As a distinct science, chemistry is fairly young. In fact, some people suggest that chemistry, as it is known and practised today, did not emerge until the late 1700s. This does not mean, however, that people only learned how to use chemicals a few hundred years ago. Since prehistoric times, people have used chemical substances and chemical processes to meet their needs.

**North American Aboriginal Peoples and Chemistry**

For thousands of years, Aboriginal peoples have used the chemical properties of substances and their interactions to make clothing, preserve food, treat illness, build tools, and adorn objects with colour. Figure 1.1 shows just a few examples of the many ways in which chemicals played a role in the lives of early North American Aboriginal peoples.

![Image of Aboriginal peoples using chemicals](image)

Dyes for decorating fabric, wood, and other materials were obtained from local plants. Delphinium plants, for example, produce a blue-green dye. The roots of bloodroot plants produce an orange dye. A modern example of designs created using dyed porcupine quills is shown here.

To tan leather, Aboriginal peoples from various parts of North America used different techniques. For example, some peoples used a mixture of ashes and water to pre-soak the hides. Substances in the ashes helped to break down the tough layer of mucous that coats the hide. Animal brains were applied to the hide, creating soft, water-resistant buckskin, shown here. Substances in the brains, including emulsified fats, penetrated the hide to change its properties. This process is called brain-tanning.

![Image of tanned leather](image)

To treat illnesses and alleviate pain, substances were extracted from local plants. For example, wild ginger was used by many Aboriginal peoples to treat a number of ailments including coughs, colds, and flu. A tea made from the juice of juniper berries, shown here, could be applied to the skin to soothe insect bites.

![Image of tea made from juniper berries](image)

Many Aboriginal peoples who travelled by water melted pine or spruce gum and mixed it with animal fat. They used the resulting sticky resin to build waterproof canoes.

![Image of waterproof canoe](image)

**Figure 1.1** Chemicals, chemical processes, and chemical techniques are involved in each of these examples.
Many ancient techniques and remedies work just as well as modern ones. Some Aboriginal people and others interested in traditional methods still use them today. For example, many people prefer hides that have been tanned using traditional methods. These hides are said to be softer and stronger than hides tanned using mass-production methods. As well, ancient means of healing and herbal medicine have become more popular.

**Safety in the Chemistry Laboratory**

Native medicines were, and still are, gathered, prepared, and administered by people trained to do so safely. Even household substances, such as cleaning products, can be dangerous if handled improperly. Therefore, everyone who works with chemicals must know how to handle them safely and responsibly. Handling chemicals may require the use of protective clothing, as shown in Figure 1.2.

To find out about how to handle a chemical safely, consult its Material Safety Data Sheet (MSDS). An MSDS includes important information about a chemical. This includes physical properties (such as melting point, boiling point, and odour) and chemical hazards. Instructions explain how to handle, store, and dispose of the chemical, as well as the procedure to follow in case of an accident. A sample MSDS is shown in Figure 1.3. In the activity on page 9, you will investigate a chemical and create your own MSDS.

**MATERIAL SAFETY DATA SHEET**

**PRODUCT NAME: CHLORINE**

1. **Chemical Product and Company identification**

   **ABC Gases,**
   Division of
   The ABC Group, Inc.
   313 Oxygen Road
   North Bay, Ontario

   **TELEPHONE NUMBER:** (705) 555-5555
   **24-HOUR EMERGENCY TELEPHONE NUMBER:** (705) 444-4444

   **PRODUCT NAME:** CHLORINE
   **CHEMICAL NAME:** Chlorine
   **COMMON NAMES/SYNONYMS:** Bertholite, Molecular Chlorine
   **TDG (Canada) CLASSIFICATION:** 2.3 (5.1)
   **WHMIS CLASSIFICATION:** A, DIA, D2A, D2B, E, C

