CHAPTER 3

Separating Mixtures

KEY QUESTION: How can we separate the components of a mechanical mixture or solution?

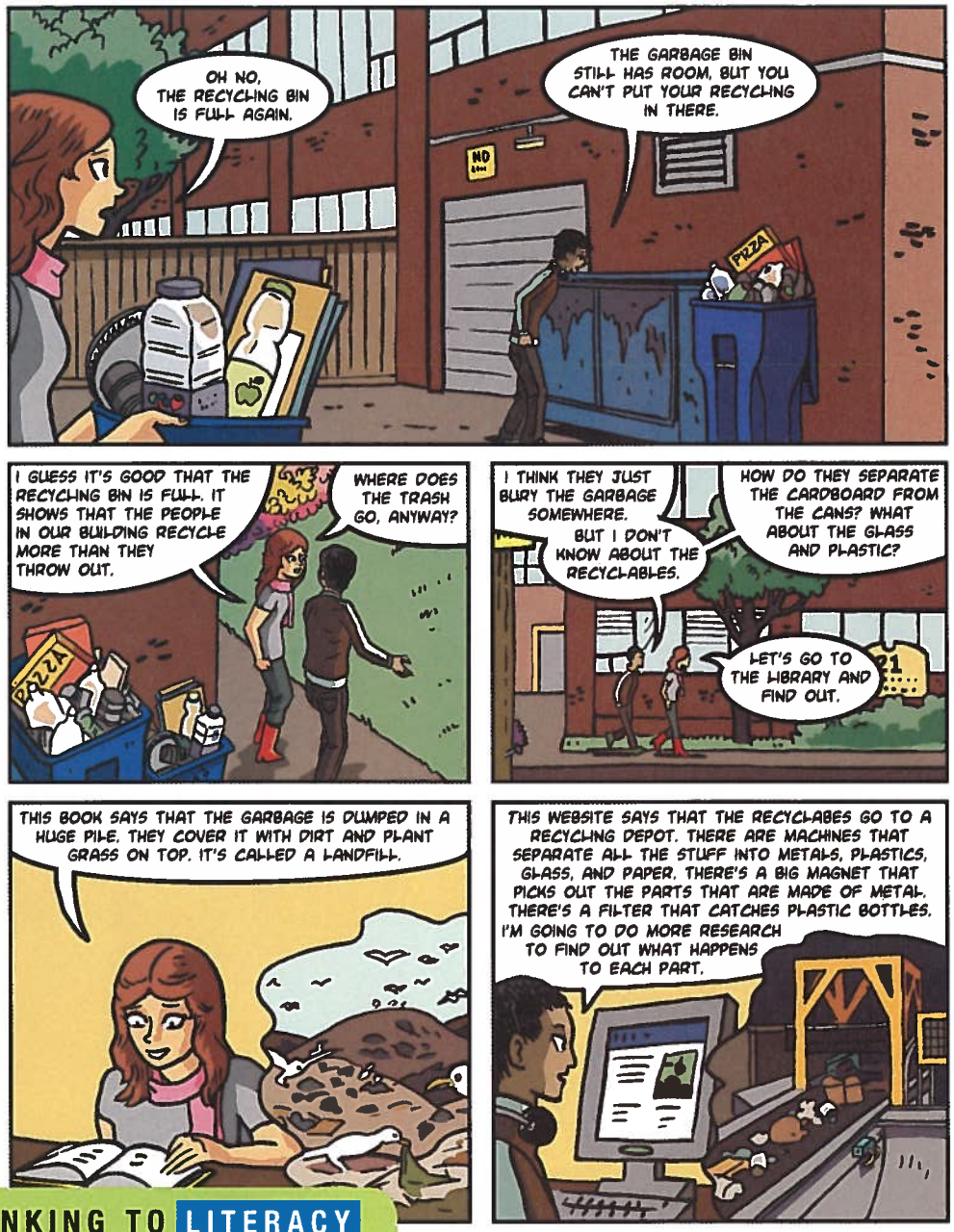
Looking Ahead

- The skills of scientific inquiry can be used to learn about methods of separating different mixtures.
- Mechanical mixtures can be separated into their components using methods such as sorting, floating, settling, attracting with a magnet, sieving, and filtering.
- Separating waste mixtures into their components protects the environment from toxins and allows valuable components to be reused.
- Solutions can be separated into their components using methods such as evaporation and distillation.
- Investigation skills can be used to determine the best method to separate mixtures.
- Many industries separate mixtures when making products.

VOCABULARY

sorting	sewage
floating	evaporate
settling	evaporation
sieve	distillation
sieving	electric generator
filter	radioactive
filtration	nuclear energy

RECYCLING DILEMMA



LINKING TO LITERACY

Critical Literacy

When you read something critically, you analyze the text and look for underlying messages. As you read the cartoon, think about the author's viewpoint.

1. The characters are faced with a dilemma. Describe the choice they must make. What does this tell you about their beliefs? Are they believable characters? Why or why not?
2. If you were to encounter this dilemma, how would you react? What could you do to make the situation better?
3. What message is the author trying to relate to readers?

Separating Mechanical Mixtures

There are different ways to separate the parts of a mechanical mixture. In this activity, you will explore some of these methods.

SKILLS MENU

- ☐ Questioning
- ☐ Hypothesizing
- ☐ Predicting
- ☐ Planning
- ☐ Controlling Variables
- ☐ Performing
- ☐ Observing
- ☐ Analyzing
- ☐ Evaluating
- ☐ Communicating

Purpose

To separate mechanical mixtures using different methods.

Equipment and Materials

- apron
- eye protection
- spoon
- 2 beakers
- 3 watch glasses
- magnet and paper
- sieve
- funnel
- plastic container
- wash bottle containing water
- 3 mystery mixtures
- paper towels
- coffee filter


apron


eye protection


spoon


2 beakers


3 watch glasses


magnet and paper


sieve


funnel


plastic container


wash bottle containing water


3 mystery mixtures


paper towels


coffee filter

Procedure

SKILLS HANDBOOK 2.B.5., 2.B.6.

Part A: Floating and Settling

1. Put on your apron and eye protection. Use the spoon to stir mixture #1. After stirring, examine the mixture and record your observations.
2. Let the mixture sit for 15 min. (You can work on Parts B and C while you wait.)
3. Examine the mixture. What parts floated to the top? What parts settled to the bottom? Record your observations.
4. Use the spoon to skim off the floating parts of the mixture (Figure 1). Put them onto a watch glass.

Figure 1 Separating the parts of mixture #1 by floating

5. Pour the liquid part of the mixture into an empty beaker, leaving the settled solids behind.

Part B: Magnetism

6. Examine mixture #2. Record your observations.
7. Wrap the magnet in paper towel. Use it to separate the mixture (Figure 2). Put the different parts on two clean watch glasses.

