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Chemistry 11

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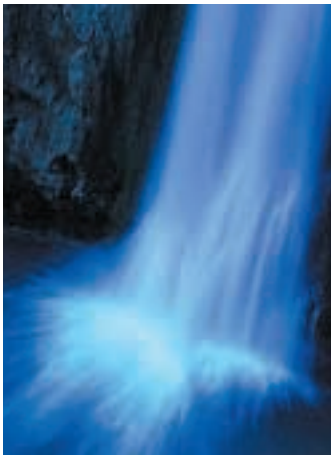
Our cover: A polarized light micrograph of a liquid crystal, a kind of substance you are familiar with from digital displays on products such as pocket calculators and laptop computers. Although liquid crystal flows like a fluid, its molecular arrangement exhibits some order, as in a solid. You will learn more about the movement of solid, liquid, and gas molecules in Unit 3.

Contents



Safety in Your Chemistry Laboratory and Classroom

The following *Safety Precautions* symbols appear throughout *Chemistry 11*, whenever an investigation or ExpressLab presents possible hazards.


appears when there is a danger to the eyes, and safety goggles, safety glasses, or a face shield should be worn


appears when substances that could burn or stain clothing are used


appears when objects that are hot or cold must be handled


appears when sharp objects are used, to warn of the danger of cuts and punctures


appears when toxic substances that can cause harm through ingestion, inhalation, or skin absorption are used


appears when corrosive substances, such as acids and bases, that can damage tissue are used


warns of caustic substances that could irritate the skin


appears when chemicals or chemical reactions that could cause dangerous fumes are used and ventilation is required


appears as a reminder to be careful when you are around open flames and when you are using easily flammable or combustible materials


warns of danger of electrical shock or burns from live electrical equipment

Actively engaging in laboratory investigations is essential to gaining a hands-on understanding of chemistry. Following safe laboratory procedures should not be seen as an inconvenience in your investigations. Instead, it should be seen as a positive way to ensure your safety and the safety of others who share a common working environment. Familiarize yourself with the following general safety rules and procedures. It is your responsibility to follow them when completing any of the investigations or ExpressLabs in this textbook, or when performing other laboratory procedures.

General Precautions

- Always wear safety glasses and a lab coat or apron in the laboratory. Wear other protective equipment, such as gloves, as directed by your teacher or by the Safety Precautions at the beginning of each investigation.
- If you wear contact lenses, always wear safety goggles or a face shield in the laboratory. Inform your teacher that you wear contact lenses. Generally, contact lenses should not be worn in the laboratory. If possible, wear eyeglasses instead of contact lenses, but remember that eyeglasses are not a substitute for proper eye protection.
- Know the location and proper use of the nearest fire extinguisher, fire blanket, fire alarm, first aid kit, and eyewash station (if available). Find out from your teacher what type of fire-fighting equipment should be used on particular types of fires. (See "Fire Safety" on page xiii.)
- Do not wear loose clothing in the laboratory. Do not wear open-toed shoes or sandals. Accessories may get caught on equipment or present a hazard when working with a Bunsen burner. Ties, scarves, long necklaces, and dangling earrings should be removed before starting an investigation.
- Tie back long hair and any loose clothing before starting an investigation.
- Lighters and matches must not be brought into the laboratory.
- Food, drinks, and gum must not be brought into the laboratory.
- Inform your teacher if you have any allergies, medical conditions, or physical problems (including hearing impairment) that could affect your work in the laboratory.

Before Beginning Laboratory Investigations

- Listen carefully to the instructions that your teacher gives you. Do not begin work until your teacher has finished giving instructions.
- Obtain your teacher's approval before beginning any investigation that you have designed yourself.
- Read through all of the steps in the investigation before beginning. If there are any steps that you do not understand, ask your teacher for help.
- Be sure to read and understand the Safety Precautions at the start of each investigation or Express Lab.

- Always wear appropriate protective clothing and equipment, as directed by your teacher and the Safety Precautions.
- Be sure that you understand all safety labels on materials and equipment. Familiarize yourself with the WHMIS symbols on this page.
- Make sure that your work area is clean and dry.

