Topic 2.6

What are some characteristics and consequences of chemical reactions?

Key Concepts

- Compounds and elements are changed during chemical reactions.
- The properties of substances that make them useful can also make them dangerous.
- There are less-harmful alternatives to many products we use and depend on.

Key Skills

Inquiry
Literacy

Key Terms

chemical reaction

When you observe that a chemical change has occurred, you know that elements or compounds (or both) have reacted. Some substances are produced during the reaction, and some substances are consumed during the reaction. For example, think about the hot, glowing coals in the main photo. Before the reaction that started the coals glowing, there was carbon (C) in the coals and oxygen (O_2) in the air. When energy was added to start a fire, the carbon and oxygen reacted together to produce carbon dioxide gas (CO_2). Now look at all the bubbling shown in the smaller photo. Before the reaction, there was acetic acid, which you know better as vinegar (CH_3COOH), and there was sodium bicarbonate, which you know better as baking soda ($NaHCO_3$). After the two substances react, there is sodium acetate ($NaC_2H_3O_2$), water (H_2O), and carbon dioxide (CO_2).

Starting Point Activity

You can learn a lot about the interaction of substances from one of the most common substances in the home: vinegar. Most of these mini-activities take a few days for observation. Your teacher will tell you how to proceed with them. (You can also do some or all of them easily at home.)

1. For each of these mini-activities, what evidence of a new substance being produced can you observe?
   - Seal up a jar containing a piece of steel wool covered with vinegar.
   - Place a stainless steel spoon in a jar of vinegar.
   - Mix about 5 mL of baking soda with about 10 mL of vinegar in a small jar.
   - Place a clean egg in a jar of vinegar so it is fully covered, and seal the jar. (Always wash your hands after handling a raw egg.)
2. What will you do with the substances of the mini-activities when you are done with them? What harm, if any, might there be to the environment? How would your answer change if you were using powerful metal-eating car-battery acid?

Compounds and elements are changed during chemical reactions.

chemical reaction: any change that occurs when substances interact to produce new substances with new properties

A **chemical reaction** occurs when pure substances interact in a way that causes them to change into other pure substances. During chemical reactions, the chemical and physical properties of the pure substances change. That's how you know a chemical reaction has occurred.

We depend on some chemical reactions to produce certain types of products that are desirable to us. We depend on other chemical reactions for the energy they release while substances interact. However, chemical reactions also often produce undesirable products. Read about this in the examples below and at the top of the next page.

A Desirable Product of a Chemical Reaction

One important chemical reaction that affects your life combines nitrogen (N_2) with hydrogen (H_2) to make ammonia (NH_3). Ammonia is used to make fertilizer. As shown in **Figure 2.15**, farmers around the world use fertilizer to grow the food you eat.

▲ **Figure 2.15** Naturally occurring fertilizing compounds in soil are not nearly enough to support the world's population with food. Commercial production of fertilizer helps to grow enough food to support one-third of Earth's population.

▲ **Figure 2.16** Chemical reactions between the compounds in fireworks and the air produce the sound and light we associate with a fireworks display.

A Desirable Release of Energy from a Chemical Reaction

Some chemical reactions are useful not because of the substances they produce, but because of the heat or light that is released during the chemical reaction. For example, we use the energy produced during combustion reactions to keep us warm, cook our food, and power our cars and trucks. As **Figure 2.16** shows, we also use combustion reactions for entertainment.

An Undesirable Product of a Chemical Reaction

Most chemical reactions produce substances that we do not want, in addition to those that we do. For example, the combustion reactions that drive our cars produce gases that contain compounds responsible for acid rain. The acid in acid rain causes changes to the acidity of water in lakes and ponds, which can kill aquatic organisms. As well, the acid in acid rain reacts with the compounds in certain kinds of rock and metal. This reaction breaks down elements or compounds in the rock and metal. As a result, surfaces of bridges, buildings, and sculptures erode much more quickly than they would otherwise. **Figure 2.17** shows an example of damage caused by acid rain.

▲ **Figure 2.17** Acid rain has wide-reaching negative effects on the environment and on human-made structures. The acid in the rain reacts with the building materials, causing them to crumble away with the passage of time.

LEARNING CHECK

1. How do you know when a chemical reaction has occurred?
2. List two desirable products of a chemical reaction.
3. Which undesirable products are formed by the combustion reactions used to heat many homes and power cars?

Literacy Focus

Activity 2.12

ANALYZE SOME CHEMICAL REACTIONS

The photos here involve chemical reactions. Answer these questions about the photos.

1. Describe the chemical reaction taking place in each photo.
2. Do you think the reactions are useful? Explain your answer.
3. Discuss the social effects, the environmental effects, or both, of the chemical reactions shown.
4. Describe two more chemical reactions that could be analyzed using the first three questions. Then answer them.

Combustion

Rusting

Cellular respiration

Food spoilage

Photosynthesis

The properties of substances that make them useful can also make them dangerous.

Many of the substances that we use at home and at work have properties that make them both beneficial and dangerous. For instance, chlorine compounds are included in many cleaners because of their bleaching ability and strong disinfectant properties. The term disinfectant really means "poisonous." Chlorine kills bacteria and moulds because one of its useful properties is that it is poisonous.

Chlorine compounds are also used on a large scale to purify drinking and swimming pool water. Here, again, the term purify refers to the poisonous property of chlorine. We use chlorine to kill bacteria and other microbes in drinking and pool water.

So although chlorine compounds are widely used, they must be used with great care because of the hazardous nature of their properties. That's why many products sold for use in the home have hazard symbols and safety warnings on their packaging. **Figure 2.18** shows the meaning of the symbols that are commonly used on products for the home. This information comes from Health Canada to inform all Canadians about the safe way to use chemical products.

