Topic 2.3

What happens during a chemical reaction, and how can it be described?

Key Concepts

- During a chemical reaction, chemical compounds are changed into different compounds with different properties.
- The four types of chemical reactions can be described using word equations.
- Chemical reactions can be described using chemical equations.
- Atoms and mass are conserved during a chemical reaction.

Key Skills

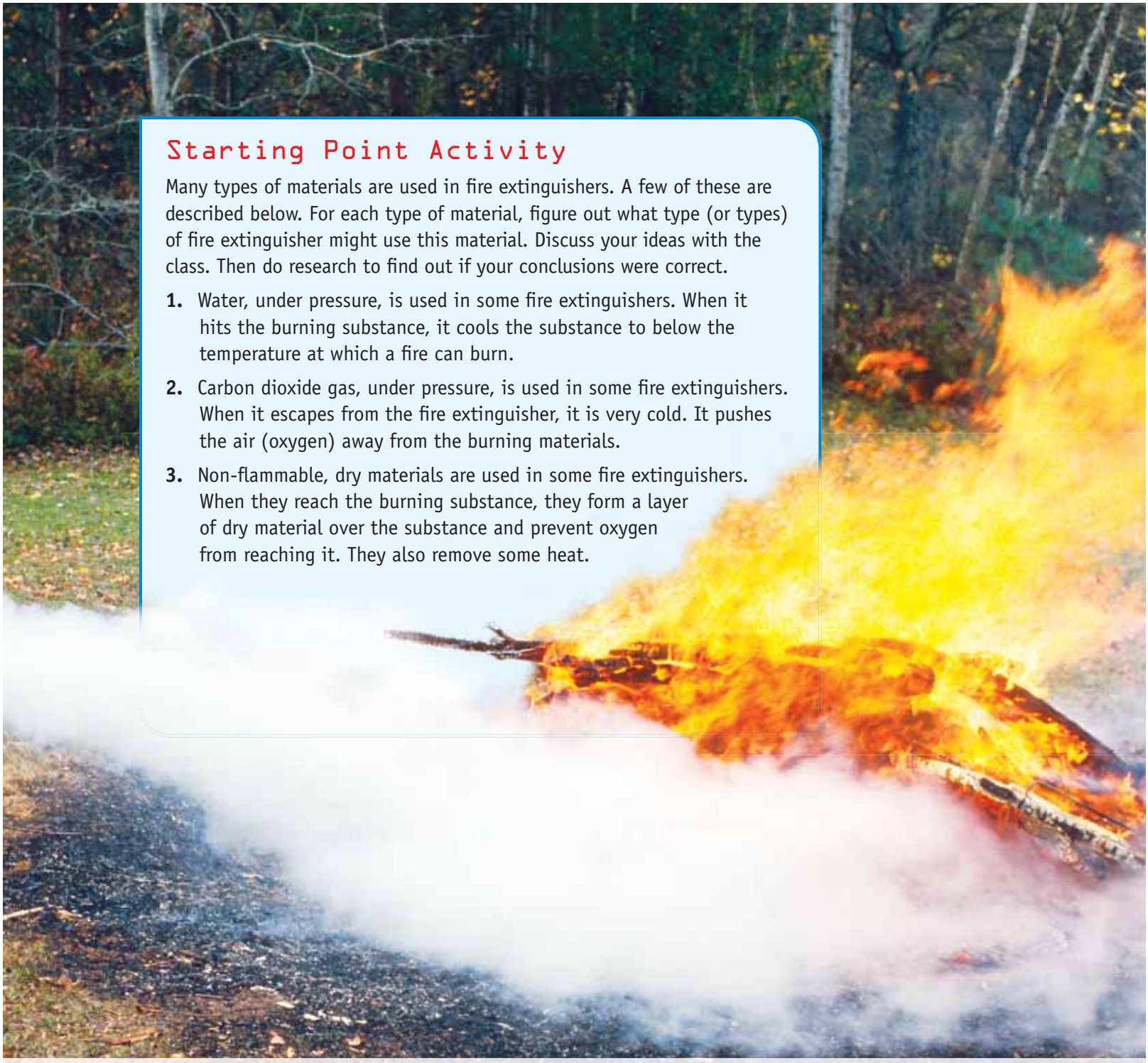
- Inquiry

Key Terms

synthesis reaction
decomposition reaction
single displacement
double displacement
word equation
chemical equation
balanced chemical equation
law of conservation of mass

A	B	C	D	K
Ordinary Combustibles	**Flammable Liquids**	**Electrical Equipment**	**Combustible Metals**	**Cooking Oils**
For ordinary combustibles such as wood or paper	For flammable liquids such as oil, grease, or gasoline	For electrical fires	For flammable metals such as lithium, magnesium, sodium, and potassium	For kitchen fires such as cooking oil or fats catching fire in a frying pan

"FIRE! Get the fire extinguisher!"
"What kind of fire extinguisher?"
"Huh?"
"What kind of fire is it?"
"Huh?"
Did you know that there are five classes of fire extinguishers for different types of fires? The labels above can be found on the five different classes of fire extinguishers.



