CHAPTER 2

Pure Substances:

Getting Ready...

- How can we organize the elements into meaningful groups?
- What properties will tell you if an object is a metal?
- What do the letters and numbers in a chemical formula mean?

This painting shows an alchemist trying to turn urine into gold. Read the opening to find out what he got instead. (Painting by Joseph Wright of Derby, 1734–1797.)

Science Log

In your Science Log, develop a flowchart or concept map to review what you already know about matter: its properties, the basic unit that makes it up, and one classification system. Think about the Getting Ready questions, and then write any other questions you can think of.

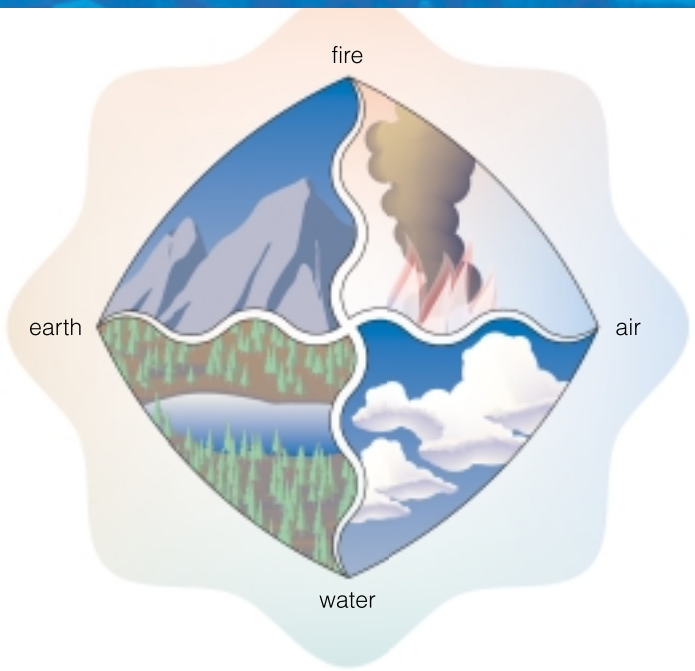
The painting above shows the eighteenth century alchemist Hennig Brand discovering phosphorus. Alchemy was a complicated mixture of religion, science, and philosophy that was practised from ancient times until the eighteenth century.

Some alchemists spent their time trying to find mixtures that would bring either great understanding or eternal life. Other alchemists, like Brand, were trying to find a way to change inexpensive raw materials into gold. Instead of making gold, Brand discovered phosphorus — a substance that glows in the dark.

Long before the alchemists, the early Greeks believed that all matter was made up of only four elements: earth, air, fire, and water. Like many early scientific ideas, this theory has been replaced by others.

In Chapter 1, you learned about pure substances and mixtures, and how to tell the difference between these two types of matter. You also learned that everything is made of particles and that substances can be divided into two categories based on the number of types of particles they contain. In this chapter, you will take a closer look at types of particles and discover ways these can be organized and combined.

Elements and Compounds



The early Greeks believed that all matter was composed of only four substances: earth, air, fire, and water.

What You Will Learn

In this chapter you will learn:

- how elements are organized in the periodic table
- how to tell whether a substance is metal or non-metal
- about the relationship between elements and compounds
- how to write element symbols and chemical formulas
- how elements and compounds are used in society

Why It Is Important

- Grouping substances with similar properties allows us to predict how substances might act. What you learn in this chapter will help you understand the short forms in future science courses, on product labels, and in media reports.

Skills You Will Use

In this chapter you will:

- draw conclusions from data you gather
- interpret chemical names and formulas
- use the periodic table to predict properties of substances
- represent elements and compounds using element symbols and chemical formulas
- carry out a decomposition reaction (electrolysis)

Starting Point ACTIVITY

Pennies into Gold

Turn pennies gold!

Safety Precautions

- Do not let the zinc and sodium hydroxide mixture boil.

What You Need

heat-resistant pad
hot plate
2 beakers (100 mL)
forceps
plastic spoon
copper penny
granular zinc, 20-mesh
paper towel
40 mL sodium hydroxide solution
steel wool
water

What to Do

1. Clean the penny with steel wool.
2. Place two spoonfuls of zinc in the beaker.
3. Add 40 mL of sodium hydroxide solution.
4. Use forceps to place the penny on the zinc.
5. Gently heat the mixture on the hot plate until the penny turns a silver colour.
6. Use forceps to remove the penny from the beaker and rinse it with cold water.
7. Dry the penny and place it directly on a medium-high hot plate. Heat until the penny turns a golden colour.
8. Turn off the hot plate. Remove the penny and rinse in cold water.
9. Wash hands thoroughly and dispose of materials as directed.