During Laboratory Investigations

- Make sure that you understand and follow the safety procedures for different types of laboratory equipment. Do not hesitate to ask your teacher for clarification if necessary.
- Never work alone in the laboratory.
- Remember that gestures or movements that may seem harmless could have dangerous consequences in the laboratory. For example, tapping people lightly on the shoulders to get their attention could startle them. If they are holding a beaker that contains an acid, for example, the results could be very serious.
- Make an effort to work slowly and steadily in the laboratory. Be sure to make room for other students.
- Organize materials and equipment neatly and logically. For example, do not place materials that you will need during an investigation on the other side of a Bunsen burner from you. Keep your bags and books off your work surface and out of the way.
- Never taste any substances in the laboratory.
- Never touch a chemical with your bare hands.
- Never draw liquids or any other substances into a pipette or a tube with your mouth.
- If you are asked to smell a substance, do not hold it directly under your nose. Keep the object at least 20 cm away, and waft the fumes toward your nostrils with your hand.
- Label all containers holding chemicals. Do not use chemicals from unlabelled containers.
- Hold containers away from your face when pouring liquids or mixing reactants.
- If any part of your body comes in contact with a potentially dangerous substance, wash the area immediately and thoroughly with water.
- If you get any material in your eyes, do not touch them. Wash your eyes immediately and continuously for 15 min, and make sure that your teacher is informed. A doctor should examine any eye injury. If you wear contact lenses, take them out immediately. Failing to do so may result in material becoming trapped behind the contact lenses. Flush your eyes with water for 15 min, as above.
- Do not touch your face or eyes while in the laboratory unless you have first washed your hands.
- Do not look directly into a test tube, flask, or the barrel of a Bunsen burner.
- If your clothing catches fire, smother it with the fire blanket or with a coat, or get under the safety shower.
- If you see any of your classmates jeopardizing their safety or the safety of others, let your teacher know.

WHMIS (Workplace Hazardous Materials Information System) symbols are used in Canadian schools and workplaces to identify dangerous materials. Familiarize yourself with the symbols below.

Poisonous and Infectious Material Causing Immediate and Serious Toxic Effects

Poisonous and Infectious Material Causing Other Toxic Effects

Flammable and Combustible Material

Compressed Gas

Corrosive Material

Oxidizing Material

Dangerously Reactive Material

Biohazardous Infectious Material

Heat Source Safety

- When heating any item, wear safety glasses, heat-resistant safety gloves, and any other safety equipment that your teacher or the Safety Precautions suggests.
- Always use heat-proof, intact containers. Check that there are no large or small cracks in beakers or flasks.
- Never point the open end of a container that is being heated at yourself or others.
- Do not allow a container to boil dry unless specifically instructed to do so.
- Handle hot objects carefully. Be especially careful with a hot plate that may look as though it has cooled down, or glassware that has recently been heated.
- Before using a Bunsen burner, make sure that you understand how to light and operate it safely. Always pick it up by the base. Never leave a Bunsen burner unattended.
- Before lighting a Bunsen burner, make sure there are no flammable solvents nearby.
- If you do receive a burn, run cold water over the burned area immediately. Make sure that your teacher is notified.
- When you are heating a test tube, always slant it. The mouth of the test tube should point away from you and from others.
- Remember that cold objects can also harm you. Wear appropriate gloves when handling an extremely cold object.

Electrical Equipment Safety

- Ensure that the work area, and the area of the socket, is dry.
- Make sure that your hands are dry when touching electrical cords, plugs, sockets, or equipment.
- When unplugging electrical equipment, do not pull the cord. Grasp the plug firmly at the socket and pull gently.
- Place electrical cords in places where people will not trip over them.
- Use an appropriate length of cord for your needs. Cords that are too short may be stretched in unsafe ways. Cords that are too long may tangle or trip people.
- Never use water to fight an electrical equipment fire. Severe electrical shock may result. Use a carbon dioxide or dry chemical fire extinguisher. (See "Fire Safety" on the next page.)
- Report any damaged equipment or frayed cords to your teacher.