Starting Point Activity

Many types of materials are used in fire extinguishers. A few of these are described below. For each type of material, figure out what type (or types) of fire extinguisher might use this material. Discuss your ideas with the class. Then do research to find out if your conclusions were correct.

1. Water, under pressure, is used in some fire extinguishers. When it hits the burning substance, it cools the substance to below the temperature at which a fire can burn.
2. Carbon dioxide gas, under pressure, is used in some fire extinguishers. When it escapes from the fire extinguisher, it is very cold. It pushes the air (oxygen) away from the burning materials.
3. Non-flammable, dry materials are used in some fire extinguishers. When they reach the burning substance, they form a layer of dry material over the substance and prevent oxygen from reaching it. They also remove some heat.

The heat and light from a fire are forms of energy that are released during chemical reactions. A fire needs three things in order to continue burning—fuel, oxygen, and heat. If you remove any one of the three, the fire will go out.

Water can remove heat but it can cause other problems. For example, oil and grease will float on water and continue to burn. Water also can conduct electrical current. If there are any live wires in the fire, and you pour water on them, you could get a very serious shock. Also, water reacts violently with some metals such as sodium and potassium.

During a chemical reaction, chemical compounds are changed into different compounds with different properties.

The products of a chemical reaction are always new substances with properties that are different from those of the reactants. But it is not always easy to tell if new substances have formed. **Table 2.7** lists the evidence that can help you decide if a chemical reaction has occurred. When a chemical reaction has occurred, one or more of these pieces of evidence may be observed.

Table 2.7 Evidence of Chemical Reactions

Evidence	Description	Example
There is a change in energy.	All chemical reactions involve a change in energy, although it is not always possible to detect it. A change in energy may be • a temperature change (increase or decrease) • light produced • electrical energy produced	
There is a change in colour.	In some chemical reactions, the colour of the products is different from the colour of the reactants.	
A gas is formed.	Gases are formed in some chemical reactions. You would observe • bubbles in a liquid, or • odour (smell)	
A solid substance (a precipitate) is formed.	In some reactions, when two clear solutions are mixed, the product is a solid that appears in the beaker. The solid that appears is called a precipitate.	

Inquiry Focus

Activity 2.10

EVIDENCE OF CHEMICAL REACTIONS

Read the steps for the three reactions below. Design a table to record the properties of the reactants, the properties of the products, and any evidence that a chemical reaction has occurred.

Safety

- Handle all the liquids very carefully.
- Clean up any spills immediately.
- Tie back loose hair.

What You Need

- candle
- candle holder
- water
- ice cubes
- 250 mL beaker
- matches
- tongs
- dilute hydrochloric acid
- zinc metal
- 2 test tubes
- test-tube rack
- vinegar
- bromothymol blue indicator
- baking soda
- scoop

What To Do

Observe as your teacher performs Reactions 1 and 2. A volunteer group can perform Reaction 3.

1. **Reaction 1: Candle Burning**
   - **a)** Observe the properties of the candle wax, including its colour, state, and texture. Record these properties in your table.
   - **b)** Watch as your teacher adds water and ice to the beaker and uses tongs to hold the bottom of the beaker over the lit candle.
   - **c)** Observe and record the properties of the substances that form at the bottom of the *outside* of the beaker.
   - **d)** Record any evidence that a chemical reaction has occurred.
2. **Reaction 2: Hydrochloric Acid and Zinc**
   - **a)** Observe the properties of the hydrochloric acid (HCl) and the zinc. Record these properties in your table.
   - **b)** Watch as your teacher adds the zinc to a small amount of HCl in a test tube.
   - **c)** Record your observations of the products of the reaction, as well as any evidence that a reaction has occurred.
3. **Reaction 3: Baking Soda and Vinegar (with Bromothymol Blue)**
   - **a)** Pour vinegar into a test tube to a depth of 1 cm. Add three drops of bromothymol blue.
   - **b)** Observe and record the properties of the vinegar-bromothymol blue mixture.
   - **c)** Observe and record the properties of the baking soda. Use a scoop to add a tiny amount of baking soda to the test tube.
   - **d)** Record your observations of the products of the reaction, as well as any evidence that a reaction has occurred.

What Did You Find Out?

1. Explain how you know that a chemical reaction occurred in each case.

LEARNING CHECK

1. Use a main idea web to summarize the evidence of a chemical reaction.
2. Burning gasoline in an engine uses oxygen and produces carbon dioxide and water vapour. Name the two reactants and the two products, and explain why this is a chemical reaction.

