Topic 2.1
How do chemical reactions affect your daily life?

Specific Expectations

- **C2.1** use appropriate terminology related to chemical reactions, including, but not limited to: *antacid, dilute, neutralization, product, reactant,* and *word equation*

Skills

- apply knowledge and understanding of safe practices and procedures
- plan investigations
- work with optical equipment
- handle and dispose of biological materials, with the aid of appropriate support materials

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 chemical reactions are, why they are important, and how to be safe while performing chemical experiments or when dealing with chemicals. Students will also learn how to read a material safety data sheet (MSDS) to determine the safety precautions to be taken for a specific chemical.

Common Misconceptions

- **Many students will forget or may not believe that common household practices involve chemical reactions.** Evidence of chemical reactions can be seen with simple demonstrations such as the following. Add yeast to warm sugar water and ask students to name the reactants (yeast and sugar) and products (carbon dioxide gas seen as bubbles, energy felt as heat, and alcohol). Another example is the simulation of hydrogen peroxide on a "cut" using a very small amount of manganese dioxide (or yeast) in a test-tube along with the peroxide. The hydrogen peroxide will bubble. Again, ask students to name the reactants (hydrogen peroxide and manganese dioxide) and products (oxygen gas and water). You could also demonstrate how to make nylon. Refer to **BLM 2-5 Making Nylon in Class** for instructions. To show a video on how nylon is made go to **www.scienceontario.ca** and follow the links.
- **Many students think that household chemicals are safe.** An understanding of the Hazardous Household Products Symbols (HHPS) will show that every chemical has hazards and must be used carefully and responsibly. Demonstrate that household chemicals can be unsafe or are even more dangerous than scientific chemicals. Add a small sample (5 mL) of oven cleaner or drain cleaner to a raw egg. The egg will become opaque. Compare this reaction to the addition of a small sample (5 mL or less) of 1.0 M NaOH or 1.0 M HCl to a raw egg. Make this demonstration even more real by discussing the similarity of an egg to the human eye. Splashing any of these chemicals in your eye will cause damage to the eye and possibly loss of vision.

Background Knowledge

All chemical reactions involve the transformation of reactants into products. Some of these products are useful to us and some are not. Later in this unit, the types of reactions will be explained but, for now, students should understand that during a chemical reaction, at least one new chemical (new molecule) is produced. The atoms of the reactants are recombined to make the products. For example: Water is made of molecules containing two atoms of hydrogen attached to one atom of oxygen. When water is placed into an electrolysis apparatus, the water molecules are broken apart and the atoms of oxygen and hydrogen recombine to form molecules of oxygen (each containing two atoms) and molecules of hydrogen (each containing two atoms). The electrolysis of water is a decomposition reaction.

Material Safety Data Sheets (MSDS) can be very confusing. They were originally intended for use by scientific professionals only. Now any career involving chemicals requires employees to be able to read an MSDS. Stress to students that they should always follow these points when dealing with an MSDS.

- Always read the name of the chemical.
- Know the hazards of that chemical.
- Understand safe handling and storage instructions.
- Know what to do in an emergency.

Literacy Strategies

Before Reading

- Ask students to brainstorm all of the chemical reactions they can think of. Give them sub-categories such as "In the kitchen", "In the car", 'In the art classroom", if they are having trouble starting.
- ELL Give students **BLM 2-6 Safety Symbols** and ask them to complete as much as they can. This can be used as a diagnostic tool and will prepare them to read about safety in the lab. Pair students with strong English skills with English language learners to describe any symbols that may be unfamiliar. By describing the symbols, student can see the connection between the warning and symbols. Use **BLM 2-7 Safety Symbols Answers** to check their work.

During Reading

- Provide time for students to begin a visual glossary in chart form, with the headings "Term", "Meaning", and "Picture of Meaning." Have students use **BLM 2-8 Visual Glossary** to organize their work.
- Have students think aloud about what they see in the pictures and figure on the page.
- ELL Many English language learners would benefit from a guided reading approach. For example talk about the text, recording and clarifying key concepts and language in the order in which they appear prior to having students participate in partner and group reading activities. On page 105 of the student textbook, students may require support to understand the reference to the movie Backdraft and some of the images used.

