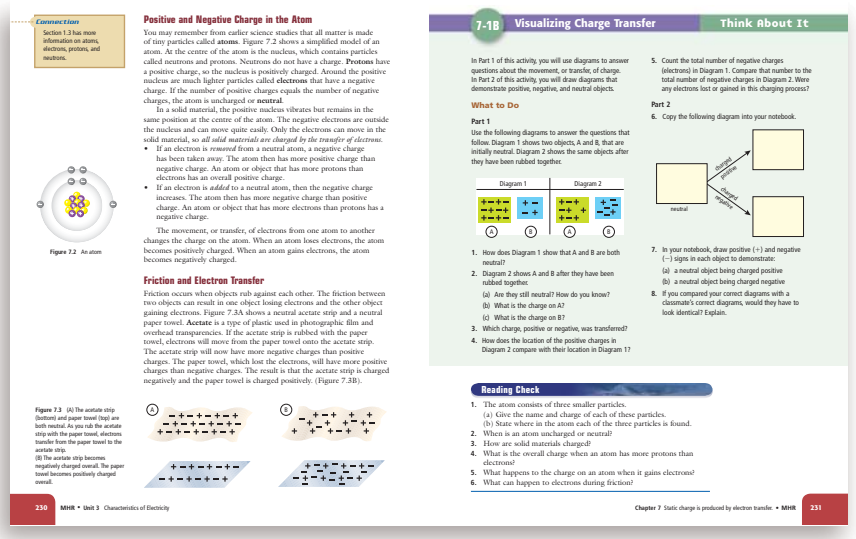
- This informal inquiry activity involves hands-on exploration, using simple materials and equipment.
- In these activities and in the investigations, you will use important science process skills, such as predicting, estimating, and hypothesizing.

Science Skills

- This box directs you to one of 10 Science Skills sections at the back of your textbook. The Science Skills sections can help you with graphing, writing an hypothesis, using a microscope, and other skills.

Think About It

- The Think About It activities look similar to Find Out activities, but you do them at your desk. They do not require any special equipment.
- For these activities, you think about a particular idea related to the concepts you are studying in the section.
- You work on your own, with a partner, or in a group, and share your thoughts with your group or class.



Connection
Section 1.3 has more information on atoms, electrons, protons, and neutrons.

Positive and Negative Charge in the Atom

You may remember from earlier science studies that all matter is made of tiny particles called **atoms**. Figure 7.2 shows a simplified model of an atom. At the centre of the atom is the nucleus, which contains particles called neutrons and protons. Neutrons do not have a charge. **Protons** have a positive charge, so the nucleus is positively charged. Around the positive nucleus are much lighter particles called **electrons** that have a negative charge. If the number of positive charges equals the number of negative charges, the atom is uncharged or **neutral**.

In a solid material, the positive nucleus vibrates but remains in the same position at the centre of the atom. The negative electrons are outside the nucleus and can move quite easily. Only the electrons can move in the solid material, *so all solid materials are charged by the transfer of electrons.*

- If an electron is *removed* from a neutral atom, a negative charge has been taken away. The atom then has more positive charge than negative charge. An atom or object that has more protons than electrons has an overall positive charge.
- If an electron is *added* to a neutral atom, then the negative charge increases. The atom then has more negative charge than positive charge. An atom or object that has more electrons than protons has a negative charge.

The movement, or transfer, of electrons from one atom to another changes the charge on the atom. When an atom loses electrons, the atom becomes positively charged. When an atom gains electrons, the atom becomes negatively charged.

Figure 7.2 An atom

Friction and Electron Transfer

Friction occurs when objects rub against each other. The friction between two objects can result in one object losing electrons and the other object gaining electrons. Figure 7.3A shows a neutral acetate strip and a neutral paper towel. **Acetate** is a type of plastic used in photographic film and overhead transparencies. If the acetate strip is rubbed with the paper towel, electrons will move from the paper towel onto the acetate strip. The acetate strip will now have more negative charges than positive charges. The paper towel, which lost the electrons, will have more positive charges than negative charges. The result is that the acetate strip is charged negatively and the paper towel is charged positively. (Figure 7.3B).

Figure 7.3 (A) The acetate strip (bottom) and paper towel (top) are both neutral. As you rub the acetate strip with the paper towel, electrons transfer from the paper towel to the acetate strip. (B) The acetate strip becomes negatively charged overall. The paper towel becomes positively charged overall.

230 MHR • Unit 3 Characteristics of Electricity

7-1B Visualizing Charge Transfer — Think About It

In Part 1 of this activity, you will use diagrams to answer questions about the movement, or transfer, of charge. In Part 2 of this activity, you will draw diagrams that demonstrate positive, negative, and neutral objects.

What to Do

Part 1

Use the following diagrams to answer the questions that follow. Diagram 1 shows two objects, A and B, that are initially neutral. Diagram 2 shows the same objects after they have been rubbed together.

Diagram 1 Diagram 2

1. How does Diagram 1 show that A and B are both neutral?
2. Diagram 2 shows A and B after they have been rubbed together.
   (a) Are they still neutral? How do you know?
   (b) What is the charge on A?
   (c) What is the charge on B?
3. Which charge, positive or negative, was transferred?
4. How does the location of the positive charges in Diagram 2 compare with their location in Diagram 1?
5. Count the total number of negative charges (electrons) in Diagram 1. Compare that number to the total number of negative charges in Diagram 2. Were any electrons lost or gained in this charging process?

Part 2

6. Copy the following diagram into your notebook.

neutral — negative electrons — charged negative

7. In your notebook, draw positive (+) and negative (−) signs in each object to demonstrate:
   (a) a neutral object being charged positive
   (b) a neutral object being charged negative
8. If you compared your correct diagrams with a classmate's correct diagrams, would they have to look identical? Explain.