Glassware and Sharp Objects Safety

- Cuts or scratches in the chemistry laboratory should receive immediate medical attention, no matter how minor they seem. Alert your teacher immediately.
- Never use your hands to pick up broken glass. Use a broom and dustpan. Dispose of broken glass as directed by your teacher. Do not put broken glassware into the garbage can.

- Cut away from yourself and others when using a knife or another sharp object.
- Always keep the pointed end of scissors and other sharp objects pointed away from yourself and others when walking.
- Do not use broken or chipped glassware. Report damaged equipment to your teacher.

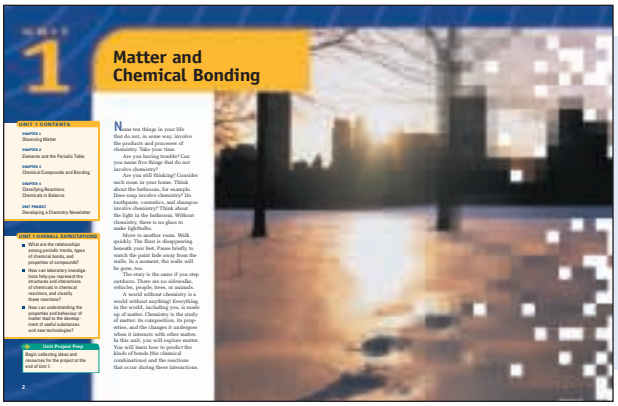
Fire Safety

- Know the location and proper use of the nearest fire extinguisher, fire blanket, and fire alarm.
- Understand what type of fire extinguisher you have in the laboratory, and what type of fires it can be used on. (See below.) Most fire extinguishers are the ABC type.
- Notify your teacher immediately about any fires or combustible hazards.
- Water should only be used on Class A fires. Class A fires involve ordinary flammable materials, such as paper and clothing. Never use water to fight an electrical fire, a fire that involves flammable liquids (such as gasoline), or a fire that involves burning metals (such as potassium or magnesium).
- Fires that involve a flammable liquid, such as gasoline or alcohol (Class B fires) must be extinguished with a dry chemical or carbon dioxide fire extinguisher.
- Live electrical equipment fires (Class C) must be extinguished with a dry chemical or carbon dioxide fire extinguisher. Fighting electrical equipment fires with water can cause severe electric shock.
- Class D fires involve burning metals, such as potassium and magnesium. A Class D fire should be extinguished by smothering it with sand or salt. Adding water to a metal fire can cause a violent chemical reaction.
- If someone's hair or clothes catch on fire, smother the flames with a fire blanket. Do not discharge a fire extinguisher at someone's head.

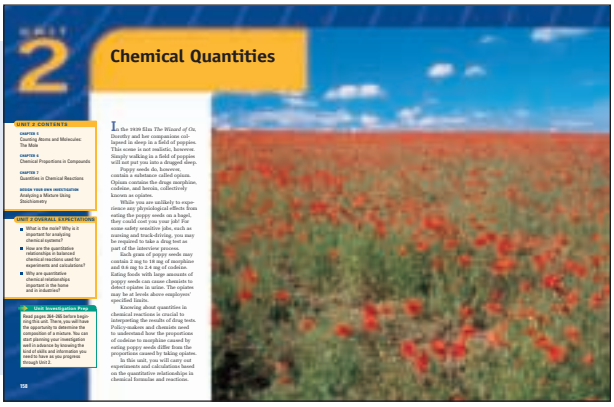
Clean-Up and Disposal in the Laboratory

- Clean up all spills immediately. Always inform your teacher about spills.
- If you spill acid or base on your skin or clothing, wash the area immediately with a lot of cool water.
- You can neutralize small spills of acid solutions with sodium hydrogen carbonate (baking soda). You can neutralize small spills of basic solutions with sodium hydrogen sulfate or citric acid.
- Clean equipment before putting it away, as directed by your teacher.
- Dispose of materials as directed by your teacher, in accordance with your local School Board's policies. Do not dispose of materials in a sink or a drain unless your teacher directs you to do so.
- Wash your hands thoroughly after all laboratory investigations.

Here is a quick glimpse at the learning that lies before you in this course. Expand your knowledge and skills from earlier courses and experience chemistry in action.

