9.0 The everyday use of mixtures and solutions has an impact on society and the environment.

The commercial process of making maple syrup has an impact on society and the environment.

What You Will Learn

In this chapter, you will:

- identify industrial applications of the processes used to separate mixtures or solutions
- assess the impact on society and the environment of different industrial methods of separating mixtures and solutions
- assess positive and negative environmental impacts related to the disposal of pure substances and mixtures

Skills You Will Use

In this chapter, you will:

- investigate processes used for separating different mixtures
- use a variety of forms to communicate with different audiences and for a variety of purposes

Why This Is Important

Industrial methods used to separate and dispose of mixtures and solutions can have dramatic effects on where and how we live and may have lasting environmental effects.

Before Writing

Thinking Literacy

Procedural/Sequential Pattern

Some types of writing give step-by-step instructions (procedural pattern), or present a series of events in order (sequential pattern). Scan this chapter for examples of writing that follow a procedural/sequential pattern. When might you use this pattern in your writing?

Key Terms

- aeration
- herbicide
- insecticide
- landfill
- overburden
- radioactive
- salt pan
- surface mining

9.0 Getting Started

Figure 9.1 The use of pesticides can produce spotless fruits and vegetables, but at a price.

If you walk past your grocery store's fresh produce section, you may see fruits and vegetables that look healthy and delicious, and practically shine with freshness (Figure 9.1). However, some of these products may have been treated with pesticides. **Pesticides** are chemical mixtures used to destroy pests that can harm crops. **Herbicides** are pesticdes that kill competing plants during the planting and growing process. **Insecticides** kill insects and pests that may spoil or damage the appearance of the crops. Even if the use of these chemical mixtures does not affect the immediate quality of the foods you eat, other side effects, such as contamination of rivers, lakes, and ground water, could result from the use and disposal of these chemicals.

Examples of the dangers to the environment of improper disposal of pure substances and mixtures are, unfortunately, too common (Figure 9.2 on the next page). One way to lessen the chance of this happening is to learn more about methods used by industries to dispose of pure substances and mixtures safely.

In this chapter, you will learn about some industrial methods used to separate mixtures. You will learn about the impact of those methods on society and the environment. You will also consider the effects of use and disposal of pure substances and mixtures on the environment. As you read through this chapter, think about your personal use of consumer products and consider how you influence the environment.

Figure 9.2 Industrial seepage from oil processing plants has created algae blooms, which deplete oxygen in the water and suffocate local fish populations. The green areas in this photo are algae.

C32 *Quick Lab*

Sifting for Precious Metals

Commercial mining often involves separating material known as ore (which contains precious metals, such as gold or silver) from rock. You can simulate this process in your classroom.

Purpose

To separate pennies, nickels, and quarters from a mixture of coins, sand, and stones

Materials & Equipment

- several pieces of paper
- sand
- small stones
- scissors
- plate
- various coins

Procedure

1. Obtain scissors, paper, coins, and quantities of sand and stones from your teacher.
2. Use scissors to cut holes in the paper. The holes should be small enough that the coins will not fit through the holes but large enough that the sand and stones will fit through the holes.
3. You may wish to measure the size of each coin to ensure that the size of holes cut in the paper is slightly less than the size of a coin. This may mean that you use more than one piece of paper and that you perform the sifting more than once.
4. Carefully sift the mixture above a plate, allowing the sand and stones to pass through the holes in the paper but not the coins.

Questions

5. How big were the holes you cut in the paper to allow passage of the sand and stone mixture but not the coins?
6. Were you able to complete the sifting process in one try, or were multiple siftings needed to separate each type of coin?
7. Provide some examples to explain how mining companies might improve upon the efficiency of sifting to separate a mixture.

9.1 Industrial Methods of Separating Components of Mixtures

Here is a summary of what you will learn in this section:

- There are different methods of separating components from mixtures.
- There are many industrial applications of the different methods of separating solutions and mechanical mixtures.

Figure 9.3 Many common products are produced from metals separated from rocks mined from the ground.

There are many different types of substances and consumer products manufactured every day that involve industrial methods of separating pure substances and mixtures into different components. Bicycles, computers, and even cellphones are produced from materials that are created by separating metals from rocks mined from the ground (Figure 9.3). Crude petroleum is refined to produce fuels, plastics, and edible oil-based products, such as synthetic whipping cream. Many foods and drinks that you consume every day, from maple syrup to diet cola, are made using processes that involve separating mixtures.

C33 *Starting Point*

Skills A C

Distillation of Antifreeze

Antifreeze helps to protect an automobile's engine from damage. It is used to prevent water in the radiator from freezing or boiling. Table 9.1 shows the boiling points of three components of antifreeze.

1. Work with a partner and use the information in the table to predict what would happen if the antifreeze solution were gradually heated until it began to boil.
2. Antifreeze boils at 188°C. When it starts to evaporate, would the gas (vapour) contain more methanol or more water? Explain your answer.
3. Why might one substance have a higher boiling point than another substance?
   Hint: Use the particle theory of matter to help explain your answers.

Table 9.1 The Boiling Points of Some Common Components of Antifreeze

Substance	Boiling Point (°C)
water	100
methanol	65
ethylene glycol	197

Separation Using Distillation

Fractional distillation is used to separate different substances or fractions that make up crude petroleum oil based on differences in their boiling points (Figure 9.4). Crude petroleum oil in liquid form is pumped through pipes into a furnace where it is heated and changed into gaseous form. The resulting mixture of very hot gases is passed into a fractionation or distillation tower. As the gases rise in the tower away from the heat, the gas mixture cools. Substances with higher boiling points, like paraffin wax, condense and are captured near the bottom of the tower where the temperature is greater. Substances with lower boiling points, like gasoline, remain as gases as they move up the tower until they condense and are captured at higher levels.

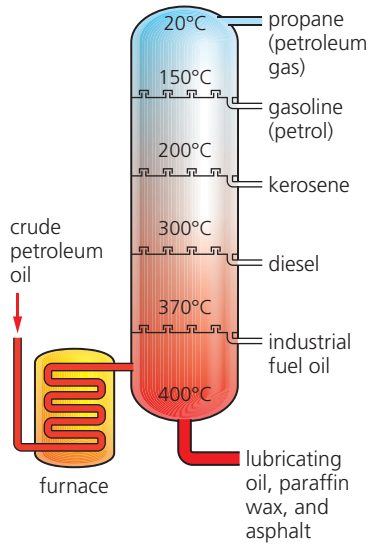


Figure 9.4 Crude petroleum is separated into different parts.

Separation Using Evaporation

Every spring, millions of litres of maple sap are collected in eastern Canada to make maple syrup. The sap is boiled to evaporate most of the water (Figure 9.5). What remains is a sweet mixture of sugar, water, and substances from the tree that give maple syrup its distinctive flavour.

For thousands of years, people living near oceans have used the heat from sunlight to evaporate seawater and obtain salt. Seawater flows into a large, low-lying area called a **salt pan**, which is surrounded by dikes. When the water has evaporated, the remaining solid is about 96 percent salt (sea salt).

Figure 9.5 It takes about 40 L of maple sap to make 1 L of maple syrup.

C34 *Learning Checkpoint*

Fractional Distillation

1. Crude petroleum is a mixture of different substances. Some are liquids and some are solids. Is crude petroleum a solution or a mechanical mixture? Explain your answer.
2. Explain how gasoline, kerosene, and crude petroleum are related.
3. Explain why substances with a lower boiling point are removed near the top of a petroleum fractional distillation tower.