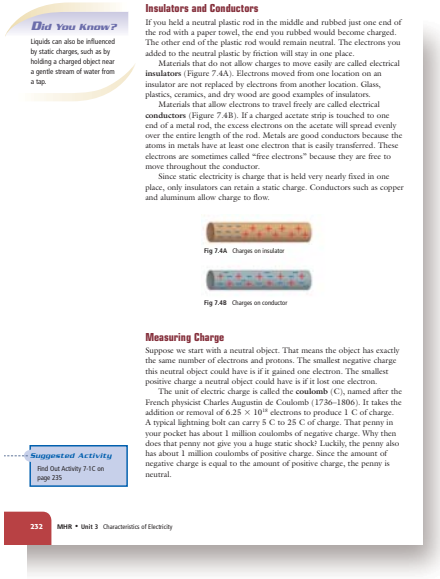
Reading Check

1. The atom consists of three smaller particles.
   (a) Give the name and charge of each of these particles.
   (b) State where in the atom each of the three particles is found.
2. When is an atom uncharged or neutral?
3. How are solid materials charged?
4. What is the overall charge when an atom has more protons than electrons?
5. What happens to the charge on an atom when it gains electrons?
6. What can happen to electrons during friction?

Chapter 7 Static charge is produced by electron transfer. • MHR 231

Section Text and Activities

- The text of each section is divided into "chunks" to help you understand the content. Each chunk has a title.
- Each picture has a caption that explains what the picture is about.
- Terms you need to know are boldfaced in the text. Each boldfaced key term is defined in the **Glossary** at the back of the textbook.
- **Reading Checks** contain questions that help you test your understanding of what you have just read.
- Find Out and Think About It activities may appear throughout the text. Longer, more formal investigations are at the end of the section.



Did You Know?
Liquids can also be influenced by static charges, such as by holding a charged object near a gentle stream of water from a tap.

Insulators and Conductors

If you held a neutral plastic rod in the middle and rubbed just one end of the rod with a paper towel, the end you rubbed would become charged. The other end of the plastic rod would remain neutral. The electrons you added to the neutral plastic by friction will stay in one place.

Materials that do not allow charges to move easily are called electrical **insulators** (Figure 7.4A). Electrons moved from one location on an insulator are not replaced by electrons from another location. Glass, plastics, ceramics, and dry wood are good examples of insulators.

Materials that allow electrons to travel freely are called electrical **conductors** (Figure 7.4B). If a charged acetate strip is touched to one end of a metal rod, the excess electrons on the acetate will spread evenly over the entire length of the rod. Metals are good conductors because the atoms in metals have at least one electron that is easily transferred. These electrons are sometimes called "free electrons" because they are free to move throughout the conductor.

Since static electricity is charge that is held very nearly fixed in one place, only insulators can retain a static charge. Conductors such as copper and aluminum allow charge to flow.

Fig 7.4A Charges on insulator

Fig 7.4B Charges on conductor

Measuring Charge

Suppose we start with a neutral object. That means the object has exactly the same number of electrons and protons. The smallest negative charge this neutral object could have is if it gained one electron. The smallest positive charge a neutral object could have is if it lost one electron.

The unit of electric charge is called the **coulomb** (C), named after the French physicist Charles Augustin de Coulomb (1736–1806). It takes the addition or removal of 6.25×10^{18} electrons to produce 1 C of charge. A typical lightning bolt can carry 5 C to 25 C of charge. That penny in your pocket has about 1 million coulombs of negative charge. Why then does that penny not give you a huge static shock? Luckily, the penny also has about 1 million coulombs of positive charge. Since the amount of negative charge is equal to the amount of positive charge, the penny is neutral.

Suggested Activity
Find Out Activity 7-1C on page 235

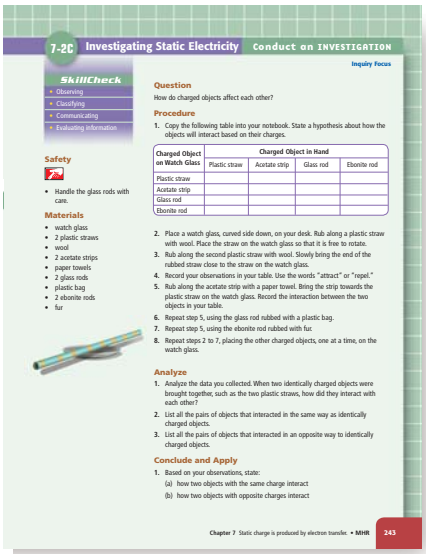
232 MHR • Unit 3 Characteristics of Electricity

Suggested Activity

- These small margin features indicate related activities your teacher may have you do from the end of the section.

Conduct an Investigation

- These formal labs give you the opportunity to develop science skills using various equipment and materials.
- In these investigations, you can ask questions about science, make observations, and obtain results.
- You then analyze your results to determine what they tell you about the topic you are investigating.
- Photographs help you do the investigation.
- Safety icons and safety warnings alert you to any special precautions you should take to help maintain a safe classroom environment.
- Each investigation has one of the following focuses: inquiry, decision-making, or problem-solving.
- In every unit you will see activities or investigations that are identified as "Core". This means that these activities are especially important for your understanding of the topic.


7-2C Investigating Static Electricity Conduct an INVESTIGATION

Inquiry Focus

SkillCheck
- Observing
- Classifying
- Communicating
- Evaluating information

Question
How do charged objects affect each other?

Procedure
1. Copy the following table into your notebook. State a hypothesis about how the objects will interact based on their charges.

Charged Object on Watch Glass	Charged Object in Hand			
	Plastic straw	Acetate strip	Glass rod	Ebonite rod
Plastic straw				
Acetate strip				
Glass rod				
Ebonite rod				

Safety
- Handle the glass rods with care.