2.1 Putting the Pieces Together

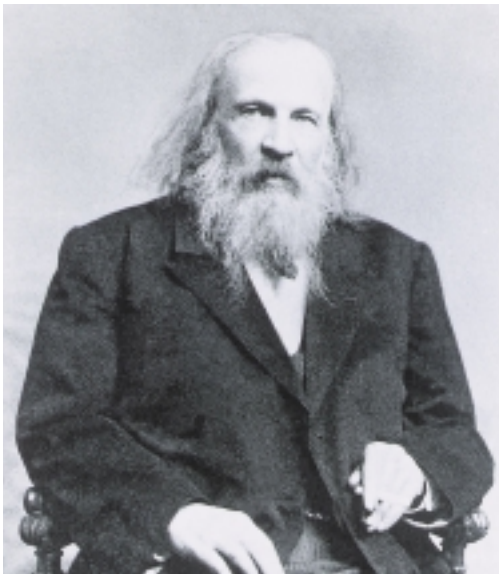


Figure 2.1 Dmitri Mendeleev puzzled out the first periodic table. The periodic table we use today is based on his work.

By the mid-1860s, scientists had discovered 64 elements and had recorded many of their properties. How would you go about organizing all of this information?

Elements are substances that cannot be broken down into other substances and contain only one kind of atom. In 1869, Dmitri Mendeleev wrote all of the information for each element on a separate file card and then put elements with similar properties in columns. He organized the elements within each group from lightest to heaviest. Then he organized the groups so that the lightest elements were on the left side of the table and the heaviest were on the right side.

As he was working, Mendeleev noticed that some elements appeared to be missing. He predicted that these elements existed but had not yet been discovered. Mendeleev made cards for the missing elements and even predicted their properties.

The Periodic Table

Mendeleev's work provided the basis for the **periodic table**. This is a chart on which scientists have organized all of the elements.

Mendeleev worked with 64 elements. Since then, the number of known elements has swelled to 112. As scientists continue to investigate, they continue to find new ones. Interestingly, scientists have discovered many of the elements that Mendeleev predicted. Mendeleev's work was so careful and logical that the properties of these newly discovered elements matched his predictions almost perfectly.

Modern advances in scientific technique and apparatus have clarified Mendeleev's data. Even with these additions, the way the periodic table is arranged has not changed much from the way Mendeleev first designed it.

READING Check

Explain what an element is.

The elements in Mendeleev's chart are made up of **atoms**. Atoms are the smallest bits of matter. Water is made up of atoms of hydrogen and oxygen. For each atom of oxygen, water has two atoms of hydrogen. You will learn more about this in Section 2.3.

Periodic tables do not all look the same, but they do have some things in common.

- They all look like a chart.
- Each square of the table includes information about one element.

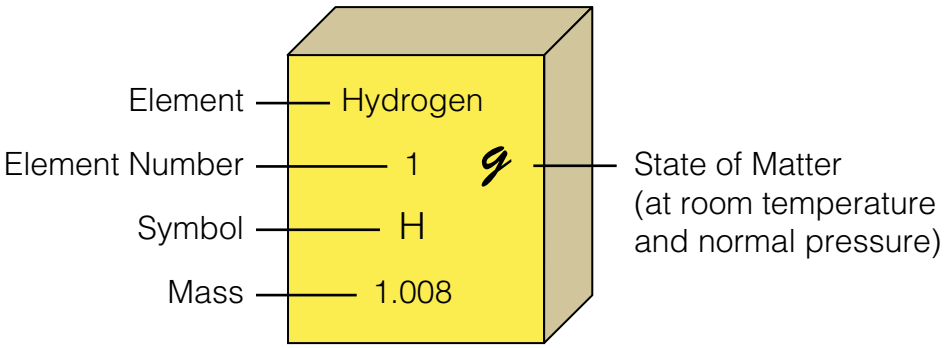
The amount of information varies depending on who made the table, but each square usually contains an element's symbol and name. Some tables include information such as the element's state, its complete name, and details about the atoms that make up the elements.

Patterns and Trends

The elements in the periodic table are arranged in columns and rows so that elements with similar properties appear together. The columns are referred to as **groups**. The rows are called **periods**.

Take a look at the simplified periodic table in Figure 2.3.