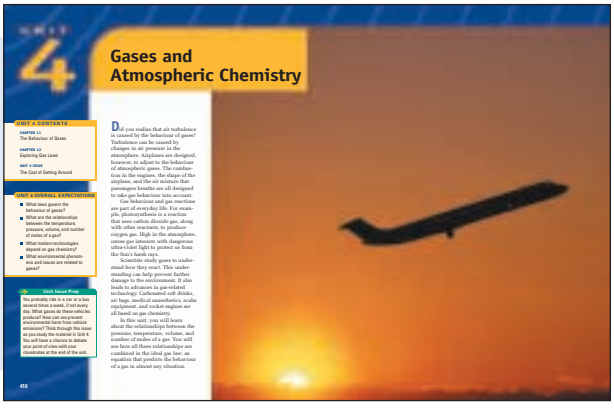


In Unit 1, you will take a close look at the periodic table. How does the arrangement of electrons affect the behaviour of an atom? How do different elements combine to form compounds? You will be able to predict the products of reactions, then test out the reactions in the lab. Also, you will take a look at common chemical substances you use every day. This unit concludes with a project in which you develop a chemistry newsletter.



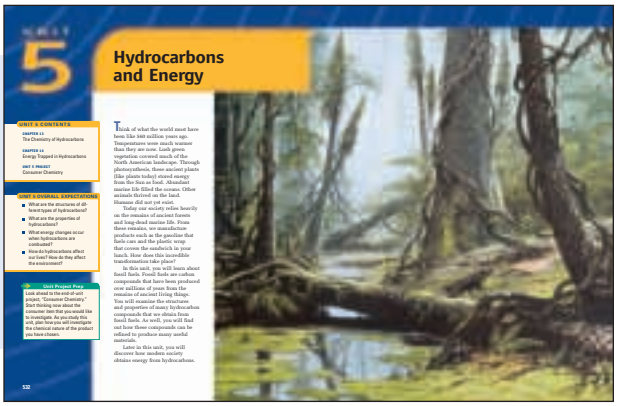
How can you measure what happens in a reaction? How can you use mass to find out the vast number of atoms and molecules involved? In Unit 2, you will discover how to describe and calculate quantitative measurements in chemical reactions. At the end of Unit 2, you will design an investigation to determine the quantitative composition of a mixture.

Why does water dissolve other substances so well? How is this important—and when does it become a problem? Solutions are essential to your life, and you use them every day. In Unit 3, you will investigate why and how things dissolve. Your understanding of solutions will prepare you for an end-of-unit simulation on a societal and environmental issue.



A rocket takes off in a cloud of vapour, and a volcano erupts, shooting molten rock into the air. What do these events have to do with gases? In Unit 4, you will find out how gases behave. You will also see how gases are used in medical and industrial situations. At the end of Unit 4, you will debate an issue related to air pollution.

Imagine your life without plastics, gasoline, or natural gas. All these products come from a common source, rooted far back in time. In Unit 5, you will look at hydrocarbons, and discover their importance in your life. Later in the unit, you will see how society obtains energy from hydrocarbons. At the end of Unit 5, you will carry out a project to investigate the chemistry of a product of your choice.


UNIT 5

Hydrocarbons and Energy

UNIT 5 CONTENTS

CHAPTER 11
The Chemistry of Hydrocarbons

CHAPTER 12
Energy Trapped in Hydrocarbons

UNIT 5 PROJECT
Consumer Chemistry

UNIT 5 OVERALL EXPECTATIONS

- What are the structures of different types of hydrocarbons?
- What are the properties of hydrocarbons?
- What energy changes occur when hydrocarbons are combusted?
- How do hydrocarbons affect our lives? How do they affect the environment?

Unit Project Prep

Look ahead to the end-of-unit project, "Consumer Chemistry." Start thinking now about the chemical product you would like to investigate. As you study this unit, plan how you will investigate the chemical nature of the product you have chosen.

Think of what the world must have been like 340 million years ago. Temperatures were much warmer than they are now. Lush green vegetation covered much of the North American landscape. Through photosynthesis, these ancient plants [like plants today] stored energy from the Sun as food. Abundant marine life filled the oceans. Other animals thrived on the land. Humans did not yet exist.