The four types of chemical reactions can be described using word equations.

synthesis reaction: two or more reactants combine to produce a new product

decomposition reaction: one compound breaks down into two or more simpler compounds or elements

single displacement reaction: one element takes the place of another element in a compound

double displacement reaction: the metal ions of two different compounds exchange places

word equation: uses words instead of chemical formulas to describe what happens to reactants and products during a chemical reaction

It simplifies the study of chemical reactions to separate them into categories. **Table 2.8** lists and describes four main types of chemical reactions. These are **synthesis reactions**, **decomposition reactions**, **single displacement reactions**, and **double displacement reactions**.

One way to describe what is happening during any type of chemical reaction is to use a word equation. A **word equation** uses words, instead of chemical formulas, to describe what happens to the reactants and products during a chemical reaction. **Figure 2.16** shows the basic form of a word equation.

▲ **Figure 2.16** This is the general form of a word equation. The number of reactants on the left side of the arrow and the number of products on the right side of the arrow will depend on the chemical reaction that the word equation describes.

A word equation in chemistry is like an equation in math, except that there are words instead of numbers and an arrow instead of an equal sign. All the reactants are listed before the arrow, and all the products are listed after the arrow. You read a word equation just like you read a sentence. **Figure 2.17** shows how you would read the word equation in **Figure 2.16.**

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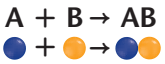
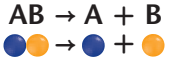
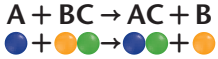
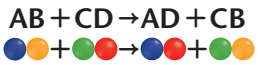
▲ **Figure 2.17** When you read a word equation, replace all the + signs with the word "and." Replace the arrow with the words "react to produce." (If there is only one reactant, you replace the arrow with the words "reacts to produce.")

Table 2.8 The Four Main Types of Chemical Reactions

Type of Reaction	Representation of the Reaction	Example
Synthesis reaction • Two or more reactants combine to produce a new product.	A + B → AB  hydrogen + oxygen → water	 Hydrogen gas is used as a fuel in rockets.
Decomposition reaction • One compound breaks down into two or more simpler compounds or elements.	AB → A + B  water → hydrogen + oxygen	 Oxygen gas is collecting at the top of the left tube and hydrogen gas is collecting at top of the right test tube.
Single displacement reaction • One element takes the place of another element in a compound.	A + BC → AC + B  D + BC → BD + C  copper + silver nitrate → copper(II) nitrate + silver	 One of the reactants and one of the products are elements. Silver crystals are forming on the copper coil.
Double displacement reaction • The metal ions of two different compounds exchange places.	AB + CD → AD + CB  silver nitrate + potassium chromate → silver chromate + potassium nitrate	 A precipitate is often produced in a double-displacement reaction. The silver chromate forms the red precipitate.

LEARNING CHECK

1. When you read a word equation, what do the symbols + and → mean?
2. Use a drawing to show that a decomposition reaction is the reverse of a synthesis reaction.
3. Use a Venn diagram to compare the similarities and differences between a single displacement reaction and a double displacement reaction.

ACTIVITY LINK
Activity 2.13, on page 152

Chemical reactions can be described using chemical equations.

chemical equation: an equation that uses chemical symbols to represent reactants and products in a chemical reaction

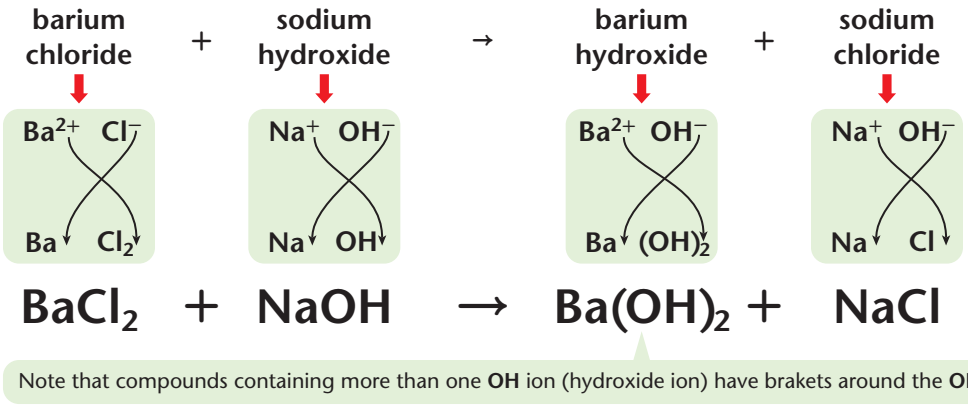
Many chemical reactions involve several reactants and products. As well, the names of compounds are different in different languages. For these reasons, chemical equations are much more convenient than word equations to represent chemical reactions. A **chemical equation** uses chemical symbols to represent the reactants and products in a chemical reaction.

