UNIT 2

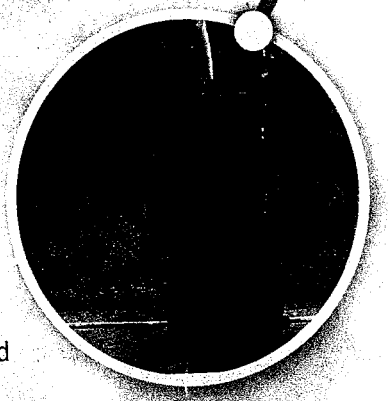
# At a Glance

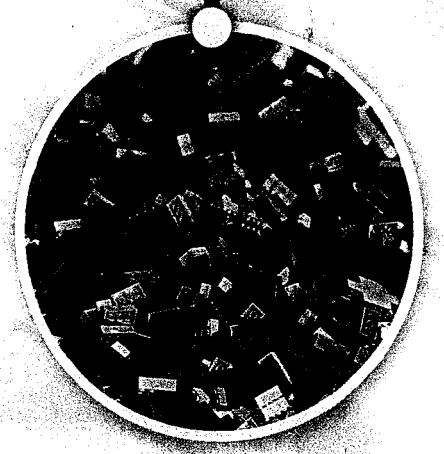
**You will demonstrate what you know, can do, and understand by being able to**

- Perform investigations and use other investigative methods to explore properties and patterns involving a variety of elements
- Use scientific understandings to describe and evaluate the development of the periodic table
- Develop and use models and other methods to represent atoms, ions, and the ability of atoms to form compounds
- Seek patterns and connections to describe, name, and write formulas for a variety of chemical compounds

ESSENTIAL QUESTION

**How do the electron arrangements of atoms determine the chemical and physical properties of elements and compounds?**





TOPIC 2.1:

**How and why do we study matter?**

***Some things you will do:***

- choose and use equipment safely and accurately
- contribute to care for self, others, community, and world

***Some things you will come to know:***

- You can describe and explain much about matter based on its properties and interactions.
- You must handle matter and equipment used to investigate it safely.

TOPIC 2.2:

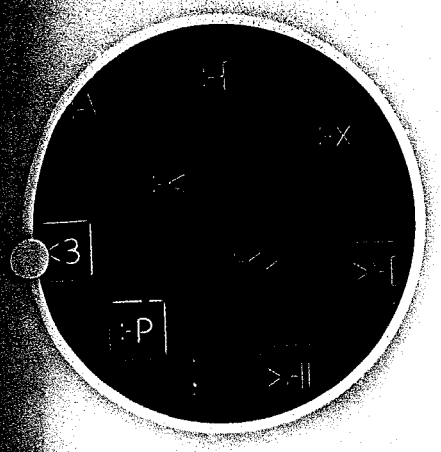
**How does the periodic table organize the elements?**

***Some things you will do:***

- seek and analyze patterns, trends, and connections in data
- analyze cause-and-effect relationships

***Some things you will come to know:***

- The periodic table is an extremely powerful tool for organizing our knowledge about the matter of the universe.



## TOPIC 2.3:

### How can atomic theory explain patterns in the periodic table?

***Some things you will do:***

- identify questions of interest based on curiosity and learning
- construct, analyze, and interpret graphs, models, and/or diagrams
- draw conclusions that are consistent with evidence

***Some things you will come to know:***

- You can use simple diagrams to represent the structure of atoms.
- You can use the periodic table to predict relationships between atoms of different elements.

## TOPIC 2.4:

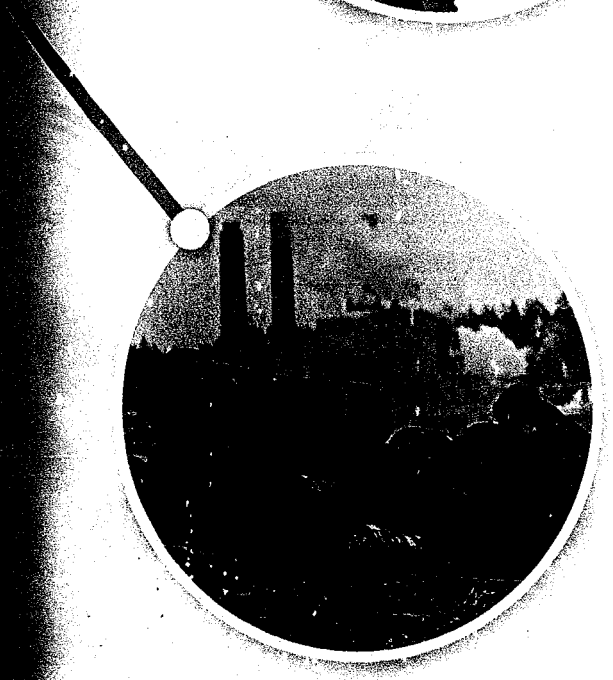
### How do elements combine to form compounds?