Figure 9.6 This water filter removes particles of dirt and some bacteria.

Figure 9.7 This industrial magnet removes steel and iron from other metals at a metal-recycling plant.

Separation Using Filtering

Water purification uses very fine filters to separate dirt and some bacteria from water. Water filters can be used to improve the taste and purity of tap water (Figure 9.6). Commercial water filters are often used to remove impurities from the water during the production of different food products.

Air filters are often used in building ventilation systems and industrial clean rooms to ensure that the air is free of dust and other substances. Fans force air through microfilters, which have tiny pores that trap dust particles, pollen, and tiny particulate matter.

Separation Using Magnetism

Recyclers of solid waste often use magnets to separate metals (e.g., iron, steel) from other waste products. Figure 9.7 shows that iron and steel are attracted to the magnet and can be removed from non-magnetic substances, such as wood and plastics. Steel and iron recovered by this process can be melted down and remanufactured into other useful products. Bits of iron and steel (e.g., paper clips, staples) can be removed with magnets from waste paper and corrugated board, which can then be reprocessed into recycled paper products.

Separation Using Sifting

Rocks containing metals (ore) are sifted before metal is extracted from ore by melting. This sifting process separates the denser metal-containing rocks from lighter rock material (which has very little metal content) to make it easier to remove the metals from the rocks.

Sifting flour is also an important process in baking. Most flour bought from grocery stores is pre-sifted. Sifting flour breaks up lumps to ensure that the flour can be measured properly. In addition, when flour is sifted, air is added so that when flour is mixed with liquid ingredients (e.g., eggs, water), the dry flour can be fully and evenly moistened, which results in light, fluffy baked goods.

Take It **Further**

Panning for gold is a separation process developed by early prospectors. They needed to separate gold from sand and gravel in streams. To do this, they would shake a pan containing water and a small amount of sand and gravel so the gold would sink to the bottom. Learn more about panning for gold and other mining techniques. Begin your search at ScienceSource.

Using Magnetism to Separate Recycled Metals

Aluminum soft drink cans have a very high value for recycling. Unfortunately, the value of this resource is often reduced because of contamination from metallic cans that contain iron and steel. Recycling centres use large magnets that attract iron and steel to remove the contaminant metals and increase the value of the recycled aluminum. In this activity, you will learn to use a magnet to separate different magnetic and non-magnetic materials.

Purpose

To separate the steel and iron cans in your recycling box from aluminum cans

Materials & Equipment

- clean metal containers for recycling
- permanent magnet (larger is better)

Procedure

1. Make a table in your notebook like the one shown below.

Table 9.2 Magnetic Properties of Cans for Recycling

Type of Container	Attracted to Magnet (Yes or No)
soft drink	

2. Select a number of metal containers (i.e., 4 to 6 different types of cans) from your recycling box.
3. Hold the magnet close to each container.
4. Make a note in the table about whether or not the container is attracted to the magnet.

Questions

5. What types of containers were attracted to the magnet?
6. Why are these types of metals attracted to the magnet?
7. Describe a process that would enable the large-scale separation of metallic cans from aluminum cans.
8. Why do you think it is necessary to separate certain types of metals from other metals before heating them?
   Hint: Think about what happens to a metal's magnetic properties when it is heated.

9.1 CHECK and REFLECT

Key Concept Review

1. Identify two industrial uses of distillation and what components of mixtures are separated in each use.
2. List three commercial products that could have been separated using sifting.
3. List at least three uses of filters to separate components of mixtures.
4. Explain how a magnet could be used to separate different types of metals at a recycling centre.

Connect Your Understanding

5. Use the particle theory of matter to explain why evaporation of seawater can be used to obtain salt.
6. Use the particle theory of matter to explain why air filters used in automobiles and furnaces must be changed regularly.
7. Explain why gasoline and propane are removed near the top of a distillation tower, whereas diesel fuel and industrial fuel oil are removed nearer the bottom of a distillation tower.

Practise Your Skills

8. Devise a procedure to separate a mixture of iron nails, salt crystals, and wood chips from a mixture that also contains copper pennies. Write down your procedure as a set of instructions.

For more questions, go to ScienceSource.

C36 *Thinking about Science, Technology, Society, and the Environment*

Separating Industrial Mixtures

Industries like mining focus on separating metals from rock mixtures. The resulting metals are used in everything from automobiles to airplanes. Most industries use technology to increase efficiency of metal extraction and to minimize costs and environmental impacts.

With a partner, consider some costs and benefits of mining by answering the following questions.

1. How does mining directly benefit you and your school?
2. What are some costs to the economy and environment that result from mining?

9.2 Impact of Industrial Methods of Separating Mixtures and Solutions

Here is a summary of what you will learn in this section:

- Some methods of separating mixtures often have a negative impact on the environment.
- Some methods of separating mixtures, such as filtering, can be positive for the environment.

Many commonly used commercial products, including gasoline and plastics, are produced in refineries. A **refinery** is an industrial plant that purifies crude substances, such as petroleum or sugar. As you learned in the previous section, mixtures such as crude petroleum are separated into different substances at refineries (Figure 9.8). These refineries are often built at a considerable distance from cities and towns. The production process often produces offensive odours and may also create by-products that can contaminate air and ground water. Many industrial separation processes have requirements and consequences that influence where they are located.

Figure 9.8 Oil refineries separate crude petroleum into different substances.

C37 *Starting Point*

Skills A C

Industrial Methods of Separating Pure Substances and Mixtures

Mining, metal extraction, oil refinement, and many other industrial processes separate useful pure substances and mixtures from other mixtures and solutions. Each method or process contributes some benefit to society or the economy. Work with a partner to determine what you already know about these processes and what you would like to learn by answering the questions that follow.

1. Identify two or more industrial processes that operate in your community.
2. What consumer products are produced by each process?
3. What waste products are produced by each process?
4. Where are the industrial plants located with respect to water bodies and houses?

Mining

Surface mining involves removing a large amount of soil and rock on the surface in order to access the valuable material underneath. This surface material is called the **overburden**. Surface mining can result in vast destruction of the environment if steps are not taken to replace the overburden and rehabilitate the disturbed area.

Open pit mining involves the removal of all materials in a large pit. This mining process is used when the material being mined is uniformly scattered in overburden that is also relatively consistent in texture. It can be used to obtain metals located near the surface (Figure 9.9). **Strip mining** involves removal of long strips of overburden in areas where the material being mined is concentrated in veins. It can also be used when the overburden is found on the sides of hills and in valleys, much like the oil that is trapped in the soil of the tar sands in Alberta.

Figure 9.9 This is an open pit mine from which iron ore was extracted.

Coal Mining

Coal is often found in large, flat deposits at or near Earth's surface. Mining can occur at or below the surface. In the Appalachian Mountains of the eastern United States, coal is found in layers beneath the tops of mountains. A method of mining called mountaintop removal has been adopted by coal mining companies and has had a large influence on this environment (Figure 9.10).

Figure 9.10 This type of coal mining is called mountaintop removal.

The **mountaintop removal** process starts with clearcutting and removal of the mountaintop forest, as none of the vegetation can survive this coal extraction process. Next, all soil on top of the mountain is removed and set aside for possible reclamation. Explosives are used to blast away the land and rock above the coal. This overburden is then pushed into a nearby valley to fill the hollow. Large trucks or draglines are used to transport coal to washing and processing plants.