Figure 2 Separating the parts of mixture #2 by magnetism

Part C: Sieving and Filtering

8. Examine mixture #3. Record your observations.
9. Place the sieve over the plastic container.
10. Stir the mixture. Pour it through the sieve. Use the wash bottle to wash any remaining mixture from the beaker into the sieve. Put the sieve and its contents to one side, resting on paper towels. Record your observations.
11. Fold the filter paper into a cone and place it in a funnel. Put the cone in the top of an empty beaker.
12. Slowly pour the contents of the container through the filter paper (Figure 3). Use water to wash any remaining mixture from the container into the filter. Record your observations.

Figure 3 Separating the parts of mixture #3 by filtering

Analyze and Evaluate

SKILLS HANDBOOK 2.B.8.

(a) In Part A, how well did floating and settling work to separate a mixture? How could you do it better?

(b) What kinds of mixtures can effectively be separated using floating and settling?

(c) In Part B, how well did magnetism work to separate a mixture? How could you do it better?

(d) Why were you instructed to wrap the magnet in paper before using it? What might have happened if you had not done this?

(e) What kinds of mixtures can effectively be separated using magnetism?

(f) In Part C, how well did sieving and filtering work to separate a mixture? How could you do it better?

(g) What kinds of mixtures can effectively be separated by sieving? By filtering?

(h) Which method was the most effective? Why?

(i) What method would you use to separate each of the following mixtures? Explain why.

i) iron filings and water
ii) sand and gravel
iii) sand and water

Apply and Extend

SKILLS HANDBOOK 2.B.4.

(j) You work in a factory that makes three different sizes of glass marbles. A problem results in all the different-sized marbles getting mixed up. Plan how to separate the marbles by size. Describe the equipment you would need.

(k) Imagine you have a mixture of paper clips, sand, pebbles, and water. Create a flow chart to show how you would separate the mixture.

(l) How could any of the techniques in this activity be used to sort recyclable waste?

Unit Task How will you apply the skills learned in this section to the Unit Task?

3.2 Separating Mechanical Mixtures

LINKING TO LITERACY

Concept Map

Concept maps are used to note and visualize details or ideas that are related. Create a concept map for this section. Start by writing the word "Mixtures" in the centre of your page. On one side of "Mixtures," write the word "Types." On the other side of "Mixtures," write "Separation methods." Draw arrows between the concepts. Now, read through the text to locate the different types of mixtures and different separation methods.

People work with mixtures every day, even though they may not know it. Here are three examples. What does each one have to do with mixtures?

- Kalia likes lettuce, onions, and red peppers in her salad, but she does not like tomatoes. Kalia always picks the tomatoes out of her salad before she eats it.
- One of Ali's chores is to sort the laundry before washing. He separates the laundry into a pile of light colours and a pile of dark colours.
- Jen boils pasta in water for lunch. Once the pasta is cooked, Jen pours it through a colander to separate the pasta from the water (Figure 1).

Figure 1 A colander separates a mechanical mixture of solid pasta and liquid water.

Kalia, Ali, and Jen are all separating mechanical mixtures. Think of the last time you separated a mechanical mixture. Maybe you took the mushrooms off of a slice of pizza before eating it. Perhaps you took the loonies and toonies out of a mixture of coins and put them in a jar. What kind of mixture did you separate? How did you do it?

Sorting

The simplest way of separating mechanical mixtures is by sorting. Sorting is used when the two (or more) types of matter are in fairly large pieces. **Sorting** simply involves looking at the various pieces and physically moving one or more of the pieces into a different container.

sorting: physically separating large pieces of a mechanical mixture so that similar pieces are together

The parts of many mechanical mixtures, however, are in pieces that are too small to separate by sorting. For these mixtures, you have to find other ways of separating the parts. This often involves finding a way in which the parts of the mixture are different from each other.

Floating and Settling

Some parts of a mechanical mixture may float or sink in water. If one part of a mixture is **floating**, you can skim it off the top using a spoon or a scoop. If one part of a mixture sinks (settles) in water, you can pour the water off, and then collect the part at the bottom. This method is called **settling**. Sand and cocoa powder both settle in water.

A mechanical mixture might include two or more different liquids, one of which floats on top of the other. In this case, the floating layer could be carefully skimmed or poured off, just as melted chicken fat is skimmed off a pot of hot chicken soup (Figure 2).

During the Gold Rush era, thousands of miners headed to Western Canada to search for gold. Many of them used the technique of settling to separate gold dust from rock dust. A miner would grind up rocks, or just pick up gravel and sand from riverbeds, and swirl the solids around in a pan full of water. Gold dust is heavier than rock dust. If there were any gold dust mixed with the rock dust, the gold dust would sink to the bottom faster than the rock dust. The swirling water would then wash the rock dust away.

The technique of settling is used on a huge scale to treat water waste (sewage) in wastewater treatment facilities. You will learn more about this process in Section 3.4.

floating: a separation technique in which a "lighter" component rises to the top of a liquid where it can be skimmed or poured off

settling: a separation technique in which a "heavier" component sinks to the bottom of a liquid, and the liquid can be poured off

Figure 2 The melted fat can be skimmed off the rest of the soup because the fat floats on top of the broth.

Complex Mixtures

Some mixtures are complex. This means that they are mechanical mixtures that include solutions. Blood, for example, is a complex mixture. Blood contains a solution of water with dissolved nutrients (called plasma) and red blood cells. However, the blood cells are very small and can only be seen with a microscope.

Medical laboratories commonly separate the components of blood. If a blood sample is taken from a patient and left for several hours, the blood cells gradually sink to the bottom of the container (Figure 3). This leaves the clear, yellowish plasma solution at the top. The solution can then be poured off, separate from the blood cells.

This ability to separate blood into its different components has important applications. People who require blood transfusions may need only one component of blood and not the others. For example, a patient may need a transfusion of only red blood cells or only the plasma component of blood due to their particular illness or injury.