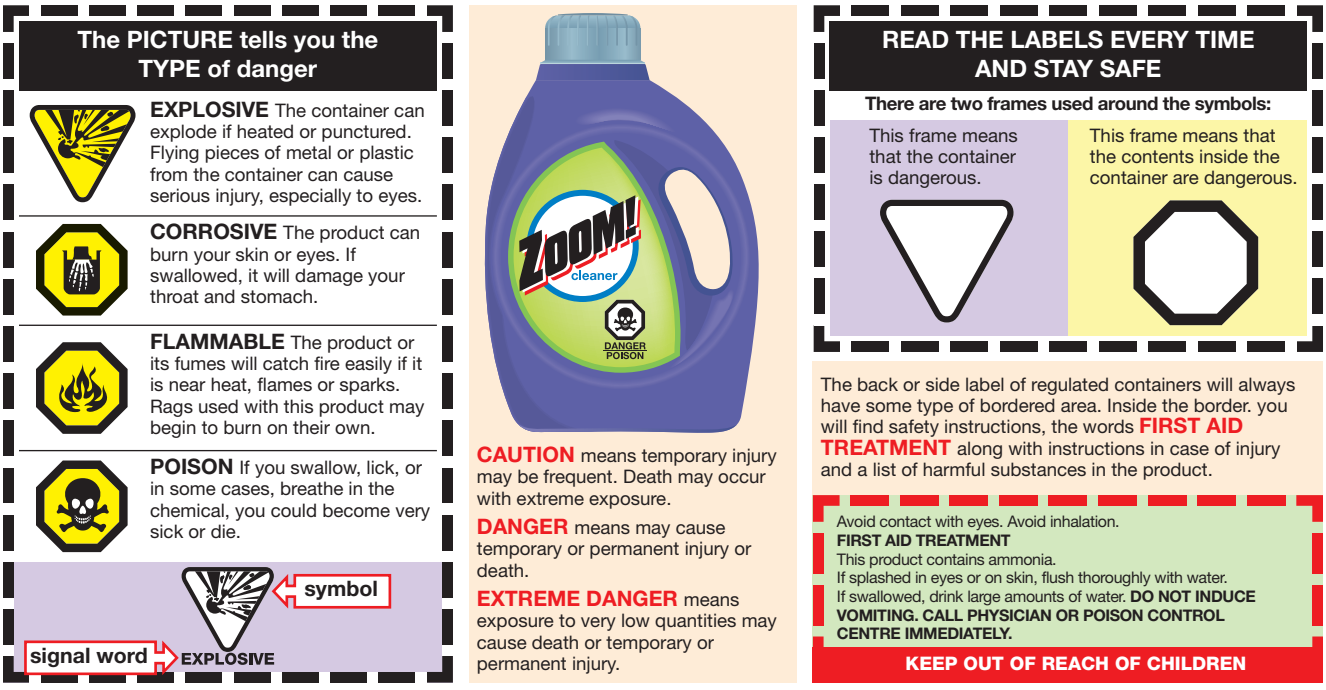


Figure 2.18 Many home products that are potentially dangerous have safety warnings on their labels. Hazardous Household Product Symbols (HHPS) are designed to be easy to understand. The shapes that outline the pictures are designed to look like road signs.

LEARNING CHECK

1. Use a t-chart to summarize the properties of bleach that make it both useful and harmful.
2. Sketch the HHPS symbol for (a) a flammable product and (b) an explosive container.
3. What HHPS symbol would you see on a container of bleach?

Literacy Focus

Activity 2.13

WHAT'S ON A LABEL?

Work in small groups. Your teacher will provide your group with a common product used in the home or the label from a common product. Examine the labelling on this product. Answer the following questions.

1. What is the intended use of this product?
2. What ingredients (substances) are found in the product?
3. What, if any, hazard-related information is included on the product labelling?
4. What, if any, safety-related instructions are provided?
5. If your product does not have a HHPS on it, design a suitable warning or safety symbol that could be used for it.
6. How does the warning and safety information for home products compare with WHMIS symbols? (Turn to page xv to review the WHMIS symbols.)

You will be asked to examine and analyze a label from products such as these in this activity.

There are less-harmful alternatives to many products we use and depend on.

If you gathered up all of the cleaning products in your home, you would find that all or most of them have some kind of warning or first aid information on them. We continue to use them because the benefits of their properties seem to outweigh the risks, or because we are unaware of the risks. However, there are alternatives with similar properties that do a similar job with fewer risks to health and the environment.

As people become more aware of the hazards of using some chemical substances, they are less willing to use more-hazardous cleaning products. Now, there are many commercially available cleaning products made with substances that are often less harmful to people and to the environment. Another, less expensive alternative is to use readily available substances that many people already have at home in the kitchen and bathroom cupboards. These are safer-to-use chemical substances that you probably already have in your kitchen cupboards at home. For most of the alternative cleaning products listed in **Table 2.8**, lemon juice can be added to improve the odour.

Note: In most cases, alternative cleaning substances are safer than traditional ones. But "safer" does not mean the same thing as "safe." Any substance—even water—can be dangerous under the right (or, rather, wrong) circumstances. There is no such thing as a chemical product that is 100% safe. All substances should be treated with care, thought, and respect.

Table 2.8 Some Alternatives to Traditional Cleaning Products

Traditional Cleaning Product	Safer-to-use Alternative
window cleaner	• a mixture of vinegar and water
furniture polish	• a mixture of white vinegar and vegetable oil
stain remover	• baking soda and water paste • hydrogen peroxide (3%) for some kinds of stains
oven cleaner	• borax and vinegar (and lots of vigorous scrubbing) • baking soda (and lots of vigorous scrubbing)
dishwasher detergent	• a mixture of baking soda and borax
fabric softener	• vinegar
toothpaste	• baking soda

Inquiry Focus

Activity 2.14

WHICH WOULD YOU CHOOSE?