Materials
- watch glass
- 2 plastic straws
- wool
- 2 acetate strips
- paper towels
- 2 glass rods
- plastic bag
- 2 ebonite rods
- fur

2. Place a watch glass, curved side down, on your desk. Rub along a plastic straw with wool. Place the straw on the watch glass so that it is free to rotate.
3. Rub along the second plastic straw with wool. Slowly bring the end of the rubbed straw close to the straw on the watch glass.
4. Record your observations in your table. Use the words "attract" or "repel."
5. Rub along the acetate strip with a paper towel. Bring the strip towards the plastic straw on the watch glass. Record the interaction between the two objects in your table.
6. Repeat step 5, using the glass rod rubbed with a plastic bag.
7. Repeat step 5, using the ebonite rod rubbed with fur.
8. Repeat steps 2 to 7, placing the other charged objects, one at a time, on the watch glass.

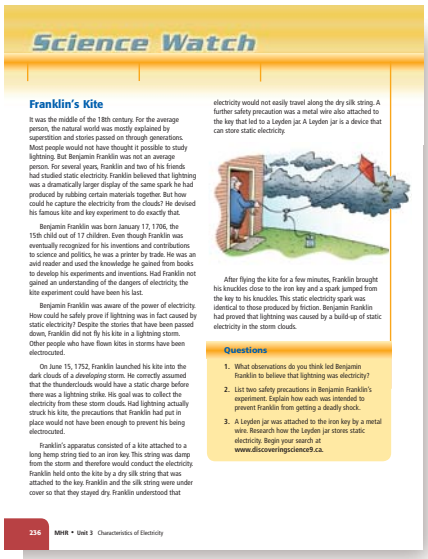
Analyze
1. Analyze the data you collected. When two identically charged objects were brought together, such as the two plastic straws, how did they interact with each other?
2. List all the pairs of objects that interacted in the same way as identically charged objects.
3. List all the pairs of objects that interacted in an opposite way to identically charged objects.

Conclude and Apply
1. Based on your observations, state:
   (a) how two objects with the same charge interact
   (b) how two objects with opposite charges interact

Chapter 7 Static charge is produced by electron transfer. • MHR 243

End-of-Section Features

- These features give you an opportunity to learn about applications or explorations of the topic you have studied in the section.
- **Science Watch** features provide information on past and current scientific topics and research.
- The "www" in "**www science**" stands for "wild, weird, wonderful." These features describe interesting and unusual science.
- **National Geographic Visualizing Science** features are exciting visual representations of a science topic.
- **Science-Math Connect** features connect the science you learned in the section to math concepts.
- **Career Connect** features are interviews with people who have a career related to the unit.


Science Watch

Franklin's Kite

It was the middle of the 18th century. For the average person, the natural world was mostly explained by superstition and stories passed on through generations. Most people would not have thought it possible to study lightning. But Benjamin Franklin was not an average person. For several years, Franklin and two of his friends had studied static electricity. Franklin believed that lightning was a dramatically larger display of the same spark he had produced by rubbing certain materials together. But how could he capture the electricity from the clouds? He devised his famous kite and key experiment to do exactly that.

Benjamin Franklin was born January 17, 1706, the 15th child out of 17 children. Even though Franklin was eventually recognized for his inventions and contributions to science and politics, he was a printer by trade. He was an avid reader and used the knowledge he gained from books to develop his experiments and inventions. Had Franklin not gained an understanding of the dangers of electricity, the kite experiment could have been his last.

Benjamin Franklin was aware of the power of electricity. How could he safely prove if lightning was in fact caused by static electricity? Despite the stories that have been passed down, Franklin did not fly his kite in a lightning storm. Other people who have flown kites in storms have been electrocuted.

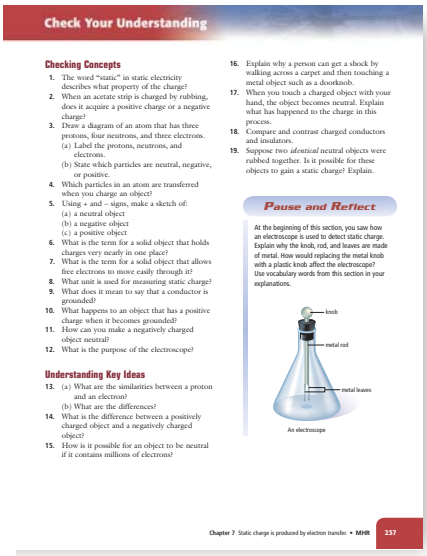
On June 15, 1752, Franklin launched his kite into the dark clouds of a developing storm. He correctly assumed that the thunderclouds would have a static charge before there was a lightning strike. His goal was to collect the electricity from these storm clouds. Had lightning actually struck his kite, the precautions that Franklin had put in place would not have been enough to prevent his being electrocuted.

Franklin's apparatus consisted of a kite attached to a long hemp string tied to an iron key. This string was damp from the storm and therefore would conduct the electricity. Franklin held onto the kite by a dry silk string that was attached to the key. Franklin and the silk string were under cover so that they stayed dry. Franklin understood that electricity would not easily travel along the dry silk string. A further safety precaution was a metal wire also attached to the key that led to a Leyden jar. A Leyden jar is a device that can store static electricity.

After flying the kite for a few minutes, Franklin brought his knuckles close to the iron key and a spark jumped from the key to his knuckles. This static electricity spark was identical to those produced by friction. Benjamin Franklin had proved that lightning was caused by a build-up of static electricity in the storm clouds.

Questions
1. What observations do you think led Benjamin Franklin to believe that lightning was electricity?
2. List two safety precautions in Benjamin Franklin's experiment. Explain how each was intended to prevent Franklin from getting a deadly shock.
3. A Leyden jar was attached to the iron key by a metal wire. Research how the Leyden jar stores static electricity. Begin your search at **www.discoveringscience9.ca**.