***Some things you will do:***

- use scientific concepts to draw conclusions
- use physical or mental models to describe phenomena

***Some things you will come to know:***

- Forming compounds is all about the stability of a full valence shell.
- Some compounds are made up of ions, while others are made up of molecules.



## TOPIC 2.5:

### How do we name and write formulas for compounds?

***Some things you will do:***

- work together to develop a game about naming and writing formulas for compounds
- analyze patterns, trends, and connections in data to help you name and write formulas for compounds

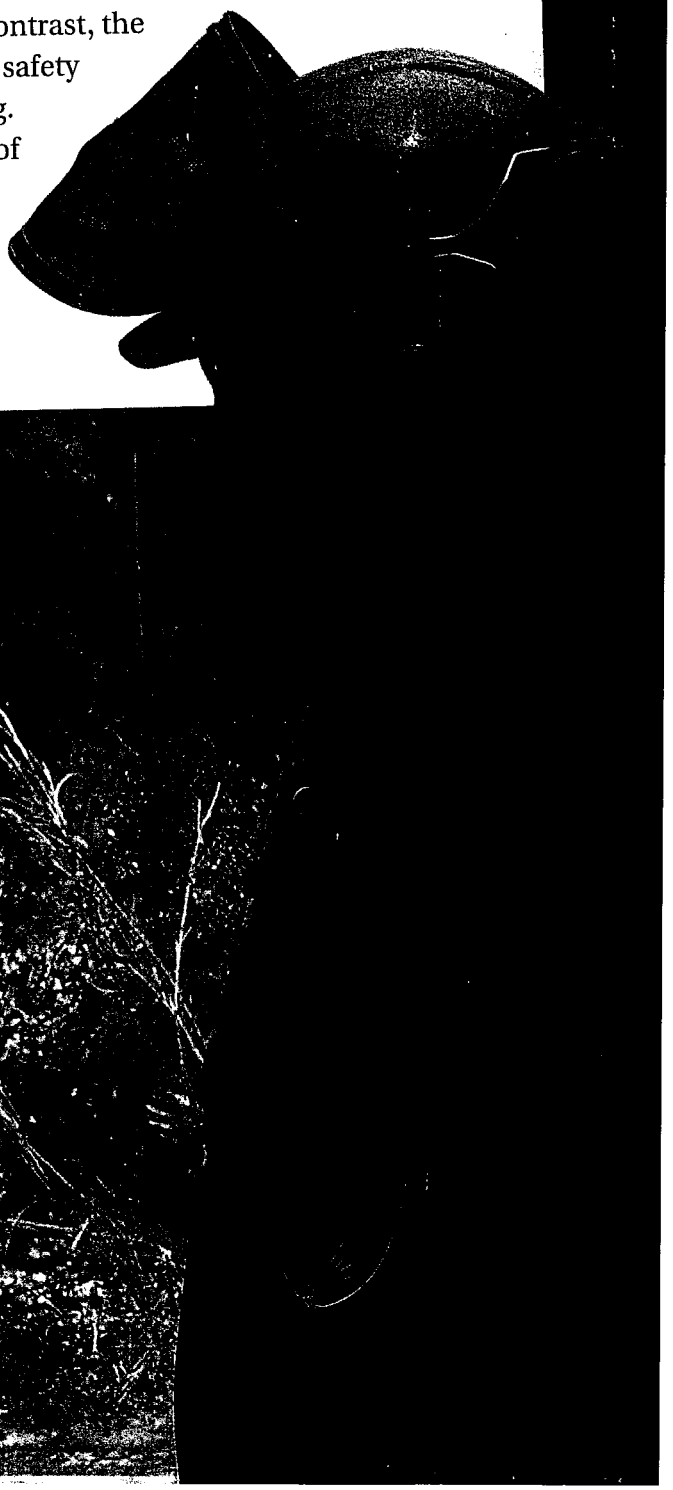
***Some things you will come to know:***

- You can name and write formulas for compounds if you know their structures or compostions.
- The periodic table can help you name and write formulas.