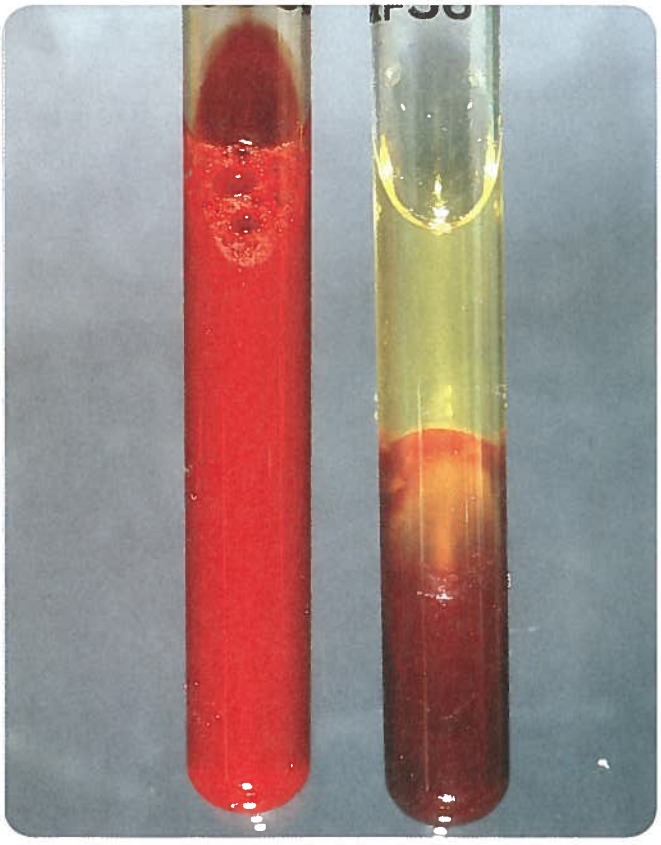


Figure 3 The test tube on the right shows how blood separates.

Figure 4 Many medical and veterinary labs have centrifuges.

The settling process can be sped up by the use of a centrifuge (Figure 4). A centrifuge is a piece of equipment that holds test tubes containing mixtures to be separated. The centrifuge spins the test tubes around very quickly to make the heavier components sink rapidly to the bottom of the tubes. Centrifuges are used in many labs to separate mechanical mixtures.

Using a Magnet

Some metals and alloys, such as iron and steel, are attracted to magnets. Other metals (for example, silver and aluminum) and most non-metals (for example, plastic and glass) are not attracted to magnets. If only one part of a mechanical mixture is attracted to magnets, a magnet can be used to separate that part from the rest of the mixture (Figure 5).

Figure 5 This magnet separates scrap metal so that it can be recycled and reused.

Using Sieves and Filters

Sometimes, different parts of a mechanical mixture contain pieces of different sizes. For example, the material extracted from a gravel pit includes both sand and gravel. The gravel company can get a better price for the gravel if it can first remove the sand. A sieve can separate mixtures like this. A **sieve** is a device with many visible holes in it that can be used to separate the components of a mixture. The smaller pieces in the mixture fall through the holes, while the bigger pieces stay on top.

This method—known as **sieving**—also works when a mechanical mixture has solid and liquid parts. The liquid parts, and perhaps some smaller solid pieces, pass through the holes, but the sieve traps the larger solid pieces. An example of a household sieve is a colander.

A **filter** is a device, with many small holes or channels, that can be used to separate a mixture. **Filtration** is similar to sieving, but it is used to remove tiny pieces of solids from a liquid or a gas. The holes through a filter are usually too small to see, so large and small solid pieces become trapped and cannot pass through.

sieve: a device used to separate the components of a mixture, with many visible holes that allow smaller solid pieces and liquids to pass through while blocking the larger solid pieces

sieving: the process of passing a mechanical mixture through a sieve to separate out the larger pieces of matter

filter: a device with many small holes that trap solid pieces of a mixture but allow liquids and gases to pass through

filtration: the process of passing a mechanical mixture through a filter to separate out solid pieces from a liquid or gas

Household filters include air filters (in furnaces and air conditioners) and coffee filters. Figure 6 shows an air filter from a furnace. As air is drawn into the furnace, it first passes through the filter. The filter traps dust and other small pieces of solids in the air. This helps the furnace work better. Air filters are also used in air circulation systems to clean the air in homes, offices, and hospitals.

Figure 6 An air filter removes small pieces of solids from the air.

Dissolving Soluble Components

If one part of a mechanical mixture dissolves easily in a solvent, you can separate this part from the rest of the mixture using dissolving. For example, suppose you had a mixture of salt and sand, and you wanted to separate out the sand. You could mix the mechanical mixture with water. The salt would dissolve in the water, and the sand would settle to the bottom of the container. After a short period of time, you could pour the salt-and-water solution off the sand. Alternatively, you could stir the whole mixture and pour it through a filter. The filter would trap the sand, but allow the solution (containing the dissolved salt) to run through.

To learn more about separating mechanical mixtures, Go to Nelson Science

TRY THIS: Separate a Mixture by Dissolving

SKILLS MENU: planning, performing, observing, analyzing, evaluating

SKILLS HANDBOOK 2.B.4.

Some kinds of matter dissolve in water. Other kinds do not. You can use this property to separate a mixture of salt and pepper.

Equipment and Materials: apron; 2 clear plastic cups; spoon; 1 large spoonful of salt; 1 large spoonful of pepper; warm water; filter paper (coffee filter)

1. Put on your apron. Mix the salt and pepper together in a cup. Examine the mixture. Think about how you could separate this mixture.
2. Add warm water to the salt-and-pepper mixture. Stir for 30 seconds. Record your observations.
3. Fold the filter paper into a cone. Put it in the top of an empty cup.
4. Stir the mixture. Pour it slowly through the filter. Use more water to rinse out any mixture sticking to the cup.

A. Does the pepper dissolve in the water? How can you tell?

B. What part(s) pass through the filter? What part does the filter catch?

C. Suggest what you could do next to separate the parts of the salt-and-water solution.

Unit Task How will you use what you have learned about separating mechanical mixtures when you start to work on the Unit Task?