236 MHR • Unit 3 Characteristics of Electricity


Check Your Understanding

Checking Concepts
1. The word "static" in static electricity describes what property of the charge?
2. When an acetate strip is charged by rubbing, does it acquire a positive charge or a negative charge?
3. Draw a diagram of an atom that has three protons, four neutrons, and three electrons.
   (a) Label the protons, neutrons, and electrons.
   (b) State which particles are neutral, negative, or positive.
4. Which particles in an atom are transferred when you charge an object?
5. Using + and – signs, make a sketch of:
   (a) a neutral object
   (b) a negative object
   (c) a positive object
6. What is the term for a solid object that holds charges very nearly in one place?
7. What is the term for a solid object that allows free electrons to move easily through it?
8. What unit is used for measuring static charge?
9. What does it mean to say that a conductor is grounded?
10. What happens to an object that has a positive charge when it becomes grounded?
11. How can you make a negatively charged object neutral?
12. What is the purpose of the electroscope?

Understanding Key Ideas
13. (a) What are the similarities between a proton and an electron?
    (b) What are the differences?
14. What is the difference between a positively charged object and a negatively charged object?
15. How is it possible for an object to be neutral if it contains millions of electrons?
16. Explain why a person can get a shock by walking across a carpet and then touching a metal object such as a doorknob.
17. When you touch a charged object with your hand, the object becomes neutral. Explain what has happened to the charge in this process.
18. Compare and contrast charged conductors and insulators.
19. Suppose two *identical* neutral objects were rubbed together. Is it possible for these objects to gain a static charge? Explain.

Pause and Reflect

At the beginning of this section, you saw how an electroscope is used to detect static charge. Explain why the knob, rod, and leaves are made of metal. How would replacing the metal knob with a plastic knob affect the electroscope? Use vocabulary words from this section in your explanations.

knob
metal rod
metal leaves
An electroscope

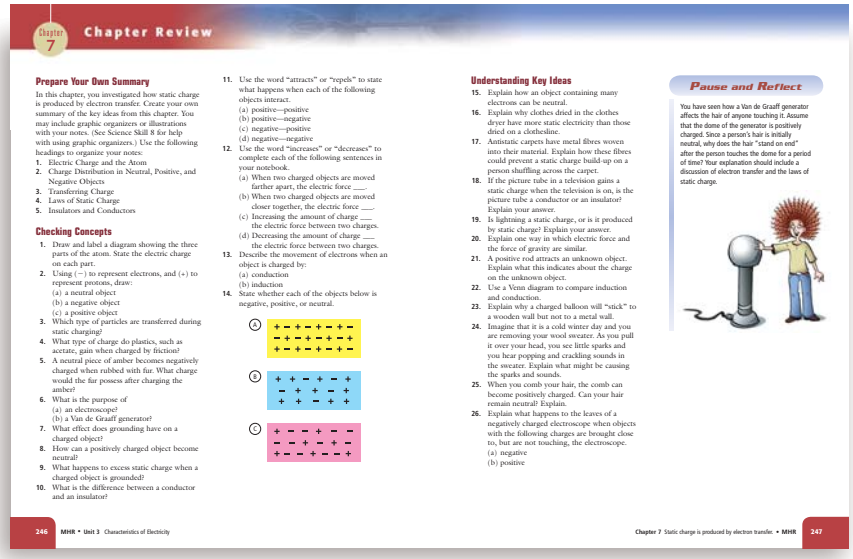
Chapter 7 Static charge is produced by electron transfer. • MHR 237

Check Your Understanding

- These section review questions test your new knowledge.

Pause and Reflect

- Pause and Reflect features help you stop and think about what you now know about the topics explained in the chapter. They also make connections among ideas throughout your book.



Chapter 7 Chapter Review

Prepare Your Own Summary

In this chapter, you investigated how static charge is produced by electron transfer. Create your own summary of the key ideas from this chapter. You may include graphic organizers or illustrations with your notes. (See Science Skill 8 for help with using graphic organizers.) Use the following headings to organize your notes:

1. Electric Charge and the Atom
2. Charge Distribution in Neutral, Positive, and Negative Objects
3. Transferring Charge
4. Laws of Static Charge
5. Insulators and Conductors

Checking Concepts

1. Draw and label a diagram showing the three parts of the atom. State the electric charge on each part.
2. Using (−) to represent electrons, and (+) to represent protons, draw:
   (a) a neutral object
   (b) a negative object
   (c) a positive object
3. Which type of particles are transferred during static charging?
4. What type of charge do plastics, such as acetate, gain when charged by friction?
5. A neutral piece of amber becomes negatively charged when rubbed with fur. What charge would the fur possess after charging the amber?
6. What is the purpose of
   (a) an electroscope?
   (b) a Van de Graaff generator?
7. What effect does grounding have on a charged object?
8. How can a positively charged object become neutral?
9. What happens to excess static charge when a charged object is grounded?
10. What is the difference between a conductor and an insulator?
11. Use the word "attracts" or "repels" to state what happens when each of the following objects interact.
    (a) positive—positive
    (b) positive—negative
    (c) negative—positive
    (d) negative—negative
12. Use the word "increases" or "decreases" to complete each of the following sentences in your notebook.
    (a) When two charged objects are moved farther apart, the electric force ___.
    (b) When two charged objects are moved closer together, the electric force ___.
    (c) Increasing the amount of charge ___ the electric force between two charges.
    (d) Decreasing the amount of charge ___ the electric force between two charges.
13. Describe the movement of electrons when an object is charged by:
    (a) conduction
    (b) induction
14. State whether each of the objects below is negative, positive, or neutral.

