Topic 2.3
What happens during a chemical reaction, and how can it be described?

Specific Expectations

- **C1.2** identify practical applications of chemical reactions in a particular profession, and assess the associated hazards, including hazards associated with the handling and disposal of chemicals
- **C2.1** use appropriate terminology related to chemical reactions, including but not limited to: *antacid, dilute, neutralization, product, reactant,* and *word equation*
- **C2.2** construct molecular models of simple chemical reactions, and produce diagrams of these models
- **C2.3** conduct and observe inquiries related to simple chemical reactions, including synthesis, decomposition, and displacement reactions, and represent them using a variety of formats
- **C2.4** use an inquiry process to investigate the law of conservation of mass in a chemical reaction, and account for any discrepancies
- **C3.3** write word equations and balanced chemical equations for simple chemical reactions

Skills

- analyze and interpret data
- make and justify conclusions based on data

Materials

Please see the teaching notes for each activity for a list of the materials required. Please see pages TR-42 to TR-46 for a summary of the materials required in this topic.

Overview

In this topic, students will explore what happens during a chemical reaction. They will also name compounds, write chemical formulas, identify reactions, and balance chemical equations.

Common Misconceptions

- **Students may find it difficult to correctly use "colour change" to identify a chemical reaction.** Many physical changes involve slight variations in colour intensity. Some students may assume that the change is a chemical change. To differentiate between a colour intensity change and a true chemical change, place copper sulfate in water. The solution becomes blue. Point out to students that even though the water turned blue, the colour is still the same as the reactant---blue. What changed was the intensity of the colour, not the colour itself. If a chemical reaction had occurred, the colour produced would be different from the original. Stress that a *new* colour must be formed.
- **Students may find balancing equations challenging.** Provide manipulatives and drawings to support learning.
- **Some chemical reactions are not obvious and may be confused with a change in physical state.** For example, the hydrolysis of water can be confused with boiling water. Before a chemical reaction can be carried out, a chemist needs to know which properties of the products to investigate. For example, if a gas is produced, test it and confirm that a new chemical was indeed created. You may need to review the tests for gases and the properties of matter from grade 9.
- **When balancing equations, students may change the subscripts in the formulas instead of placing the number in front of certain molecules to show an increase in the numbers of that molecule.** Remind students that the formula defines the chemical compound and if the formula is changed, the compound is changed. For example, H_2O is water but H_2O_2 is hydrogen peroxide.
- **Polyatomic ions are may be difficult for students to describe or write.** The study of polyatomic ions is enrichment material. If students are struggling with polyatomic ions like nitrate or carbonate, simplify what you expect them to know and treat the ions as a single unit that is involved in the reactions. Avoid having students balance equations that involve polyatomic ions.

Background Knowledge

Molecules are made when atoms join in chemical bonds. A chemical formula tells the proportion of each type of atom present in the compound formed. Each chemical formula has a chemical name created using rules (see Topic 2.2).

All chemicals have properties associated with them. Some are solid, some react with water, some are explosive, and some are colourful. When a reaction occurs, some of these properties change and the properties of the new chemicals are apparent. We use the fact that reactions change properties to make new chemicals that we use every day. For example, sodium metal is very reactive with water and will burn skin. Chlorine is a toxic gas. But when the two elements combine they make a harmless chemical we use every day: sodium chloride or table salt.

Chemicals follow definite rules when they react which are determined by each atom's ability to bond with other atoms. There are only four types of reactions. All of them involve the changing of bonds between atoms. There is no creation of new atoms, just a rearrangement of the existing ones.

Literacy Strategies

Before Reading

- Have students scan the headings in the topic and predict what they might learn. Then have them to look at the diagrams and photographs. Ask how the images support their predictions. Have students to revise their predictions if necessary.
- Have students brainstorm different chemical reactions they might encounter. Examples might include mixing baking soda and vinegar to make a eco-friendly cleaning solution, adding baking powder to cake ingredients to make the cake rise, and so on.
- Before starting this topic, make a list of the key terms and have students look up the definitions using a dictionary. Students can compare their definitions with the ones in the textbook. Dictionary definitions are often difficult for English language learners. Provide first language dictionaries or give students explanations that are understandable.

During Reading

- ELL Have students read aloud some of the subtopics and talk about their understanding of what they have read. English language learners may benefit from having others read words that they may struggle with.
- In small groups, students can look at diagrams and photographs, and discuss what is going on in each image and when a chemical reaction might be occurring.

After Reading

- DI Use inside outside circles to summarize what students have learned. Bodily-kinesthetic and interpersonal learners will benefit from this exercise. English language learners will benefit from some teacher modelling of creating summaries.
- DI Have students draw pictures to illustrate the concepts. Visual learners will enjoy this task.