During this process, millions of litres of waste water are stored in nearby pools created by the construction of earthen dams. After the coal is removed, the stored topsoil may be deposited on the exposed surface, and steps can be taken to replant trees to ensure revegetation.

Thinking Literacy

Elements of Procedural/Sequential Writing

Writers sometimes use the procedural/sequential pattern when describing information in paragraphs. Reread the information on the mountaintop removal process in the last two paragraphs on the previous page. What signal words did the author use that tell you this is an example of procedural/sequential writing? Can you think of other signal words a writer using this pattern might use?

How could you visually display the steps in the mountaintop removal process? Develop a graphic organizer to do this. Think about how you will organize the boxes and the kind of lines you will use to connect the boxes. Share your ideas with a partner.

Extracting Metals from Ore

Most metals found in Earth's crust are combined with other substances and must be separated by chemical means. For example, gold is extracted from ore by combining it with cyanide, which makes the gold able to dissolve in water. Cyanide is a very toxic chemical. However, cyanide loses its toxicity when exposed to sunlight.

As a result, many gold extraction plants have **tailing ponds** (Figure 9.11). These are large pools where the cyanide compounds (mixed in with crushed rock) break down in sunlight. However, during periods of heavy snow, rain, or floods, the ponds may overflow. Harmful chemicals can escape these ponds and enter ground water, which may lead to environmental damage.

Figure 9.11 Refining gold involves cyanide, which can poison aquatic habitats.

Refining Oil

When oil is refined, very large amounts of gases are released into the atmosphere, along with a noticeable smell. As a result, refineries are usually located far from populated areas. Waste gases produced by the refining process, such as methane or natural gas, are released and sometimes set aflame in a process known as **gas flaring** (Figure 9.12). Waste methane is a significant greenhouse gas. It has 25 times the ability to trap heat in the atmosphere that carbon dioxide has. Some refineries have attempted to recapture and recycle this gas for use as fuel.

Figure 9.12 Waste gases are burned off during "flaring."

Figure 9.13 Large amounts of fuel are consumed to evaporate water to produce maple syrup.

Evaporation and the Environment

Nearly every industrial separation process that relies on evaporation (such as the production of certain fuels, distilled spirits, and many types of plastics) uses heat from fuel combustion to speed up the process. For example, to produce 1 L of maple syrup, 40 L of water must be separated by evaporation (Figure 9.13). This may involve burning of fuel wood from maple trees or some other fuel. This process produces a considerable amount of carbon dioxide, which can have a negative impact on the environment.

Figure 9.14 Water filters are used to purify drinking water.

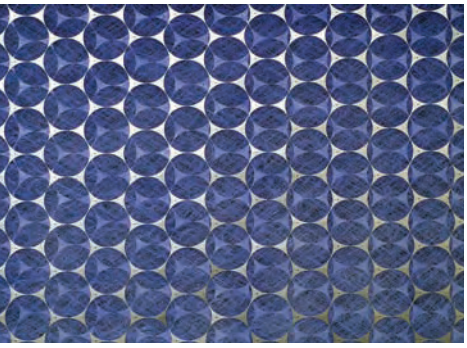


Figure 9.15 Filters in your furnace can remove dust and pollen from the air.

Filters and the Environment

Some methods of separating mixtures can have a positive impact on the environment. Filtering is an example of a separation method with positive consequences. Air and water filters are the two most common types of filters.

Filtering Liquids

Waste water treatment involves the use of filters that separate impurities from water. This process helps to make it possible for municipalities to provide large amounts of pure treated water for domestic use. Where treated water is not available or when you want the additional assurance of purity, water filters can be used to obtain pure water for home use (Figure 9.14). In this case, an industrial process of separating mixtures (water filtration) has a positive impact on society and the environment.

Filtering Air

Many people suffer from asthma or allergies that are made worse by breathing air contaminated with dust, pollen, and other matter produced by combustion of fuels. Smog can make it impossible for some people to leave their house. Filters can greatly improve the quality of air both inside and outside the home, making it healthier for people to breathe. For example, air filters are used in furnaces and air purification devices to help clean the air inside the home (Figure 9.15). This is another industrial process (air filtration) that has a positive impact on society and the environment.

Take It Further

An automobile air filter allows the engine to "breathe." Find out how the air filter works. Begin your search at ScienceSource.

Benefits of an Air Filter on Indoor Air Quality

Air filters are beneficial to the environment, as they can improve the air quality in the surrounding area. They are used to separate impurities, such as dust, pollen, and by-products of combustion, from the air you breathe. Like most filtering processes, larger particles are blocked by the filter while smaller particles are allowed to pass through tiny openings in the filter.

Purpose

To demonstrate the benefits of an air filter on indoor air quality

Materials & Equipment

- 2 plastic drinking straws
- facial tissue
- cellulose tape
- eraser
- cheesecloth (optional)

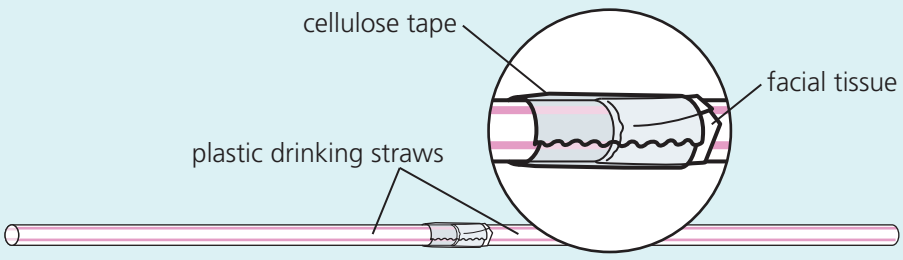
Procedure

1. Cut a small piece of facial tissue. The piece should be just large enough to cover the end of a straw.
2. Place the tissue between the ends of two straws. Tape the two straws together, end to end, with the tissue between the straws.
3. Breathe in through the straws to test if air passes through the tissue filter and the straw-and-tissue apparatus. Adjust the tissue filter and straws to allow the passage of air.
4. Use the eraser to make rubber crumbs by rubbing the eraser on your desk or a sheet of paper.
5. Attempt to suck up the rubber crumbs by drawing air through the straw-and-tissue apparatus. Be careful not to inhale the rubber crumbs.
6. After several attempts, remove the tissue filter from its location between the two straws. Examine the tissue for evidence of trapped particles.
7. (Optional) Repeat steps 1 to 6 using cheesecloth instead of tissue.

Questions

With a classmate or as a whole class, discuss the following questions.

8. Why was air able to pass through the straw-and-tissue apparatus?
9. Why were other particles not able to pass through the tissue?
10. What modifications could you make to the straw-and-tissue apparatus to make this more effective for use with smaller particles?
11. What did this experiment tell you about the effectiveness of air filters in improving indoor air quality?



SKILLS YOU WILL USE
- Asking questions
- Recording and organizing data

Removing Carbon Dioxide from Air

When you breathe, you take in air, which is a mixture of gases. Limewater is a solution of the solid chemical calcium hydroxide in distilled water. It can be used to detect carbon dioxide.

Materials & Equipment

- 50 mL limewater solution
- 100-mL beaker or jar
- plastic drinking straw
- dark piece of paper

CAUTION: Do not eat or drink anything during this activity.

Question

How can carbon dioxide be removed from air?