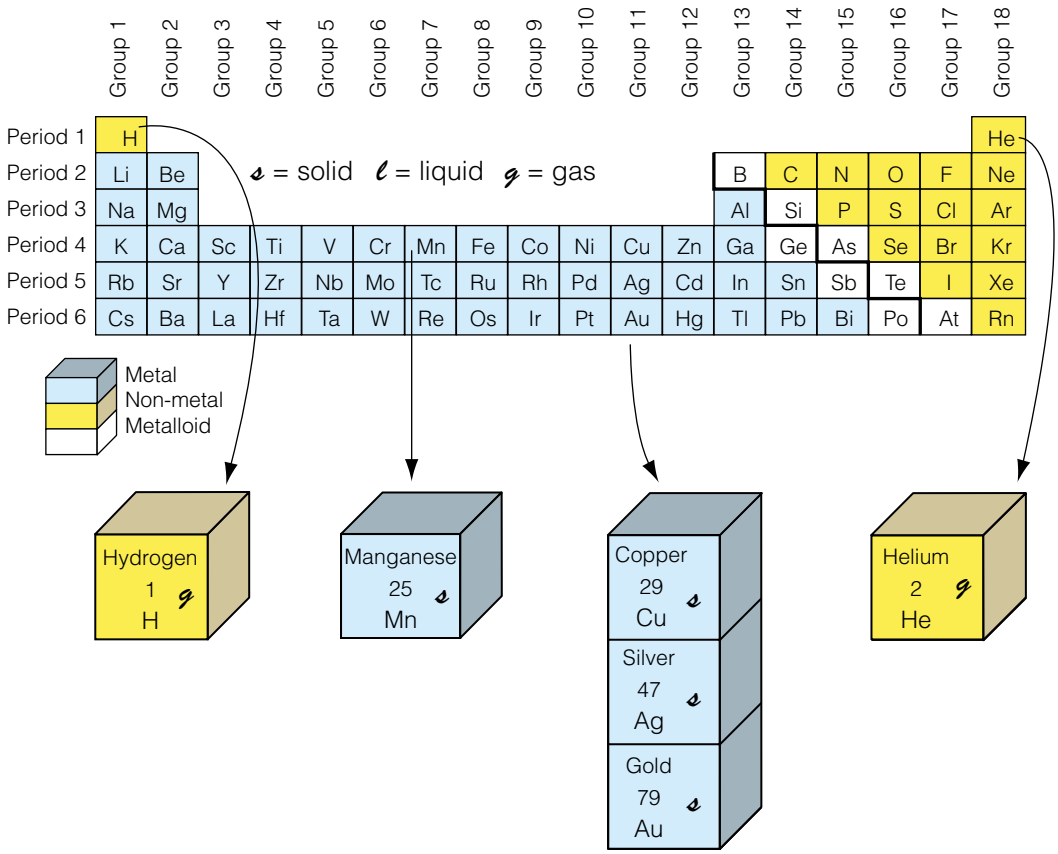
- Place your finger on the first row. Name the elements in this period.
- Run your finger down the eleventh column. List the elements in this group.
- Place your finger at the place where the fourth row (period) and the seventh column (group) meet. What element is there?



READING Check

What information is found in each square of the periodic table?

Figure 2.2 Each square in the periodic table contains identifying information about one element.



Try This!

With a partner, choose one element and research its properties and uses. Use drawings to make a cartoon of the element or show people using the element in a unique way.

Figure 2.3 The modern periodic table contains a wealth of information. Elements are arranged in order of increasing mass, in periods (rows), and in groups (columns) according to their physical and chemical properties.

Metals and Non-metals

Take another look at Figure 2.3. Run your finger along the staircase-like line on the right hand side of the periodic table. This line separates the metallic elements from the non-metallic elements. The metals are on the left of the line; the non-metals are on the right.

Think back to the various physical and chemical properties you studied in Chapter 1. These properties help distinguish metals from non-metals.

- **Metals** are good conductors of heat and electricity. They can be bent, stretched into a wire, and polished until shiny. Metals are solids at room temperature. The one exception to this is mercury, which is a liquid.
- **Non-metals** are poor conductors of heat and electricity. They are dull, not shiny, in appearance. Most are gases or brittle solids at room temperature. The exception to this is bromine, which is a liquid at room temperature.
- The white squares between the metals and non-metals show **metalloids**. These elements share some of the properties of metals and some of the properties of non-metals.

READING Check

What property makes it possible to shape aluminum into soft-drink cans and baseball bats?

Your body contains metals, non-metals, and metalloids. Iron helps release energy to your body cells. Carbon is a key element in all sugars, carbohydrates, and proteins. Potassium helps to maintain the fluid balance in your tissues.

Table 2.1 Properties of Metals and Non-metals

Metals	Non-metals
• bright metallic shine (lustre)	• dull, various colours
• easily shaped (malleable)	• brittle
• solids (except mercury)	• solid or gas (except bromine)
• good conductors of heat and electricity	• poor conductors of heat and electricity

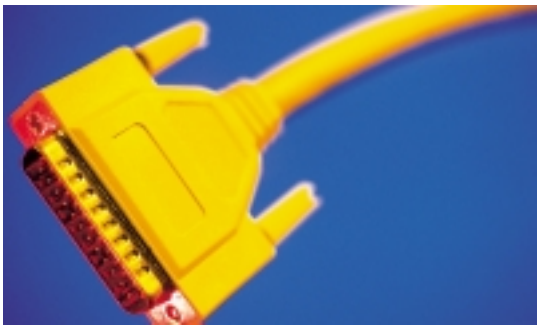


Figure 2.4 Can you identify the properties shown here? Here's a hint: all metals share them.

DidYouKnow?

Figure 2.5 World War I gas mask
Chlorine is a very toxic greenish-yellow gas. During World War I, some armies used chlorine gas as a weapon. Many soldiers died from inhaling the gas. The gas mask was invented to avoid such deaths. Find chlorine in the periodic table. Is it a metal or a non-metal?

Off the Wall

Gallium is found below aluminum in group 13. Although gallium is a solid metal, its melting point is low enough that it will melt in your hand.