Assessment FOR Learning

Tool	Evidence of Learning	Supporting Learners
Learning Check, page 143	Students include the items in Table 2.7 in their organizer.	• Have students complete Activity 2.10. • Hand out **BLM 2-30 Table 2.7** and have students add examples from their own lives and draw pictures to show what each statement in the table means.
Activity 2.12, page 151	Students correctly identify each type of chemical reaction.	• Provide students with **BLM 2-31 Types of Reactions.**
Activity 2.13, page 152	Students create word equations for each type of reaction.	• Provide activity cards with the reactants and products jumbled so students can sort them and create the word equations.
Investigation 2B, page 153	Students explain the law of conservation of mass and describe situations that might occur to “break” the law.	• Give concrete examples of the law of conservation of mass. For example, think of making a fruit salad with one melon and two apples. The mass of the fruit you start with is equal to the mass of fruit salad you make. Conservation is ‘lost’ if some of the fruit is eaten or discarded such as the seeds, rind, or skin.
Review, question 1, page 157	Students balance simple chemical equations.	• Provide manipulatives such as paper clips to help students visualize the reactions. Encourage visual learners to draw the molecules. • Provide **BLM 2-38 Topic 2.3 Review (Alternative Format).**
Review, question 8, page 157	Students use the information in the paragraph to create a balanced chemical equation for the reaction.	• Provide scaffolding for answering question 8 as shown in **BLM 2-38 Topic 2.3 Review (Alternative Format).**

Topic 2.3 (Student textbook pages 140–157)

Using the Topic Opener

- Write the topic question on the chalkboard: "What happens during a chemical reaction and how can it be described?" Ask students to look at the picture on pages 140 and 141, and try to answer the question using rapid writing for one minute. Rapid writing is difficult for many English language learners. Ensure that they understand the task, and allow them to write in their first language.
- Ask students to explain why combustion (fire) is a chemical reaction and why firefighting may also involve a chemical reaction.
- Demonstrate fire by simply lighting a match or a lighter.
- Show students **BLM 2-4 Fire Triangle,** which shows the required components for a combustion reaction. Ask them to identify the reactants in a fire. Ask them to predict the products. Then reveal the word equation for combustion. Discuss how fighting fires involves removing one of the three corners from the fire triangle. Discuss how the fuel could be many different things but must be combustible. Have students consider each type of fuel and think of which corner of the fire triangle should be removed to stop the fire safely. For example, students should know that oil and water do not mix so an oil fire should not be fought with water.
- Forest fires are an important part of the renewal of a forest. Ask students if they have had any experience seeing the aftermath of a fire or if they have ever been near a large fire (not a bonfire).
- Discuss a career as a firefighter and how this career connects to chemistry.

Starting Point Activity (Student textbook page 141)

Pedagogical Purpose

This activity has students apply their knowledge of the fire triangle to determine which type of fire extinguisher would use a given material.

Planning	
Materials	match or lighter (optional) classroom fire extinguisher (optional) **BLM 2-4 Fire Triangle** (optional)
Time	15 min in class
Safety	If demonstrating fire, take care that it is a small fire and that no combustible fumes or liquids are nearby.

Activity Notes and Troubleshooting

- Assign groups of students to discuss each scenario. Tell them that you will be asking random students to report on the findings of the group. There will be duplication of scenarios so make sure that you include all groups in the discussion. Provide time for each group to do research if they need more information. Only call on students who you are sure are confident enough to speak without rehearsal.
- Some students will require more information about each type of fire. Give them **BLM 2-4 Fire Triangle** to help them.

Additional Support

- Demonstrate the combustion of a metal. For example, place a rice-sized piece of sodium into some water. The sodium will burn.
- ELL Provide **BLM 2-4 Fire Triangle** to students and ask them to add other combustible materials to the corner labelled "Fuel". English language learners will benefit from the summary.
- Discuss the fire safety equipment students should have at home. For example, baking soda should be near the stove, in case of fire, or a small fire extinguisher should be close but not next to the stove. Also discuss the proper technique for escaping a fire. Demonstrate and have students perform the "stop, drop, and roll" rule.

Starting Point Activity Answers

1. A

2. C, D

3. B, C, D, K

Instructional Strategies for Topic 2.3

Student textbook pages 142–143

- Carry out the experiment in **BLM 2-32 Chemical Reaction Demonstration** to demonstrate all the changes that can occur to show a chemical reaction. Ask students after the demonstration to list the changes they observed.
- Have students make notes, using Table 2.7 as a guide. Ask students to add to the examples shown in the table. Use the list with English language learners to model turning observations into good notes. Do some of the writing, talking about each step. Then have students complete the task, perhaps using sentence starters or cloze passages.
- DI Have visual learners to draw a cartoon that illustrates one of the indicators of a chemical reaction in a humorous way
- DI Ask linguistic learners to make up a mnemonic or a poem to help them remember the indicators of a chemical reaction.

Student textbook pages 144–145

- Before starting this section, write this recipe on the chalkboard: "Mix 2 cups of flour with 1 cup of water and 2 tablespoons of butter." Ask students to simplify the recipe by replacing some of the words with symbols.
- Explain to students that chemical reactions are similar to recipes. They can be described using sentences, word equations, or chemical equations.
- Ask students to simplify the following reaction by changing it to an equation: "Zinc added to hydrochloric acid makes hydrogen gas and zinc chloride." Demonstrate which words can be replaced with symbols. Circle "added to" and replace it with a + symbol. Circle "makes" and replace it with an → symbol. The sentence becomes: zinc + hydrochloric acid → hydrogen gas + zinc chloride.
- Have students list different words that could be used in place of the + symbol or the → symbol.
- Have students practise changing sentences into word equations.
- While reading page 145, demonstrate each type of reaction as shown below. Have students act it out and give them an analogy for the reaction. Supply students with **BLM 2-31 Type of Reactions** to help them take notes.