Today our society relies heavily on the remains of ancient forests and long-dead marine life. From these remains, we manufacture products such as the gasoline that fuels your car and the plastic that covers the sandwich in your lunch. How does this incredible transformation take place?

In this unit, you will learn about fossil fuels. Fossil fuels are carbon compounds that have been produced over millions of years from the remains of ancient living things. You will examine the structures and properties of many hydrocarbon compounds that we obtain from fossil fuels. As well, you will find out how these compounds can be refined to produce many useful materials.

Later in this unit, you will discover how modern society obtains energy from hydrocarbons.

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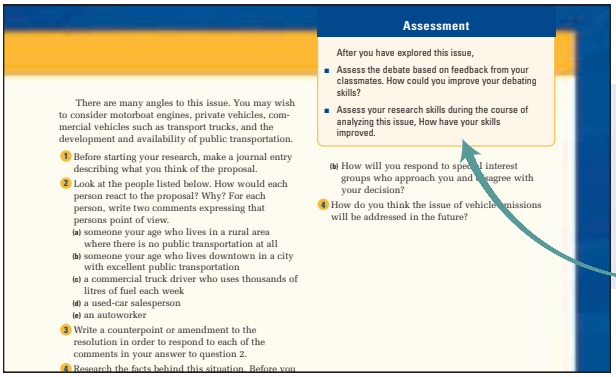

Assessment

After you have explored this issue,

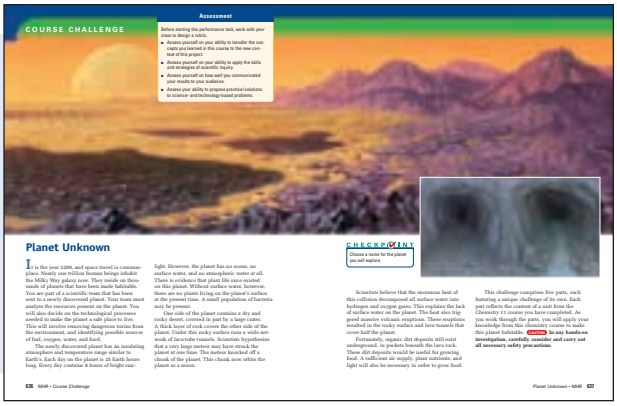
- Assess the debate based on feedback from your classmates. How could you improve your debating skills?
- Assess your research skills during the course of analyzing this issue, How have your skills improved.

There are many angles to this issue. You may wish to consider motorboat engines, private vehicles, commercial vehicles such as transport trucks, and the development and availability of public transportation.

1. Before starting your research, make a journal entry describing what you think of the proposal.
2. Look at the people listed below. How would each person react to the proposal? Why? For each person, write two comments expressing that persons point of view.
   (a) someone your age who lives in a rural area where there is no public transportation at all
   (b) someone your age who lives downtown in a city with excellent public transportation
   (c) a commercial truck driver who uses thousands of litres of fuel each week
   (d) a used-car salesperson
   (e) an autoworker
3. Write a counterpoint or amendment to the resolution in order to respond to each of the comments in your answer to question 2.
4. Research the facts behind this situation. Before you
   (b) How will you respond to special interest groups who approach you and disagree with your decision?
4. How do you think the issue of vehicle emissions will be addressed in the future?

You will probably be designing rubrics to assess your end-of-unit project, issue, or investigation. Remember to include criteria that address all of the Achievement Chart categories, as shown in Chapter 1, page 10. As you work on these tasks, refer back to these rubrics.

Following the five units of the textbook is a Chemistry Course Challenge. This is your opportunity to demonstrate an understanding of the concepts covered in the course. You will apply your skills of inquiry to explore the possibility of settling an unknown planet. At the end of the challenge, you will communicate your ideas to a government task force. By applying practical chemistry skills to a new, "real-life" situation, you will see how science and technology connect with society and the environment.


COURSE CHALLENGE

Assessment

Before starting this performance task, work with your class to design a rubric.