Procedure

1. Obtain 50 mL of limewater solution from your teacher and place it in a 100-mL beaker.
2. Observe the colour and clarity of the limewater solution and make note of it in your notebook.
3. Place the limewater solution on top of a dark piece of paper.
4. Blow air through a straw to make bubbles in the limewater solution. Observe and make note of any changes that you observe.
5. Wash your hands thoroughly after completing this investigation.

Analyzing and Interpreting

6. Describe the changes that occurred in the limewater as you bubbled your breath through it.
7. What substances are present in the air that you exhale?
8. How do you know that something in the air that you exhaled through the straw was responsible for changing the appearance of the limewater solution?
9. Suggest a way to modify the experiment to decide whether breathing adds carbon dioxide to air or carbon dioxide is already present in the air before you breathe it.

Skill Builder

10. How could you organize the observations that you made during this activity to present your findings clearly?

Forming Conclusions

11. What is the answer to the question at the beginning of this activity?
12. What normally happens to the carbon dioxide that you exhale?

9.2 CHECK and REFLECT

Key Concept Review

1. (a) Distinguish between the terms "open pit mining" and "strip mining."

(b) Why are open pit mining and strip mining both considered to be surface mining?

2. Oil refining separates crude petroleum into different pure substances and mixtures by the method of fractional distillation.

(a) List two ways in which oil refining benefits society and the environment.

(b) List two ways in which oil refining negatively affects society and the environment.

(c) List two strategies followed by oil refineries that minimize their harmful influence on society and the environment.

Connect Your Understanding

3. Filtering technologies involve the use of something that blocks some particles, but leaves most particles able to pass through the filter. List three ways in which filters affect you or one of your family members.

Practise Your Skills

4. Air purifiers, like the one shown below, dramatically reduce the concentration of indoor pollutants. Draw a simple diagram of an air purifier to show how it might work. Be sure to include the following labels: unfiltered air, filtered air, filter, and fan.

For more questions, go to ScienceSource.

C41 *Thinking about Science, Technology, Society, and the Environment*

Air Purifiers

Many people heat their home with forced-air furnaces that come equipped with air filters to trap dust, pollen, and other air-borne pollutants. However, many homes are heated by other means. For example, other heating solutions include use of wood stoves, electric space heaters, or hot water radiators, none of which come with air filters. Should people using this heating technology be required to use air purifiers? With a partner, decide whether or not you would support some type of law or by-law requiring air purification technology in every home. Be prepared to report your thinking to the class.

9.3 Effects of Use and Disposal of Pure Substances and Mixtures on the Environment

Here is a summary of what you will learn in this section:

- Careless use and disposal of pesticides has a harmful effect on the environment.
- The release of raw sewage has a negative effect on waterways.
- Disposal of industrial substances and mixtures, as well as by-products of industrial processes, has a negative impact on the environment.

The headlines screamed, "Raw sewage streams into Toronto creeks." Of course, everyone was concerned and wondered how this could happen. Raw sewage can make people sick and it can also damage the environment. Upon further investigation, it was revealed that cities across Canada treat their sewage differently. Partially treated sewage is regularly discharged into the waterways around many large urban centres in Canada.

C42 *Starting Point*

Skills A C

Dilution versus Pollution

Many pure substances and mixtures have very little impact when they occur at very low levels. For example, chlorine can be diluted to allow people to swim safely in a pool. However, other substances retain the ability to harm even in very small concentrations.

Starting with blue food colouring that is 87 percent blue dye by volume, do the following:

- Add 1 mL of blue food colouring to 99 mL of tap water (Figure 9.16).
- Collect 1 mL of the resulting solution and add it to another 99 mL of tap water.
- Repeat the process until you can no longer see the blue colour.

Consider This

1. After how many dilutions can you no longer see the blue colour?
2. Some substances are toxic at levels of less than one part per million. If the blue dye were toxic, do you think dilution with water would be an effective treatment method?

Figure 9.16 The blue food colouring represents a toxic substance.

Sewage and Waste Water Treatment

Sewage is the liquid waste water from toilets, baths, showers, and sinks. The water may also contain run-off from roofs, urban green spaces, and roadways, and liquid waste from industries. It is treated at a waste water treatment plant, and the treated water is eventually returned to the environment. Figure 9.17 illustrates that waste water treatment usually involves a three-stage process that includes mechanical, biological, and chemical treatments.

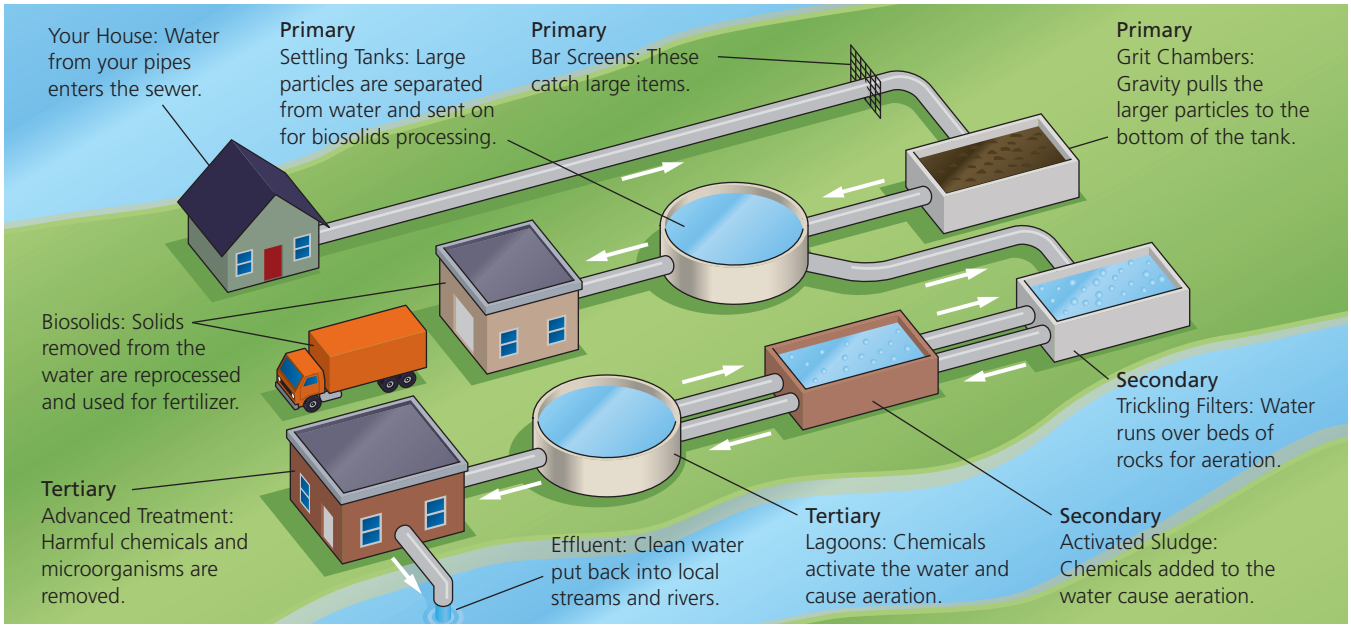


Figure 9.17 Waste water usually goes through three levels of treatment: mechanical, biological, and chemical.

Primary, Secondary, and Tertiary Treatment

Water flowing into the treatment plant is full of solids that must be removed before further processing. **Primary treatment** involves separation of a mechanical mixture, including removal of suspended solids, rocks, sand, and grit. It allows heavy matter in the mixture to settle to the bottom of a sedimentation tank before moving on to secondary treatment. The solid matter that settles at the bottom of the tank is called **sludge**.