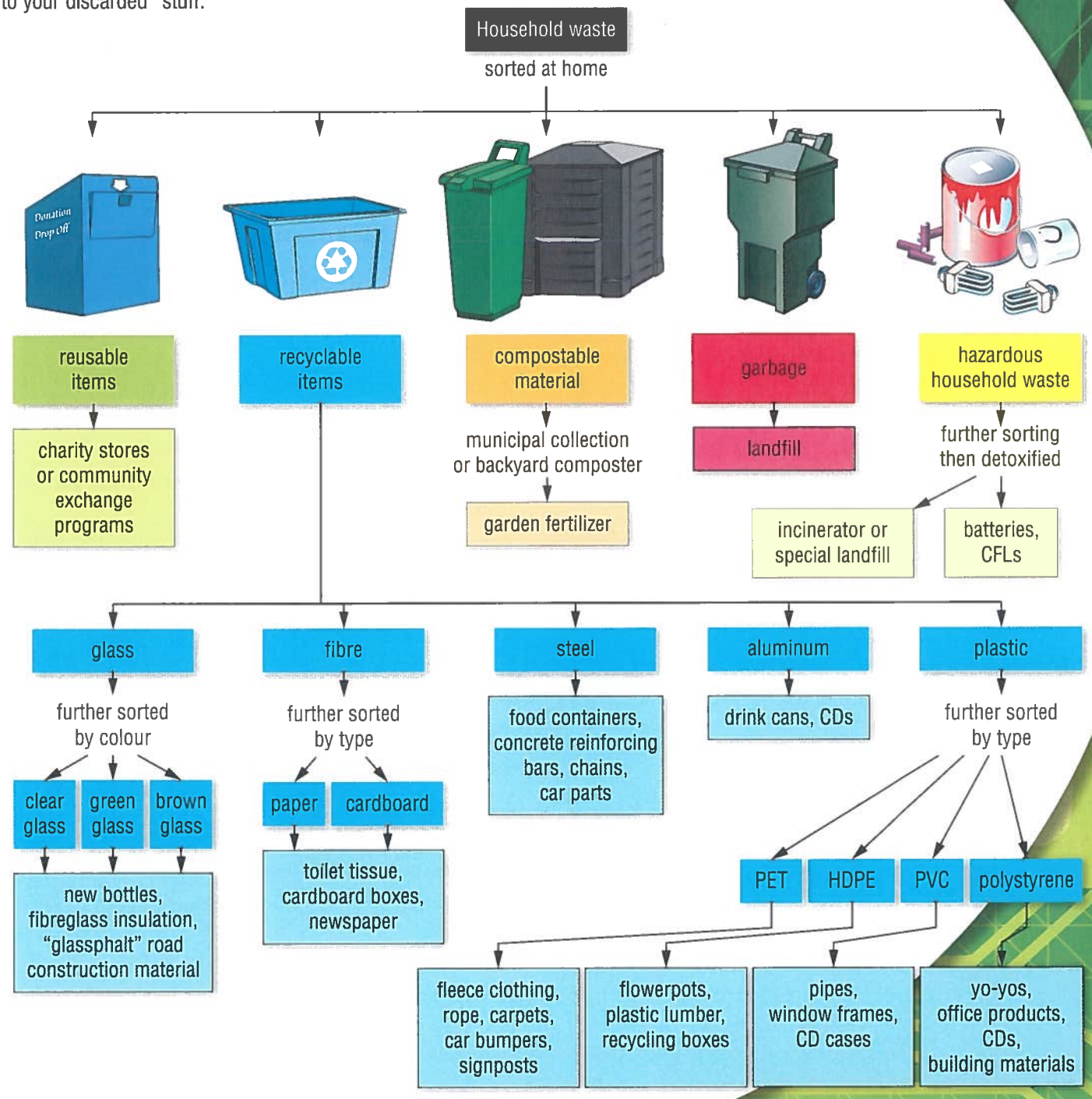
CHECK YOUR LEARNING

1. What are four methods of separating a mechanical mixture?
2. Describe one way to separate each of the following mechanical mixtures:
   - **(a)** metals in a scrap yard
   - **(b)** salt and sand
   - **(c)** sand and gravel
   - **(d)** sand and water
3. Some air purification systems include filters. How do air filters make the air healthier for people to breathe?
4. What is the difference between a filter and a sieve?

Tech CONNECT

Sorting Solid Waste

When you have finished with your household items and they are of no more use to you, you want to move the unwanted objects out of your home. What happens to them next? This flow chart describes what happens to your discarded "stuff."



Separating Recyclables

SKILLS MENU

- ☐ Identify a Problem/Need
- ☐ Planning
- ☐ Selecting Materials and Equipment
- ☐ Designing
- ☐ Testing
- ☐ Modifying
- ☐ Communicating

We are all being asked to reduce the quantity of waste that we produce. Recycling programs are expanding across Ontario. Recyclable materials are generally brought to a recycling depot all mixed together. The various parts must be separated before the materials can be turned into new, useful objects. How are the parts separated? Your challenge is to design and test equipment to separate a mixture of recyclable materials.

Scenario

Your school administration has asked your class to suggest ways to sort mixed recycled materials. You will work in teams. You will be shown a sample of the kinds of materials that will be in the mixture. Each team will design and test their own separator, or series of separators.

Design Brief

Your challenge is to (a) plan a process, and then to (b) design, build, and test a separator for mixed recyclable materials. Your process should be efficient, with as few steps as possible. It should also have the least possible impact on the environment.

Research and Consider

Discuss, in your group, how to address this challenge. What separation methods would be most appropriate? What steps are required? What equipment and materials will you need? Is there anything you need to research?

Plan and Construct

SKILLS HANDBOOK 4.B.4.

1. Write a detailed plan for processing the recyclable materials.
2. Draw a flow chart to illustrate how your separator will work. (A sample flowchart is illustrated in the Tech Connect on the previous page.)
3. Collect the equipment and materials that you need and build your separator.
4. Modify your plan during the building process, if necessary. Remember to record your changes.

Test and Modify

Using a sample of the recyclable mixture, test your separator. Does it meet the Design Brief? Make any necessary changes. Retest your separator until it efficiently separates the mixture into the various categories, which you should collect in different containers.

Evaluate

Did your separator separate the mixture of recyclable materials as required? How could it be improved? How could it be made more efficient? How could it be less damaging to the environment?

Communicate

SKILLS HANDBOOK 4.B.7., 4.C.

Create a poster about your separator. Include a large, labelled diagram, with notes on how the separator works. Explain why your design is efficient and why it has little negative impact on the environment.

3.4 Protecting the Environment by Separating Mixtures

Think about the last time you visited a lake or a river. Was there a bad smell? Was there dirty white foam at the edge of the water? If you noticed either of these problems, the water may have been polluted. There are two main ways to avoid polluting water:

- Identify sources of pollution and find ways to stop or limit pollution from these sources.
- Treat any water that contains pollutants, such as waste from sinks and toilets, before it reaches lakes and rivers.

Sewage Treatment

The mixture of water and waste that you flush down the sink or toilet is called **sewage**. What happens to sewage after it is flushed?

sewage: the mixture of water and waste that is flushed down toilets and sink drains

Sewage passes through drains and pipes until it reaches a sewage treatment plant. It then goes through one or more stages of treatment to remove the solids, break down the organic material, and kill any disease-causing organisms. The number of treatment stages depends on many things, including space, cost, and end use. The three main stages are primary treatment, secondary treatment, and tertiary treatment.

To learn more about sewage treatment,
Go to Nelson Science

Primary Treatment

Half the solids in sewage are removed from the mixture during the primary treatment. First, the sewage passes through a metal grid. This sieves out objects that will not easily decompose, such as items made of fabric and plastic. Next, the sewage is poured into a large pool and allowed to settle for several hours (Figure 1). Most solids settle to the bottom, and floating components (such as oil and grease) rise to the top. The solids are removed, treated, and used as fertilizer, burned, or sent to a landfill.