TOPIC 2.1

# How and why do we study matter?

According to the B.C. government, about 2000 wildfires occur in the province each year. One strategy to prevent wildfires or to fight existing ones is to carry out planned, or prescribed, burns. The firefighter shown here is working at a prescribed burn, which was started on purpose and is carefully kept within planned boundaries. The fuel used to start the fires is highly flammable. In contrast, the firefighter's clothing and safety equipment resist burning. The different properties of different substances and materials determine how they can be used and how we can work with them safely.



## Key Concepts

- Matter and its interactions make up our world.
- Safety is key when working with matter.

## Curricular Competencies

- Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal interest.
- Ensure that safety and ethical guidelines are followed in your investigations.
- Critically analyze the validity of information in secondary sources and evaluate the approaches used to solve problems.

# Starting Points

**Choose one, some, or all of the following to start your exploration of this Topic.**

1. **Identifying Preconceptions** What is matter? In your own words, define the term. Use your definition to explain whether each of these terms related to the introduction is an example of matter: wood, smoke, oxygen, fuel, plan, firefighter, fire, heat, gloves, crackling sound.
2. **Questioning and Predicting** Wildfires can occur naturally, but today most are started by human activities. It is not just the burning that causes harm but the smoke. What compounds are released into the air when wood burns? What are the chemical and physical properties of these compounds? How are they dangerous to human and animal life?
3. **Communicating** First Peoples in B.C. have used controlled burning techniques as part of their traditional practices. Invite an Elder or traditional knowledge keeper to share how and why controlled burns may be used and how they are done safely.

## Key Terms

There are six key terms that are highlighted in bold type in this Topic:

- matter
- mixture
- compound
- pure substance
- element
- chemical reaction

Flip through the pages of this Topic to find these terms. Add them to your class Word Wall along with their meaning. Add other terms that you think are important and want to remember.

CONCEPT 1

# Matter and its interactions make up our world.

## Activity

### Describe It, Separate It

Your teacher will provide your group with a mixture. You will have access to equipment such as magnets, filters, and sieves. Before starting, examine **Figure 2.1** below.

1. Is your mixture heterogeneous or homogeneous (a solution)? How do you know?
2. Can you separate your mixture into parts? Try to do so.
3. Are the parts of your sample mixtures or pure substances? Explain.
4. What further tests would you like to conduct to gather more information about the components of your sample?

**matter** anything that has mass and takes up space

**pure substance** matter that has a definite composition and cannot be separated by physical means

**mixture** a blend of two or more pure substances in which each substance retains its individual properties; can be separated by physical means

You are surrounded by **matter**, and chemistry is the science of matter and its interactions. By studying chemistry, we can better understand the properties and behaviour of matter on Earth and beyond. Matter can be classified as either a **pure substance** or a **mixture**. Pure substances are made up of one type of particle. Mixtures are made up of two or more pure substances, and therefore two or more types of particles. **Figure 2.1** summarizes the classification of matter.