Secondary treatment is a biological process involving **aeration**, which mixes waste water and sludge with large volumes of air. Living organisms, such as bacteria and protozoa, help to break apart larger clumps. This finer material then drops to the bottom of retention tanks and is removed.

Suggested Activity
C44 Decision-Making Analysis on page 260

Tertiary treatment involves application of chemicals, such as chlorine, to disinfect and kill remaining germs, and to remove phosphates. Other treatments include exposure to high-intensity ultraviolet (UV) light and treatment with ozone gas, which also kill germs.

Any sludge remaining at the end of the process must be disposed of. This can involve bacterial action, burial, or incineration (burning).

Environmental Impact

In Canada, completely treated waste water is usually safe to return to the environment. However, during periods of heavy use or very rainy weather, water treatment plants become overwhelmed and waste water is not retained long enough to ensure purity. This commonly leads to the release of contaminated water. Recent upgrades to waste water treatment plants in Ontario have greatly increased the capacity to store and treat waste water effectively.

Pesticides

As you learned at the beginning of this chapter, farmers use pesticides, such as insecticides and herbicides, to protect their crops. Home-owners often use insecticides to maintain their lawns and gardens. Farmers use herbicides to control weeds to enable the maximum growth of crops (Figure 9.18). However, the widespread use of pesticides has had a significant impact on the environment.

Figure 9.18 Insecticides and herbicides are used to control harmful pests and weeds.

Residues

According to environmental studies, almost every lake, river, and stream in the more populated areas of North America contains varying levels of pesticide **residues**. These are chemicals that come from pesticides.

Residue levels are very low in some areas, but in waterways that flow into the Great Lakes, the level of pesticide contamination is significant. The Ontario Ministry of the Environment recommends that, "Women of childbearing age and children under 15 should restrict their consumption of most sport fish caught in Ontario waters and some freshwater fish should not be consumed at all."

It is difficult to prevent pesticides from entering our water supply. Figure 9.19 shows ways that pesticides can move into water supplies. For example, some chemicals are introduced through **percolation** where they seep into the ground and later enter a water supply. As the liquid chemicals move through the ground, leaching may occur. **Leaching** is a process in which soluble parts of a substance are separated out. Another example is pesticide drift. When pesticides are sprayed over an area, the wind can carry the chemical particles out over water. When they settle in the water, they may build up in harmful concentrations that can damage the environment for years.

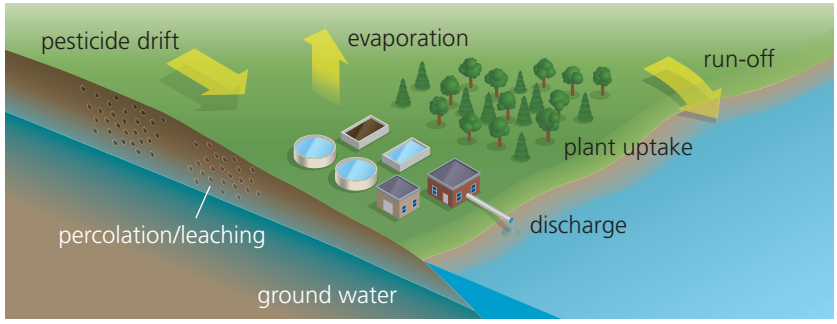


Figure 9.19 Pesticides and their residues can enter waterways in different ways.

Environmental Impact

The effects of pesticide use have been noted in farmers, in the environment, and in residues found in foods. Farmers have reported headaches, dizziness, and vomiting as a result of using pesticides that are considered safe. Long-term health problems include respiratory and digestive problems, memory disorders, and skin and eye problems.

Environmental contamination from pesticides has led to fewer kinds of living things in soil and waterways. This means that plants and animals that were native to an area are now either completely gone or greatly reduced in numbers. Also, many fruits (e.g., apples, oranges) and vegetables (e.g., lettuce, spinach) may contain pesticide residues or have residues present on their surfaces.

C43 *During Writing*

Thinking Literacy

Using a Procedural/Sequential Pattern

List, in sequential order, all the pure substances and mixtures you have used since you woke up this morning. Much of what we use in a day produces some form of waste product, such as paper waste or water waste. Re-examine your list and think about ways you could reduce the amount of waste you produce. Use your ideas to write a procedural paragraph outlining an action plan that could reduce the waste products created at your school. Remember to include signal words appropriate to this type of writing.

Figure 9.20 Burlington Bay is one of the main locations for steel production in Canada.

Figure 9.21 Industrial processes sometimes result in chemicals being released into the air.

Figure 9.22 Household solid waste is buried under soil and stored in landfills.

Disposal of Pure Substances and Mixtures

Burlington Bay, located in the extreme west of Lake Ontario, is an example of the influence of industry on the landscape (Figure 9.20). The water, air, and environment have been polluted by steel manufacturers for years. An unknown amount of industrial waste material has been released into the environment by the steel industry since it began in Hamilton nearly 100 years ago. The amount of waste is surely very large, but we are still just learning about its effect on the environment and human health.

Sudbury is another example of an area damaged by the disposal of industrial waste mixtures. Much of the land has been damaged by acid rain, which is caused by sulphur released into the air (Figure 9.21). In addition, a by-product of nickel and copper smelting is **slag** (a mixture of waste rock), which was discarded over a large area of land in the greater Sudbury area. This damaged the natural environment.

Landfills

Household solid waste, including garbage and waste from lawns and gardens, is usually disposed of in large landfills (Figure 9.22). A **landfill** is an area where garbage is disposed of and buried under layers of soil. Many items pose no hazard with this type of storage. However, many hazardous liquids are not suitable for landfill and must be treated in another manner. For example, some oil-based paints contain lead, which is a very toxic pure substance. Latex paint does not contain lead and is safe for disposal in a regular landfill.

Hazardous chemicals must be stored in special sites for the disposal of hazardous wastes. Examples include mercury, a pure substance found in fluorescent light bulbs, and cadmium, a pure substance found in rechargeable batteries. Disposal sites for hazardous wastes are specially constructed to contain dangerous solid and liquid substances. These sites are sealed to prevent the movement of ground water, which could carry harmful liquids into wells and other drinking water sources.

Nuclear Energy and Uranium

Figure 9.23 Nuclear power plants generate electricity using uranium as fuel.

Uranium is the fuel source most commonly used in generating electricity from nuclear power (Figure 9.23). The uranium is not burned like fossil fuels, so there is no release of air pollution or carbon dioxide. Instead, energy is released in a controlled nuclear reaction. However, the use of uranium as a fuel source for nuclear power has some significant social and environmental implications.

Uranium is not uncommon in Earth's crust. In fact, it can be found in small amounts in most rocks, dirt, and in the oceans. However, to be used as a fuel source, uranium must be concentrated and purified. Uranium is radioactive. A **radioactive** substance releases energy in the form of radiation. This radiation can be harmful. Uranium fuel must be produced carefully to avoid harming workers and the environment.

Storage and Disposal

Typically, the uranium used as a fuel source can last for a period of about six years. The spent fuel must be stored temporarily in a large pool of water, where it cools and loses some of its radioactivity. After about five years in a spent fuel pool, the uranium is cool and stable enough for transportation to a reprocessing site. About 95 percent of the uranium can be reprocessed and used again as fuel. Unfortunately, the remaining 5 percent remains dangerously radioactive and must be prepared carefully for long-term storage.