Figure 2.6

Disc CONNECT

How are chemicals classified? What is the periodic table? What are the properties of metal and non-metal elements? To answer these and other questions, load the **science.connect™ 1** student CD-ROM onto your computer. Launch the **Periodic Table** applet and follow the instructions.

DidYouKnow?

Figure 2.7

Bismuth has a very low melting point for a metal (271°C), making it an excellent "plug" for fire sprinklers. As a fire starts, the air near the ceiling quickly reaches temperatures up to 500°C. This melts the bismuth plug, letting water flow from the sprinkler heads.

INVESTIGATION 2-A

SKILL CHECK
- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Reading the Periodic Table

Think About It

The periodic table contains important information about the elements. To give you practice using it, copy the following chart into your notebook.

Element Name	Symbol	Period	Group	Metal or Non-metal
chromium				
		4	17	
	P			
		1	18	
bohrium		7		
			15	metal
			14	non-metal
tin				
	Cl			
	Nb		5	

What to Do

1. Use a copy of the periodic table to complete the chart provided.

Analyze

1. Which parts of the table were easiest to complete — the ones with the element name, the element symbol, the period number, or group number?
2. Look at the elements that you classified as metals. On which side of the staircase line are they located?
3. Some lines on the table only give you the group number and the period number. How did you use this information to find the element name and symbol?
4. What pattern(s) did you notice while looking at the element numbers in the periodic table?

DESIGN & DO

INVESTIGATION 2–B

SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Properties of Metals and Non-metals

Challenge

Design and construct a series of tests that will determine whether an element is a metal or a non-metal.

Safety Precautions

- Sulfur is combustible and toxic.
- Wear rubber gloves when handling elements.

Apparatus

conductivity tester

magnet

Materials

samples (copper, sulfur, carbon, iron, magnesium, nitrogen, lead, and zinc)

steel wool

Design Criteria

A. The tests must establish whether the element is a metal or non-metal based on its properties.

B. The tests must be safe enough to carry out in the classroom and short enough to be completed in one class period.

Plan and Construct

1. List all of the properties of metals and non-metals.
2. How could you test whether or not a sample can be bent easily?
3. How could you test how well it conducts electricity?
4. How might you use the steel wool?
5. What other apparatus or materials do you need to carry out the investigation?
6. Write out a procedure for testing each of the properties you have identified. Show it to your teacher before you begin.
7. **(a)** Use a chart to record your observations.
   (b) Before you look at the samples, predict whether each substance is a metal or a non-metal. Wash your hands thoroughly.

Evaluate

1. Did you explain the safety precautions for this investigation?
2. Were you able to classify each of the samples?
3. **(a)** Based on the data you collected during your tests, what properties do all metals share?
   (b) What do all non-metals have in common?
4. Which test results could have been misleading?

Extend Your Skills

5. Imagine that you are given a sample of an element. The sample is a dull grey colour and is fairly heavy for its size. It is so soft that you can dent its surface with your fingernail. Would your tests reveal that the element was a metal or a non-metal?
6. Summarize the properties of metals and non-metals in a chart or concept web you can display in class.

Key Terms

element
periodic table
atom
group
period
metal
non-metal
metalloids

Check Your Understanding

1. What does the position of neon in the periodic table tell you about its properties? List these properties.
2. Classify each of the following as either a metal or a non-metal.
   (a) greenish-yellow gas
   (b) silver-coloured solid that conducts electricity
   (c) greyish solid that is shiny when sanded
   (d) very brittle brown crystal
   (e) very shiny silver-coloured liquid that conducts electricity
3. Copy the following table into your notebook and use your periodic table to fill in the blanks.

Element Symbol	Element Name	Group	Period	Metal or Non-metal
Br				
N				
Ca				
Pt				

4. What information is included in each square of the periodic table?

2.2 Elements and Compounds

DidYouKnow?

Your body contains many elements, including calcium, phosphorus, iron, iodine, sodium, potassium, oxygen, and nitrogen. Check the periodic table and identify which of these are metals, non-metals, and metalloids.

Elements and Compounds in Society

Elements and compounds are used all around you. The coins in your pocket, the sugar on your cereal, and the fluid in your car battery are examples of how you use elements and compounds. Everything around us, including our own bodies, can be broken down into the elements that are found in the periodic table.

READING Check

List three elements and three compounds that you commonly use.

Figure 2.8 Are helium-filled balloons inflated with a compound or an element? Check the periodic table to see.

Compounds

The periodic table lists elements. A substance made up of two or more different elements chemically combined together is known as a **compound**.

- Oxygen is a pure substance that consists of a single element.
- Distilled water is a pure substance that consists of more than one element. Distilled water consists of the elements oxygen and hydrogen joined chemically. Water is a compound.

READING Check

How are letters and words like elements and compounds?

Most substances in the world are compounds. You can use this knowledge to add a third level of organization to the flowchart of matter from Chapter 1.