In this activity, you will use a number of criteria to assess which type of cleaning product is the best choice for you.

What You Need

- commercially available cleaners
- lemons
- vinegar
- baking soda
- vegetable oil
- fabric
- "dirt"

What To Do

1. Choose one pair of household products: one commercially available and one alternative.
2. Make a table in your notebook similar to this one. Write the name of the commercial product and alternative product in the two right columns.

Test	Commercial Product	Alternative Product
effectiveness		
price		

3. Test each of your two products for their functionality. Test them as you would use them at home. For example, if they are glass cleaners, use them to clean glass. Assign each of the products a value from 5 (great) to 1 (awful) on their ability to do their job.
4. Ask your teacher for the price of each of the products. Assign the products a value from 5 (inexpensive) to 1 (very expensive) based on their cost.
5. With your partner, determine two other criteria to use to assess the products. Assess the products on these two criteria, and record the values from 5 (great) to 1 (awful).
6. Clean up your equipment. Wash your hands.

What Did You Find Out?

1. Which of your two products do you think is the "best"? Explain your answer.
2. Why did you choose the two criteria you added to assess your products?
3. How do your results compare with the rest of the class? Are commercially available products "better" than alternative products? Explain.

LEARNING CHECK

1. Why do we use cleaning products that can be hazardous?
2. Explain why using baking soda would be a safer way to clean an oven than using a more-hazardous product, but would not be considered 100 percent safe.

Skill Check

Initiating and Planning

✓ **Performing and Recording**

✓ **Analyzing and Interpreting**

✓ **Communicating**

Identifying an Unknown Gas

When chemical reactions take place, a gas is often produced. During this investigation, three different gases will be collected. You will identify the gas produced based on its chemical properties.

Caution! Your teacher may perform part or all of this investigation in a different way in order to ensure the safest possible environment for your class.

Safety

- Put on safety goggles and a lab apron.
- Be cautious when testing for gases.
- Be careful when handling the burning splints.
- Make sure the splints are properly extinguished immediately after being used.

What You Need

10 mL dilute hydrochloric acid
4 test tubes
test tube rack
mossy zinc
rubber stopper
test tube holder
2 wooden splints
5 mL 3% hydrogen peroxide
yeast
marble or limestone chip
5 mL limewater
balloon

What To Do

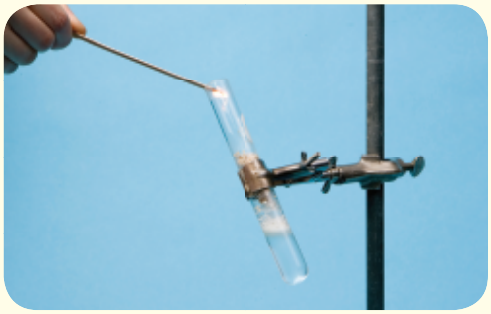
1. Work with a partner to perform each of the following tests. Record your observations as you complete each step.
2. Be sure to clean up your work station as you complete each part. Place each substance in the appropriate waste container, as directed by your teacher.

Part 1: Test for Hydrogen Gas

3. Obtain 5 mL of hydrochloric acid in a test tube, a piece of mossy zinc, and a wooden splint. Have the wooden splint nearby.
4. One partner holds the test tube at a 45° angle, using a test-tube holder, and then slides the zinc down the side of the test tube into the acid. A reaction should begin. Trap some of the gas in the tube using a rubber stopper.
5. **Test for Hydrogen:** Your teacher will show you how to light the splint. The other partner brings the flaming splint close to the mouth of the test tube. Hydrogen gas will ignite and burn rapidly down the test tube with a "whoop" sound.
6. Extinguish the wooden splint.

Part 2: Test for Oxygen Gas

7. Obtain 5 mL of 3% hydrogen peroxide in a test tube, some yeast, and a wooden splint.
8. One partner adds the yeast to the hydrogen peroxide. A reaction should begin. Trap some of the gas in the tube using a rubber stopper.
9. **Test for Oxygen:** Your teacher will show you how to light the splint and produce a glowing ember. The other partner brings the ember to the mouth of the test tube and inserts the glowing ember into the test tube. If oxygen is present, the glowing ember will burst into a bright flame.
10. Extinguish the wooden splint.



If oxygen gas is present, a flame will form from the ember.

Part 3: Test for Carbon Dioxide Gas

11. Obtain 5 mL of hydrochloric acid in a test tube, a small piece of marble or limestone, and a second test tube containing 5 mL of limewater.
12. One partner holds the test tube with the acid at a 45° angle, and slides the piece of marble down the side of the tube into the acid. The other partner places the balloon over the top of the test tube. The balloon will inflate with any gas that is produced.
13. **Test for Carbon Dioxide:** Keep the new gas inside the balloon by twisting the balloon closed. While the balloon is still twisted closed, attach it to the mouth of the test tube containing limewater. Once attached, invert the balloon-covered test tube so the limewater will mix with the gas in the balloon. Then return the test tube to an upright position. If carbon dioxide is present, the limewater will turn white and milky.

Slide the marble or limestone chip down the side of the test tube.

What Did You Find Out?

1. Describe the three gases by their physical properties. Could you use their physical properties to tell them apart?
2. Which chemical property was used to tell the three gases apart?
3. Which of the three gases could be used in a fire extinguisher? Explain your answer.