Waste uranium material from nuclear power generation remains dangerously radioactive for a very long time. Some estimates suggest that spent nuclear fuel will pose a hazard for at least 10 000 years. Given that an average nuclear power plant produces up to 30 tonnes of waste fuel per year, the safe disposal of nuclear fuel is a very large problem. Some radiation and environmental experts recommend storage of spent nuclear fuel in deep underground deposits that can be monitored for leakage. The actual uranium fuel would first be sealed in dry storage casks made of steel and further encased in concrete containers, which would be moved to a final storage location, possibly kilometres underground.

Take It Further

Canadian technology is behind a type of nuclear reactor used in Ontario. CANDU stands for **CAN**ada **D**euterium **U**ranium. This type of nuclear reactor has a very impressive safety record. Learn more about CANDU reactors. Begin your search at ScienceSource.

C44 Decision-Making Analysis

Toolkit 4

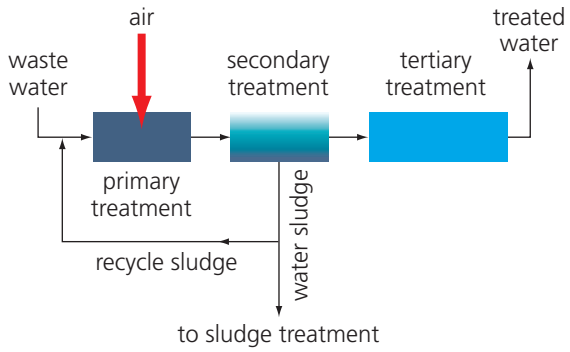
SKILLS YOU WILL USE
- Gathering information
- Organizing information

Community Treatment of Waste Water

Issue

How is waste water treated in your community?

Background Information



Municipalities across Ontario have established locations to treat waste water. Find out where your local waste water treatment plant is located and how it operates. In this activity, you will have a chance to learn more about waste water and its treatment in your community.

Before Field Trip

1. Find out the current population of your community.
2. Bring with you the materials requested by your teacher.

After Field Trip

3. Determine the volume of water treated daily at your local waste water treatment facility.
4. Calculate the per capita volume of water treated (the total amount of waste water treated divided by the population of the municipality).
5. Drawing on what you learned at the waste water treatment plant, list two or three problems that complicate the process of waste water treatment.

Analyze and Evaluate

6. What are some ways that people could reduce the amount of water that they discharge from their homes?
7. Explain how severe storm activity can affect the capacity of a waste water treatment facility.
8. List three ways to reduce the amount of water consumed and the amount of waste water produced at your school.
9. Use information collected during your field trip to answer the following questions. Be prepared to present your information to the class in a form determined by your teacher.
   (a) Explain how waste water is treated in your community.
   (b) Identify the major source or sources of raw water, the volume of water treated, and the average time required for water to pass through the water treatment facility.
   (c) Identify the major physical components and chemicals used in primary, secondary, and tertiary treatments of waste water.

SKILLS YOU WILL USE
- Gathering information
- Determining bias

Dealing with Dangerous Disposal Practices

Issue

How can you determine whether or not a mixture of cellulose is hazardous waste or a soil conditioner that can benefit agriculture?

Background Information

A by-product of paper production is a **slurry**, or mixture of cellulose, chemicals, heavy metals, and other unknown solutions. Paper manufacturers must be able to dispose of this mixture safely. Otherwise, it could be hazardous for the soil and the environment. Some environmental experts claim that the slurry is good for soils if it is applied under certain conditions in a limited amount.

Analyze and Evaluate

1. Use information from the Internet to learn about other uses of waste cellulose.
2. Identify alternatives to spreading cellulose on agricultural fields.
3. Try to determine the exact contents of the waste cellulose mixture.
4. Determine the potential benefits of spreading cellulose or other waste paper on agricultural fields.
5. Use the information you have developed to make a plan for the safe use and disposal of waste cellulose.
6. Prepare a list of precautions that must be exercised to ensure the safe and proper working of your plan.
7. Could you make an informed decision about safe disposal practices based on the information you collected? If so, how did you know your information was true and complete? If not, what steps could you take to ensure that the information you obtain is complete and reliable?
8. Share the results of your inquiry with the class as directed by your teacher.

9.3 CHECK and REFLECT

Key Concept Review

1. What is a pesticide, and why would a farmer want to use pesticides?
2. Identify and explain three ways in which pesticides find their way into waterways.
3. Explain the difference between primary and secondary treatment of waste water.
4. Identify two chemicals added to treated waste water to kill germs and disinfect.
5. Explain why emissions from an industrial smokestack are mixtures and not solutions.

Connect Your Understanding

6. Use the particle theory of matter to explain how sedimentation tanks help to remove solid wastes in the treatment of waste water.
7. Identify at least two ways in which heavy rain can affect the efficiency of waste water treatment facilities.
8. Use the particle theory of matter to explain the connection between air pollution and the disposal of industrial wastes.

Practise Your Skills

9. Suppose you represent a citizens group in a community where a mining company has applied to build a refinery that will have a large smokestack. Write a list of questions that you can present to the company to find out whether the refinery will damage the environment.

For more questions, go to ScienceSource.

C46 *Thinking about Science, Technology, Society, and the Environment*

The Cost of Generating Electricity

In 2007, the government of Ontario pledged to shut down all coal-fired electricity generating stations by 2014. They were concerned about pollutants, such as mercury, entering the environment and large amounts of carbon dioxide contributing to climate change. Critics suggested upgrading the plants to remove pollutants from the exhaust. Supporters wanted a switch to non-polluting power sources. Both options are expensive. What do you think is the best approach? Discuss your opinion with a partner and be prepared to share it with the class.

DAILY PLANET

Making Connections

Jay Ingram

Jay Ingram is an experienced science journalist and is the host of *Daily Planet* on Discovery Channel Canada.

The Brazil Nut Effect

The next time you open a can of mixed nuts, take a careful look before you start munching. Which ones are sitting on top? The big ones! But the big ones are heavier, and gravity should have pulled them to the bottom. You are looking at a strange phenomenon called The Brazil Nut Effect.

Amidst all the peanuts, cashews, and walnuts, the Brazil nuts are the biggest and the most impressive demonstration of this gravity-defying effect. How do they get to the top? Believe it or not, physicists have been trying to figure this out since the 1930s.

First of all, the container has likely been shaken a lot from the time it was sealed in the factory until you opened it. That is the key to the effect. As a result, smaller nuts (or pieces of nuts) are jostled, slip down, and fill in the tiny spaces under the big ones, and with time, the big ones end up on top. But that's not the whole answer.

That shaking also triggers a flow inside the container, with nuts moving in a slow stream up the middle, across the top, and down the sides. Small nuts just keep going around and around like that, but big ones get stuck at the sides of the can. They were able to push smaller nuts out of the way on their way up, but they can't squeeze them aside on the way down — the downward stream is just too thin. So they stay on top.

And even that isn't the whole story. Scientists at the University of Chicago have discovered the weirdest thing: the density of the nut is crucial. If you have three large nuts, all the same size but different weights, the lightest and heaviest move up the fastest; the one in the middle is slowest. Even stranger is their discovery that the air in the can must be responsible for that: if the can is put in a vacuum, these nuts of different densities all move at the same speed. They aren't yet able to explain all this.