   **PREPARED BY:** ABC GASES (705) 555-5555
   **PREPARATION DATE:** 3/1/00
   **REVIEW DATES:** 3/7/01

2. **Composition, Information on Ingredients**

<table>
<thead>
<tr>
<th>INGREDIENT</th>
<th>% VOLUME</th>
<th>PEL-Osha</th>
<th>TLV-ACGIH</th>
<th>LD₅₀ or LD₅₀, Route/Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorine</td>
<td>100.0</td>
<td>1 ppm Ceiling</td>
<td>5.6 ppm TWA</td>
<td>1 ppm STEL</td>
</tr>
</tbody>
</table>

   2. As stated in the ACGIH 1994-95 Threshold Limit Values for Chemical Substances and Physical Agents.

3. **Hazards Identification**

   **EMERGENCY OVERVIEW**
   
   Corrosive and irritating to the eyes, skin and mucous membranes. Inhalation may result in chemical pneumonitis and pulmonary edema. Nonflammmable. Oxidizer, may expedite or accelerate combustion if contacting reducing agents.

**Figure 1.2** Researchers test protective equipment in the Defence Research Development Canada (DRDC) laboratories at Suffield, Alberta.

**Figure 1.3** What safety precautions would you need to take when working with chlorine?
In Canada, managing hazardous materials is covered by WHMIS, the Workplace Hazardous Materials Information System. WHMIS legislation ensures that workers are informed about, and trained to handle, the hazards they may encounter. WHMIS informs workers about the chemicals in three ways.

1. Controlled products must have informative labels, in both English and French, on their containers.
2. Each controlled product must have a Material Safety Data Sheet (MSDS).
3. Workers who handle chemicals must complete an education program provided through their employer.

Examine Figure 1.4 to review WHMIS symbols and their meanings. WHMIS symbols identify eight classes of hazards labelled A, B, C, D1, D2, D3, E, and F. A substance may be associated with more than one hazard. You can learn more about the WHMIS symbols and lab safety at the beginning of your textbook.

**Career CONNECT**

**Pyrotechnician**

Fireworks! Dazzling colour, ear-splitting sound, fantastic bursts, sprays, and explosions of light — all brought to you by chemists known as pyrotechnicians. As the science of fireworks developed, chemists learned that the standard mixture of gunpowder used in fireworks could be processed to produce different effects. It could be compressed into different shapes that would vary the speed of its ignition. A common shape is the marble-sized ball, called a star. For a display, many stars are placed in a container called a shell. A lifting charge in the base of the shell is ignited electronically. When the shell is in position high in the air, a secondary burst ignites the stars.

Pyrotechnicians use their chemical background to mix fireworks. Most fireworks are mixed by hand to avoid the possibility of a stray spark from metal machinery igniting the gunpowder. One dazzling aspect of fireworks is their colour. Not until the nineteenth century did pyrotechnicians figure out how to produce the vibrant colours we see today. By replacing an ingredient in gunpowder with one that raised the temperature of combustion from 1700°C to 2000°C, they made it possible to use a new set of chemicals. They learned that adding compounds with certain metals produced vivid colours. Copper compounds produced blue, strontium compounds produced red, and barium compounds produced green. Today, pyrotechnicians can produce all the colours of the rainbow by carefully selecting the compounds. For sound, other mixtures of chemicals are used to produce “screches,” “whistles,” and “bangs.”

The number one concern of pyrotechnicians is safety. The chemicals they work with are highly explosive and very powerful. In Canada, the Explosives Research Division of Natural Resources Canada offers a course leading to the title of Display Supervisor. Supervisors are allowed to fire shells of different sizes, depending on their level of expertise. Team up with a partner to find out what you can about fireworks safety in Canada. What kinds of rules exist? How often are the rules updated?

Today, professional firework displays are electronically controlled by computers. Music is often an integral part of the displays.
Understanding an MSDS

Certain information must be included on a Material Safety Data Sheet, but there is no set format. In this activity, you will use print and Internet resources to find information you would need to develop a chemical MSDS.