Understanding Key Ideas

15. Explain how an object containing many electrons can be neutral.
16. Explain why clothes dried in the clothes dryer have more static electricity than those dried on a clothesline.
17. Antistatic carpets have metal fibres woven into their material. Explain how these fibres could prevent a static charge build-up on a person shuffling across the carpet.
18. If the picture tube in a television gains a static charge when the television is on, is the picture tube a conductor or an insulator? Explain your answer.
19. Is lightning a static charge, or is it produced by static charge? Explain your answer.
20. Explain one way in which electric force and the force of gravity are similar.
21. A positive rod attracts an unknown object. Explain what this indicates about the charge on the unknown object.
22. Use a Venn diagram to compare induction and conduction.
23. Explain why a charged balloon will "stick" to a wooden wall but not to a metal wall.
24. Imagine that it is a cold winter day and you are removing your wool sweater. As you pull it over your head, you see little sparks and you hear popping and crackling sounds in the sweater. Explain what might be causing the sparks and sounds.
25. When you comb your hair, the comb can become positively charged. Can your hair remain neutral? Explain.
26. Explain what happens to the leaves of a negatively charged electroscope when objects with the following charges are brought close to, but are not touching, the electroscope.
    (a) negative
    (b) positive

Pause and Reflect

You have seen how a Van de Graaff generator affects the hair of anyone touching it. Assume that the dome of the generator is positively charged. Since a person's hair is initially neutral, why does the hair "stand on end" after the person touches the dome for a period of time? Your explanation should include a discussion of electron transfer and the laws of static charge.

246 MHR • Unit 3 Characteristics of Electricity

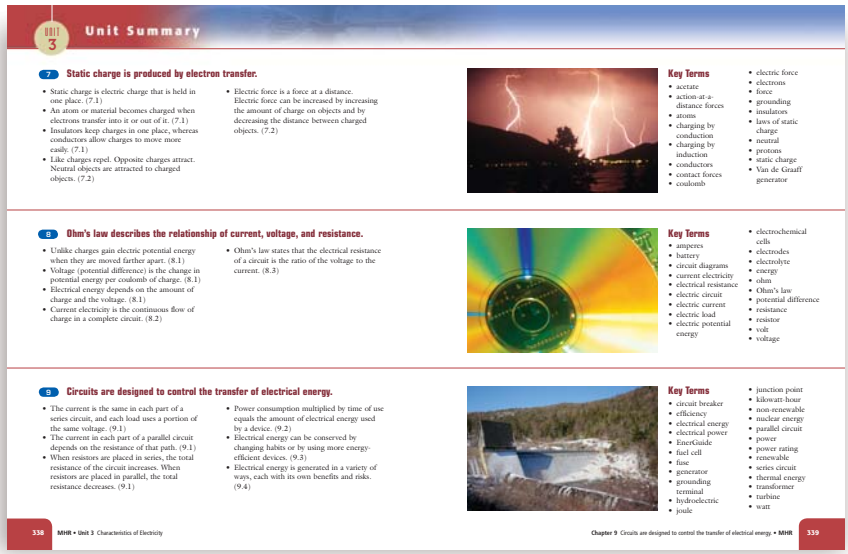
Chapter 7 Static charge is produced by electron transfer. • MHR 247

Chapter Review

- At the end of each chapter, the Chapter Review can help you study for a chapter test.
- The guide under the heading "Prepare Your Own Summary" can help you summarize what you have learned in the chapter.
- The review questions help you recall, think about, and apply what you have learned.

Unit Summary

- This is a summary of the Key Ideas and Key Terms covered in the unit.
- The photographs next to the Key Terms are from the chapter openers to remind you of what you covered in that chapter.



Unit 3 Unit Summary

7 Static charge is produced by electron transfer.

- Static charge is electric charge that is held in one place. (7.1)
- An atom or material becomes charged when electrons transfer into it or out of it. (7.1)
- Insulators keep charges in one place, whereas conductors allow charges to move more easily. (7.1)
- Like charges repel. Opposite charges attract. Neutral objects are attracted to charged objects. (7.2)
- Electric force is a force at a distance. Electric force can be increased by increasing the amount of charge on objects and by decreasing the distance between charged objects. (7.2)

Key Terms
- acetate
- action-at-a-distance forces
- atoms
- charging by conduction
- charging by induction
- conductors
- contact forces
- coulomb
- electric force
- electrons
- force
- grounding
- insulators
- laws of static charge
- neutral
- protons
- static charge
- Van de Graaff generator

8 Ohm's law describes the relationship of current, voltage, and resistance.

- Unlike charges gain electric potential energy when they are moved farther apart. (8.1)
- Voltage (potential difference) is the change in potential energy per coulomb of charge. (8.1)
- Electrical energy depends on the amount of charge and the voltage. (8.1)
- Current electricity is the continuous flow of charge in a complete circuit. (8.2)
- Ohm's law states that the electrical resistance of a circuit is the ratio of the voltage to the current. (8.3)

Key Terms
- amperes
- battery
- circuit diagrams
- current electricity
- electrical resistance
- electric circuit
- electric current
- electric load
- electric potential energy
- electrochemical cells
- electrodes
- electrolyte
- energy
- ohm
- Ohm's law
- potential difference
- resistance
- resistor
- volt
- voltage

9 Circuits are designed to control the transfer of electrical energy.

- The current is the same in each part of a series circuit, and each load uses a portion of the same voltage. (9.1)
- The current in each part of a parallel circuit depends on the resistance of that path. (9.1)
- When resistors are placed in series, the total resistance of the circuit increases. When resistors are placed in parallel, the total resistance decreases. (9.1)
- Power consumption multiplied by time of use equals the amount of electrical energy used by a device. (9.2)
- Electrical energy can be conserved by changing habits or by using more energy-efficient devices. (9.3)
- Electrical energy is generated in a variety of ways, each with its own benefits and risks. (9.4)