Synthesis

- Example: magnesium + oxygen → magnesium oxide
- Experiment: Use a Bunsen burner to light a small piece of magnesium ribbon. Note: do not look at the flame. It is bright enough to cause eye damage. The product of the reaction is a piece of ash, which is magnesium oxide.
- Act it out: Ask one student to represent magnesium, and another to represent oxygen. Combine them by linking arms to represent magnesium oxide.
- Analogy: Compare this to a girl and a boy getting together for a dance.

Decomposition

- Example: water → oxygen + hydrogen
- Experiment: Use a Hoffman apparatus and perform electrolysis of water, then test the gases to prove that oxygen and hydrogen are produced.
- Act it out: Ask two students to represent water by linking arms and then separate them into oxygen and hydrogen.
- Analogy: Compare this to a couple ending their dance.

Single Displacement

- Example: iron + copper sulfate → iron sulfate + copper
- Experiment: Place some steel wool into a solution of copper sulfate and wait a few minutes.
- Act it out: Ask one student to represent iron and a two students to represent copper sulfate. Have the iron student replace the copper student.
- Analogy: Compare this to a girl or a boy switching dance partners, Note that only one person switches partners.

Double Displacement

- Example: lead nitrate + potassium iodide → potassium nitrate + lead iodide
- Experiment: In a test tube, mix 5 mL of each chemical. Note: lead iodide is toxic. Follow safety procedures to dispose of the products.
- Act it out: Have two pairs of students represent lead iodide and potassium iodide, then have them switch partners.
- Analogy: Compare this to two couples switching partners at a dance.

Student textbook pages 146–147

- Before starting this section, write a simple math equation on the board and ask students to rewrite the equation using words. For example, "$4 \times 5 = 20$" is written as: "Four times five equals twenty." Ask students to choose which method they prefer for writing a mathematical equation. Then write a mathematical equation in words and ask students to write the equation using symbols. For example, "Eighteen divided by three equals six" can be written as: "$18 \div 3 = 6$."
- Explain to students that chemical reactions are similar to mathematical equations. They can be described using sentences, word equations, or chemical equations. Using a chemical equation makes a chemical reaction easy to understand, no matter what language you speak.
- While reading, model how to change a word equation into a chemical equation either by using the example in the textbook or by showing a different reaction. You can also demonstrate a reaction and then write the word equation and chemical equation. A good demonstration would be to add 1 cm of magnesium ribbon to 10 mL of 0.5 M hydrochloric acid. This reaction produces hydrogen gas (which can be tested with a flaming splint) and magnesium chloride.

- Remind students that a limited number of elements can exist as molecules. Have them refer to Table 2.9 on page 147. HOFBrINCl (the clown) is a good mnemonic to help them remember the common diatomic molecules.
- After reading, ask students to choose a simple reaction they have seen in this topic and write the word equation. They should then trade their word equations with a partner and try to write the chemical equation.

Student textbook pages 148–150

- Before starting this section, ask students to "rapid write" in response to this statement: "Explain the law of conservation of mass in a predict-observe-explain format." For a demonstration, place approximately 5 to 10 mL of sodium hydroxide in a small flask and approximately 5 mL of iron nitrate solution into a small test tube. Place the test tube in the flask and put a stopper on the flask. Measure the mass, and then mix the contents and measure the mass again. The masses should be the same.
- Demonstrate the law using the analogy of a balance. Have students examine Figure 2.20 on page 148. Ask students to explain why the equation is balanced by describing the components of each side of the balance.
- Build models to represent parts of a chemical reaction and describe the chemicals and reactions as you build. For example: $H_2O \rightarrow H_2 + O_2$. Build the water molecule and then talk about how it will decompose. Take the water molecule apart and start to build the products. Act like you are confused because you do not have enough parts to build the oxygen molecule. Ask students to suggest what you should do and respond to their suggestions with reasons why that would or would not work. Add another water molecule to decompose to provide enough atoms to make oxygen gas. You could ask students to write the balanced equation: $2\ H_2O \rightarrow 2\ H_2 + O_2$.
- Write an unbalanced equation and ask students to identify what is wrong with it. For example: $Na + Cl_2 \rightarrow 2\ NaCl$. Ask them to draw a picture of each part of the reaction. They should see that there are not enough sodium atoms on the left side to make two molecules of NaCl.
- DI Have visual learners use coloured paper clips or magnetic circles to make atoms and molecules that are easily linked together and whiteboards to show the reaction symbols.
- DI Have spatial learners use building blocks (such as Lego®) to represent atoms to reduce anxiety over using model kits.
- Have students copy the steps for balancing equations on page 150 into their notebooks.

Activity 2.10 Evidence of Chemical Reactions (Student textbook page 143)

Pedagogical Purpose

This activity gives students hands-on experience performing and observing chemical reactions. Students use the experiments to find evidence that a chemical reaction has occurred.