How To Write a Chemical Equation from a Word Equation

To write a chemical equation from a word equation, work with each reactant and product separately. Use the rules on pages 129 and 132, as well as the periodic table on page 450, to write the formulas of the reactant compounds and product compounds. Then replace each chemical name with a chemical formula. **Figure 2.18** shows how to convert a word equation into a chemical equation. The following word equation is used as an example:

barium chloride + sodium hydroxide → barium hydroxide + sodium chloride

This example also introduces you to a new type of negative ion. It is called a hydroxide ion. It consists of one oxygen atom and one hydrogen atom and it has one negative charge. The hydroxide ion is symbolized, OH^-. The two atoms remain attached during many chemical reactions. They behave very much like the non-metal ions that you have learned about. If there is more than one hydroxide ion in a compound, you put brackets around the symbols to show that the two atoms remain together. The subscript is written outside of the brackets. For example, calcium hydroxide is written, $Ca(OH)_2$.



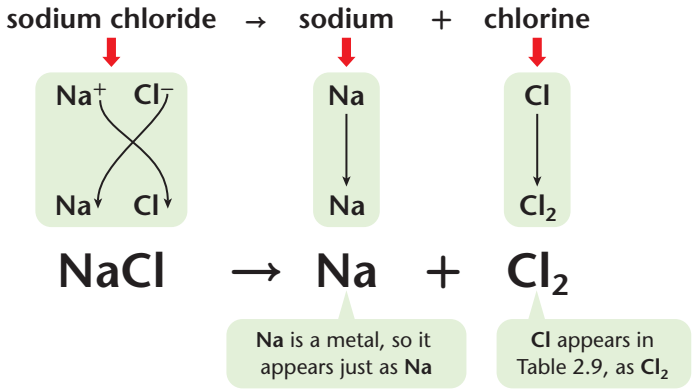
▶ **Figure 2.18** Writing a chemical equation from a word equation

Writing a Chemical Equation for Word Equations That Include Elements

The chemical formulas of most elements are the same as the elements' chemical formulas in the periodic table. However, some non-metal elements are found as a molecule that contains more than one atom of the element. All the non-metal elements that contain more than one atom of the element are shown in **Table 2.9.** When writing a chemical equation for a word equation that includes elements, use **Table 2.9** to determine whether or not each element contains more than one atom. If the element is not in **Table 2.9**, its chemical formula is the same as its symbol in the periodic table. Use **Figure 2.19** to see how this works.

Table 2.9 Elements That Contain More Than One Atom of the Element

Non-metal Element	Found in Nature as	Non-metal Element	Found in Nature as
hydrogen, H	H_2	sulfur, S	S_8
nitrogen, N	N_2	chlorine, Cl	Cl_2
oxygen, O	O_2	selenium, S	Se_8
fluorine, F	F_2	bromine, Br	Br_2
phosphorus, P	P_4	iodine, I	I_2



◀ **Figure 2.19** Some elements, such as chlorine, exist in nature as molecules containing more than one atom. These need to be accurately represented when writing a chemical equation from a word equation.

LEARNING CHECK

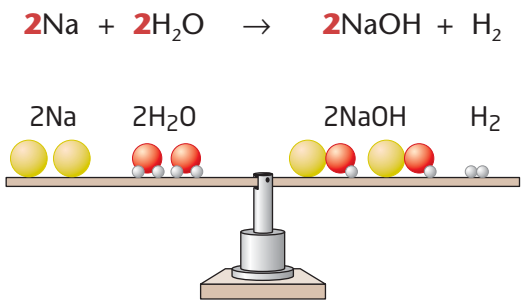
1. Explain the difference between a word equation and a chemical equation.
2. Provide symbols or formulas for the following elements and compounds:
   a) sodium **b)** dihydrogen monoxide **c)** sodium hydroxide **d)** hydrogen
3. Using your formulas from question 2, write a chemical equation for this word equation:
   sodium + dihydrogen monoxide → sodium hydroxide + hydrogen
4. Write a chemical equation for the word equation:
   calcium oxide + dihydrogen monoxide → calcium hydroxide

Atoms and mass are conserved during a chemical reaction.

balanced chemical equation: represents a chemical reaction using coefficients (numbers in front of the reactants and products) that tell you how much of the reactants are used and how much of the products are made

A chemical equation is like a food recipe. It has a list of ingredients (the reactants) and tells you what you will get at the end (the products). What is missing? A recipe tells you how much of each ingredient you will need and how much of the product you will be able to make.

A **balanced chemical equation** is more precise than a recipe. It represents a chemical reaction using numbers in front of the reactants and products. The numbers tell you how much of the reactants are used and how much of the products are made. The numbers in front of the reactants and products are called *coefficients*. Figure 2.20 shows an example of a balanced chemical equation.



▶ **Figure 2.20** A balanced chemical equation tells you how much of each reactant is used and how much of each product is made in a chemical reaction. You can count the number of sodium, hydrogen, and oxygen atoms on the two sides of the balance to see that they are the same.

The Law of Conservation of Mass

law of conservation of mass: during a chemical reaction, the total mass and number of atoms of the reactants equal the total mass and number of atoms of the products.