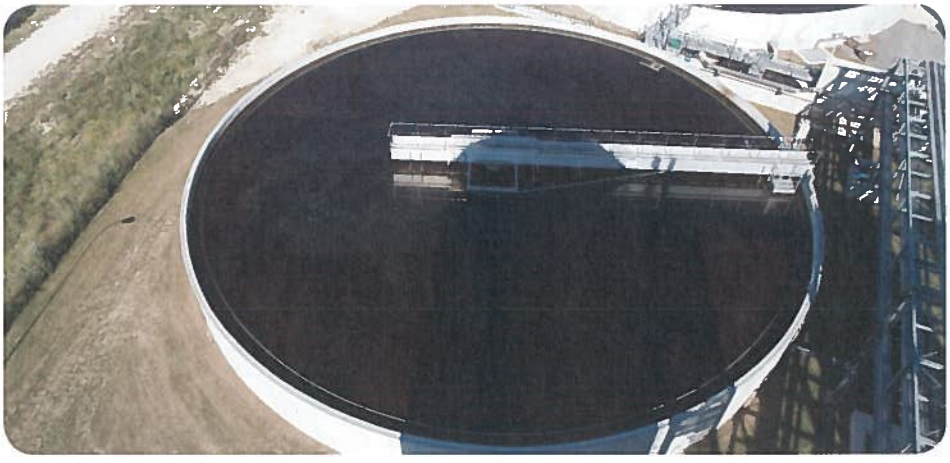


Figure 1 During primary treatment, sewage settles in a large pool.

LINKING TO LITERACY

Topic Sentences

Often (but not always), the topic sentence will be the first sentence of a paragraph. When reading informational text, look for the topic sentence in each paragraph to help you remember key ideas.

Read the text on the next three pages. Think about what you read. How much do you remember? Read the text again, but this time, read only the topic sentence for each paragraph. Can you remember important details more clearly?

Secondary Treatment

The remaining dirty water passes through tanks containing bacteria during the secondary treatment. Oxygen gas is bubbled through the mixture (Figure 2). The bacteria break down any remaining human waste and plant material. Next, the water is allowed to settle again. The bacteria settle to the bottom and are removed.

Figure 2 During secondary treatment, bacteria remove any wastes left in the liquid mixture.

Tertiary Treatment

Pollutants like phosphorus and nitrogen are removed during the tertiary treatment (Figure 3). Various kinds of bacteria are encouraged to grow in the wastewater. The water may also pass through filters, have ozone bubbled through it, or be exposed to ultraviolet radiation. Finally, chlorine is added to the water to kill any remaining organisms. Now the water is clean enough to be returned to the ocean, lake, or river.

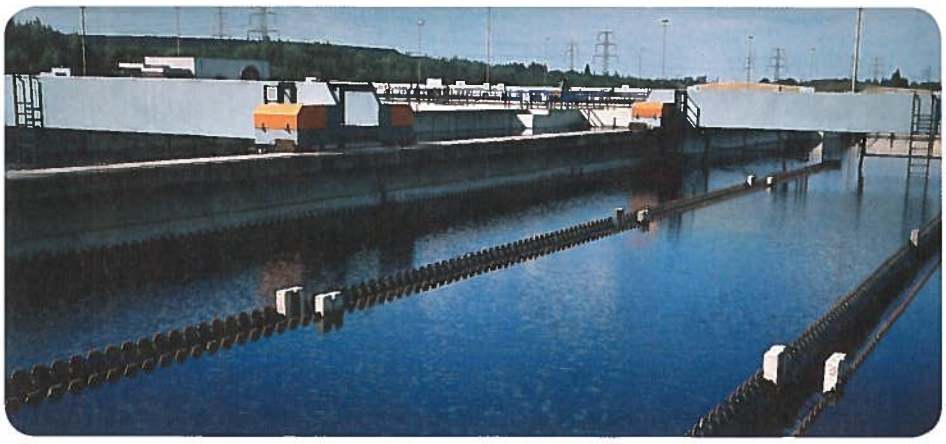


Figure 3 During some tertiary treatments, chemicals are added to the water. The water may also be filtered.

Figure 4 Once a bird's feathers are coated in oil, the bird quickly loses body heat and dies.

To learn more about oil spill cleanup,
Go to Nelson Science

Keeping Our Water Clean

As you learned in Section 2.1, polluted water is a mixture of contaminants and pure water. Besides sewage, the contaminants can get into water from

- waste produced by manufacturing or processing factories
- fertilizers, pesticides, or salt from farms, golf courses, or roads
- accidental spills and leaks

Clean water is important to everyone, and we must work together to keep pollutants out of the water.

Mixtures of dirty water can be very difficult to separate. Petroleum and petroleum products are transported on ships around the world, including around the Great Lakes. If an oil-carrying cargo ship leaks or sinks, the oil escapes into the ocean or lake water. Some of the substances in oil sink and contaminate the lake or sea bed. Other parts float and spread over the surface, affecting the wildlife that live on or near the water (Figure 4). It is very difficult to separate oil from water once they are mixed. Oil spill clean-up operations are time-consuming, costly, and usually only partly successful.

TRY THIS: Clean Up an Oil Spill

SKILLS MENU: planning, performing, evaluating, communicating

SKILLS HANDBOOK 4.B., 3.I.

In this activity, you will plan and investigate different methods of removing oil from water.

Equipment and Materials: apron; shallow container; spoon; medicine dropper; water; cooking oil; paper plate; cotton balls; straws; detergent; other materials of your choice

1. Put on your apron. Run water into the container until it is a few centimetres deep.
2. Pour a small amount of oil on the water. Wait until the oil spreads over the water, and then pour another small amount. Keep pouring until about half the water is covered with a thin layer of oil.
3. Use the spoon, cotton balls, medicine dropper, straws, detergent, and any other material you choose to clean up the "oil spill." Try at least three different methods. For example:
   - Use the cotton balls or paper towels to soak up the oil.
   - Use the medicine dropper to suck up oil.
   - Use the straws to move the oil to one corner.
   - Add drops of detergent to the oil.

A. Which method was the most successful? Why?

B. Do you think this method could be used to clean up a real oil spill? Explain your answer.

C. Research ways of cleaning up an oil spill on the ocean. Are any of these ways similar to what you did in this activity? Explain how.

Unit Task As you work on the Unit Task, you will have to think about the environmental considerations that were mentioned in this section.

CHECK YOUR LEARNING

1. What are the two main ways to avoid water pollution?
2. How is settling used in sewage treatment?
3. Briefly outline the main steps of the sewage treatment process.
4. List some ways in which pollutants can get into water.
5. Why is it particularly difficult to separate oil and water once they are mixed?
6. Give at least one example of how oil spills can endanger wildlife.

Separating Solutions

3.5

Have you ever been swimming in the ocean (Figure 1)? Once you dry off, you may notice that your skin feels strange. Maybe you licked your fingers and tasted salt. Where did the salt come from?

