Chemical Properties

5.3

A fireworks display is the perfect ending to a Canada Day celebration (Figure 1). A great deal of artistry and planning goes into each show. When the skies are dark, the pyrotechnician ignites the first explosive mixture. The sky lights up with showers of colour and brilliance, accompanied by noise, smoke, and gasps of appreciation from the crowd.

To learn more about becoming a pyrotechnician,
GO TO NELSON SCIENCE

Figure 1 Fireworks traditionally mark Canada Day celebrations.

In scientific terminology, we are seeing the chemical properties of the fireworks. A **chemical property** is a property of a substance that describes its ability to undergo changes to its composition to produce one or more new substances. Fireworks contain ingredients such as metal flakes, fuel, and a bursting charge (Figure 2). These substances react together to produce new substances, some of which are visible in the smoke. The entire reaction releases a great deal of energy, which appears in the form of light, sound, thermal energy, and high-speed motion high into the sky.

chemical property a characteristic of a substance that is determined when the composition of the substance is changed and one or more new substances are produced

All substances have chemical properties. Denim, for example, is resistant to cleaning solutions such as paint removers; that is, the composition of the cotton fabric is unchanged by these chemicals. If you decide to burn your old pair of jeans in a bonfire, you may find that the composition of the cotton changes. Flames engulf the fabric and entirely new substances are produced, called ashes. The resistance to paint removers and the ability to burn are chemical properties of cotton denim.

We take advantage of the chemical properties of substances in our daily lives. We mix different substances together to create products that we want. Baking soda causes a cake to rise, and bacterial cultures turn milk into cheese. We use other chemicals to clean our silver jewellery and clogged shower heads. New chemical products are continually produced to suit our changing lifestyles. Such a wide variety of products is available to us that it is helpful to have a basic understanding of chemical properties.

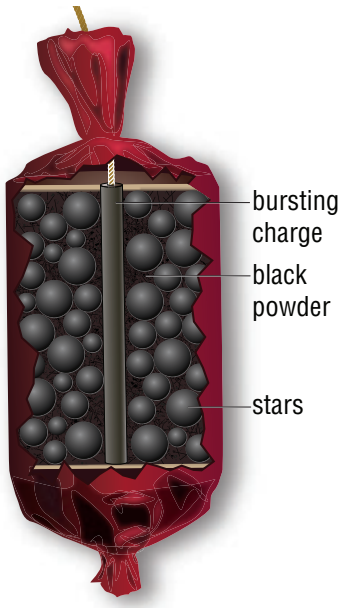

Figure 2 Inside a fireworks tube

Chemical Changes

chemical change a change in the starting substance or substances and the production of one or more new substances

How can you tell if a chemical change has taken place? A **chemical change** is always accompanied by a change in the starting substance or substances and the production of one or more new substances. The original substances do not disappear. Instead, the components of the original substances are rearranged in the process of forming a new substance or substances.

TRY THIS MAKE COMMON CHEMICAL CHANGES

SKILLS: Performing, Observing, Analyzing, Evaluating, Communicating

Chemical changes occur everywhere and all the time—at home, at school, and in your own body. In this activity, you will identify any evidence that a substance has changed its composition and something new has been produced.

Equipment and Materials: 2 teaspoons; 3 clear drinking glasses; vinegar; baking soda; lemon juice; strong tea; milk

1. Gather the following items from your kitchen: vinegar, baking soda, lemon juice, strong tea, milk (Figure 3). Combine the items as directed. Record your observations after each step.

Figure 3 Do this activity at home using equipment and materials from your kitchen.

(i) Place a teaspoon of baking soda into a clear drinking glass and pour a teaspoon of vinegar into the glass.

(ii) Fill a second drinking glass about half-full of strong dark tea. Add a teaspoon of lemon juice.

(iii) Fill a third drinking glass about one-quarter full of milk. Add an equal amount of vinegar. Mix gently and allow the mixture to sit for a little while.

A. In each of the activities above, identify any evidence that a new substance was produced. T/I

B. In each of these activities, do you think the process can be reversed so that the end product is changed back to its original form? Explain your answer. T/I

C. Compare the reversibility of these changes to a change of state, such as ice melting. What type of change occurs in a change of state? K/U

D. Compare the reversibility of these changes to a substance dissolving, such as a teaspoon of salt dissolving into a glass of water. What type of change occurs when a substance dissolves? K/U

E. List three differences between physical changes and chemical changes. K/U

WRITING TIP

Identify the Purpose

When writing the second sentence of a summary, consider three common purposes of science texts: to inform, to describe, to explain. For example, a text might describe the process of producing the indigo colour of blue jeans, or it might inform readers of the main ideas of the particle theory.

You can look at the scene of the chemical event for clues about the type of change that has occurred. In the case of the dye that colours cotton denim fibres, the yellow dye in the soaking vat visibly changes when it is exposed to oxygen in the air. A new compound with a new indigo colour is formed right within the fibres of the denim. This colour change is evidence of a chemical change.

Some examples of evidence of chemical change are listed below:

- a change of colour—a new substance has formed that has a different colour than the original substance
- a change of odour—a new substance has formed that has a detectable odour (in scientific language, all smells are called odours, whether they are pleasant or unpleasant)
- bubbles are visible that are not caused by heating—a new substance is produced in the form of a gas
- a new solid is seen—a new substance that is produced does not dissolve in the mixture and shows up as a solid; the solids that are formed in this way are often powdery and are called **precipitates**
- a change in temperature or light—energy is released or absorbed during the chemical change, and is detected as a change in temperature or light

precipitate a solid that separates from a solution

Many chemical changes are easy to observe and occur all around you. Figure 4 shows three examples of common chemical changes.