- Assess yourself on your ability to transfer the concepts you learned in this course to the new context of this project.
- Assess yourself on your ability to apply the skills and strategies of scientific inquiry.
- Assess yourself on how well you communicated your results to your audience.
- Assess your ability to propose practical solutions to science- and technology-based problems.

Planet Unknown

In the year 2200, and space travel is commonplace. Nearly one trillion human beings inhabit the Milky Way galaxy now. They reside on thousands of planets that have been made habitable. You are part of a scientific team that has been sent to a newly discovered planet. Your team must analyze the resources present on the planet. You will also decide on the technological processes needed to make the planet a safe place to live. This will involve removing dangerous toxins from the environment, and identifying possible sources of fuel, oxygen, water, and food.

The newly discovered planet has an insulating atmosphere that keeps the temperature close to Earth's. Each day on the planet is 25 Earth hours long. Every day contains 8 hours of bright sunlight. However, the planet has no ocean, no surface water, and no atmospheric water at all. There is evidence that plant life once existed on this planet. Without surface water, however, there are no plants living on the planet's surface at the present time. A small population of bacteria may be present.

One side of the planet contains a dry and rocky desert, covered in part by a large crater. A thick layer of rock covers the other side of the planet. Under this rocky surface runs a wide network of lava-tube tunnels. Scientists hypothesize that a very large meteor may have struck the planet at one time. The meteor knocked off a chunk of the planet. This chunk now orbits the planet as a moon.

CHECKPOINT

Choose a name for the planet you will explore.

Scientists believe that the enormous heat of this collision decomposed all surface water into hydrogen and oxygen gases. This explains the lack of surface water on the planet. The heat also triggered massive volcanic eruptions. These eruptions resulted in the rocky surface and lava tunnels that cover half the planet.

Despite the volcanic dirt deposits still exist underground, in pockets beneath the lava rock. These dirt deposits would be useful for growing food. A sufficient air supply, plant nutrients, and light will also be necessary in order to grow food.

This challenge comprises five parts, each featuring a unique challenge of its own. Each part reflects the content of a unit from the Chemistry 11 course you have completed. As you work through the parts, you will apply your knowledge from this chemistry course to make this planet habitable. **CAREER** **In any hands-on investigation, carefully consider and carry out all necessary safety precautions.**

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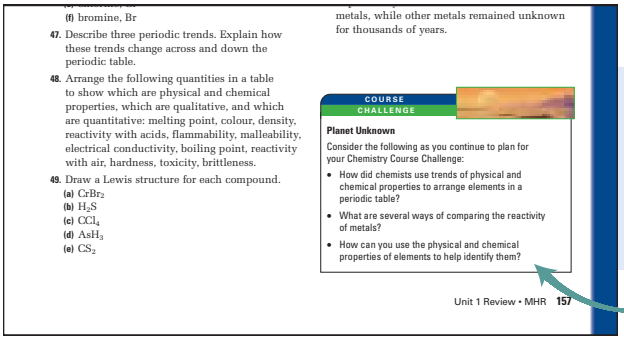
Planet Unknown • MHR 637


(f) bromine, Br

47. Describe three periodic trends. Explain how these trends change across and down the periodic table.
48. Arrange the following quantities in a table to show which are physical and chemical properties, which are qualitative, and which are quantitative: melting point, colour, density, reactivity with acids, flammability, malleability, electrical conductivity, boiling point, reactivity with air, hardness, toxicity, brittleness.
49. Draw a Lewis structure for each compound.
   (a) $CrBr_2$
   (b) H_2S
   (c) CCl_4
   (d) AsH_3
   (e) CS_2

metals, while other metals remained unknown for thousands of years.

COURSE CHALLENGE

Planet Unknown

Consider the following as you continue to plan for your Chemistry Course Challenge:

- How did chemists use trends of physical and chemical properties to arrange elements in a periodic table?
- What are several ways of comparing the reactivity of metals?
- How can you use the physical and chemical properties of elements to help identify them?

Unit 1 Review • MHR 157

Watch for this feature in text margins throughout the textbook and in the Unit Reviews to help you begin planning for your Course Challenge. The cues are designed to trigger your thought processes, and point you to a line of research.