Making a DIFFERENCE

Adrienne Duimering was 14 when she saw statistics about fatal fires in Canada. Many of the fires were preventable, and Adrienne wanted to know what products were available to help prevent fires. She discovered that fire retardants (chemicals that fireproof flammable fabrics) can be expensive and toxic to the environment. Adrienne decided to study fire retardants for her 2007 science fair project. She wanted to find an inexpensive, environmentally friendly fire retardant. Adrienne tested the fire-retarding abilities of sodium bicarbonate (baking soda) and ammonium sulfate (a common fertilizer) on common materials. She found that both compounds were effective retardants. Her project won a silver medal at the Canada-Wide Science Fair.

Are there products in your home that could be replaced with safe, less expensive alternatives?

In 2004, when Sarah Mediouni was 12, she and her friends started a campaign to get Orangeville, Ontario to ban the use of pesticides.

During their campaign, Sarah and her friends met with their mayor and town council. They presented the officials with statistics and a 2004 report by the Ontario College of Family Physicians that linked pesticide exposure to cancer and other illnesses in children. They also presented petitions signed by 300 young people and more than 400 adults. Sarah helped deliver flyers advertising local seminars on ways to care for lawns without using pesticides. A pesticide by-law came into effect in Orangeville in 2007.

Sarah says it felt great to have an impact on the issue. "It made me realize that a small group of kids can actually have an impact on something important."

In what ways can you have a valuable impact or make an important contribution in your community?

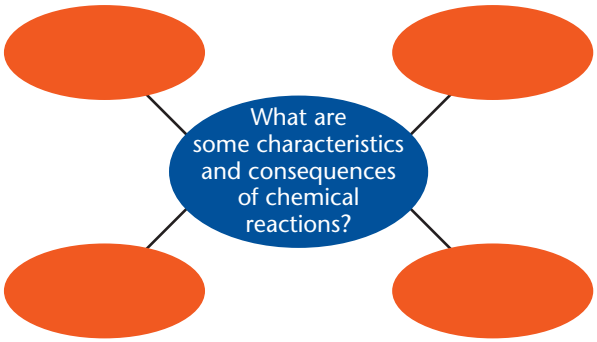
Topic 2.6 Review

Key Concept Summary

- Compounds and elements are changed during chemical reactions.
- The properties of substances that make them useful can also make them dangerous.
- There are less-harmful alternatives to many products we use and depend on.

Review the Key Concepts

1. K/U Answer the question that is the title of this topic. Copy and complete the graphic organizer below in your notebook. Fill in four examples from the topic using key terms as well as your own words.



2. A Why are chemical reactions important to us? Answer this question by providing examples of chemical reactions that you encounter in your daily life.

3. K/U Are the chemical products of a reaction always something we can use? Explain why or why not.

4. A Commercial fertilizers are produced to help farmers try to grow enough food to feed everyone in the world. Fertilizers are also used by some homeowners in cities to keep their lawns and gardens lush and healthy. However, not all the fertilizer is used by the plants, and excess fertilizer runs off into water systems and makes its way into waterways. This run-off damages the water systems. Do you think fertilizer use should be banned in all cities? Support your opinion with appropriate evidence.

5. T/I A reaction that produces a gas occurred and the gas was collected. Several tests were performed. A flaming splint was brought close to the gas and nothing happened. A glowing ember did not relight when placed in the gas. When mixed with limewater, the limewater turned cloudy.

a) In your notebook, draw a t-chart with the headings "Evidence" and "Inferences." Record each observation in the "Evidence" column and then complete the "Inferences" column.

b) Identify the gas that was collected. Explain how you know.

6. A The compound calcium carbonate (lime) is sometimes added into a lake that has been affected by acid rain. The compound reacts with acid in the lake, causing the lake water to become less acidic. Liming a lake, as this process is called, is not a permanent solution to the effects of acid rain. Explain why this is the case.

SCIENCE AT WORK

CANADIANS IN SCIENCE

Florell Essibrah

Florell Essibrah's lab is a bakery, and her chemicals include flour, egg, sugar, and butter. She mixes them together to make cake batter. Nearby are cookies decorated with the colourful icing that she has made. Her cake, cookies, and other baked goods each will taste, smell, and feel different. The taste, smell, and texture depend on the chemical and physical properties of the ingredients that go into making them. Like any chemist, a baker is keenly aware of the properties of the substances that go into making a final product.

When did you decide you wanted to pursue a career as a baker?

Florell Essibrah attended E.C. Drury Secondary School for the Deaf. While in high school, she completed a co-operative education program that involved working at a bakery, where she learned from an internationally trained pastry chef. The co-op program helped her decide to pursue a career in baking. She registered as a baker in the Ontario Youth Apprenticeship Program and will attend George Brown College to continue her education.

What do you like most about working in a bakery?

"It can be very busy, but I like to be busy. I like to have a lot of work to do," says Florell, who uses American Sign Language. "I enjoy making desserts and cookie icing the best."