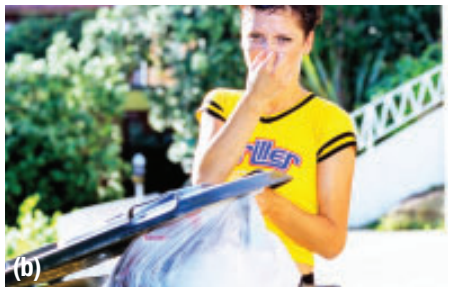

Figure 4 Evidence of chemical changes: (a) Colourless egg whites turn white during the chemical change called cooking. (b) The new products formed from chemically changed garbage are not always fragrant. (c) Bubbles of carbon dioxide gas are produced when baking soda reacts with vinegar.

TRY THIS TO ROT OR NOT TO ROT

SKILLS: Predicting, Performing, Analyzing, Communicating

SKILLS HANDBOOK 3.B.3., 3.B.7.

Rotting is the smelly way by which substances are naturally reused and recycled so that they can be made into new things. When rotting is contained and controlled, we call it composting (Figure 5). Of course, when we declare that we compost, we are claiming credit that rightfully belongs to the millions of microscopic bacteria and fungi that are doing the actual dirty work. These organisms are called decomposers. The decomposers' role is to break down complex compounds into small reusable components.

Figure 5 Composting is a great way of reducing waste that goes to landfills and at the same time fertilizing your garden.

In this activity, you will choose a variety of materials and investigate whether they can be decomposed in soil. Some items will be natural (from a plant or animal). Other items will be synthetic (made by chemical means). After your experiment is set up, it will be left to decompose. You will retrieve it in Section 7.7 for examination. At that time, you will see what has rotted and what has not rotted.

Wash your hands thoroughly with soap and water after handling the soil and its contents.

Equipment and Materials: large container (for example, bucket, plastic tub, large pop bottle, small aquarium); garden soil or potting soil with compost starter (from garden store); water; a few small twigs or pebbles; selection of fruit or vegetable peels and scraps (do not include meats); selection of leaves, flowers, and stems; selection of synthetic plastics and polystyrene, cut into small pieces; small pieces of paper towel and newspaper; old spoon

1. Predict which types of items will decompose in the soil and which will not. Give reasons for your prediction. T/I
2. Record the physical properties of each item you have selected to bury in the soil.
3. Add water to the soil. Mix until the soil has the wetness of a wrung-out sponge.
4. Place the twigs or pebbles at the bottom of the container to allow drainage.
5. Pour a layer of soil into the container followed by a layer of selected items. Ensure that each layer contains items of natural and synthetic materials.
6. Repeat step 5 until the container is filled.
7. Cover the container loosely with a lid and allow it to sit in a warm location. Check the moisture level every few days and add water if required.

A. Suggest reasons why the ability to decompose is an important characteristic of consumer goods. A

B. Suggest situations where the inability to decompose is an important characteristic of a product. A

C. List some examples of objects or appliances at home that are used to slow the decomposition of substances such as food or wood. A

UNIT TASK Bookmark

You can apply what you learned in this section about chemical properties to the Unit Task described on page 286.

IN SUMMARY

- A chemical property is a property of a substance that describes its ability to undergo changes to its composition to produce one or more new substances.
- A chemical change is a change in the starting substance or substances and the production of one or more new substances
- Evidence of chemical change includes
  - colour change
  - odour change
  - gas production
  - precipitate production
  - energy change

CHECK YOUR LEARNING

1. Describe the difference between a physical change and a chemical change. K/U
2. Explain why water freezing is not a chemical change. K/U
3. Classify each of the following as a physical or a chemical property. Give reasons for your answer. K/U
   (a) metallic lustre
   (b) boiling point
   (c) explodes when ignited
   (d) changes colour when mixed with water
4. Classify each of the following as a physical change or a chemical change. For each chemical change, explain how you can tell that a new substance has been formed. K/U
   (a) Water boils and turns into steam.
   (b) Wood is sawed and made into a toy box.
   (c) Firewood burns and ashes remain.
   (d) Orange drink crystals are stirred into a pitcher of water.
   (e) Sugar, eggs, and flour are mixed and baked into cookies.
5. What evidence is there that a glowstick works as a result of a chemical change (Figure 6)? K/U

Figure 6 What kind of change causes glowsticks to glow?

6. When a candle is lit and allowed to burn for 15 minutes, some wax drips and collects at the base of the candle, and the candle becomes shorter. K/U C
   (a) Did you observe any physical changes? Explain.
   (b) Why did the candle become shorter? What happened to the missing section of the candle?
   (c) Did you observe any evidence of chemical change? Explain.
7. Think about each of the following situations and describe one chemical change that is occurring. Provide evidence of the chemical change. K/U
   (a) A driver starts the car in the driveway.
   (b) A bathroom cleaning product removes a stain in the sink.
   (c) Bubbles form when baking soda is mixed with lemon juice.
   (d) Cookies baking in the oven give off a delicious aroma.
   (e) A match is struck and ignites.
   (f) Bleach turns a red towel white.
   (g) A banana tastes sweeter as it ripens.