After Reading

- DI Have students summarize the meaning of the words *reactant* and *product* as they relate to chemical reactions. Ask students to draw a picture relating reactant, product, and chemical reaction. This will make the words more meaningful for spatial learners. Some English language learners benefit from starting with the drawings, and then using their sketches to summarize. Encourage them to use their first language to organize their thoughtts before they try to explain in English.

Assessment FOR Learning

Tool	Evidence of Learning	Supporting Learners
Starting Point Activity, page 111	Students describe the components of a chemical reaction, explain that a new substance is produced, and list evidence of a chemical reaction occurring. They also list desirable and non-desirable products of a chemical reaction.	• Have students work in groups. Assign a specific picture to each group for discussion. Ask each group to identify the practical aspect of the reaction and create a skit that includes the practical aspect, desirable products, and undesirable products. Give students **BLM 2-9 Practical Reactions** to complete. • Demonstrate a simple chemical reaction, such as burning a candle, and ask students to list the desirable and undesirable products.
Learning Check, question 1, page 113	Students apply their knowledge of the words *reactant* and *product*.	• Give students a template to consider whenever they evaluate a reaction. For example: reactant 1 + reactant 2 → product 1 + product 2 • Remind students that reactants are substances that *react* and products are substances that are *produced*.
Learning Check, question 2, page 115	Students distinguish between WHMIS and HHPS and their use and importance.	• Use **BLM 2-10 Safety Symbol Card Match** as a game for review. Give pairs of students a safety symbol and ask them to hold up their symbol or to stand if it applies to statements you read aloud.

Topic 2.1 (Student textbook pages 110–117)

Using the Topic Opener

- Ask students why some chemical reactions come with both risks and benefits. Provide a specific example if students are reluctant to respond. For example, burning fossil fuels provides energy, but the by-product of carbon dioxide is a greenhouse gas. Encourage students to think critically about the chemical reactions in the Unit Opener.
- Ask students to brainstorm different reactions they are familiar with at home, in cars, or in art. After generating a list with a partner, have students choose two reactions they are familiar with and describe the purpose of the reaction, and any undesirable products. This will prepare students to complete the activity, which is also an effective diagnostic tool.
- To engage students, demonstrate some simple household reactions (such as burning a candle or mixing yeast, water, and sugar) and discuss the wanted and unwanted products of these reactions.

Starting Point Activity (Student textbook page 111)

Pedagogical Purpose

In this activity, students think critically about common chemical reactions.

Planning	
Materials	**BLM 2-9 Practical Reactions** (optional)
Time	15 min in class

Activity Notes and Troubleshooting

- Have students work in groups. Assign each group one or two pictures to discuss.
- Put the photos in corners by topic: cooking, cars, metal working, and cleaning, and have students go to the corner that represents reactions they know.
- Or have students work in pairs and choose one or two pictures to discuss. This will increase accountability of all students. Discuss each picture as a class.

Additional Support

- Students could use **BLM 2-9 Practical Reactions** to organize their answers.
- ELL Choose one or two reactions for English language learners to examine.
- DI Bodily-kinesthetic and interpersonal learners will benefit from a four corners approach to this activity.
- DI Spatial and logical-mathematical learners will benefit from using a graphic organizer or seeing the reactions demonstrated, such as a candle burning.

Starting Point Activity Answers

1. The definition should refer to the production of a new substance. Evidence could be energy released, a colour change, or the production of bubbles.
2. The car battery, welder's torch, flare, and ethanol demonstrate the release of energy. Brightening fabrics, baking bread, and food preservatives demonstrates a colour change. Bread also demonstrates the production of bubbles.
3. Answers may vary. For example: a candle burning, and gunpowder exploding.
4. Answers may vary. For example: food spoiling, metal rusting, and acid rain.
5. Answers may vary. For example: It is easier to think of practical examples than non-practical examples. The practical reactions make our lives better.
6. Answers may vary, but should recognize that people will differ on what is practical. For example, some people may say gunpowder is practical and others may say it is not.