The ocean is a solution of salt and other solutes in water. After you swim in the ocean, the water on your skin **evaporates**. This means that the water on your skin is heated by the warm skin and changes from the liquid state to the gas state. As a gas, the water dissolves in the air and "disappears." The salt does not evaporate, so it gets left behind on your skin. What does this have to do with separating a solution?

evaporate: change from a liquid to a gas

Figure 1 Ocean water contains salt. The salt dries on your skin when the water evaporates.

As you know, solutions are mixtures in which the particles of the different components are so completely mixed that the mixture appears to be a single pure substance. How can you separate a solution into its components? To answer this question, you need to think about how the particles of a solution behave.

Particles of a Solution

Figure 2 shows sugar and water being mixed together. What happens to the sugar particles when they are mixed with the water particles? Think back to the model of dissolved particles in a solution (Figure 6 in Section 1.6). Remember that the particles of a solution are evenly mixed.

The sugar particles are still in the solution. They have not changed into something different. If you were to make a solution of sugar and water in your kitchen at home, you could tell that the sugar is still there because the solution would taste sweet.

Figure 2 How can we get the sugar back from a sugar and water solution?

Separating Solutions by Evaporation

How could you reclaim the sugar from a water-and-sugar solution? Think about some of the differences between sugar and water. When you heat liquid water, it evaporates quite easily. Sugar does not evaporate so easily. You can use this difference to remove the water from the sugar-and-water solution, leaving the sugar behind.

evaporation: the process by which a sample of matter changes from a liquid to a gas

Evaporation occurs when a liquid changes into a gas. The solid (or a more concentrated solution) is left behind.

Evaporation is often used to remove the liquid from a solution made of a liquid and a solid. This is how maple syrup is made from maple sap. The process of making maple syrup only releases water into the air, so it is not directly damaging to the environment. However, burning wood or natural gas to heat the sap releases gases that cause pollution.

TRY THIS: Make a Stalactite

SKILLS MENU: performing, observing, analyzing, communicating

SKILLS HANDBOOK 2.B.7.

Look at the cave in Figure 3. When water evaporates, it leaves its dissolved solutes behind. You can use this fact to make your own cave formations!

Equipment and Materials: apron; large bowl; spoon; piece of cardboard; 2 clear plastic cups; warm water; Epsom salts; 50 cm of cotton string or wool yarn

1. Put on your apron. Pour about 400 mL of warm water into the large bowl. Add large spoonfuls of Epsom salts and stir until you get a saturated solution (until no more will dissolve).

Figure 3 Dripping water evaporates, leaving behind the mineral solutes. Over thousands of years, the minerals form stalactites hanging from the roof and stalagmites on the ground below.

2. Choose a place in your classroom or home where the experiment can stay for about a week. Put the cardboard on a flat surface.
3. Pour half of the solution into each cup. Place one cup at each side of the piece of cardboard, about 15 cm apart.
4. Rinse the string in tap water. Next, soak the string in the saturated solution for a few seconds.
5. Hang the string between the two cups as shown (Figure 4). Let the string sag in the middle, but do not let it touch the cardboard.
6. Wait for several days. Be careful not to touch your experiment.

A. Was your experiment successful? What happened?

B. Explain your observations.

C. Explain how the stalactites you made are similar to, or different from, the rock formations in Figure 3.

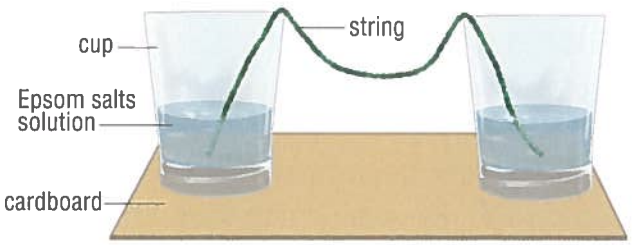


Figure 4 Creating stalactites

Separating Solutions by Distillation

Is there a way of separating two liquids that are mixed together without losing either of them? There is a way if one of the liquids evaporates more easily than the other. **Distillation** is the process of heating a solution of two or more liquids until one liquid evaporates into a gas. The gas is then trapped and cooled until it becomes a liquid again (Figure 5).

distillation: the process of separating liquids in a solution by heating the solution, trapping and cooling the gas, and collecting the resulting pure liquid

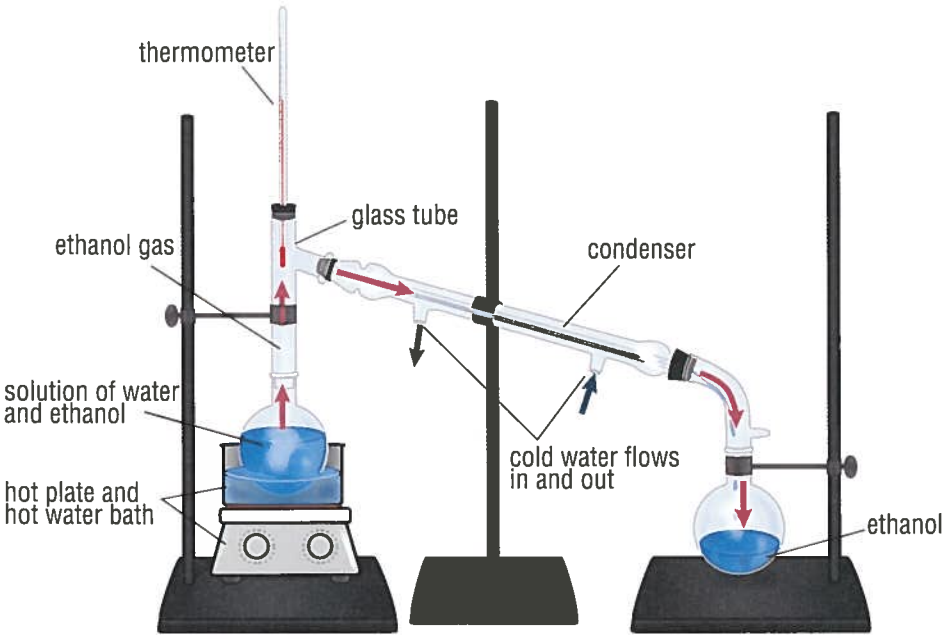


Figure 5 To separate ethanol and water using distillation, the solution is heated to just below 78 °C. The ethanol evaporates rapidly at this temperature. As a gas, it travels to the condenser where cold water cools it. The ethanol then cools to become a liquid again. As a liquid, it drips into the collecting flask on the right. Most of the water stays behind in the round-bottomed flask on the left.

If you had a liquid solution with more than two liquid components, you could repeat the distillation process to separate all the liquid parts of the solution. You would have to use a different collecting flask for each component that evaporated and then cooled to become a liquid again.

LINKING TO LITERACY

Locating Information

Think about the concept map you created in Section 3.2. What connections can you make between concepts learned in that section and in this one (Section 3.5)? What two additional methods of separation can you now add to your concept map?