Try a Brazil Nut Experiment yourself: open a can, take out all the nuts, mix them up, put them back in, and shake the can. I bet you'll see the big ones on top. But imagine: scientists aren't really sure exactly why that happens.

9.0 Chapter Review

Assess Your Learning

Key Concept Review

1. In the manufacture of maple syrup, what substance is separated from the mixture? What is left behind in the mixture? (k)
2. List five methods of industrial separation of mixtures. (k)
3. (a) Which of the following products has the lowest boiling point: kerosene, propane, or gasoline? (k)
   (b) How does boiling point affect the location at which a substance is removed during the process of fractional distillation? (k)
4. List the methods of separation used in water purification. (k)
5. Filters are used to separate components of mixtures. Identify examples of filters, the substances separated, and the mixtures from which they are separated in the following items. (k)
   (a) car
   (b) furnace
   (c) kitchen tap

Connect Your Understanding

6. In some communities, the quality of water may not always be the same. Especially in times of heavy rain, surface run-off may cause bits of soil and bacteria to enter a community's water supply. What advice would you give these communities about treatment methods for drinking water? (t)
7. Evaporation is used commonly in tropical regions to collect salt from seawater. Why is this process not used extensively in North America? (a)

After Reading — Thinking Literacy

Reflect and Evaluate

Reflect on the processes involved in writing a procedural paragraph. When would a writer choose to use this organizational pattern? What special features do writers include when they write in this way? Are there other words you have encountered in your own reading and life that mean the same thing as "procedure"? How does the ability to recognize procedural writing help you as a reader? Write a summary of 35 words or less describing procedural writing.

ACHIEVEMENT CHART CATEGORIES
(k) Knowledge and understanding (t) Thinking and investigation (c) Communication (a) Application

Practise Your Skills

8. Hydrogen peroxide solution is a cleanser that can be applied directly to skin to help kill bacteria that cause acne. To be safe, the solutions must be no more than 3% hydrogen peroxide in water, although it can be less concentrated. Which of the following solutions of hydrogen peroxide are safe for application to skin?

(a) 6 g in 200 mL

(b) 5 g in 100 mL

(c) 20 g in 200 mL

(d) 3 g in 50 mL

Unit Task Link

In your unit task, you will investigate water samples taken from a number of sources. You have just examined some consequences of industrial methods of separating mixtures and disposing of mixtures and pure substances. As you continue to work on your unit task, consider how local industrial and commercial processes might affect water quality near you.

C47 Thinking about Science, Technology, Society, and the Environment

Bottled Water

Many school boards in Ontario have discouraged the use, and some have banned the sale, of bottled water in schools and school board buildings.

There are many reasons for this decision. First, the amount of oil needed to produce the plastic mixture necessary to manufacture the bottles is considered an unnecessary and wasteful use of resources. Second, a great deal of waste is generated when empty plastic bottles are later disposed of. Some sources suggest that up to 90 percent of plastic water bottles eventually end up in landfills. Third, there is concern about who owns the water that is eventually put in bottles, and the price that bottling companies pay for the water, and whether or not that price is fair. Others say that the quality of water in bottled water, which may be treated by filtering alone, is no better, and possibly worse, than regular tap water.

Work with a partner to make a list of the benefits that can be obtained from the use of bottled water. Include in the list examples from your own experience that support your opinion. Make another list of the costs associated with the use of bottled water. These costs should include examples from your own experience and also opinions that you may hold.

Use these lists to help as you discuss the following questions. Be prepared to discuss your findings with your class.

1. Do you think your school or school board should ban the sale of bottled water?

2. If so, what alternatives are possible to provide clean, fresh drinking water for students and school staff?

3. If not, what steps can you take to address the previously mentioned concerns?

UNIT C Summary

7.0 The particle theory of matter can be used to explain pure substances and mixtures.

KEY CONCEPTS

- A mixture can be classified as either a solution or a mechanical mixture.
- There are six points of the particle theory of matter (e.g., all matter is made of particles, there are spaces between particles).

CHAPTER SUMMARY

- Everything that we see is made up of matter.
- Matter can be classifed as a pure substance or a mixture.
- Mixtures can be classified as solutions or mechanical mixtures.
- The particle theory of matter describes the characteristics of matter.

8.0 Mixtures and solutions can be analyzed through concentration, solubility, and separation.

KEY CONCEPTS

- Solutions consist of solutes and solvents.
- Solutions can be dilute or concentrated, and saturated, unsaturated, or supersaturated.
- The concentration of a solution is the amount of solute dissolved in a specific amount of solvent.

CHAPTER SUMMARY

- The concentration of a solution can be described in qualitative and quantitative terms.
- Solutes and solvents can be identified in various kinds of solutions.
- Solubility is affected by temperature, type of solute, and type of solvent.
- Rate of dissolving in a particular solution is affected by temperature, particle size, and stirring.
- Solutions and mechanical mixtures are separated in different ways.
- Water is sometimes known as the universal solvent.

9.0 The everyday use of mixtures and solutions has an impact on society and the environment.

KEY CONCEPTS

- Commercial products consisting of solutions and mechanical mixtures can be separated in different ways.
- The improper use and disposal of pure substances and mixtures can have a harmful effect on society and the environment.

CHAPTER SUMMARY

- There are many industrial applications of the methods used to separate components from mechanical mixtures and solutions.
- Many industrial methods of separating mixtures have a negative impact on the environment.
- Some methods of separating mixtures, such as filtering, can be positive for the environment.
- Improper disposal of industrial substances and mixtures, as well as by-products of industrial processes, has a negative impact on society and the environment.

UNIT C Task

"Clearly" You Can Drink This Water

Getting Started

It was not that long ago that people could safely drink water directly from springs, streams, and creeks. Today, we would not think about doing this! Pollution, in many forms, has entered nearly all surface water bodies.

In this unit, you have developed many skills of investigation that are used to maintain supplies of clean water. These skills include differentiating between pure substances and mixtures as well as techniques to separate them. Most consumer goods are made from pure substances and mixtures. When the goods are no longer needed, there is a risk that the components will find their way back into our environment if they are not recovered properly.

These streams may look safe to drink from, but one is definitely not.

Your Goal

You will investigate water samples taken from a number of surface water sources. In each case, you will use your skills of observation and investigation to purify the water as thoroughly as possible. As well, you will match the recovered components of the sample to a "creek profile" that will allow you to determine the source of each of the samples.

What You Need

- equipment that was used throughout this unit for separating mixtures
- water samples from each of the creeks
- profile cards for each of the creeks

Steps to Sucess

1. As a class, review techniques for separating pure substances and mixtures.
2. As a group, review the properties of solutions and mechanical mixtures.
3. Create an observations table that will allow you to record your results.
4. With each of the water samples, separate all of the impurities that form the mixture with the water. Set them aside for identification.
5. Using what you have learned about the particle theory of matter, make a hypothesis as to the identity of the impurities.
6. When your analysis is complete, match it to a "profile card" that identifies the creek from which the sample was taken.

How Did It Go?

7. How pure were you able to make the samples? What was the final test that you used before deciding that you were finished?
8. Was there any equipment or materials that you know would have improved your investigation?
9. Were you able to determine which creeks your samples came from?
10. Create a brief report of the requirements for water treatment before water reaches your tap.