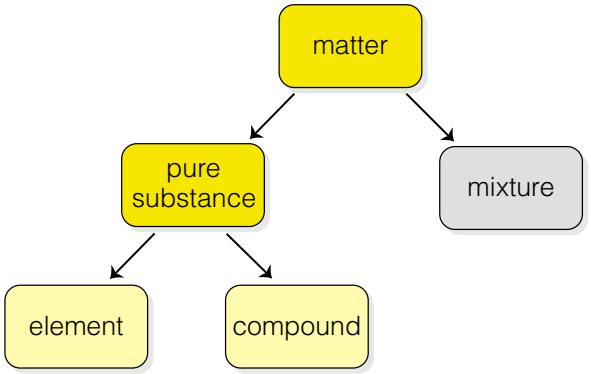


Figure 2.9 Elements and compounds represent a third level of organization in the matter flowchart.

Testing for Compounds

An element is a pure substance that cannot be broken down into simpler substances.

Compounds, however, are made up of two or more elements. Compounds *can* be broken apart into simpler substances. This is done through a process called a **decomposition reaction**.

Try This!

Examine the ingredients list on a sports drink label. Choose one element or compound and try to find out why the element or compound is added to the drink.

READING Check

What is a decomposition reaction?

Figure 2.10 Decomposition reactions break compounds down into simpler substances. This is similar to a clock being broken down into the parts that make it up.

CONDUCT AN

INVESTIGATION 2-C

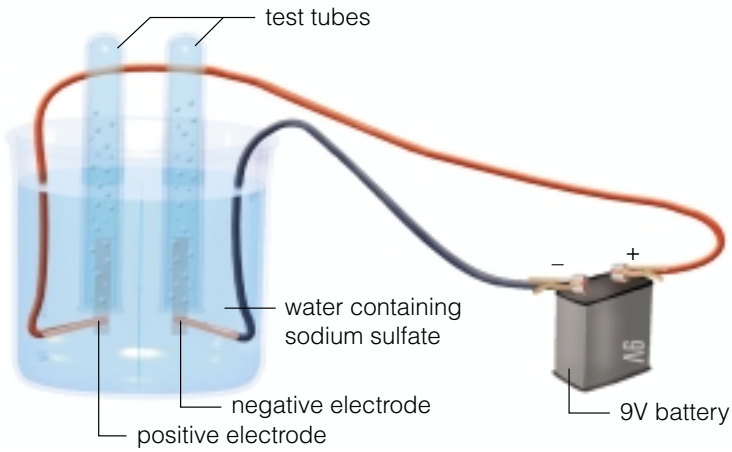
SKILL CHECK

- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

Decomposition Reaction

Think About It

Very soon after Alessandro Volta invented the battery, a scientist named Sir Humphry Davy began forcing electricity through melted compounds. The compounds separated into the elements that made them up. This is called a decomposition reaction.



A decomposition reaction that uses electricity is called electrolysis.

An electrolysis apparatus consists of a battery with wires connected to each terminal. On the other end of each wire is a solid material that conducts electricity. This item is called an electrode.

During electrolysis, two electrodes are placed into a liquid containing a compound. As electricity passes through the liquid from one electrode to the other, the electricity breaks the liquid compound into simpler substances. This process is called decomposition.

In this investigation you will use electrolysis to separate water into its two elements — hydrogen and oxygen.

Problem

How can a compound be separated into its elements?

Prediction

What will happen when electricity is passed through water?

Safety Precautions

- You will be working with flammable substances, so be very careful.
- Hydrogen is explosive.
- Oxygen supports combustion.
- Wash your hands when you have completed this investigation.

Apparatus

9 V battery
400 mL beaker
eye dropper
2 graphite pencil leads for electrodes
stirring rod
2 test tubes (50 mL)
2 wire leads with alligator clips

Materials

sodium sulfate solution
water
2 wooden splints

Procedure

1. Pour 300 mL of water into the 400 mL beaker.
2. Add 2–3 mL of sodium sulfate solution and stir.
3. Attach one wire end to each of the battery terminals.

4. Attach the other end of each wire to the pencil lead electrodes.

5. Fill a test tube from the rest of the solution. Put your thumb over the end, turn the tube upside down, and dip it into the water so that the open end (with your thumb covering it) is completely immersed.

6. Carefully take your thumb away. Put the open end of the test tube over one of the electrodes.

7. Repeat for the second test tube and electrode.

8. Observe and record what happens in the test tubes.

9. When one of the test tubes is almost full of gas, disconnect a wire from the power source to stop the electric current.

10. Estimate and record the volume of gas in the other test tube.

11. Light a wooden splint. Place your thumb over the opening of the test tube that is full of gas. Lift it out of the water, keeping it inverted. Carefully remove your thumb and hold the flaming splint near the opening of the test tube. Record what happens.

12. Light another wooden splint. Blow out the flaming splint so that it is glowing. Lift up the other test tube and let the water drain out. Repeat the test you did in Step 11.

Analyze

1. Describe the tests for hydrogen and oxygen gas.
2. What gases were present in the test tubes? How do you know?
3. Is water a compound or an element? Explain.