To learn more about evaporation and distillation, Go to Nelson Science

Unit Task How can you use information about separating solutions as you work on the Unit Task? Can you use evaporation or distillation?

CHECK YOUR LEARNING

1. Describe one way to separate sugar from a sugar-and-water mixture.
2. Explain, using a labelled diagram, how the process of distillation works.
3. The sap from a sugar maple tree is a mixture of sugar dissolved in water.
   (a) What method is used to make maple syrup?
   (b) When you boil maple sap, something leaves the mixture. What is it? Is this process likely to be harmful to the environment?

Separating a Solution

SKILLS MENU

- ☐ Questioning
- ☐ Hypothesizing
- ☐ Predicting
- ☐ Planning
- ☐ Controlling Variables
- ☐ Performing
- ☐ Observing
- ☐ Analyzing
- ☐ Evaluating
- ☐ Communicating

Once a solute is dissolved in water, can you get it all back again? In this investigation, you will make a salt-and-water solution using measured quantities of salt and water. Next, you will plan and perform your own procedure to reclaim the salt from the mixture. You will determine whether the quantity of solute changes after it dissolves into a solution.

Testable Question

How is the quantity of salt affected when the salt is reclaimed from a salt-and-water solution?

Hypothesis/Prediction

SKILLS HANDBOOK 2.B.3.

Make a hypothesis based on the Testable Question. Your hypothesis should include a prediction and a reason for your prediction based on the particle theory.

Experimental Design

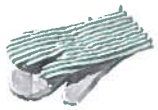
In this investigation, you will plan your own procedure to reclaim the salt in a solution made of 5 g of salt and 100 mL of warm water. You will compare the mass of the salt before and after to determine whether or not the amount of salt changes during the investigation.

Equipment and Materials

- eye protection
- apron
- oven mitts
- balance
- weighing papers
- large beaker
- graduated cylinder
- stirring rod
- hot plate
- wire gauze with ceramic centre
- salt
- warm water


eye protection


apron


oven mitts


balance


weighing papers


large beaker


graduated cylinder


stirring rod


hot plate


wire gauze with ceramic centre


salt


warm water

Procedure

Part A: Planning

SKILLS HANDBOOK 2.B.4.

1. Read through the whole investigation.
2. With your partner, brainstorm how you will separate the solution and collect the salt.
3. Write the steps of your procedure. You may use a flowchart. Your procedure should include
   - steps you will follow to separate the solution
   - safety precautions
   - a way to measure the amount of salt obtained after the separation
4. Create a table in which to record your observations.
5. Have your teacher check your procedure before you continue.

Part B: Making the Solution

6. Measure and record the mass of an empty beaker.
7. Measure out 5 g of salt. Pour the salt into the empty beaker. Measure and record the total mass of the beaker and salt.
8. Add 100 mL of warm water to the beaker. Stir until you cannot see any solid salt.

Part C: Separating the Solution

9. Perform the procedure you planned, using the prepared salt-and-water solution. Record your observations in your table.

Analyze and Evaluate

SKILLS HANDBOOK 2.B.7.

(a) Calculate the mass of the salt used to make your solution in Part B.

(b) Calculate the mass of the salt that is left behind in Part C.

(c) Answer the Testable Question.

(d) Where is the water at the end of the procedure? Use the particle theory to explain your answer.

(e) When you make a solution of salt and water, does the salt cease to exist? Use the particle theory to explain your answer.

(f) When you separate a salt-and-water solution using your procedure, what happens to the salt? Use the particle theory to explain your answer.

Apply and Extend

(g) To make candy, sugar is mixed with water and flavourings (Figure 1). The mixture is then heated for several minutes. Use what you have learned in this investigation to explain the purpose of these two steps.

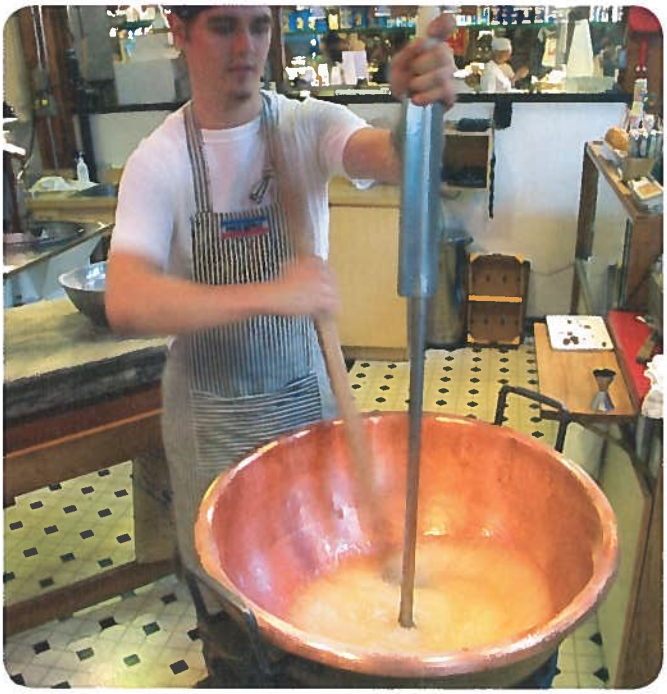


Figure 1 Making candy requires a knowledge of chemistry

Unit Task How will you use the skills you learned in this investigation when you work on the Unit Task?

3.7 Mixtures in Industry

Many industries separate mixtures to produce pure products. In this section, you will learn about three industries that separate mixtures: the flour industry, the petroleum industry, and the nuclear power industry. As you read through this section, ask yourself these questions:

- What are the components of the mixture?
- Is the mixture a mechanical mixture or a solution?
- What method is used to separate the mixture into its pure components?
- How does the separation method work?

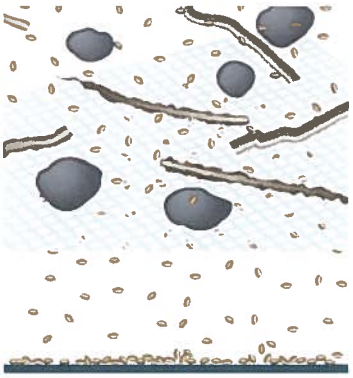
Making Wheat Flour

Bread, cake, cookies, and many other baked goods are made from wheat flour. How are the grains of wheat in Figure 1 made into flour?

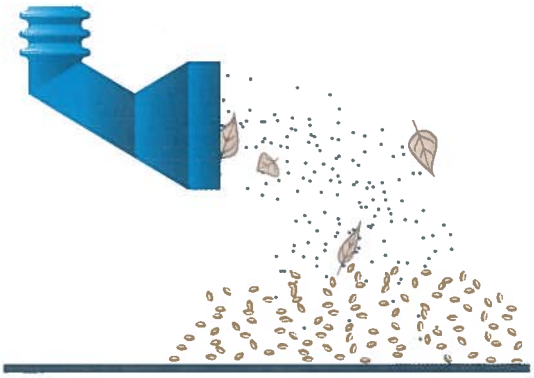
Figure 1 Wheat grains are crushed and separated into their components.