Planning			
Materials	Reaction 1 candle candle holder water ice cubes 250 mL beaker tongs matches	Reaction 2 pea-sized piece of zinc metal test tube test-tube rack 10 mL dilute hydrochloric acid (0.1 M to 0.5 M)	Reaction 3 test tube test-tube rack scoop 10 mL vinegar bromothymol blue indicator 15 mL baking soda
	BLM 2-33 Evidence of Chemical Reactions Table (optional)		
Time	30 min in class 20 min preparation		
Safety	Caution students to handle all the liquids very carefully. Students should clean up any spills immediately as some of the chemicals are corrosive. Students should tie back loose hair. Students should wear gloves, goggles, and aprons.		

Skills Focus

- work safely with chemicals and equipment
- create data tables
- make and record observations

Activity Notes and Troubleshooting

- Reaction 1 should be done as a demonstration unless the beakers are set up using retort stands and clamps to prevent the risk of fire. To support English language learners, read the instructions aloud as you complete the demonstration and use the language of the demonstration as you carry it out. If there is enough equipment, Reaction 1 could be carried out by several small groups.
- The zinc metal could be replaced with a pea-sized piece of calcium metal for a more vigorous reaction.
- Instead of a candle holder, you could use melted wax to stick the candle to an old beaker or a Petri dish.
- Reaction 2 and Reaction 3 could be carried out by students provided safety procedures are followed. These experiments could be set up at stations.
- For Reaction 3, students should pour the vinegar slowly into the baking soda so they can see the gradual colour change.

Additional Support

- ELL Provide students, especially for English language learners, with **BLM 2-33 Evidence of Chemical Reactions Table** to record their observations.
- DI Perform a flame test on the gas produced in Reaction 2. Ask students to identify the product of the reaction. They should remember that hydrogen pops from grade 9. Logical-mathematical learners will appreciate the demonstration and a chance to determine the gas produced.
- DI Carrying out the experiments will appeal to bodily-kinesthetic learners. Have students perform at least Reaction 2 or Reaction 3.

Activity 2.10 Answers

What To Do

1.

Reactants	Properties of Reactants	Properties of Products	Evidence of a Chemical Reaction
wax	white, solid, hard, slippery	black, greasy, sooty	heat is released, light is produced, a new solid substance is produced

2.

Reactants	Properties of Reactants	Properties of Products	Evidence of a Chemical Reaction
hydrochloric acid	colourless, liquid	colourless, gas white, solid	bubbles form, heat is released, a precipitate is produced
zinc	solid, grey, shiny		

3.

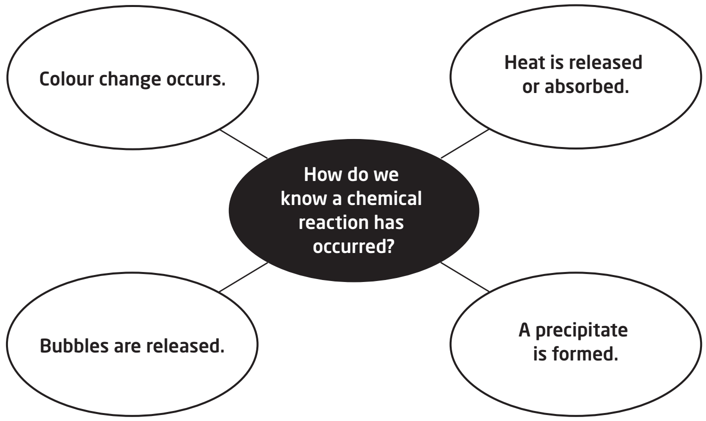
Reactants	Properties of Reactants	Properties of Products	Evidence of a Chemical Reaction
vinegar-bromothymol blue mixture	yellow, liquid	colourless, gas green then blue, liquid (in vinegar and baking soda)	colour changes, bubbles form
baking soda	white, solid, powder		

What Did You Find Out?

1. In Reaction 1, there was a release of heat and a colour change when the bottom of the beaker turned black. Bubbles formed in the water.
   In Reaction 2, bubbles formed and the test tube got warmer.
   In Reaction 3, there were colour changes and bubbles formed.

Learning Check Answers (Student textbook page 143)

1.



2. Reactants: gasoline, oxygen. Products: carbon dioxide, water vapour. It is a chemical reaction because energy is released as heat.

Learning Check Answers (Student textbook page 145)

1. The + symbol means mixed with or added to. The → symbol means creates, produces, or makes.
2. For example, A + B → AB is a synthesis reaction. AB → A + B is a decomposition reaction.
3. Venn diagrams should contain the following points.
   Single Displacement: An element reacts with a compound to make a different compound and element.
   Double Displacement: Two compounds react to make two new compounds.
   Both: There are two reactants and two products.

Learning Check Answers (Student textbook page 147)

1. A word equation uses the chemical names and a chemical equation uses the chemical formulas.
2. **a)** Na **b)** H_2O **c)** NaOH **d)** H_2
3. $Na + H_2O \rightarrow NaOH + H_2$
4. $CaO + H_2O \rightarrow Ca(OH)_2$

Activity 2.11 Balancing Chemical Equations (Student textbook page 149)

Pedagogical Purpose

This activity provides an opportunity for students to model chemical reactions. Note: Activity 2.13 should be carried out before Activity 2.11.