Instructional Strategies for Topic 2.1

Student textbook pages 112–113

- Before reading, ask students to look at the pictures and relate the pictures to the topic statement. Ask for additional examples of reactions that support our lives and assist us. Students can refer to the Starting Point Activity if necessary.
- As students read, they should stop and record new terms in their visual glossary. Hand out **BLM 2-8 Visual Glossary** for those who need help organizing their work.
- DI Prepare Reaction Type cards using **BLM 2-11 Reaction Type Cards**. After students have read the topic, provide groups of students with one set of cards. Ask them to act out the reactions for the class. Classmates should try to identify the reactants and products of the role-play reaction. One reaction could be assigned per group. This activity will appeal to bodily-kinesthetic and interpersonal learners.
- Discuss the meaning of the word *dilute*. This concept can be demonstrated with drink powder and water. Students could taste and rate the sweetness of a fixed mass of powder to varying volumes of water.

Student textbook pages 114–115

- Before reading, assess students' prior knowledge of lab safety by using **BLM 2-6 Safety Symbols**. View, and discuss, a WHMIS safety video with students.
- DI Prepare the safety symbol cards beforehand. Use **BLM 2-10 Safety Symbol Card Match**. Give half of the class a safety symbol and the other half a descriptor. Students should go around the classroom looking for the student holding the matching symbol or descriptor. The pair of students then read their cards together. This activity will appeal to spatial and bodily-kinesthetic learners.
- Students should add new words to their visual glossary, and then discuss each image, and where they might see the different types of safety symbols. Hand out **BLM 2-8 Visual Glossary** if necessary to help them organize their work.
- After reading these pages, have pairs of student form groups of four. Each group should have examples of HHPS and WHMIS. The group could complete the Learning Check together.
- For the Learning Check questions, provide **BLM G-49 Venn Diagram**, if necessary.

Activity 2.1 Inflating a Balloon (Student textbook page 113)

Pedagogical Purpose

This activity has students produce a chemical reaction in which they can easily identify the reactants and the products.

Planning	
Materials	Per group: round balloon (preferably transparent) 15 mL baking soda plastic water bottle or Erlenmeyer flask 50-100 mL of white vinegar graduated cylinder spoon **BLM 2-12 Inflating a Balloon** (optional) **BLM 2-13 Inflating a Balloon Diagrams** (optional)
Time	10 min in class 5 min preparation
Safety	Students should wear safety goggles. Remind students not to point the balloon or bottle at their classmates while the chemicals are reacting.

Skills Focus

- make observations
- draw conclusions
- explain and support reasoning

Activity Notes and Troubleshooting

- Have students work in pairs while setting up the apparatus. One student should hold the mouth of the balloon open while the other student puts the baking soda into the balloon. Do not let them blow up the balloon first as this will cause the baking soda to stick to the balloon and not fall into the vinegar.
- DI Each student should have an opportunity to touch the bottle to feel the carbon dioxide gas forming inside the bottle and moving into the balloon, inflating it. Students should also feel heat energy being given off by the reaction. For bodily-kinesthetic learner, feeling the gas bubbling will confirm that a gas is produced and the effects of the gas moving can be seen as the balloon inflates.

Additional Support

- ELL You could give English language learners a list of adjectives beforehand to help them describe the reactants and products. Review this vocabulary with them to ensure understanding. Use **BLM 2-12 Inflating a Balloon** to help them, if necessary.
- DI ELL Spatial and English language learners will need a visual representation of the steps to follow. Use **BLM 2-13 Inflating a Balloon Diagrams** to help them decode the instructions and questions.
- After completing the activity have students discuss Figure 2.2 on page 113 in small groups using the following focus questions.
  - Are you surprised at any of the products made from vinegar? Explain.
  - What do you use vinegar for at home?
  - Do you know of any other uses for vinegar? List them.
- Enrichment—As a teacher demonstration, capture the gas produced in the experiment in a test tube. Insert a lighted splint into the container to demonstrate that the gas is carbon dioxide. The flame should be extinguished. Tell students beforehand what happens if a flame is introduced to oxygen (flame burns brighter), hydrogen (the gas "pops"), or carbon dioxide (the flame is extinguished).
- Enrichment—As a challenge, have students write the chemical formula for the reaction. Provide the following template:

  $NaHCO_3 + CH_3COOH \rightarrow$ _____ + _____ + CH_3COONa

  baking soda + vinegar → gas + liquid + sodium acetate liquid

  ($NaHCO_3 + CH_3COOH \rightarrow CO_2 + H_2O + CH_3COONa$)

  You could explain that the last product is a salt that has been dissolved in the liquid so it is not visible.