UNIT C Review

Key Terms Review

1. Create a mind map that illustrates your understanding of the following terms. (k)

- aeration
- concentrated
- distillation
- evaporation
- filtration
- heat
- herbicide
- insecticide
- kinetic energy
- landfill
- mechanical mixture
- mixture
- overburden
- particle
- pure substance
- radioactive
- salt pan
- saturated
- solubility
- solute
- solution
- solvent
- surface mining
- temperature

Key Concept Review

7.0

2. Explain the difference between a mechanical mixture and a solution. (a)

3. List all six points of the particle theory of matter. (k)

4. If all matter is made up of particles, what is between them? (k)

5. How does heat affect the speed of particles and distance between particles? (k)

6. How does an increase in temperature account for the fact that substances change state? (a)

7. Use the particle theory of matter to explain the difference between a pure substance and a mixture. (k)

8. Explain how heat is involved in the sublimation of carbon dioxide (dry ice) when it changes from a solid to a gas. (k)

9. Describe the changes in the state of matter when you light a wax candle on a birthday cake and later blow it out. (k)

10. People are composed of at least 70 percent water. Explain why people can be described as mechanical mixtures. (t)

8.0

11. Use the terms "solute" and "solvent" to explain the difference between a dilute and a concentrated solution. (k)

12. Use the particle theory of matter to explain the difference between a saturated and an unsaturated solution. (k)

13. Explain why solute particles must be attracted to solvent particles to enable formation of a solution. (k)

14. Does water dissolve all solutes? Explain your answer using examples. (k)

15. Steel is an alloy made up of iron and carbon. Explain why iron is considered the solvent and carbon is the solute. (a)

16. Use the particle theory of matter to explain why stirring speeds up dissolving. (k)

17. Use the particle theory of matter to explain why latex paint dissolves in water. (a)

ACHIEVEMENT CHART CATEGORIES
(k) Knowledge and understanding (t) Thinking and investigation (c) Communication (a) Application

9.0

18. Describe a method to separate aluminum cans from steel cans. (k)

19. Explain the difference between distillation and evaporation. (k)

20. Explain how air filters work to remove dust particles. (k)

21. Ore is sifted before it is heated and melted to extract metal. Explain how sifting makes this process more efficient. (a)

22. Why are oil refineries located at a large distance from populated areas? (k)

23. Strip mining and open pit mining are both types of surface mining. Identify at least one negative environmental consequence of surface mining. (k)

24. Explain why strip mining is suitable for obtaining oil from tar sands in Alberta. (k)

25. Explain why mountaintop removal is potentially so destructive to the local environment. (k)

26. Use the particle theory of matter to explain why gold becomes soluble in water when combined with cyanide. (a)

27. Evaluate the use of cyanide as a means to extract gold from ore. Provide reasons to support your opinion. (t)

28. Tailing ponds are built to prevent environmental contamination but may lead to release of contaminants into streams and rivers. Explain how mining companies could minimize this risk. (t)

Connect Your Understanding

29. Explain why liquid laundry detergent is particularly useful for washing in cold water. (a)

30. Some paint can be dissolved in water, while other paints must be dissolved using oil-based solvents. How could you determine which solvent to use? Explain at least two ways. (t)

31. Water treatment facilities require the use of sedimentation tanks. Use the particle theory of matter to explain how these tanks help to separate materials in the waste water mixture. (a)

32. Explain how filters placed on faucets in your home could actually result in water that is more pure than bottled water. (t)

33. Pesticides tend to kill all types of insects, including those that actually feed on pest species. Describe two methods that you could use around your lawn and garden to reduce the need for pesticides. (a)

34. Explain why cautions about consumption of fish are generally stronger for women of childbearing age and for children under the age of 15. (t)

35. Most people do not apply pesticides and herbicides directly to or spill these chemicals in waterways. Yet, these mixtures are found in many lakes and streams. Explain how this happens. (a)

36. Many lakes and rivers experience sharp increases in contamination from bacteria after summer thunderstorms. Explain why this happens. (a)

37. Balloons filled with air tend to remain inflated for a much longer time than balloons filled with helium do. Use the particle theory of matter to explain the difference. **Hint:** The particles of helium are smaller than most particles that make up air. (t)

38. Salad dressings made with oil and vinegar tend to separate and must be shaken before use. Use the particle theory of matter to explain why oil does not dissolve in water. (t)

39. Tennis racket technology has changed in the past five years. Rackets made from composite materials have made weaker players more competitive. Use the particle theory of matter to explain your classification of the composition of the materials that make up new rackets. (a)

40. Use the particle theory of matter to explain why a pizza is classified as a mixture but salt is a pure substance. (t)

41. Use the particle theory of matter to explain why steam, ice, and water are all considered to be the same substance. (t)

42. On a hot summer day, a glass of cold water warms rapidly. However, if an ice cube is added, the same amount of water will not warm up until the ice cube is melted. Explain why this is so using the particle theory of matter. (t)

43. Use the particle theory of matter to explain why 5 g of water occupies the space of 5 mL in the liquid state but completely fills a room when it evaporates. (t)

44. Describe one situation where you observed the contributions of science and technology to the understanding of pure substances and mixtures. (t)

Practise Your Skills

45. Draw a concept map that connects together the words solution, solute, solvent, evaporation, and distillation. (k)

46. Draw a tree diagram with the title "Separating Mixtures" to show the different methods by which mechanical mixtures and solutions can have their components separated. (k)

47. DDT is a pesticide that can cause harm when 1 mL of DDT is present in 1 000 000 L of water. If 1 mL of DDT has a mass of 1 g, what is the concentration of such a solution of DDT in g/1000 mL? (t)

48. Construct a comparison matrix titled "Surface Mining" that compares "open pit mining," "strip mining," and "mountaintop removal" with characteristics of "destruction of habitat," "large use of water," "minerals concentrated in the ground in veins." (t)

ACHIEVEMENT CHART CATEGORIES
(k) Knowledge and understanding (t) Thinking and investigation (c) Communication (a) Application

Revisit the Big Ideas

49. Select five items that can be found in your refrigerator at home. Classify the items as either pure substances or mixtures. (k)

50. Write a short paragraph that shows clearly how these three words are related to one another: solute, solvent, and solution. (c)

51. Explain the meaning of these terms in your own words: distillation, filtration, and evaporation. (k)

52. Use the particle theory of matter to explain the differences between pure substances and mixtures. Provide examples of each. (k)

53. Explain how temperature is involved in the process of changing between different states of matter. Use the particle theory of matter in your explanation. (k)

54. Write a five-sentence paragraph focusing on the mining industry that supports or refutes this statement: "Mining is all about collecting and separating pure substances from mixtures." (t)

55. A supersaturated solution contains more dissolved solute than could be dissolved by the solvent under normal circumstances. Use the particle theory of matter to explain how this occurs. (t)

56. Some municipalities have banned the use of pesticides on lawns and gardens. Write a five-sentence paragraph to either support or refute this universal ban. Be sure to support your opinion with examples. (t)

57. Ketchup appears to be uniformly red in colour and consistent in texture, but it is classified as a mechanical mixture rather than a solution. Use the particle theory of matter to explain why this is so. (t)

C48 *Thinking about Science, Technology, Society, and the Environment*

Changing Your Consumption Habits

We use pure substances and mixtures every day. Think about what you have eaten today, the content of the air that you have breathed, and the substances produced by your use (e.g., carbon dioxide, waste products). Now, multiply this by about six billion, and you will have an estimate of the impact of humans on the environment.

If you could change anything you wanted, what would you do to change your consumption and production of pure substances and mixtures at school, in your home, in your community, or in Canada? Brainstorm some ideas with a partner, and then share them with your class.