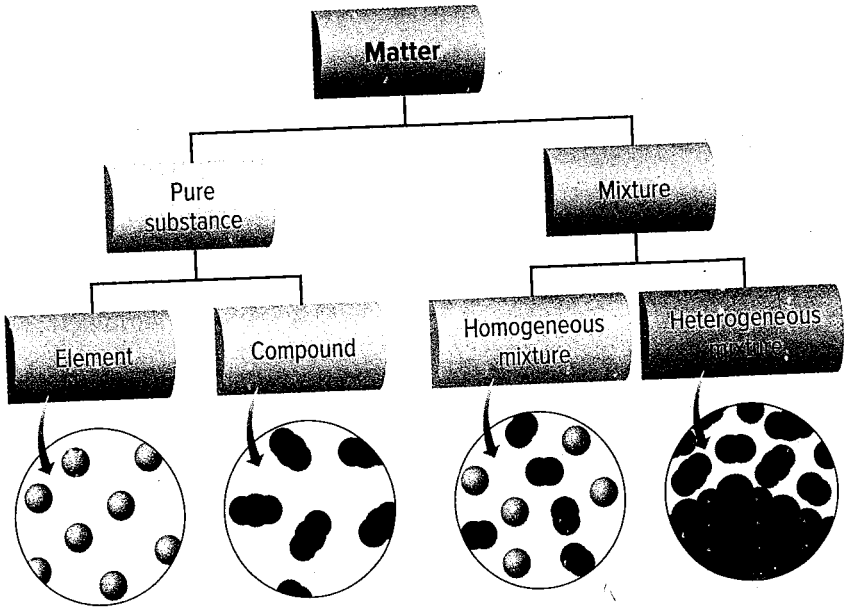
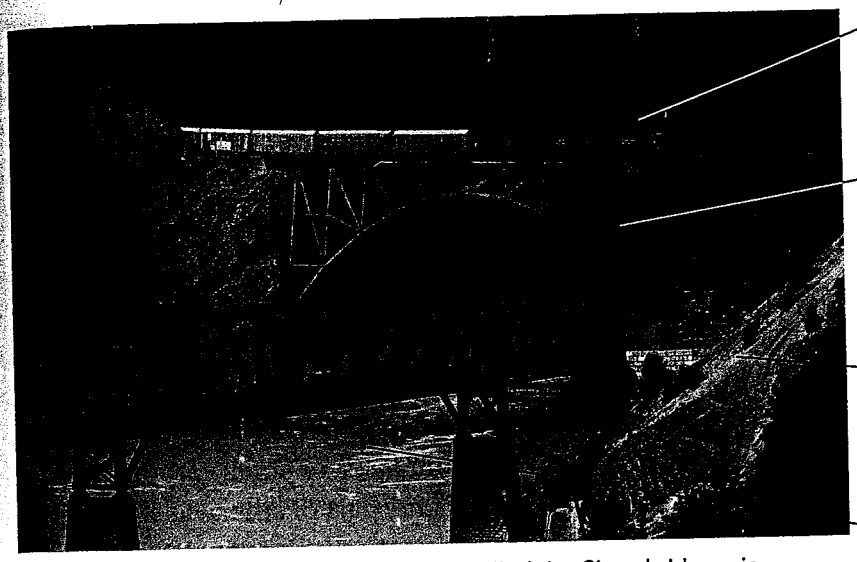



**Figure 2.1** Matter is either a mixture or a pure substance. A mixture can be homogeneous or heterogeneous. A pure substance can be an element or a compound. **Give one example of each of these: a mixture, an element, and a compound.**



This train runs on diesel fuel. Diesel is a mixture of chemical compounds made of the elements hydrogen and carbon.

The metal used to make the bridge is steel. Steel is a very strong solid mixture—an alloy—composed of iron and small amounts of other elements, such as carbon.

The rock of the hillside is a mixture that includes quartz, which is a compound made of the elements silicon and oxygen.

This river water is a mixture made up of the compound water, a variety of compounds and elements dissolved in the water, and suspended bits of rock.

**Figure 2.2** This pair of railway bridges, called the Cisco bridges, is found at Siska, B.C. **Make a table to list the mixtures, compounds, and elements mentioned. Add one example not mentioned.**

## Mixtures, Compounds, and Elements

Most of the materials we interact with each day are mixtures. **Figure 2.2** shows and describes some examples of solid, liquid, and gas mixtures. Some—such as air and steel—are homogeneous mixtures, or *solutions*. They are mixed uniformly throughout, and you cannot see their components, even with a microscope. Others, such as rock, have different parts that you can see. These are *heterogeneous mixtures*. But all are made up of two or more different pure substances.

Pure substances can be elements or compounds. **Elements** are made up of just one type of atom and cannot be broken down into simpler substances by chemical means. **Compounds** are made up of atoms of two or more elements.

**element** a pure substance that cannot be broken down into simpler substances by physical or chemical means

**compound** a pure substance made up of two or more elements; can be broken down into elements by chemical means

## Properties of Matter

The steel of the railway tracks in **Figure 2.2** is a strong, hard, shiny solid. Rock is also a hard solid, but it is brittle. Air is a clear, colourless gas. These descriptions all use *physical properties*. These are characteristics of matter that can be observed or measured without changing its chemical identity. In contrast, *chemical properties* describe the ability of matter to react with another substance to form one or more different substances. **Table 2.1** gives further examples.