During a chemical reaction, atoms are not created and atoms are not destroyed. Instead, atoms of the reactants are rearranged to form the new product substances. This fact is summarized by a scientific law called the **law of conservation of mass.**

The law of conservation of mass
During a chemical reaction, the total mass and number of atoms of the reactants equals the total mass and number of atoms of the products.

INVESTIGATION LINK
Investigation 2B, on page 153.

The law of conservation of mass is the reason that chemical equations must be balanced. The quantity or mass of the reactants must always equal the quantity or mass of the products.

If a chemical equation is balanced, the number of each type of atom on the reactant side is equal to the number of each type of atom on the product side. You can see this in Figure 2.21.

$$2\,Na + 2\,H_2O \rightarrow 2\,NaOH + H_2$$

The 2 in front of **Na** means two atoms of **Na** or **Na Na**

The 2 in front of H_2O means 2 sets of H_2O
$2 \times H_2 = H\ H\ H\ H$
$2 \times O = O\ O$

The 2 in front of **NaOH** means 2 sets of **NaOH**
$2 \times Na = Na\ Na$
$2 \times O = O\ O$
$2 \times H = H\ H$

If there is no coefficient, it means a 1, so 1 set of $H_2 = H\ H$

◀ **Figure 2.21** You can see that this equation is balanced because there are 2Na, 4H, and 20 in both the reactants (on the left) and the products (on the right).

Inquiry Focus

Activity 2.11

BALANCING CHEMICAL EQUATIONS

In this activity, you will build models of the reactants and products from the word equations you wrote in Activity 2.13 on page 152. Then you will use your models to balance the chemical equations.

What You Need

- materials to build models of reactants and products

What To Do

1. Make a table like the one below to record your data for each of the four reactions. Leave enough space to write the reactions and draw diagrams of the models you build.

Reaction	Chemical Equation and Diagrams of Models
1	→

2. Convert the first word equation from Activity 2.13 to a chemical equation and write it in the first row of your table.
3. Use the materials provided by your teacher to build each reactant and product in the first chemical reaction.
4. Ensure that the quantity of reactants used is equal to the quantity of products made. You may need to make more models so you can count the number of each reactant atom and each product atom.
5. Use coefficients in front of the reactants and products to show how many of each you had to build to make sure that mass was conserved.
6. Draw diagrams of your models below the chemical equation. Your diagrams and chemical equation should both be balanced for each type of atom.
7. Repeat steps 2 to 6 for the other three word equations.

What Did You Find Out?

1. Compare your results with those of your classmates. Explain and solve any differences.
2. Explain how the law of conservation of mass relates to the models you built for the chemical reactions.
3. How do you know when chemical equations are balanced?

LEARNING CHECK

1. What is the law of conservation of mass?
2. How does the law of conservation of mass apply to balancing chemical equations?

continued on the next page . . .

... continued from previous page

Balancing Chemical Equations

To balance a chemical equation, follow the steps below.

Go to **scienceontario** to find out more

Step 1 Make a table with the reactants and products. Count and record how many of each type of atom are on each side of the equation.

$Na + CuCl_2 \rightarrow Cu + NaCl$

Reactants	Products
1 Na	1 Na
1 Cu	1 Cu
2 Cl	1 Cl

Step 2 Identify an unbalanced atom. *Multiply* the compound on the other side of the equation, which contains that atom, by a coefficient to balance this atom in the reaction. Change the numbers in your table to indicate the change.

Chlorine is unbalanced. Since there are only 2 Cl atoms on the product side, place the coefficient 2 in front of NaCl. (This means that you multiply NaCl by 2.) The coefficient must go in front of the whole compound, because it applies to the Na atoms and the Cl atoms in the whole compound.

$Na + CuCl_2 \rightarrow Cu + \mathbf{2}\ NaCl$

Reactants	Products
1 Na	**2** Na
1 Cu	1 Cu
2 Cl	**2** Cl

Step 3 Repeat what you did in step 2 for any other unbalanced atoms, until all the atoms balance.

Now sodium is unbalanced. Since there are now 2 Na on the product side and there is only 1 Na on the reactant side, place the coefficient 2 in front of Na on the reactant side. (Multiply Na by 2.)

$\mathbf{2}\ Na + CuCl_2 \rightarrow Cu + \mathbf{2}\ NaCl$

Reactants	Products
2 Na	**2** Na
1 Cu	1 Cu
2 Cl	**2** Cl

Step 4 Count the atoms on each side of the chemical equation to make sure that they are all balanced.

LEARNING CHECK

1. Balance the following chemical equations using the steps described on these pages.
   - **a)** $Na + O_2 \rightarrow Na_2O$
   - **b)** $SnO_2 + H_2 \rightarrow Sn + H_2O$
   - **c)** $SeCl_6 + O_2 \rightarrow SeO_2 + Cl_2$
   - **d)** $Fe + O_2 \rightarrow Fe_2O_3$ (HINT: Start with Fe)
   - **e)** $Cu + S_8 \rightarrow Cu_2S$ (HINT: Start with S)
2. How can you be sure that you have balanced a chemical equation correctly?