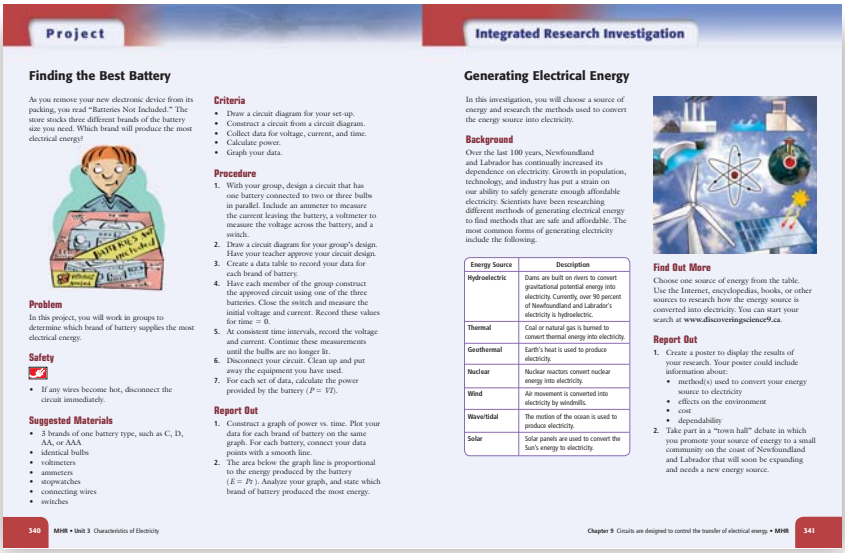
Key Terms
- circuit breaker
- efficiency
- electrical energy
- electrical power
- EnerGuide
- fuel cell
- fuse
- generator
- grounding terminal
- hydroelectric
- joule
- junction point
- kilowatt-hour
- non-renewable
- nuclear energy
- parallel circuit
- power
- power rating
- renewable
- series circuit
- thermal energy
- transformer
- turbine
- watt

338 MHR • Unit 3 Characteristics of Electricity

Chapter 9 Circuits are designed to control the transfer of electrical energy • MHR 339

End-of-Unit Project and Integrated Research Investigation

- Each **Project** lets you apply key concepts and skills from the unit. You complete the Project as part of a team.
- For the **Integrated Research Investigation,** you explore a unit-related topic. You have an opportunity to use information that you have researched to do a report or presentation about that topic.



Project

Finding the Best Battery

As you remove your new electronic device from its packing, you read "Batteries Not Included." The store stocks three different brands of the battery size you need. Which brand will produce the most electrical energy?

Problem

In this project, you will work in groups to determine which brand of battery supplies the most electrical energy.

Safety

- If any wires become hot, disconnect the circuit immediately.

Suggested Materials

- 3 brands of one battery type, such as C, D, AA, or AAA
- identical bulbs
- voltmeters
- ammeters
- stopwatches
- connecting wires
- switches

Criteria

- Draw a circuit diagram for your set-up.
- Construct a circuit from a circuit diagram.
- Collect data for voltage, current, and time.
- Calculate power.
- Graph your data.

Procedure

1. With your group, design a circuit that has one battery connected to two or three bulbs in parallel. Include an ammeter to measure the current leaving the battery, a voltmeter to measure the voltage across the battery, and a switch.
2. Draw a circuit diagram for your group's design. Have your teacher approve your circuit design.
3. Create a data table to record your data for each brand of battery.
4. Have each member of the group construct the approved circuit using one of the three batteries. Close the switch and measure the initial voltage and current. Record these values for time = 0.
5. At consistent time intervals, record the voltage and current. Continue these measurements until the bulbs are no longer lit.
6. Disconnect your circuit. Clean up and put away the equipment you have used.
7. For each set of data, calculate the power provided by the battery ($P = VI$).

Report Out

1. Construct a graph of power vs. time. Plot your data for each brand of battery on the same graph. For each battery, connect your data points with a smooth line.
2. The area below the graph line is proportional to the energy produced by the battery ($E = Pt$). Analyze your graph, and state which brand of battery produced the most energy.

Integrated Research Investigation

Generating Electrical Energy

In this investigation, you will choose a source of energy and research the methods used to convert the energy source into electricity.

Background

Over the last 100 years, Newfoundland and Labrador has continually increased its dependence on electricity. Growth in population, technology, and industry has put a strain on our ability to safely generate enough affordable electricity. Scientists have been researching different methods of generating electrical energy to find methods that are safe and affordable. The most common forms of generating electricity include the following.

Energy Source	Description
Hydroelectric	Dams are built on rivers to convert gravitational potential energy into electricity. Currently, over 90 percent of Newfoundland and Labrador's electricity is hydroelectric.
Thermal	Coal or natural gas is burned to convert thermal energy into electricity.
Geothermal	Earth's heat is used to produce electricity.
Nuclear	Nuclear reactors convert nuclear energy into electricity.
Wind	Air movement is converted into electricity by windmills.
Wave/tidal	The motion of the ocean is used to produce electricity.
Solar	Solar panels are used to convert the Sun's energy to electricity.

Find Out More

Choose one source of energy from the table. Use the Internet, encyclopedias, books, or other sources to research how the energy source is converted into electricity. You can start your search at **www.discoveringscience9.ca**.

Report Out

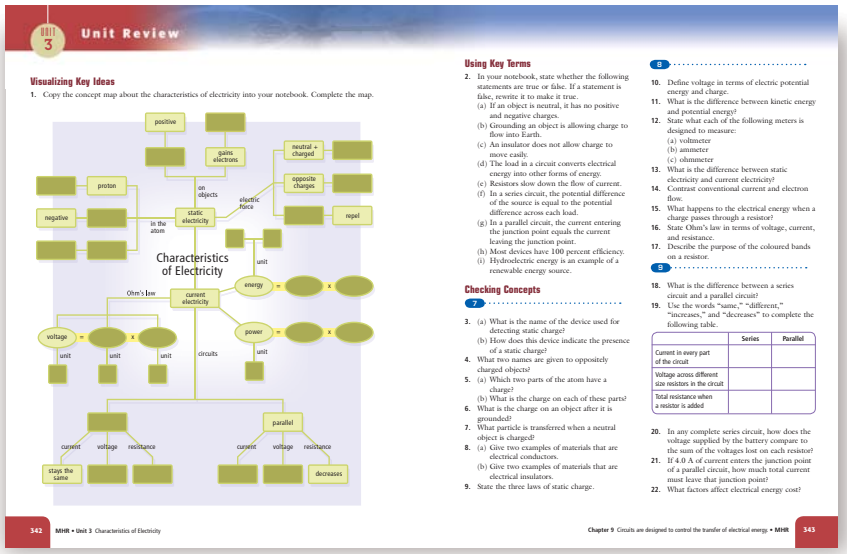
1. Create a poster to display the results of your research. Your poster could include information about:
   - method(s) used to convert your energy source to electricity
   - effects on the environment
   - cost
   - dependability
2. Take part in a "town hall" debate in which you promote your source of energy to a small community on the coast of Newfoundland and Labrador that will soon be expanding and needs a new energy source.