Planning	
Materials	materials to build models of reactants and products word equations from Activity 2.13
Time	75 min in class

Skills Focus

- communicate ideas using models
- write balanced chemical equations

Activity Notes and Troubleshooting

- Models can be built using molecular model kits, modelling clay and sticks, paper clips, paper cut-outs, foam balls, or Lego®.
- DI Have visual learners draw the atoms using a different coloured circle for each element. For example, hydrogen can be black, oxygen can be white, aluminum can be grey, copper can be brown, chlorine can be yellow, sodium can be blue, calcium can be pink, nitrogen can be green, and magnesium can be red.

Additional Support

- DI Bodily-kinesthetic learners should enjoy building the models while visual learners will enjoy drawing the models.
- ELL Pair English language learners with other students to create models and record the equations. Encourage these partners to use key vocabulary and check English language learners' understanding as they proceed.

Activity 2.11 Answers

What To Do

Diagrams may vary.
Reaction 1: $2\ H_2O \rightarrow 2\ H_2 + O_2$
Reaction 2: $2\ Al + 3\ CuCl_2 \rightarrow 2\ AlCl_3 + 3\ Cu$
Reaction 3: $2\ NaOH + Ca(NO_3)_2 \rightarrow 2\ NaNO_3 + Ca(OH)_2$
Reaction 4: $2\ Mg + O_2 \rightarrow 2\ MgO$

What Did You Find Out?

1. Students should work cooperatively to explain any difference in their models.
2. The models show the law of conservation of mass because, for each reaction, the total number of atoms of the reactants equals the total number of atoms of the products.
3. Chemical equations are balanced when the total number of atoms of the reactants equals the total number of atoms of the products.

Learning Check Answers (Student textbook page 149)

1. The law of conservation of mass states that 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.
2. The law applies in that the number of atoms of each element on the reactant side of the equation must equal the number of atoms of the same element on the product side.

Learning Check Answers (Student textbook pages 150)

1. a) $4\ Na + O_2 \rightarrow 2\ Na_2O$
   b) $SnO_2 + 2\ H_2 \rightarrow Sn + 2\ H_2O$
   c) $SeCl_6 + O_2 \rightarrow SeO_2 + 3\ Cl_2$
   d) $4\ Fe + 3O_2 \rightarrow 2\ Fe_2O_3$
   e) $16\ Cu + S_8 \rightarrow 8\ Cu_2S$
2. A chemical equation is balanced if the number of each type of atom in a reaction is the same on both sides of the reaction arrow.

Activity 2.12 Word Equations, Chemical Equations, and Balancing

(Student textbook page 151)

Pedagogical Purpose

This activity provides an opportunity for students to practise writing word equations, chemical equations, and balancing equations after observing chemical reactions.

Planning	
Materials	Station 1 water in a beaker test tube test-tube rack scoopula calcium oxide pH paper waste beaker Station 2 calcium carbonate Bunsen burner spark lighter splint test tube test-tube clamp and rack waste beaker Station 3 zinc metal strip silver nitrate solution in a dropper bottle steel wool paper towel Station 4 barium hydroxide solution in a labelled beaker zinc nitrate solution in a labelled beaker, with a labelled medicine dropper or in a labelled dropper bottle test tube test-tube rack waste beaker materials to build models of reactants and products **BLM 2-34 Word Equations, Chemical Equations, and Balancing Stations** (optional) **BLM G-52 Activity 2.12 Cards** **BLM G-53 Reaction Type Cards** **BLM 2-35 Word Equations, Chemical Equations, and Balancing Models** (optional)
Time	75 min in class 30 min preparation
Safety	Barium hydroxide and silver nitrate are very toxic. Calcium oxide is corrosive. Warn students to be very careful when handling the chemicals. Students should wear gloves, goggles, and aprons. Remind students to clean up spills immediately. Students should be careful with the Bunsen burner. Students should point test tubes away from themselves and others when testing for gas products.

Skills Focus

- work safely with chemicals and equipment
- make observations
- make inferences

Activity Notes and Troubleshooting

- Set up the four stations in different areas of the room. Have students work in groups of four and rotate students from station to station every 10 minutes. For each station, assign each student in the group a role such as safety person, recorder, materials gatherer, clean up person, or tester. This will increase overall participation and accountability. Check whether English language learners have had experience with this strategy. If not, pair them with a classmate who can help them understand what to do.
- Station 1: Calcium oxide will react with the water and produce heat. Remind students to observe the reactions for colour changes, precipitate, gas, and temperature changes before they start the activity.
- Station 2: This reaction is best done as a demonstration. Use your knowledge and comfort level with your class to decide if it is safe to have them using Bunsen burners. When calcium carbonate is heated, it will decompose to make calcium oxide and carbon dioxide. The flame should go out.
- Station 3: Silver nitrate will stain skin. Warn students to be careful. The experiment can be done on a piece of paper towel or in a spot plate. There is no need for test tubes.
- Station 4: Place a beaker to the side labelled "Waste" for students to dispose of their products. The products of this reaction are hazardous. Follow safe disposal procedures. Ensure English language learners understand this caution.
- Models can be built using molecular model kits, modelling clay and sticks, paper clips, paper cut-outs, foam balls, or Lego®.