Conclude and Apply

4. Draw a picture of the two test tubes, showing the amount of gas each held when you disconnected the power. The gases in these test tubes were collected by decomposing water using electricity. The chemical formula for water is $H_2O_{(l)}$
   - **(a)** Which test tube likely contains hydrogen? oxygen?
   - **(b)** Does there appear to be a relationship between the chemical formula of water and the volume of gas in each test tube? Explain.
5. What would happen if you switched the wires on the battery terminals?

Career CONNECT

Archeologists find evidence of lead pipes in the plumbing of ancient ruins where clean water was piped into buildings. In more recent times, plumbing pipes were fastened together with lead-based solder. Normally this worked fine. Unfortunately, if the water became acidic, the lead dissolved into the water. Drinking water from such pipes could cause lead poisoning.

Today, most houses are plumbed with copper piping. More recently, plastic piping has been used. Plastic is a very strong, flexible, and stable compound that makes an excellent material for water pipes. Plastic's physical properties make it safer for plumbers to work with — no soldering with hot metal.

Figure 2.11 Knowledge of the properties of elements and compounds helps plumbers.

DidYouKnow?

Decomposition reactions happen everywhere. They happen when soda pop goes "flat" and when muffins "rise" in the oven.

Internet CONNECT

www.mcgrawhill.ca/links/science.connect1

Fluid replacement is a must before, during, and after strenuous physical activity. Dehydration can cause fatigue and loss of concentration. It can also increase heart rate, and could lead to death. A number of companies manufacture sports drinks reported to improve athletic performance. To investigate the elements and compounds in one of these drinks, go to the above website. Go to Internet Connects, Unit A, Chapter 2, and then to Elements in a Sports Drink.

Key Terms

compound
decomposition reaction

Check Your Understanding

1. Describe the difference between an element and a compound.
2. How can a decomposition reaction help you determine whether a pure substance is an element or a compound?
3. What would happen if you tried to decompose an element? Why?
4. How are elements and compounds used in society? Give five examples.

Try This!

The chemical formula for table salt is $NaCl_{(s)}$. Is salt an element or compound?

Check the chemical formula for other common materials. Decide whether they are elements or compounds.

2.3 Chemical Names and Formulas

As scientists from different parts of the world discovered new elements, they quickly realized that they had a problem. They could not understand each other's symbols and names for elements.

In 1919, a group of chemistry organizations from around the world came together to form the International Union of Pure and Applied Chemistry (IUPAC). The chemists in IUPAC established an international standard for chemical symbols and names. The standard was based on the names and symbols suggested by a Swedish chemist back in 1817.

Today, even students in Japan and Greece learn these international symbols rather than ones based on their own alphabet.

READING Check

Why are the same element symbols used around the world?

Table 2.2 How Do They Say Hydrogen?

Language	Name of Element	Symbol
English	hydrogen	H
French	hydrogène	H
German	wasserstoff	H
Italian	idrogeno	H
Portuguese	hidrogênio	H
Spanish	hidrógeno	H

Element symbols are either one or two letters. Often the first letter of the element name is used.

Example: C for carbon or N for nitrogen.

Once scientists ran out of letters, they began using the first letter of the element name and a second letter from the name.

Example: Ca for calcium and Zn for zinc.

Some of the elements were discovered in ancient times and have Latin or Greek names. These elements were given a symbol based on their historic name.

Example: Pb for lead, which was known in Latin as *plumbum*.

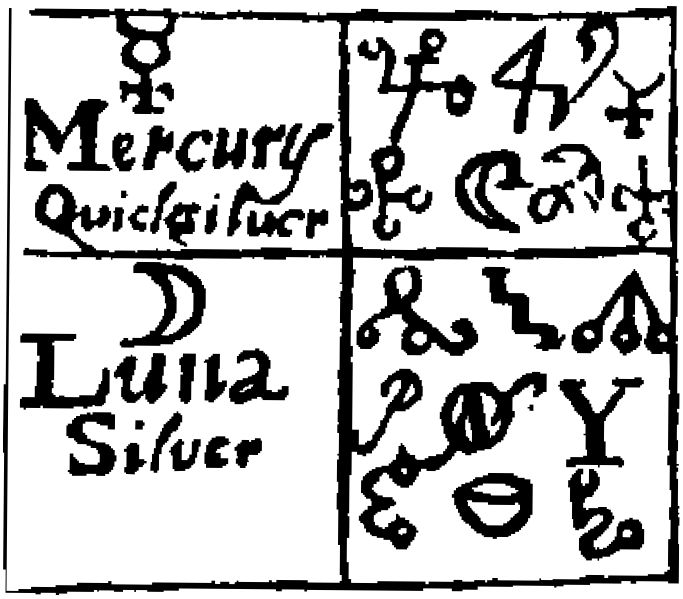


Figure 2.12 Alchemists in the 1600s used descriptions and symbols such as these to keep track of the elements they discovered. Today the standard names and element symbols established by the IUPAC ensure chemists everywhere can understand each other's symbols.