340 MHR • Unit 3 Characteristics of Electricity

Chapter 9 Circuits are designed to control the transfer of electrical energy • MHR 341

Unit Review

- At the end of each unit, the Unit Review can help you study for a unit test.
- The review questions help you recall, think about, and apply what you have learned.


Unit 3 Unit Review

Visualizing Key Ideas

1. Copy the concept map about the characteristics of electricity into your notebook. Complete the map.

Characteristics of Electricity

Using Key Terms

2. In your notebook, state whether the following statements are true or false. If a statement is false, rewrite it to make it true.
(a) If an object is neutral, it has no positive and negative charges.
(b) Grounding an object is allowing charge to flow into Earth.
(c) An insulator does not allow charge to move easily.
(d) The load in a circuit converts electrical energy into other forms of energy.
(e) Resistors slow down the flow of current.
(f) In a series circuit, the potential difference of the source is equal to the potential difference across each load.
(g) In a parallel circuit, the current entering the junction point equals the current leaving the junction point.
(h) Most devices have 100 percent efficiency.
(i) Hydroelectric energy is an example of a renewable energy source.

Checking Concepts

3. (a) What is the name of the device used for detecting static charge?
(b) How does this device indicate the presence of a static charge?
4. What two names are given to oppositely charged objects?
5. (a) Which two parts of the atom have a charge?
(b) What is the charge on each of these parts?
6. What is the charge on an object after it is grounded?
7. What particle is transferred when a neutral object is charged?
8. (a) Give two examples of materials that are electrical conductors.
(b) Give two examples of materials that are electrical insulators.
9. State the three laws of static charge.

10. Define voltage in terms of electric potential energy and charge.
11. What is the difference between kinetic energy and potential energy?
12. State what each of the following meters is designed to measure:
(a) voltmeter
(b) ammeter
(c) ohmmeter
13. What is the difference between static electricity and current electricity?
14. Contrast conventional current and electron flow.
15. What happens to the electrical energy when a charge passes through a resistor?
16. State Ohm's law in terms of voltage, current, and resistance.
17. Describe the purpose of the coloured bands on a resistor.

18. What is the difference between a series circuit and a parallel circuit?
19. Use the words "same," "different," "increases," and "decreases" to complete the following table.

	Series	Parallel
Current in every part of the circuit		
Voltage across different size resistors in the circuit		
Total resistance when a resistor is added		

20. In any complete series circuit, how does the voltage supplied by the battery compare to the sum of the voltages lost on each resistor?
21. If 4.0 A of current enters the junction point of a parallel circuit, how much total current must leave that junction point?
22. What factors affect electrical energy cost?

342 MHR • Unit 3 Characteristics of Electricity

Chapter 9 Circuits are designed to control the transfer of electrical energy. • MHR 343

Other Features

Word Connect

- The Word Connect margin feature gives you additional information on scientific terms.

Explore More

- You can "Explore More" by following the suggestions in these features to investigate further a topic you have studied.

internet connect

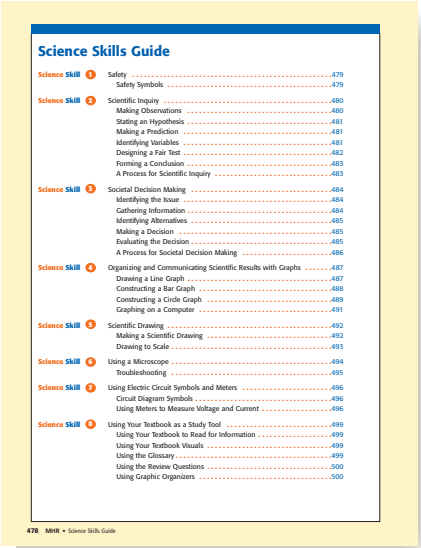
- These features help you research more information about a topic.
- The ***Discovering Science 9*** web site links you to other web sites related to the topic you are researching.

- Safety icons are included in many activities and investigations. The safety icons are extremely important. They alert you to any safety precautions you should take. Safety icons used in ***Discovering Science 9*** are shown on page 479.

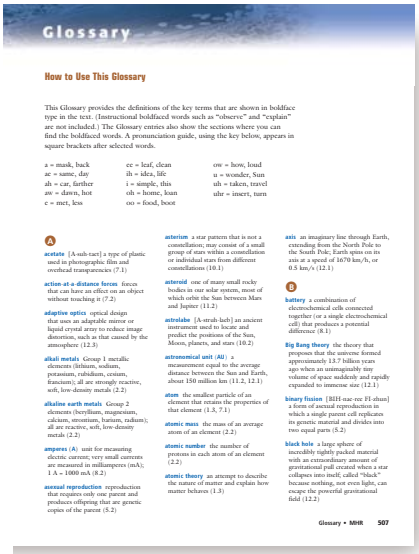
At the Back of Your Textbook

Science Skills

- At the back of ***Discovering Science 9***, you will find the Science Skills appendix. These skills will help you review and develop the skills and knowledge that you need to be successful in this course.