Additional Support

- DI ELL Provide visual learners and English language learners with **BLM 2-34 Word Equations, Chemical Equations, and Balancing Stations** for instructions with diagrams. Students can create instruction cards for each reaction. They can make cards of the reactants and products for each reaction, which they can arrange into chemical equations. They can also classify the reactions by cutting out the reaction type cards on the last page of the blackline master.
- DI ELL Provide visual learners and English language learners with **BLM 2-35 Word Equations, Chemical Equations, and Balancing Models**. This blackline master provides a visual representation of the chemicals and will assist students in building models of the reactants.
- DI Bodily-kinesthetic learners should enjoy building the models while visual learners will enjoy drawing the models.
- To simplify the reactions, tell students to treat hydroxide, nitrate, and carbonate as one "unit." Have them create their models showing the polyatomic molecules as one component instead of showing each individual atom.

Activity 2.12 Answers

What To Do

Models may vary.

Reaction	Evidence	Word Equation, Balanced Chemical Equation, and Reaction Type
1	heat, pH paper changed colour	calcium oxide + water → calcium hydroxide $CaO + H_2O \rightarrow Ca(OH)_2$ synthesis
2	gas produced	calcium carbonate → carbon dioxide + calcium oxide $CaCO_3 \rightarrow CO_2 + CaO$ decomposition
3	colour change	zinc + silver nitrate → zinc nitrate + silver $Zn + 2AgNO_3 \rightarrow 2Ag + Zn(NO_3)_2$ single displacement
4	colour change, precipitate	barium hydroxide + zinc nitrate → zinc hydroxide + silver nitrate $Ba(OH)_2 + Zn(NO_3)_2 \rightarrow Zn(OH)_2 + Ba(NO_3)_2$ double displacement

Activity 2.13 Writing Word Equations (Student textbook page 152)

Pedagogical Purpose

This activity provides students with an opportunity to perform chemical reactions, write word equations, and classify the reactions. Note: This activity should be done before Activity 2.11.

Planning	
Materials	Station 1 Hoffman apparatus and electrical power source water 2 wooden splints matches 2 test tubes test-tube rack Station 2 1 cm^3 piece of steel wool 1 cm^2 piece of aluminum metal copper (II) chloride solution (saturated) in a labelled beaker, with a labelled medicine dropper paper towel spot plate Station 3 0.1-0.5 M sodium hydroxide in a labelled beaker, with a labelled medicine dropper calcium chloride in a labelled beaker, with a labelled medicine dropper test tube test-tube rack Station 4 magnesium ribbon or sparkler Bunsen burner tongs **BLM 2-36 Writing Word Equations Stations** (optional) **BLM G-54 Activity 2.13 Cards** **BLM G-53 Reaction Type Cards**
Time	75 min in class 30 min preparation
Safety	Warn students not to look directly at the magnesium while it burns. The light is bright enough to cause eye damage. Sodium hydroxide is corrosive. Use a dilute solution. Students should wear gloves, goggles, and an apron. Students should tie back loose hair. Students should clean up spills immediately. None of the products of these reactions are toxic. They can go directly down the drain.

Skills Focus

- make observations and record data
- work safely with chemicals and equipment
- make conclusions

Activity Notes and Troubleshooting

- Supply students with **BLM 2-36 Writing Word Equations Stations, BLM G-54 Activity 2.13 Cards**, and **BLM G-53 Reaction Type Cards**.
- Note: Reaction 1 is a decomposition reaction. Water is the initial reactant, which becomes oxygen and hydrogen gas. This is not clear in the table in the student textbook, which shows hydrogen and oxygen as the reactants. Have students change the Lab Station and Reaction description to: "1. water in Hoffman apparatus."
- The flame tests for Reaction 1 can be performed by students but you may choose to demonstrate the flame test. It takes some time to collect enough gas to test. If only one set of Hoffman apparatus is available, this experiment should be done as a class.
- Reaction 4 should be done as a demonstration. Warn students not to look at the burning magnesium. The light is bright enough to cause eye damage.
- It very important to have students work in groups of three or four. Have students rotate between stations approximately every 15 minutes. Check that each reaction is completed before they move. Groups should work together to write the equations using the activity cards.
- Each student in a group should be assigned a role to encourage participation. Students should switch roles when the group moves to another station.
- Depending on your students, you may wish to divide the activity into two class periods.
- To reduce the clean-up, have students perform the reactions on spot plates instead of in test tubes. As long as the solids are covered by the liquid (in the case of steel wool and aluminum), the same observations can be made and there will be less chemical waste.
- Prepare the solutions of chemicals and place each into a separate labelled dropper bottle with a medicine dropper instead of placing them into beakers. Prepare enough dropper bottles for each station. By doing so you will have prepared the lab for several classes or semesters.

Additional Support

- DI Spatial and bodily-kinesthetic learners will benefit from manipulatives such as paper clips to represent the reactants and products.
- Students may struggle with the "hydroxide" ion in Reaction 3. Assist them by drawing a molecule of sodium hydroxide on the board and labelling the OH as "hydroxide".
- Enrichment—Provide these additional questions for discussion. Ensure that English language learners understand the questions being asked.
  - Which observations provided the most convincing evidence of a chemical reaction?
  - Is this enough evidence to prove that a reaction has occurred? Explain.
  - Which of your observations is measurable (quantitative)?
  - Is it possible to measure any of the other changes? How?
  - What kind of energy was produced by this reaction?
  - Where do you think this energy came from?