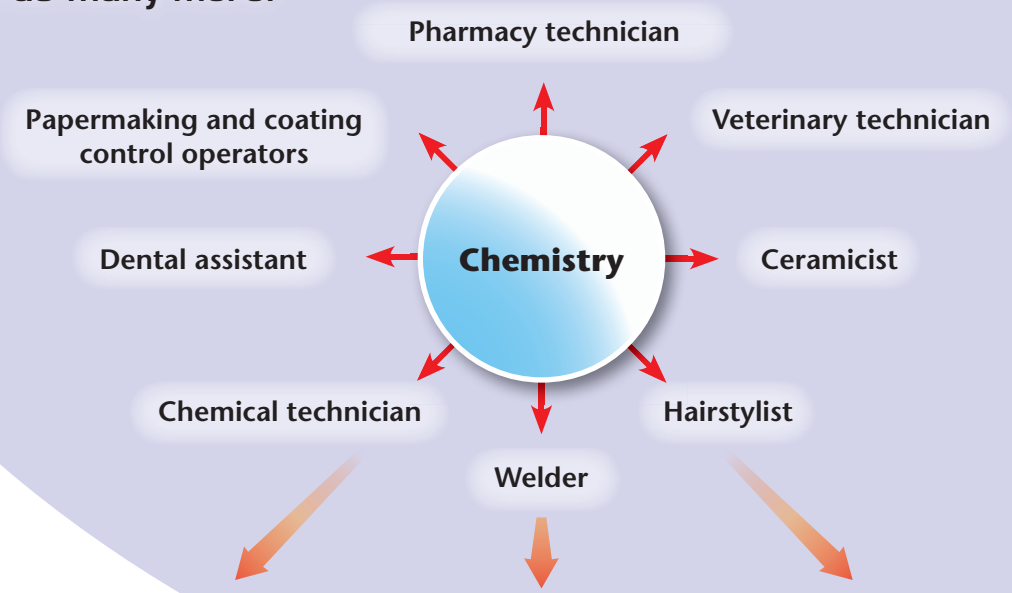
What skills do bakers need?

Bakers handle large amounts of many different ingredients and use and work with large equipment, including mixers and ovens. Good organizational and planning skills, therefore, are essential. Creativity, attention to detail, and a keen eye for making precise, accurate measurements are also valuable assets.

Bakers work for food manufacturers, grocery and other food stores, hotels, catering businesses, and other specialty baking and pastry businesses.

Put Science To Work

The study of chemistry contributes to these careers, as well as many more!



▲ Chemical technicians help prepare and conduct chemical tests. They may work in research and quality control laboratories, in the manufacturing industry, or companies that make products such as foods.

▲ Welders use special equipment to permanently join metals together to make or repair metal parts. Welders often work as mechanics in the automotive industry, as well as in aerospace and pipeline construction.

▲ Hairstylists apply chemicals, such as dyes, tints, and bleach, to treat and colour hair. They also use chemicals to straighten or curl hair.

Over To You

Work Life Learning

1. How does baking involve chemistry?
2. Why does a baker need good organizational and planning skills?
3. Research a career involving chemistry that interests you. What are the essential skills needed for this career? What would you need to do to pursue this career? e-LINK

Go to **scienceontario** to find out more

Unit 2 Summary

Topic 2.1: In what ways do chemicals affect your life?

Key Concepts

- Everything—including you and everything around you—is made up of chemicals.
- Substances have characteristics that make them useful, hazardous, or both.
- Handling chemicals and lab equipment safely and responsibly is a part of your life at school.

Key Terms

matter (page 97)

Big Ideas

- The use of elements and compounds has both positive and negative effects on society and the environment.

Topic 2.2: How do we use properties to help us describe matter?

Key Concepts

- Physical properties describe how matter looks and feels.
- Chemical properties describe how substances can change when they interact with other substances.

Key Terms

physical property (page 106)
conductivity (page 106)
density (page 106)
lustre (page 106)
solubility (page 106)
texture (page 106)
chemical property (page 108)
combustibility (page 108)
precipitate (page 108)
decomposition (page 108)

Big Ideas

- Elements and compounds have specific properties that determine their uses.

Topic 2.3: What are pure substances and how are they classified?

Key Concepts

- Pure substances are elements and compounds.
- Elements are metals and non-metals.

Key Terms

mixture (page 114)
pure substance (page 114)
compound (page 114)
element (page 114)
metal (page 117)
non-metal (page 117)

Big Ideas

- Elements and compounds have specific properties that determine their uses.

Topic 2.4: How are properties of atoms used to organize elements into the periodic table?

Key Concepts

- Elements are made up of atoms, which are made up of subatomic particles.
- Elements are arranged in the periodic table according to their atomic structure and properties.
- Elements in the same family (group) share similar physical and chemical properties.

Key Terms

atom (page 122)
proton (page 122)
neutron (page 122)
electron (page 122)
nucleus (page 122)
atomic number (page 122)
periodic table (page 124)
period (page 124)
family (page 124)

Big Ideas

- Elements and compounds have specific properties that determine their uses.

Topic 2.5: In what ways do scientists communicate about elements and compounds?

Key Concepts

- Chemical symbols are used to represent elements.
- Chemical formulas are used to represent the types and numbers of atoms in compounds.

Key Terms

chemical symbol (page 132)
molecule (page 133)
chemical formula (page 133)

Big Ideas

- Elements and compounds have specific properties that determine their uses.

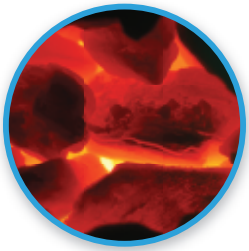
Topic 2.6: What are some characteristics and consequences of chemical reactions?

Key Concepts

- Compounds and elements are produced and consumed during chemical reactions.
- The properties of substances that make them useful can also make them dangerous.
- There are less-harmful alternatives to many products we use and depend on.

Key Terms

chemical reaction (page 142)



Big Ideas

- Elements and compounds have specific properties that determine their uses.
- The use of elements and compounds has both positive and negative effects on society and the environment.

Inquiry Investigation: Rust Formation

Rust forms when a metal reacts with oxygen in the air. This chemical reaction is called corrosion. Corrosion damages metal in vehicles and supports for roads and bridges, and exposed metals in buildings.

In this project, you will investigate one factor affecting the formation of rust in iron, steel, and aluminum nuts and bolts.

Investigate Question

What factors influence the corrosion of certain metals?

Initiate and Plan

1. As a class, list the factors that influence the corrosion of metals.
2. Choose one factor (independent variable) to test its contribution to rust formation (dependent variable). Predict its effect on each of the metals.
3. Design your test. Include:
   - equipment and materials
   - step-by-step testing method
   - safety precautions
   - a procedure for recording results
   - criteria for measuring and judging results
4. Have your teacher approve your investigation.