Activity 2.1 Answers

Reactants	Products
• baking soda is a white powder • vinegar is a clear liquid with a sharp smell	• gas is clear and colourless • water is a clear liquid with no smell

The properties of the products are different from the reactants. This means that a new substance was made by a chemical reaction.

Learning Check Answers (Student textbook page 113)

1. The reactants are baking soda and vinegar.
2. No. Freezing is a change of state not a chemical reaction. No reactants were added to the water but heat was removed. The ice has the same chemical composition as the water, that is, hydrogen and oxygen atoms only, so no new products were created.

Learning Check Answers (Student textbook page 115)

1. Answers should include some of the following points:
   - Work in an open, well ventilated area that has local exhaust ventilation.
   - Make sure the area is away from any source of heat, sparks, or flame.
   - Wear butyl rubber gloves and safety goggles. A butyl rubber apron is also recommended.
   - A NiOH gas respirator with an organic vapour cartridge or filter is also suggested when working with high concentrations of acetone.
   - Be sure that an eye wash station is within close distance to the work area.
   - Be sure there is a hazardous materials disposal site close to the work area.
2. Venn diagrams should include the following points.
   HHPS: tells about danger of container or contents; is intended for consumers
   WHMIS: tells about the dangers of the chemical; is used with an MSDS; is intended for the workplace
   Both: help us to use chemicals safely; indicate the precaution or safety gear needed

Activity 2.2 Becoming Familiar with an MSDS (Student textbook page 116)

Pedagogical Purpose

This activity extends student knowledge beyond that of just reading WHMIS. It shows them how to read a MSDS. In science, people must learn to read a variety of types of material; the MSDS is one.

Planning	
Materials	At least 3 different MSDS. Preferably a different sheet per student.
Time	20 min in class 20 min preparation

Skills Focus

- sort information
- analyze information

Activity Notes and Troubleshooting

- MSDS are available in your WHMIS binder. Your school is required to have a binder in the chemical storage room containing a WHMIS for each chemical the storage room contains. Alternatively, a MSDS can be found attached to each chemical bottle in the storage room or by contacting the chemical supply company.
- Group students randomly by assigning each student a number and a letter (A1, A2, A3, B1, B2, B3, and so on). To simplify the activity, give all the students numbered 1 a copy of the first MSDS, all the 2s the second MSDS, and all the 3s the third MSDS. Pair students with the same sheet for the first part of the activity. Then ask the As to group together, the Bs to group together, and so on.

Additional Support

- For bodily-kinesthetic and interpersonal learners, allow students to confer with another student who has the same MSDS sheet. This will increase student confidence and their ability to share their findings in their mixed groups.
- Choose MSDS sheets for chemicals students will be using in subsequent labs. Tell them that you have specifically chosen those sheets to prepare them for the labs. This will make the activity more practical.
- ELL Choose simpler MSDS for some English language learners. The same information is included on all sheets but some companies present them in a clearer format. Some English language learners may understand the concepts but need some support with the instructional language used in the directions. Review the steps prior to grouping students, or place English language learners in groups with a student with strong English skills.
- ELL Give English language learners the properties of a chemical and ask them to design the MSDS for that chemical. You could cut up an MSDS for them but not include the headings. To increase success, provide the headings on a separate template and ask students to paste the components into the correct areas of the sheet.
- DI Enrichment—Challenge each group to pick one of their three chemicals and act out a situation in which the chemical has either been spilled or has hurt someone. Groups should use the information on the MSDS to correctly remedy the situation. Ask students from other groups to guess what symbols would be found on the chemical's MSDS or what the name of the chemical is.
- DI Musical learners could make a jingle for their chemical listing the nine characteristics on the MSDS.