Activity 2.13 Answers

What To Do

Lab Station and Reaction	Properties of Reactants	Properties of Products	Evidence of Reaction
1. water in Hoffman apparatus	colourless, liquid	both gas, colourless	bubbles form
2. aluminum + copper(II) chloride	silvery, shiny, solid; light blue-green, liquid	green-grey liquid; brown solid	colour changes, precipitate (solid) forms
3. sodium hydroxide + calcium nitrate	colourless, liquid; white, granular, solid	white, translucent, liquid	colour changes, precipitate disappears
4. magnesium + oxygen	grey, shiny, solid; colourless, gas	white, powdery, solid	light and heat produced, white powder produced

What Did You Find Out?

1.-2. Reaction 1: water + electricity → hydrogen gas + oxygen gas; decomposition
Reaction 2: aluminum + copper (II) chloride → aluminum chloride + copper; single displacement
Reaction 3: sodium hydroxide + calcium nitrate → sodium nitrate + calcium hydroxide; double displacement
Reaction 4: magnesium + oxygen → magnesium oxide; synthesis

Investigation 2B The Law of Conservation of Mass

(Student textbook page 153)

Pedagogical Purpose

This activity provides students with evidence to support why an equation needs to be balanced. Use this simplified explanation when presenting the task to English language learners.

Planning		
Materials	Per group: graduated cylinder dilute sodium hydroxide solution (0.1-0.5 M) 200 mL Erlenmeyer flask **BLM 2-37 Investigation 2B, The Law of Conservation of Mass** (optional)	dilute iron(III) nitrate solution (10%) small test tube (that will fit inside flask) stopper (for flask) balance
Time	20 min in class 10-30 min preparation	
Safety	Students should clean up spills immediately. Students should wear gloves, goggles, and aprons. The products are not very toxic. Follow local disposal regulations.	

Background

In any chemical reaction, the atoms are simply rearranged. The mass of the atoms that react must equal the mass of the atoms that are produced. This phenomenon is explained by the law of conservation of mass and is applied when chemical equations are balanced to show the equal numbers of each type of atom. The law of conservation of mass can only be proven in a closed system. If you were to measure the mass of baking soda and vinegar and then combine them in an open beaker, the resulting mass would be less due to the loss of atoms in the production of carbon dioxide gas.

Skills Focus

- design an observation table
- work safely with chemicals and equipment
- take accurate measurements
- record data
- make inferences

Activity Notes and Troubleshooting

- Students should work in small groups, ideally in pairs.
- Assign each student different responsibilities for this activity. For example: measuring (the different quantities can be shared and assigned), safety, clean up, recording, and data checking.
- You can use any two solutions from previous activities. Potassium iodide and lead nitrate are classic solutions but be careful because lead is toxic.
- If using electronic balances, demonstrate how to use one before students begin the investigation. Tell them to press “tare” before measuring the mass of their flask to reset the balance to zero. Warn them about leaning on the bench while they make their observations as this changes the reading on the balance. Also, instruct them that each balance has a maximum load and that they are not to find the mass of anything other than the flask.
- Show students how to place the test tube into the flask (see the figure on page 153). and stress the importance of not allowing the contents to mix until after the initial mass is taken.

- Make sure that the stoppers do not have holes in them. You need an airtight seal to get good results.

Additional Support

- Provide students with **BLM 2-37 Investigation 2B**, The Law of Conservation of Mass for instructions.
- ELL DI For visual learners or English language learners, draw the diagrams for each step in the procedure on the chalkboard as you explain the step. To support English language learners, read the opening paragraph and write the key instructional words *compare* and *support*. Review the law of the conservation of mass.
- Ask students to create their observation table before completing the lab and then give formative feedback to them before they are allowed to proceed.
- DI Ask logical-mathematical learners to create a question that applies their knowledge of the law of conservation of mass.
- Enrichment—Ask students to design an experiment to prove that the reaction of baking soda and vinegar follows the law of conservation of mass.

Investigation 2B Answers

What Did You Find Out?

1. The masses should be the same.
2. Answers may vary depending on how carefully students carried out the experiment. If they spilled the solution or did not take accurate measurements, their results will not support the law of conservation of mass.

Inquire Further

3. $Fe(NO_3)_3 + 3NaOH \rightarrow Fe(OH)_3 + 3NaNO_3$

Using Strange Tales (Student textbook pages 154–155)

Literacy Support

Before Reading

- Ask students to brainstorm examples of chemistry being used to solve a crime on TV shows like *CSI: Crime Scene Investigation.* Do not assume that English language learners are familiar with these types of programs or comic book formats.
- Ask students how accurate they think those chemistry examples are. Can forensics experts really find a DNA match in 30 seconds?

During Reading

- Assign students a role to read aloud. One student should be the female detective, one the rookie, and one the narrator. Have the rest of the class follow along as the students read.
- While listening, tell students to look for at least three examples of how chemical reactions are used to help solve crimes. English language learners may need to listen and follow along with the first reading, then go back to the text to find specific information.

After Reading

- Allow students time to discuss and compare their notes from the reading.
- Ask random students to share a reaction that they noted.