Perform and Record

5. Conduct your investigation and record the results.

Analyze and Interpret

1. Describe the results of your investigation. Did the factor tested affect the formation of rust on each metal? Describe how.
2. Did the results match your prediction? Explain why or why not.
3. Compare your results with those of other classmates who tested the same factor.
4. What changes would you make if you were going to repeat your investigation?

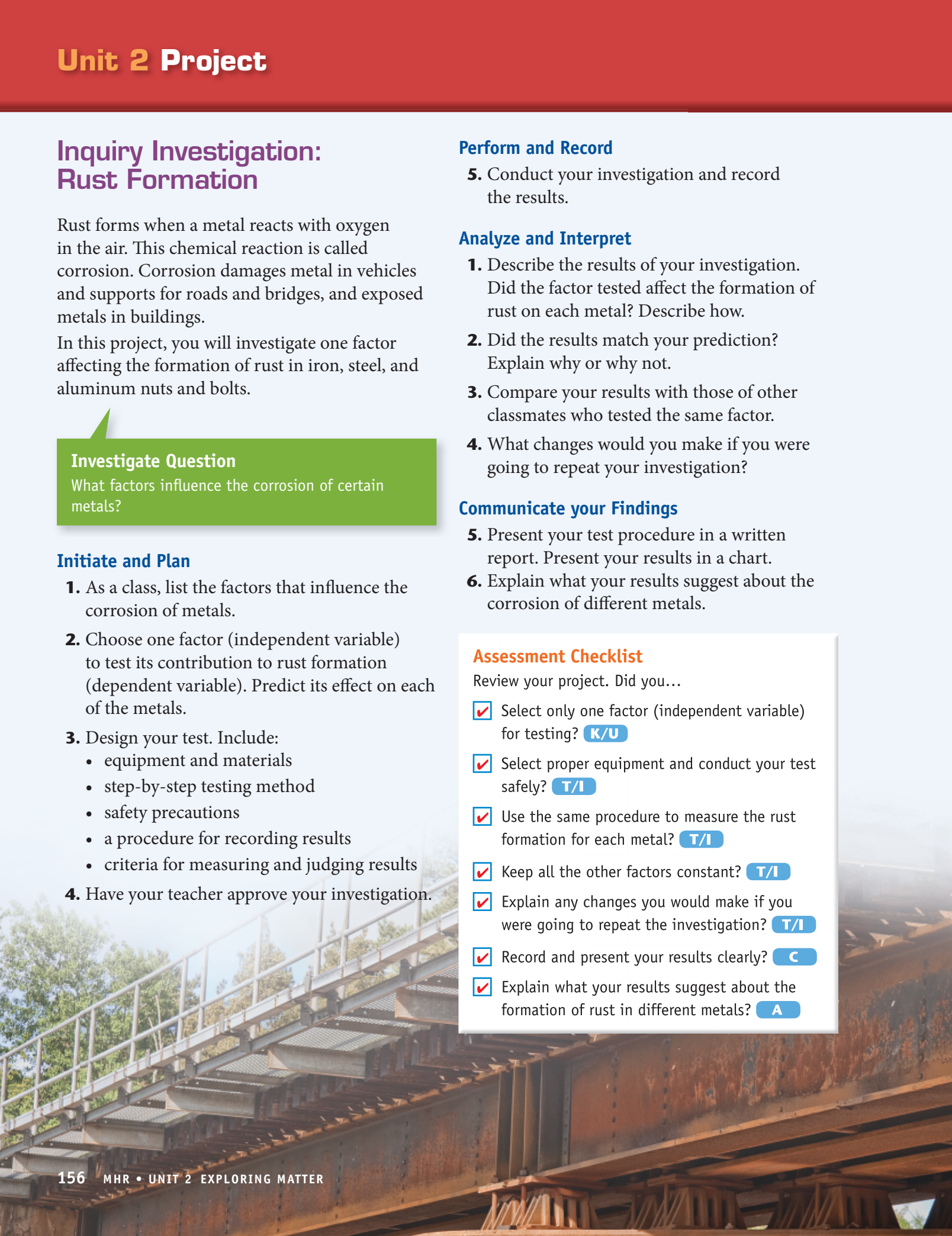
Communicate your Findings

5. Present your test procedure in a written report. Present your results in a chart.
6. Explain what your results suggest about the corrosion of different metals.

Assessment Checklist

Review your project. Did you…

- ☑ Select only one factor (independent variable) for testing? K/U
- ☑ Select proper equipment and conduct your test safely? T/I
- ☑ Use the same procedure to measure the rust formation for each metal? T/I
- ☑ Keep all the other factors constant? T/I
- ☑ Explain any changes you would make if you were going to repeat the investigation? T/I
- ☑ Record and present your results clearly? C
- ☑ Explain what your results suggest about the formation of rust in different metals? A



An Issue to Analyze: Evaluating the Use of Road Salt

Road salt melts ice on winter roads, making driving safer. Road salt also contributes to corrosion of vehicles, roads, and bridges and contaminates land and aquatic ecosystems.

Issue

Federal and municipal authorities and the private sector release about 5 million tons of chloride salts into the Canadian environment annually. A half million tons is from road salt on Ontario roads. Should this use be regulated? Explain your reasoning.

Initiate and Plan

1. Create questions to give you enough information to evaluate this issue. Include:
   - the benefits of using salt on winter roads
   - the ways road salt gets into land and aquatic ecosystems
   - the effect of road salt on those ecosystems
   - some possible ways of reducing the impact of road salt (consider what other countries do)
2. Research and list possible sources of the information you need.
3. Choose a graphic organizer or other method to organize your findings.
4. Present your plan for your teacher's approval.