Activity 2.2 Answers

What To Do

5. There are nine categories of information that must be present on an MSDS in Canada. These categories are specified in the Controlled Products Regulations.

1. Product Information: product identifier (name), manufacturer and supplier's names, addresses, and emergency phone numbers

2. Hazardous Ingredients

3. Physical Data

4. Fire or Explosion Hazard Data

5. Reactivity Data: information on the chemical instability of the product and the substances it may react with

6. Toxicological Properties: health effects

7. Preventive Measures

8. First Aid Measures

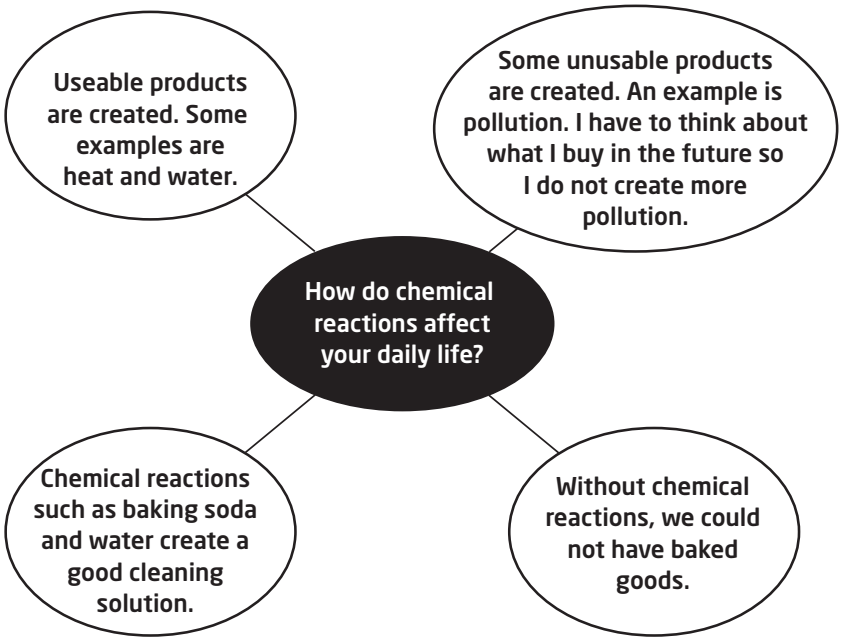
9. Preparation Information: who is responsible for preparation and date of preparation of MSDS

Topic 2.1 Review (Student textbook page 117)

Please see also **BLM 2-14 Topic 2.1 Review (Alternative Format)**.

Answers

1. Answers may vary. For example:



2. a) It is a chemical reaction and not a physical change because new chemicals (carbon dioxide, water, and sodium acetate) are made.

b) The reactants are vinegar and baking soda.

c) The products are carbon dioxide, water, and sodium acetate.

3. Answers may vary. For example:

a) hair spray, hair dyes, and chemicals for perming hair

b) motor oil, gasoline, and antifreeze

c) propane tanks, gasoline, and paint

d) disinfectants, floor polish, acids, alcohol, and photo-lab chemicals

4. a) They need to know WHMIS so that they do not put explosive or flammable containers of cleaners near the stoves or mix poisonous chemicals into the food.

b) They need to know WMHIS to know when to wear gloves when working with certain chemicals or how to store the chemicals.

c) WHMIS will help them store their chemicals safely. It will also warn them about mixing certain chemicals.

d) WHMIS will help them with first aid if anyone gets chemicals spilled on them, help them store the chemicals safely, and indicate which chemicals to keep away equipment with heat, spark, or flame, such as welding torch.

5. a) MSDS is an abbreviation for Material Safety Data Sheet.

b) Answers may vary. For example: science lab, chemical manufacturing plant, hospital

6. a) On furniture stripper or paint thinner.

b) The label explains hazards, warns about storage, and tells what safety equipment is needed.

c) No, you need to look at the MSDS for more information. But it does tell you what safety equipment to use, how to be careful about when using it, and how to keep safe while using it.