**Table 2.1 Physical and Chemical Properties**

| Physical Properties | | Chemical Properties |
|---|---|---|
| • colour | • state of matter | • combustibility |
| • malleability | • melting point | • reactivity with acids |
| • texture | • boiling point | • reactivity with oxygen |
| • viscosity | • hardness | • lack of reactivity |
| • ability to conduct heat and electricity | • solubility | |

## Chemical Reactions

**chemical reaction** a process in which the atoms of one or more pure substances are rearranged to form a different substance or substances.

An important part of studying matter is carrying out and observing chemical reactions. In a **chemical reaction**, one or more pure substances interact to form a different substance or substances. For example, elements can react to form compounds, compounds and elements can react to form different compounds, and compounds can break apart to form elements and simpler compounds.

A fire is a common example of a chemical reaction. In a forest fire, compounds in plants react with oxygen in the air to form many compounds, including carbon dioxide, carbon monoxide, and water, as well as the element carbon. You cannot see or smell carbon dioxide or carbon monoxide, but water is a visible part of smoke as it cools and forms droplets in the air. You can see the carbon as the black charcoal left behind by the fire. Energy is also released in the form of light and heat. **Figure 2.3** shows other examples of chemical reactions.

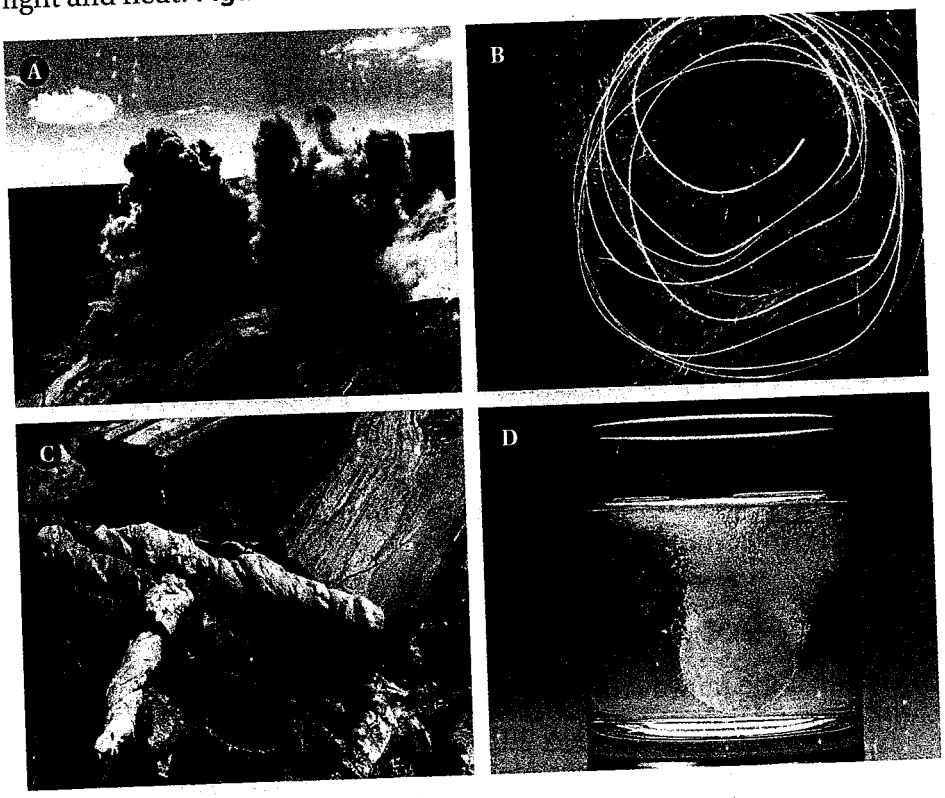



**Figure 2.3** Ⓐ Explosive chemical reactions are used in mining to break apart rock and soil. Ⓑ In a sparkler, metals react with air and release energy in the form of light and sound. Ⓒ Exposing food to heat results in chemical reactions that change its taste and appearance. Ⓓ The chemical reaction between substances in this tablet and water produces gas, which you can see as bubbles in the water.

### Before you leave this page . . .

1. What is the difference between a pure substance and a mixture? Use diagrams in your answer.
2. List three physical properties of water at room temperature.
3. Give one example of an element and one example of a compound. Explain how they are different.
4. What happens in a chemical reaction?