Perform and Record

5. Gather and record information to answer your questions.

Analyze and Interpret

1. Prepare a PMI chart showing positive points for use of road salt alongside negative effects of road salt.
2. Is road salt necessary to keep winter roads safe? Justify your conclusion.
3. How serious is the damage that road salt does to the environment? Give examples.
4. How could regulation help the environment? State your position on the issue and justify it.

Communicate your Findings

5. Present your findings to the class, using a poster, slide show, or a written or oral report.
6. Include a graphic organizer to show how road salt finds its way into different ecosystems.

Assessment Checklist

Review your project. Did you…

- ☑ research how road salt is used in winter to minimize driving hazards? K/U
- ☑ consult credible resources to find out about possible environmental damage? T/I
- ☑ use graphic organizers to record your research? C
- ☑ prepare a PMI chart showing benefits road salt alongside negative effects? T/I
- ☑ clearly state your position on the issue and justify your position? C
- ☑ note at least one technique or alternative to reduce the use of road salt? A

Unit 2 Review

Connect to the Big Ideas

1. Elements and compounds have specific properties that determine their uses. The wide use of silicon in computers and electronic devices is due to the unique properties of this element. Use a research process to discover what properties make silicon the element of choice for computers and electronic devices. Present your findings in an information pamphlet or a small poster.
2. The use of elements and compounds has both positive and negative effects on society and the environment. In recent years, citizens around the world have been encouraged to change the type of light bulb used in their homes. Incandescent light bulbs produce waste heat. Compact fluorescent light bulbs (CFL bulbs) are much more energy-efficient; they use less electricity and thus reduce greenhouse gas emissions. However, CFL bulbs are made with a very small amount of the element mercury, which is poisonous to the human nervous system. CFL bulbs are sealed so that the mercury stays inside the bulb unless it gets broken. Use a PMI chart to weigh the advantages and disadvantages of the use of CFL bulbs. Decide whether you think they should continue to be produced. Write a blog promoting your decision.

Knowledge and Understanding K/U

3. Identify each of the following properties as physical or chemical.
   - **a)** butter melts in a frying pan
   - **b)** honey is denser than water
   - **c)** a limestone statue bubbles when an acid touches it
   - **d)** aluminum is a good conductor of heat and electrical current
   - **e)** snow is white
   - **f)** many non-metals are brittle
   - **g)** peroxide reacts with protein in hair

4. What chemical property of potassium is shown in the photograph below?

5. A substance dissolves in water. Describe one of its physical properties.
6. Solid water—ice—is less dense than liquid water. Therefore, ice floats on water. Describe how your life would be different if ice were not less dense than liquid water.
7. Draw and label pictures of the particles found in a pure substance and the particles found in a mixture. Describe how pure substances and mixtures are different.
8. Use a concept map to show the relationship between an element and a compound.
9. Classify each of the following as an element, a compound, or a mixture.
   - **a)** gold
   - **b)** air
   - **c)** orange juice
   - **d)** sugar
   - **e)** salt
10. How do the properties of bleach make it suitable for cleaning? What are some hazards related to using bleach?
11. Use a Venn diagram to summarize the similarities and differences between metals and non-metals.

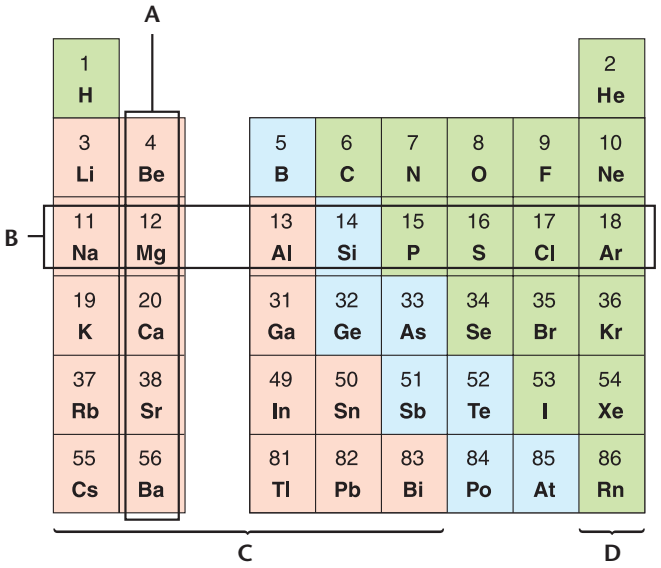
12. What can you determine from the atomic number of an atom?

13. Draw a diagram comparing the three subatomic particles found in an atom. Use a symbol and a charge to label each diagram.

14. Draw a diagram of a calcium atom. Place the subatomic particles in the correct position and energy level.

15. Describe the different patterns involving elements in the periodic table.

16. Identify the features of the periodic table below that are indicated by the letters A, B, C, and D.



17. What is the symbol or the chemical formula for each of the elements and compounds listed below?

a) carbon

b) fluorine

c) carbon dioxide

d) hydrogen peroxide

e) potassium

18. Draw the HHPS symbol that you would see on a container of a poisonous household product.

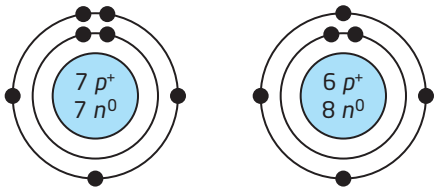
19. What properties of copper make it useful for electrical wiring?

Thinking and Investigation T/I

20. While baking at home, you discover that the labels have fallen off the containers of flour and baking soda (sodium hydrogen carbonate). Describe a *safe* way in which you could use a difference in the properties of these two substances to tell them apart. (Do *not* taste the substances.)