Science Skills Guide

478 MHR • Science Skills Guide


Glossary

How to Use This Glossary

This Glossary provides the definitions of the key terms that are shown in boldface type in the text. (Instructional boldfaced words such as "observe" and "explain" are not included.) The Glossary entries also show the sections where you can find the boldfaced words. A pronunciation guide, using the key below, appears in square brackets after selected words.

a = mask, back
ae = same, day
ah = car, farther
aw = dawn, hot
e = met, less
ee = leaf, clean
ih = idea, life
i = simple, this
oh = home, loan
oo = food, boot
ow = how, loud
u = wonder, Sun
uh = taken, travel
uhr = insert, turn

A

acetate [A-suh-tate] a type of plastic used in photographic film and overhead transparencies (7.1)

action-at-a-distance forces forces that can have an effect on an object without touching it (7.2)

adaptive optics optical design that uses an adaptable mirror or liquid crystal array to reduce image distortion, such as that caused by the atmosphere (12.3)

alkali metals Group 1 metallic elements (lithium, sodium, potassium, rubidium, cesium, francium); all are strongly reactive, soft, low-density metals (2.2)

alkaline earth metals Group 2 elements (beryllium, magnesium, calcium, strontium, barium, radium); all are reactive, soft, low-density metals (2.2)

amperes (A) unit for measuring electric current; very small currents are measured in milliamperes (mA); 1 A = 1000 mA (8.2)

asexual reproduction reproduction that requires only one parent and produces offspring that are genetic copies of the parent (5.2)

asterism a star pattern that is not a constellation; may consist of a small group of stars within a constellation or individual stars from different constellations (10.1)

asteroid one of many small rocky bodies in our solar system, most of which orbit the Sun between Mars and Jupiter (11.2)

astrolabe [A-strah-layb] an ancient instrument used to locate and predict the positions of the Sun, Moon, planets, and stars (10.2)

astronomical unit (AU) a measurement equal to the average distance between the Sun and Earth, about 150 million km (11.2, 12.1)

atom the smallest particle of an element that retains the properties of that element (1.3, 7.1)

atomic mass the mass of an average atom of an element (2.2)

atomic number the number of protons in each atom of an element (2.2)

atomic theory an attempt to describe the nature of matter and explain how matter behaves (1.3)

axis an imaginary line through Earth, extending from the North Pole to the South Pole; Earth spins on its axis at a speed of 1670 km/h, or 0.5 km/s (12.1)

B

battery a combination of electrochemical cells connected together (or a single electrochemical cell) that produces a potential difference (8.1)

Big Bang theory the theory that proposes that the universe formed approximately 13.7 billion years ago when an unimaginably tiny volume of space suddenly and rapidly expanded to immense size (12.1)

binary fission [BIH-nay-ree FI-shun] a form of asexual reproduction in which a single parent cell replicates its genetic material and divides into two equal parts (5.2)

black hole a large sphere of incredibly tightly packed material with an extraordinary amount of gravitational pull created when a star collapses into itself, called "black" because nothing, not even light, can escape the powerful gravitational field (12.2)

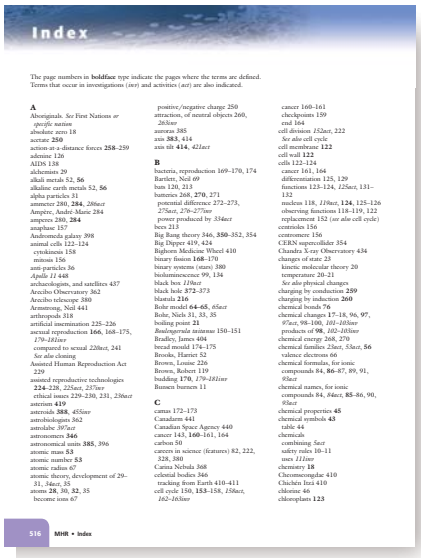
Glossary • MHR 507

Glossary

- Each boldfaced term in your textbook is defined in the Glossary at the back of the book.
- The Glossary is organized alphabetically.

Index

- The Index at the back of the book helps you locate a particular topic in the book.
- The Index is organized alphabetically.


Index

The page numbers in **boldface** type indicate the pages where the terms are defined. Terms that occur in investigations (*inv*) and activities (*act*) are also indicated.

516 MHR • Index

A Scavenger Hunt

Discover how to use your ***Discovering Science 9*** textbook. Answer the following questions. Your teacher may hand out a concept map for you to record your answers.

Knowledge

1. What are the four units you will study in ***Discovering Science 9?***
2. Turn to the opening page of one of the units and find the Key Ideas. Name two ways you could use the Key Ideas to help you learn.
3. Turn to the opening page of any chapter. List the three headings that give you an overview of what you can expect to gain from the chapter.

Reading and Understanding

4. At the beginning of every section, you will find the Key Words. How could you use these words to help you learn?
5. What is the purpose of the shaded box at the beginning of each section?
6. Where can you find the definitions for all the bolded words in the text?
7. Find a Reading Check within a chapter. How could you use a Reading Check to help you learn?

"Doing" Science

8. Activities are printed on a green background. Name the three types of investigation activities.
9. Where can you find information to help you connect an electric meter?
10. Where can you find information on the safety rules you need to follow when you work with chemicals?

Study Tools

11. You can organize the information you learn using folded paper. Where can you find suggestions in each chapter for how to fold your organizer?
12. (a) What are the questions called at the end of a section that test whether you know the material in the section?
    (b) What are the questions called at the end of a chapter?
    (c) What are the questions called at the end of a unit?
13. Find a Unit Summary. How could you use this feature to help you study?

Going Beyond

14. Four different careers are described in your textbook. What are two of the careers?
15. Find an Explore More feature that you would like to know more about. Name the topic.
16. What is the website that has links to the topics in your ***Discovering Science 9*** textbook?