Inquiry Focus

Activity 2.12

WORD EQUATIONS, CHEMICAL EQUATIONS, AND BALANCING

Now that you've had some practice with equations and balancing, you can put everything together in this activity.

Safety

- Tie back loose hair.
- Secure burner to a retort stand.

What You Need

- Bunsen burner
- spark lighter
- splint
- 3 test tubes
- test tube rack
- scoop
- test-tube clamp
- dropper bottles (for each solution)
- calcium oxide
- water
- pH paper
- calcium carbonate
- zinc metal
- silver nitrate solution
- barium hydroxide solution
- zinc nitrate solution
- Activity Cards supplied by your teacher
- materials to build models of reactants and products

What To Do

1. Make a table like the one below to record your data. Leave enough space to write the reactions and draw diagrams of the models you will build.

Part A: Observing or Performing Reactions

2. At each station, observe the demonstration or perform the reaction described.
3. Record any evidence of a chemical reaction.
4. Clean up as directed by your teacher.

Part B: Writing Reactions, Building Models, and Balancing Equations

5. Use the Activity Cards to make a word equation for the first reaction. Record the word equation in your table.
6. Write a chemical equation for the word equation using the rules on page 146. Record the chemical equation in your table.
7. Use the materials from your teacher to build each reactant and product in the first reaction.
8. Use the rules for balancing chemical reactions, and the models you built, to balance the chemical equation. **Hint:** Make more models of each reactant and product as you need them.
9. Place the correct coefficients in the chemical equation you have written.
10. Draw diagrams of your models under the chemical formulas. Your diagrams and chemical equations should both be balanced for each type of atom.
11. Use **Table 2.8** to identify the type of chemical reaction. Record the reaction type in your table.
12. Repeat steps 5 to 11 for the other three reactions.

Reaction	Evidence of Chemical Reaction	Word Equation, Balanced Chemical Equation, Diagrams of Models, and Reaction Type
1		calcium oxide + water →
2		calcium carbonate →
3		zinc + silver nitrate →
4		barium hydroxide + zinc nitrate →

Inquiry Focus

Activity 2.13

WRITING WORD EQUATIONS

Writing a word equation is often easier when you can see the evidence of a chemical reaction. At each lab station in this activity, you will observe a chemical reaction and write a word equation based on your observations.

Safety

- Tie back loose hair.
- Secure burner to a retort stand.

What You Need

- Hoffman apparatus
- 4 test tubes
- medicine droppers
- steel wool
- water
- aluminum metal
- copper(II) chloride solution
- dilute sodium hydroxide solution
- calcium nitrate solution
- magnesium ribbon
- Bunsen burner
- tongs
- wooden splint
- activity cards
- reaction type cards

What To Do

1. Make a table like the one below to record your observations.
2. At each station, record the properties of the reactants. Then either observe the demonstration or perform the reaction described.
3. Record the properties of the products and any evidence of a chemical reaction.
4. Clean up as directed by your teacher.

What Did You Find Out?

1. Using the activity cards, write a word equation for each reaction.
2. Using the information from **Table 2.8** and your word equation, classify each reaction using the reaction type cards.
3. Compare your results with your classmates' results.

Evidence of Chemical Reactions

Lab Station and Reaction	Properties of Reactants	Properties of Products	Evidence of Reaction
1. hydrogen gas + oxygen gas (using Hoffman apparatus)			
2. aluminum + copper(II) chloride			
3. sodium hydroxide + calcium nitrate			
4. magnesium + oxygen			

The Law of Conservation of Mass

In this investigation, you will compare the masses of reactants and products in a chemical reaction to see if they support the law of conservation of mass.

Skill Check

- initiating and planning
- ✓ **performing and recording**
- ✓ **analyzing and interpreting**
- ✓ **communicating**

What To Do

1. Read the steps of the investigation. Then design a table to record the measurements and the observations you will be making.
2. Use a graduated cylinder to measure 20 mL of sodium hydroxide solution. Pour the solution into the Erlenmeyer flask.
3. Pour iron(III) nitrate solution into the small test tube until it is about half full.
4. Tilt the flask and carefully let the test tube slide down inside. Do not let the solutions mix. Seal the flask with the stopper. Refer to the photo.
5. Measure the mass of the flask and its contents. Record the mass in your table. Also record the appearance of the contents of the flask.
6. Tip the flask so the solutions can mix.
7. Measure the mass of the flask and its contents. Record the mass in your table. Also record the appearance of the contents of the flask.
8. Follow your teacher's instructions to safely dispose of the materials and clean up your work area.

Safety

- Rinse any spills with plenty of water, and report them to your teacher immediately.
- Sodium hydroxide can cause blindness.