21. You have found a chunk of a dull, grey substance while on a nature walk. Outline the steps you could use to determine if this chunk is a metal or a non-metal.

22. Do the following diagrams show atoms of the same element? Explain your answer.



23. A company that sells bottled water calls one of its products, "Nature's Pure Source Water."

a) Write the chemical formula for the only ingredient that you would expect to find in this product. Explain your answer.

b) The nutrient analysis label on the product records that the product contains 25 ppp (parts per million) of magnesium, 70 ppm calcium, and 1 ppm sodium. Write the chemical symbols for these three elements.

24. Choose one of the lab tests for hydrogen, oxygen, or carbon dioxide. Use a flowchart to outline the procedure for this test.

Communication C

25. Create a collage of pictures that shows different examples of matter. Draw your own pictures or cut out visuals from newspapers or magazines.

26. Draw models of the following compounds:
- **a)** water, H_2O
- **b)** methane, CH_4
- **c)** ammonia, NH_3

27. Use diagrams and words to explain the difference between an atom and a molecule to someone who is in Grade 6.

28. Batteries are used in many everyday devices. Research the chemicals present in the batteries you use in technologies such as cell phones, as well as the hazards associated with these chemicals. Devise a plan of action for the safe disposal of these batteries after they are used up. Create a school PA message, a poster, a website, or another text form to share your plan of action with others.

29. You are the manager of a cleaning service. You have recently hired some new employees, and you are training them about various health hazards they need to be aware of when doing their jobs. Design an information sheet that outlines the benefits and the hazards of using chlorine bleach.

Application A

30. A facial tissue, a sheet of paper, and a cardboard box are all made from wood fibres. Discuss how the physical properties of each material make it useful for its intended purposes. Name a chemical property that these three materials have in common.

31. In question 23, you read about a bottled water product that has the word "pure" in its name. Write a letter to the marketing manager of this company explaining how the use of the word "pure" on the label is misleading. Use your science knowledge to support your claim.

32. Identify the element at each of the following positions in the periodic table in **Figure 2.9**. Provide the full name and the symbol for each element.
- **a)** group 2, period 3
- **b)** group 14, period 2
- **c)** group 18, period 2

33. Silver is a metallic element with many useful properties. It is malleable and can be polished, moulded, and stretched. It is better than any other metal at conducting heat and electricity. Do some research to find out more about this precious metal and its properties. Make a t-chart listing some properties of silver and some everyday uses based on those properties.

34. A question on a quiz asks you how many energy levels in calcium contain electrons. Explain how you would use a periodic table to find the correct answer to the question.

35. What is the meaning of each of these icons?

36. The chemical symbol for the element, nitrogen, is N. However, when chemists describe the gas, nitrogen, in the atmosphere, they write N_2. Explain why they write the symbol with a subscript of 2.

37. Sodium phosphate is a compound that may be used in some cleaning products, The chemical formula for sodium phosphate is Na_3PO_4. What does the formula tell you about sodium phosphate?

Literacy Test Prep

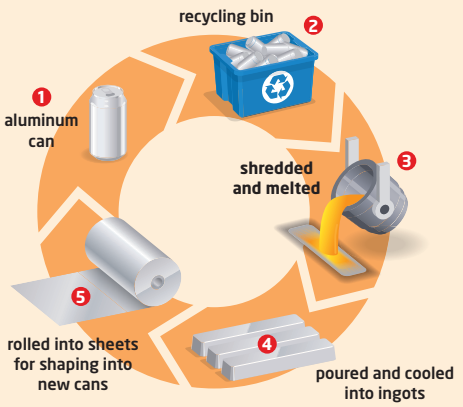
Read the selection below and answer the questions that follow it.

Aluminum Production

Aluminum is a useful material because of its properties. Aluminum has a low density compared with other metals, so it forms very strong, lightweight alloys with other metals. It is very reactive but does not corrode. Aluminum is easy to work with, so it can be flattened and bent to the desired shape. It also is a very good conductor of heat and electricity.

Aluminum is obtained from a compound called aluminum oxide, which comes from bauxite that is mined. A large amount of electrical energy is needed to process the bauxite and aluminum oxide. Although bauxite is not mined in Canada and must be imported, our abundant hydroelectric power plants allow Canada to be one of the world's main producers of aluminum.

Each year, about 1.5 billion kg of aluminum are used to produce beverage cans in North America. This requires about 5 billion kilowatt-hours of electricity—the same amount of electricity that is used by over half a million homes each year. Recycling the aluminum in cans, however, requires only 5 percent of the energy needed to make new aluminum. Also, unlike most other metals, 100 percent of the aluminum can be recycled.



Multiple Choice

In your notebook, record the best or most correct answer.

34. Canada is a large producer of aluminum because Canada has many

a) bauxite mines
b) hydroelectric power stations
c) beverage canning factories
d) deposits of elemental aluminum

35. Aluminum is useful because of all the following properties **except**

a) its ability to form alloys
b) its conductivity
c) its ability to be easily shaped
d) its high density

36. What is the correct order in the production of aluminum beverage cans?

a) bauxite → aluminum oxide → cans
b) aluminum oxide → bauxite → aluminum → cans
c) bauxite → aluminum → aluminum oxide → cans
d) bauxite → aluminum oxide → aluminum → cans

37. The purpose of the last paragraph is to

a) encourage the reader to recycle aluminum cans
b) organize information about the production of aluminum
c) inform the reader of aluminum use
d) recommend that the reader use less energy in the home

Written Answer

38. Aluminum is used to manufacture parts for airplanes. Describe two properties of aluminum that you think are important in the production of these parts. Use specific details from the selection to support your answer.