Chemical Formulas

We use short forms and symbols to simplify communication. You have already come across some of the short forms used to represent the elements. In chemistry, we use a different element symbol to represent each element and a **chemical formula** to represent the compounds these elements form.

Chemical formulas are made up of letters and numbers.

- Letters tell you which elements are in a substance.
- Subscript numbers tell you the proportion of these elements in a substance.
- A subscript letter tells you the state of matter.

For example, in Figure 2.13, the chemical formula for water tells you that this substance is made up of the elements hydrogen and oxygen. It also tells you that there are two hydrogen atoms for every oxygen atom in the substance. In addition, the subscript letter that follows tells you if the substance is a solid, liquid, or gas at room temperature.

READING Check

Read the names and formulas for the compounds in Table 2.3. Write the chemical formula for hydrogen peroxide, a substance used to bleach hair. This compound is made from hydrogen and oxygen.

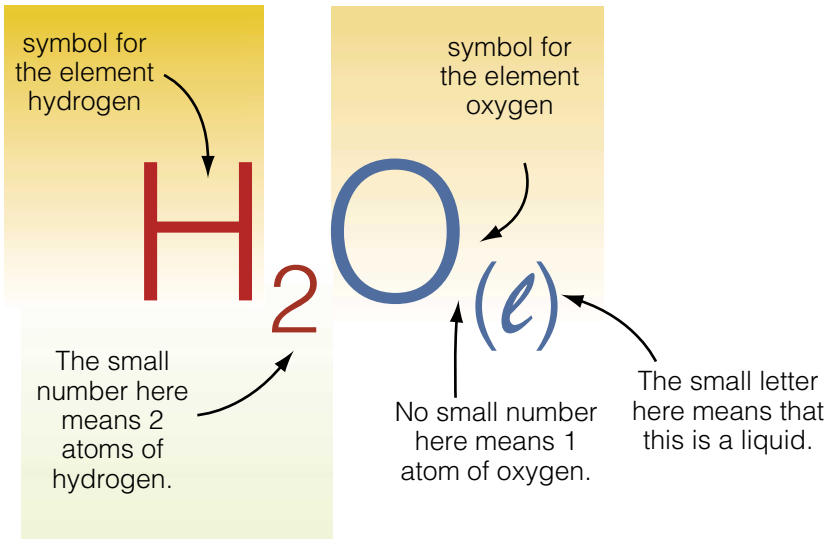


Figure 2.13 This chemical formula tells you that for every atom of oxygen found in water, there are two atoms of hydrogen. It also tells you that water is a liquid at room temperature.

Table 2.3 Chemical Formulas of Common Compounds

Compound	Chemical Formula
sodium bicarbonate (baking soda)	$NaHCO_{3(s)}$
carbon dioxide	$CO_{2(g)}$
hydrogen peroxide	$H_2O_{2(l)}$
glucose (sugar)	$C_6H_{12}O_{6(s)}$
methane (natural gas)	$CH_{4(g)}$

Find Out ACTIVITY

Interpreting Chemical Formulas

SKILLCHECK
- Initiating and Planning
- Performing and Recording
- Analyzing and Interpreting
- Communication and Teamwork

What to Do

1. Copy the table into your notebook.
2. For each compound, write the name of the elements in the "Number and Name of Elements" column. Then add up and record the number of elements represented by the formula.
3. For each compound, write the total number of atoms represented by the chemical formula in the "Total Number of Atoms" column.

What Did You Find Out?

1. **(a)** What information do the subscript numbers in a chemical formula provide?
   (b) If there is no subscript number, what number is understood?
2. The chemical formula for strychnine is $C_{21}H_{22}N_2O_{2(s)}$. What is the total number of atoms represented by this formula?

Compound Name	Common Use	Chemical Formula	Number and Name of Elements	Total Number of Atoms
calcium carbonate	chalkboard chalk	$CaCO_{3(s)}$		
sodium phosphate	heavy-duty cleaner	$Na_3PO_{4(s)}$		
magnesium chloride	de-icing roads	$MgCl_{2(s)}$		
monosodium glutamate (MSG)	food seasoning	$NaC_5H_8NO_{4(s)}$		
hydrogen peroxide	bleach and disinfectant	$H_2O_{2(l)}$		
glucose	sugar	$C_6H_{12}O_{6(s)}$		
carbon dioxide	fizz in pop, dry ice	$CO_{2(g)}$		
freon-12	refrigerator coolant	$CCl_2F_{2(g)}$		

Check Your Understanding

Key Terms
element symbol
chemical formula

1. Using a periodic table, complete the chart below.

Element Symbol	Element Name
	sodium
Zn	
Cu	
N	

2. Write the chemical formula for a compound that is made up of one atom of nitrogen and two atoms of oxygen.
3. Suppose you were given a sample of an element. The sample is bright red in colour, dull in appearance, and brittle and crumbly. Is the element a metal or a non-metal? Why?