What You Need

- graduated cylinder
- dilute sodium hydroxide solution
- 200 mL Erlenmeyer flask
- dilute iron(III) nitrate solution
- small test tube
- stopper
- balance

What Did You Find Out?

1. How did the mass of the reactants, flask, test tube, and stopper before the reaction compare with their mass after the reaction?
2. Do your results support the law of conservation of mass? Explain why or why not.

Inquire Further

3. The word equation for the chemical reaction in this investigation is:

   iron(III) nitrate + sodium hydroxide → sodium nitrate + iron(III) hydroxide

   The chemical formulas for these compounds are:

   iron(III) nitrate: $Fe(NO_3)_3$
   sodium hydroxide: $NaOH$
   sodium nitrate: $NaNO_3$
   iron(III) hydroxide: $Fe(OH)_3$

   Write a balanced chemical equation for this chemical reaction.

Strange Tales of Science

Crime Scene Chemistry

Solving a crime is all about logic and reasoning, right? Not quite, Inspector Clouseau! If you've ever watched a crime scene TV show, you know that solving a crime is also about chemistry. Check out the following tale of murder and mayhem to find out what chemical reactions tell investigators about the nature of a crime.

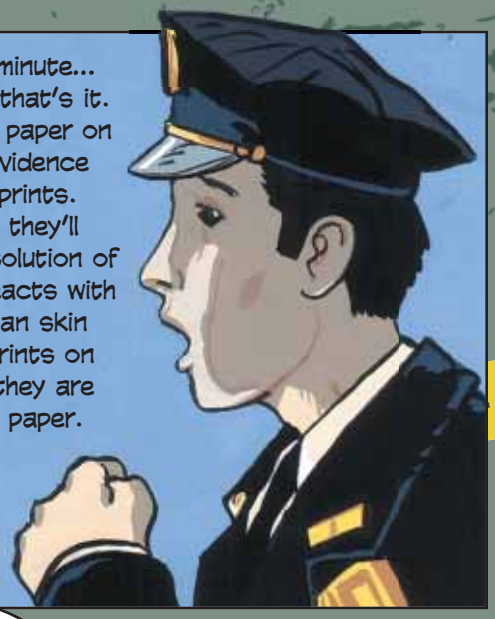
In a dingy apartment building, the police are investigating a crime on a dark, wet night...

The police enter the room to find the homicide team hard at work...

"Invisible" traces of blood can be illuminated with luminol in a chemical reaction. The luminol compound is mixed with other chemicals, including hydrogen peroxide. If blood is present, iron in the blood accelerates a reaction between the hydrogen peroxide and luminol. The reaction gives off enough light that the blood is visible in a dark room.

Okay. Not bad. What's Gonzales up to at the desk?

Okay give me a minute... ninhydrin! Yeah, that's it. He's placing the paper on the desk in an evidence bag to test for prints. Back at the lab, they'll use a chemical solution of ninhydrin that reacts with chemicals in human skin to reveal fingerprints on surfaces where they are hard to see, like paper.



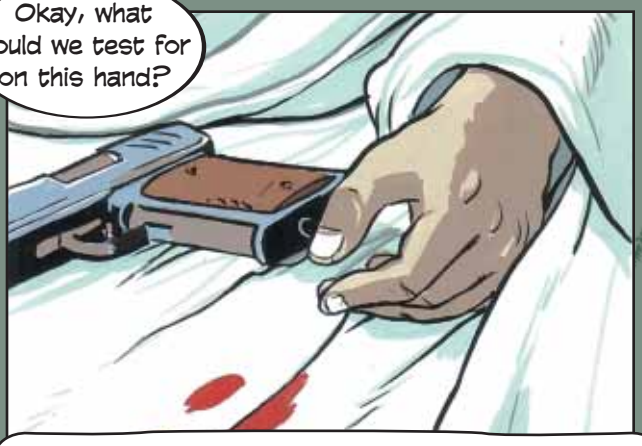
NOT CRO

DO

Okay, you're almost in the clear. One more... let's look at the victim.

Gulp!

Okay, what could we test for on this hand?



Well... a fired firearm releases gases, soot, and gunpowder, known as gunshot residue. Lead is often found in it... so to find out if the victim fired the gun himself, we could try to detect lead that's not visible to the naked eye. We could spray the skin with a solution of sodium rhodizonate, plus several other acids. If lead is present, a chemical reaction produces an easy-to-see shade of violet.

Well, Rubenstein, I don't impress easy, but you've earned yourself a cup of the finest coffee this neighbourhood has to offer.

Better make it a decaf. I don't think my nerves could take that much more today!

NOT CRO

DO

The crime isn't solved yet, but thanks to the application of chemical reactions in forensic science, the police are a lot closer to finding out what happened here on this cold, dark night.

So... What do you think?