Instructional Strategies

- ELL Listening to a person read aloud will help English language learners develop fluency and more familiarity with the syntax and phonetic features of English and become familiar with the format of the text itself.
- Allow students who are going to read aloud to pre-read their sections and get help with any pronunciations.
- List new chemicals, such as ninhydrin, on the chalkboard before reading.

Strange Tales Answers

1. Luminol should still detect the iron from the blood in the soil because iron will not decompose. The results might not be very accurate since some soil naturally contains iron. For example, soil in PEI is very red due to its high iron content.
2. Answers may vary. The script should include two of the following: using luminol to detect blood, ninydrin to detect fingerprints, sodium rhodizonate to detect gun shot residue, or other substances such as phenolphthalein to detect blood.
3. Answers may vary. For example: cobalt thiocyanate (in a solution of glycerine) forms a blue precipitate in the presence of cocaine.

Using Making a Difference (Student textbook page 156)

Literacy Support

Before Reading

- Pre-teach vocabulary words like *electrolyzer* and *surface area*. Provide **BLM G-38 English Word Study,** if necessary.
- Assign students either the number 1 or the number 2. Ask students numbered 1 to read the first article and those numbered 2 to read the second article silently to themselves. English language learners may benefit from a partner activity, or from reading a succinct version in which the syntax has been simplified prior to reading independently.

During Reading

- Students should write one important fact or idea from their story.
- Students should write one question they have about their story.

After Reading

- Make an "inside-outside circle" with number 1s on the inside and number 2s on the outside. Allow students to refer to their written text for this activity.
- Students should be facing a person who read the other story. Have them share their one important fact with their partner.
- Have the inside circle move three people to the right. Students should share their important fact with their new partners.
- Have the outside circle move two people to the left. Students should present their question to their new partners.
- Have the inside circle move one person to the right. Students should summarize what they learned about the other story with their new partner and then discuss the two stories.
- Have the outside circle move one person to the left. Students should share how these two stories connect to them personally.

Instructional Strategies

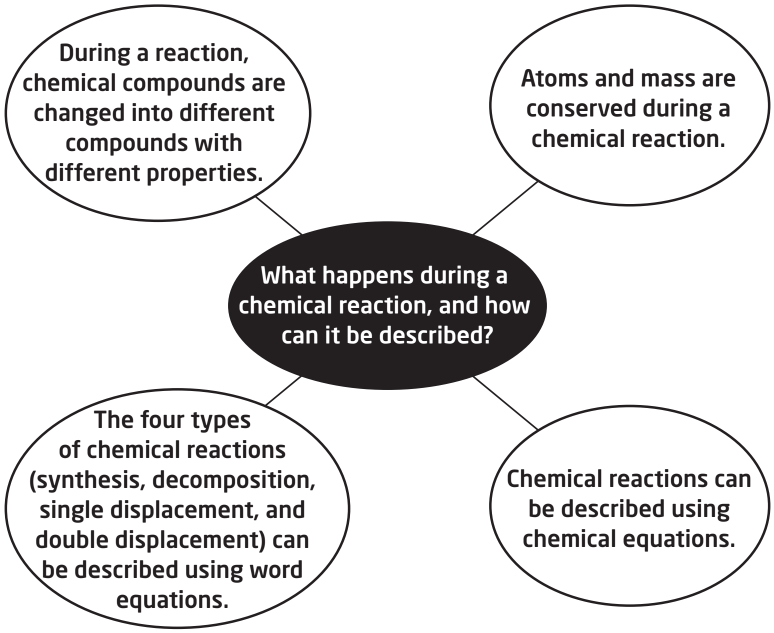
- Use an inside-outside circle to improve verbal skills and to make all students accountable.
- Use the inside-outside circle for interpersonal sharing of information.

Topic 2.3 Review (Student textbook page 157)

Please see also **BLM 2-38 Topic 2.3 Review (Alternative Format).**

Answers

1.



2. Answers may vary. Organizer should list the following points: colour change, energy change, precipitate formation, difficult to reverse, gas production.

3. **a)** single displacement
b) double displacement
c) synthesis
d) decomposition

4. **a)** sodium + calcium chloride → sodium chloride + calcium
b) barium chloride + silver nitrate → barium nitrate + silver chloride
c) nitrogen + oxygen → nitrogen dioxide
d) aluminum oxide → aluminum + oxygen

5. **a)** $H_2O \rightarrow O_2 + H_2$
b) $Li + H_2O \rightarrow LiOH + H_2$
c) $Zn + HCl \rightarrow ZnCl + H_2$
d) $KI + AgNO_3 \rightarrow KNO_3 + AgI$
e) $S + O_2 \rightarrow SO_2$

6. Yes, if the container was not closed, a gas could have reacted to increase the mass of the products.

7. **a)** $2\ C + O_2 \rightarrow 2\ CO$
b) $Cl_2 + 2\ NaBr \rightarrow Br_2 + 2\ NaCl$
c) $2\ NH_3 \rightarrow N_2 + 3\ H_2$
d) $3\ Na + 3\ H_2O \rightarrow 3\ NaOH + H_2$
e) $2\ NaOH + H_2S \rightarrow Na_2S + 2H_2O$

8. **a)** C_3H_8, O_2, CO_2, H_2O
b) $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$
c) $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$