Procedure

1. Design your own form to record the following MSDS information:
   - chemical name
   - chemical formula
   - physical properties (e.g., appearance, odour, melting point, and boiling point)
   - chemical stability and reactivity (e.g., explosiveness, flammability)
   - potential health effects
   - handling and storage
   - disposal

2. Use the Internet Connect on page 11 to learn about the Workplace Hazardous Materials Information System (WHMIS) and Material Safety Data Sheets. Bookmark at least one site that has MSDS information.

3. Your teacher will give you the name and formula of a chemical. Write the formula on your form, as well as the name of the chemical.

4. Most MSDS searches are by chemical name. A search for a specific name often turns up several possibilities, however, depending on how the chemical is sold. For example, sodium hydroxide is sold in solid form as pellets, at different levels of purity, and in various solutions. Look up your chemical in the form specified by your teacher.

5. As you proceed, keep a list of any words that are unfamiliar to you.

6. Record the appropriate information about your chemical on your form. Here are some things to keep in mind:
   - Note any unusual information. (E.g., does the chemical decompose before it boils?)
   - For chemical stability and reactivity, note any dangerous decomposition products. List any warnings about contact with other chemicals.
   - List any potential health hazards, such as exposure to the skin or eyes. Is the chemical poisonous?
   - Is special handling or storage required, other than a cool, dry, ventilated area?
   - What procedures should be followed if there is an accidental leak or spill?

What Did You Find Out?

1. From the MSDS you prepared, create a 1-page safety sheet that could be placed in a storeroom, near containers of your chemical. Use point form and plain English. Include information about dangers, handling, and storage, as well as procedures to be followed in case of an accidental spill.

2. Employers must provide education programs for people who use hazardous chemicals. What additional information would you expect to learn from an education program? Use your list of unfamiliar words to help you answer the question.
Classifying Matter

In previous science courses, you learned to classify matter in a variety of useful ways. Figure 1.5 shows a system that chemists use to classify matter. Answer the Practice Problems that follow to make sure that you understand this system.

Figure 1.5  Try to use this system to classify examples of matter that you see around you right now.

Practice Problems

1. State whether each of the following is a pure substance or a mixture.
   (a) seawater
   (b) iron
   (c) sodium chloride (non-iodized table salt)
   (d) bronze

2. State whether each of the following mixtures is homogeneous or heterogeneous.
   (a) sugar dissolved in water
   (b) oil-and-vinegar salad dressing
   (c) cranberry juice
   (d) steel

3. State whether each of the following pure substances is an element or a compound.
   (a) copper, Cu
   (b) oxygen, O₂
   (c) water, H₂O
   (d) methane, CH₄

4. Classify each of the following substances.
   (a) graphite, C
   (b) clear shampoo
   (c) motor oil
   (d) sodium hydrogen carbonate, NaHCO₃ (baking soda)
Section 1.1 Summary

In this section you learned about the importance of safety for everyone who works with chemical substances and products. It does not matter whether these substances are cleaning solutions, herbal medicines, or fireworks. You are now ready to take a closer look at the structure of matter in the next section.

Check Your Understanding

1. Name three ways in which WHMIS ensures workers have the information they need about the substances they use.

2. What does MSDS stand for? What information would you expect to find on an MSDS?

3. For each of the following WHMIS symbols, what precautions would you take if you were using a product with the symbol on its packaging?
   - (a) flammable and combustible material
   - (b) corrosive material
   - (c) poisonous and infectious material causing other toxic effects

4. Apply Using the Internet, investigate each of the eight WHMIS symbols. Create a table that shows the following for each symbol: two risk factors associated with the class of chemical, and two precautions that you could take to minimize the risk involved.

5. Thinking Critically You can work with dangerous substances safely if you take the appropriate precautions. On the other hand, substances that most people consider harmless may be dangerous under some circumstances. Water, for example, is probably the most familiar substance on Earth, and is necessary to all life. However, water can be fatal by inhalation (drowning). In addition, heating water in an enclosed container can cause an explosion.
   - (a) Name another familiar substance that most people consider harmless.
   - (b) Classify the substance according to Figure 1.5 on page 10.
   - (c) Under which circumstances might this substance be dangerous?
   - (d) How would you avoid these circumstances?