1. You are a detective investigating a crime scene in a field a year after the crime was committed. Do you think luminol could still detect the presence of blood in the soil? Explain your reasoning.
2. Work with a partner or in a small group. Write a script for a 10 minute scene in a crime scene investigation television show. Include at least two chemical reactions in your script. Present your scene to your class.
3. Chemical reactions are also used to identify illegal drugs. Choose one illegal drug. Use library or computer resources to learn more about a chemical reaction used to identify it.

Making a DIFFERENCE

Simon Pickup became interested in the explosive possibilities of hydrogen when he was in Grade 4. Simon built a mini-hydrogen electrolyser for a science project. A hydrogen electrolyser splits water into hydrogen and oxygen and creates energy. "At the time, I thought it would be the coolest thing to blow something up," he says. "But as I learned more about hydrogen, I became less interested in blowing hydrogen up for the sake of an explosion and more interested in blowing it up in our cars."

As Simon learned more about hydrogen's potential as a clean, renewable energy source, he asked himself, "Why don't we live in a hydrogen-powered world yet?" With this question in mind, Simon founded Youth Hydrogen in 2004. The organization is dedicated to clean energy and the development of the world's first hydrogen-based city.

How could you find out more about a topic that is important to you?

When Sergio Morales and Andrew Hanna saw a newscast about the number of people who die each year from heart attacks or strokes, they decided to do a science project on heart attacks. They discovered research that suggests daily doses of Aspirin™ can reduce the risk of heart attacks, and a single dose taken during a heart attack can increase the chances of survival.

Aspirin™ dissolves in hydrochloric acid in the stomach. It thins the blood and can break down clots. Sergio and Andrew found that Aspirin™, crushed to increase its surface area and taken with carbonated lemonade, dissolves the quickest in hydrochloric acid.

They created a website to educate people about their results, and a "Heart Attack Kit," which can be used to quickly create a mixture of Aspirin™ in lemonade to increase the chance of survival from heart attack or stroke.

Is there a news story you have seen that you could investigate further in a science project?

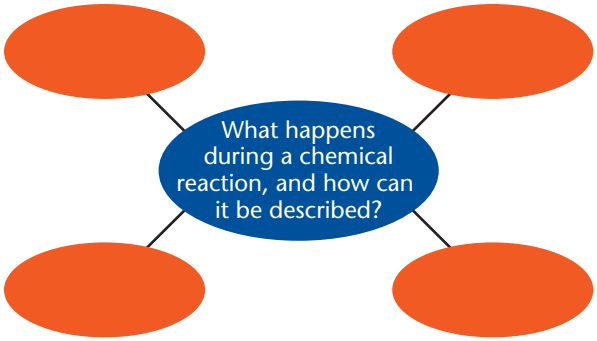
Topic 2.3 Review

Key Concepts

- During a chemical reaction, chemical compounds are changed into different compounds with different properties.
- The four types of chemical reactions can be described using word equations.
- Chemical reactions can be described using chemical equations.
- Atoms and mass are conserved during a chemical reaction.

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. C Use an organizer such as a word web or a flowchart to summarize the types of evidence that can help you decide if a chemical reaction has occurred.

3. K/U Classify the following reactions as one of synthesis, decomposition, single-displacement, or double-displacement:

a) $2\ Na + CaCl_2 \rightarrow 2\ NaCl + Ca$

b) $BaCl_2 + 2\ AgNO_3 \rightarrow Ba(NO_3)_2 + 2\ AgCl$

c) $N_2 + 2\ O_2 \rightarrow 2\ NO_2$

d) $2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$

4. T/I Write word equations for the reactions in question 3.

5. T/I Write a chemical equation from each of the following word equations.

a) water reacts to produce oxygen and hydrogen

b) lithium and water react to produce lithium hydroxide and hydrogen

c) zinc and hydrogen chloride react to produce zinc chloride and hydrogen

d) potassium iodide and silver nitrate react to produce potassium nitrate and silver iodide (HINT: nitrate is NO_3^-. Similar to OH^-, it acts as a unit.)

e) sulfur and oxygen react to produce sulfur dioxide

6. A During a chemical reaction, your measurements show that the mass of the products is greater than the mass of the reactants that you started with. Is this possible? Explain what probably happened.

7. T/I Balance the following chemical reactions.

a) $2\ C + O_2 \rightarrow CO$

b) $Cl_2 + NaBr \rightarrow Br_2 + NaCl$

c) $NH_3 \rightarrow N_2 + H_2$

d) $Na + H_2O \rightarrow NaOH + H_2$ (HINT: Water can also be written as HOH.)

e) $NaOH + H_2S \rightarrow Na_2S + H_2O$

8. A Propane, the fuel used in many gas barbeques, has the chemical formula C_3H_8. When propane burns in oxygen, it produces carbon dioxide and water.

a) Write the chemical formula for the reactants and products in this reaction.

b) Write a chemical equation for the reaction.

c) Balance the chemical equation. (HINT: Balance the oxygen last.)