CHAPTER

2 Review

Key Terms

element	group
periodic table	period
atom	metal
non-metal	decomposition reaction
metalloids	element symbol
compound	chemical formula

Reviewing Key Terms

If you need to review, the section numbers show you where these terms were introduced.

1. In your notebook, match each item in column A with the correct term in column B.

A	B
(a) row	i. group (2.1)
(b) not shiny	ii. chemical formula (2.3)
(c) chemistry puzzle	iii. non-metal (2.1)
(d) conducts heat well	iv. period (2.1)
(e) column	v. element (2.1)
(f) cannot be divided	vi. metal (2.1)
(g) can be broken down into simpler substances	vii. element symbol (2.3)
(h) only works on compounds	viii. metalloid (2.1)
(i) one or two letters	ix. periodic table (2.1)
(j) shorthand for a compound	x. decomposition reaction (2.2)
(k) shares properties with metals and non-metals	xi. compound (2.2)

2. Describe the difference between:
(a) a group and a period (2.1)
(b) an element and a compound (2.2)
(c) a metal and a non-metal (2.1)

3. If an element symbol is used to identify an element, then what is used to identify a compound? (2.3)

4. What information about a substance does a chemical formula represent? (2.3)

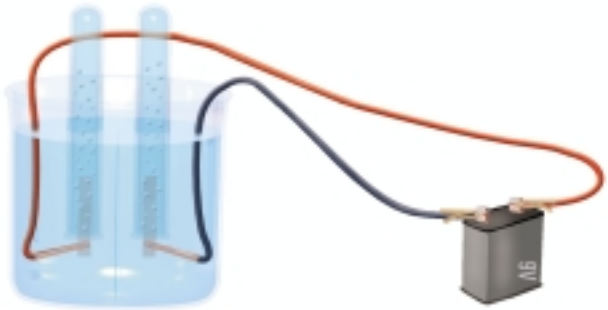
Understanding Key Ideas

Section numbers are provided if you need to review.

5. Copy the following chart into your notebook and fill in the blanks. (2.1)

Element Name	Symbol	Period	Group
cadmium			
	Zr		
		4	1
		1	1
	O		
	Nb	5	

6. Explain the purpose of this apparatus and what it does. (2.2)



7. List two examples of elements and two examples of compounds. (2.2)

Developing Skills

8. Examine the periodic table. (2.1)
(a) How can you tell if an element is a metal or a non-metal?
(b) How do the number of metals compare to the number of non-metals?

9. Many recently discovered elements have been named after famous chemists. Research one of the following chemists. Describe his or her contributions to the discovery of one of the

elements. Share what you learned with the class. (2.3)

- Marie Curie (curium)
- Albert Einstein (einsteinium)
- Dmitri Mendeleev (mendelevium)
- Alfred Nobel (nobelium)
- Ernest Lawrence (lawrencium)
- Neils Bohr (bohrium)

Problem Solving/Applying

10. Which of the following elements and compounds might be used for the products listed below? (2.2)

aluminum, tungsten, mercury, gold, helium, neon, baking soda, steel, nylon, carbon dioxide

(a) high quality electronics
(b) household light bulb
(c) frame for a building
(d) to make a balloon float
(e) fire extinguisher
(f) climbing rope
(g) food and beverage containers

11. Sucrose is a white solid commonly known as sugar. It is made up of carbon, hydrogen, and oxygen in a ratio of 12:22:11. What is the chemical formula for sucrose? (2.3)

12. What properties of aluminum make aluminum foil useful in baking food? (2.1)

13. Copy the following table into your notebook and fill in the blanks. (2.1)

Common Name	Chemical Formula	Number and Name of Elements	Total Number of Atoms
nicotine	$C_{10}H_{18}O_{2(s)}$		
ibuprophen (Advil™)	$C_{13}H_{18}O_{2(s)}$		
caffeine	$C_8H_{10}N_4O_{2(s)}$		
acetominophen (Tylenol™)	$C_8H_9NO_{2(s)}$		
diazepam (Valium™)	$C_{16}H_{13}ClN_2O_{(s)}$		

14. As a customs official, it is your job to keep dangerous substances out of Canada. The labels on a crate you are examining are written in Spanish but contain the following chemical formulas: $NaHCO_{3(s)}$, $CaCO_{3(s)}$, $NaCl_{(s)}$. Do you recommend that the crate be allowed to enter the country? Or should you request more information from the shipping company? Explain. (2.3)

Critical Thinking

15. Why is the modern periodic table one of the foundations of modern chemistry? (2.1)

16. When Dmitri Mendeleev created the periodic table, there were 64 known elements. Most of these first elements were discovered by individual chemists working alone. Why do you think elements discovered in the 1900s were discovered by teams of chemists working together rather than by individuals? (2.1)

Pause & Reflect

1. Go back to the beginning of the chapter and check your answers to the Getting Ready questions on page 22. Were your answers correct? How would you answer those questions now that you have a better understanding of the concepts presented in this chapter?
2. Why is it so important that all of the elements be organized in the periodic table?