Purifying the Wheat Grains

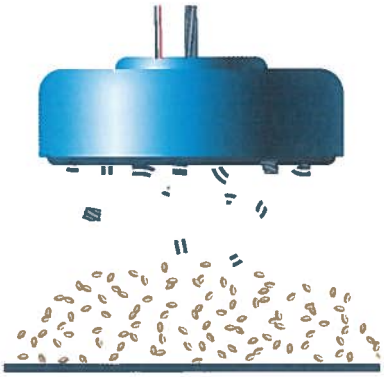
Wheat flour must be made from ground wheat grains and nothing else. Wheat grains arriving at a flour mill may be mixed with dust, sand, metal splinters, or parts of other plants. Figure 2 shows how the wheat is separated from the rest of this mixture.



Wheat grains pass through metal sieves. Sticks and stones are caught by the sieve.



A vacuum extractor sucks up the impurities that are lighter than wheat grains, such as dust and leaves.



Magnets pick out any pieces of iron and steel in the mixture.

Figure 2 Methods used to purify wheat grains

Grinding the Wheat Grains

A wheat grain has three main parts: endosperm, bran, and wheat germ (Figure 3). In a process called "milling," metal rollers break open the wheat grains (Figure 4). The milled mixture is passed through a series of sieves to separate the endosperm, bran, and germ from each other. The endosperm is used to make white flour.

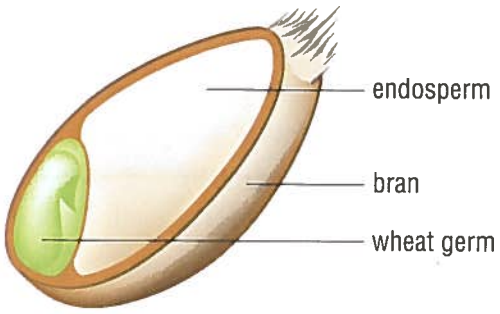


Figure 3 Parts of a grain of wheat

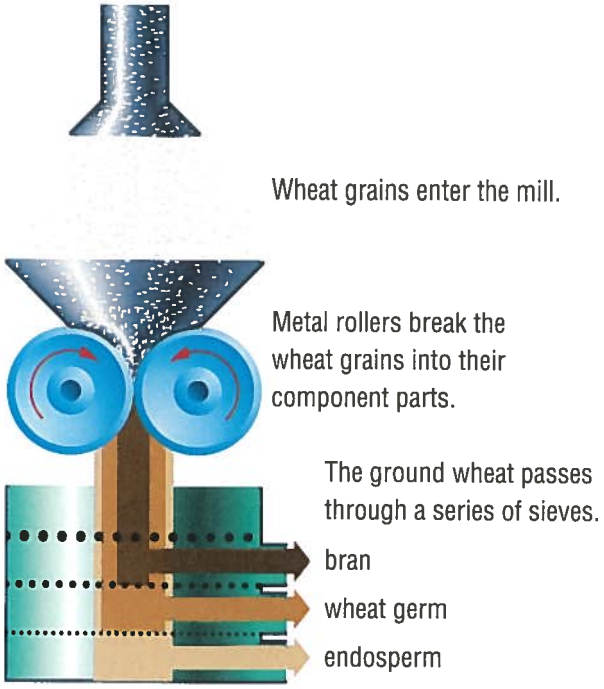


Figure 4 Grinding and sieving the wheat grains

The bran and wheat germ are often sold separately from the endosperm. Bakers sometimes add bran and wheat germ to breads, muffins, and other baked goods. This adds fibre and nutrients. Whole-wheat flour is a mixture of all three parts of the wheat grain. Eating products made from whole-wheat flour, rather than white flour, is often a healthy choice because whole-wheat is less processed and contains more nutrients.

Refining Petroleum

Petroleum, or crude oil, is a homogeneous mixture of many pure substances found deep in the ground (Figure 5). Many products in your everyday life are made from petroleum, including plastics, asphalt, many medicines, synthetic fibres, and fertilizers. Most of the fuels that power cars, trucks, trains, and airplanes also come from petroleum.

To learn more about refining petroleum,
Go to Nelson Science

Figure 5 Petroleum is found in many places around the world, including Canada, Saudi Arabia, Russia, and the United States.

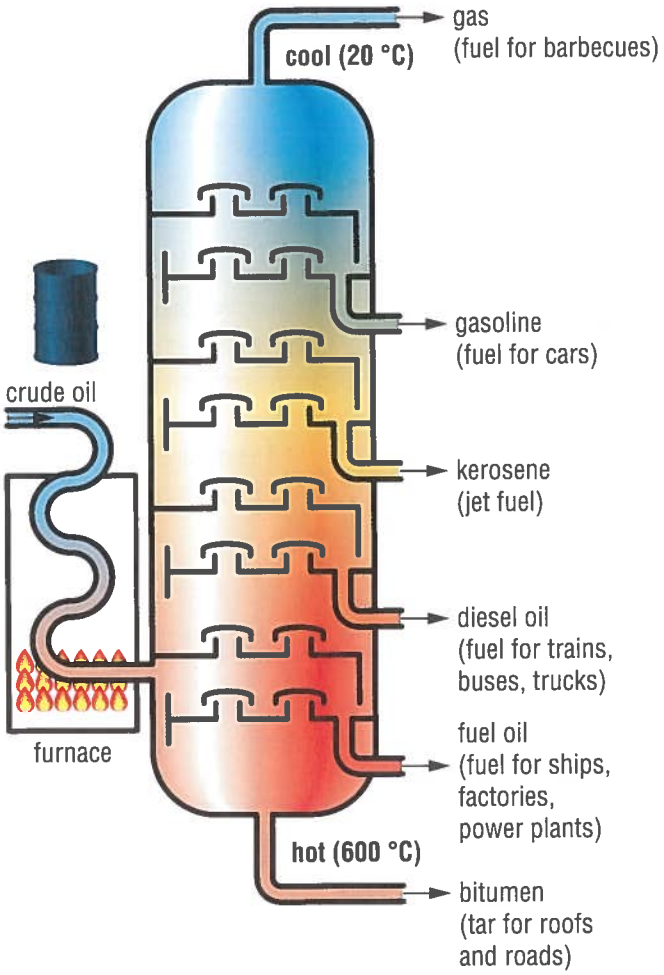


Figure 6 Crude oil is purified in a fractional distillation column.

Petroleum comes out of the ground as a thick, liquid mixture of many different substances. Each component of the mixture boils at a different temperature. Engineers have developed a technology to separate the various components (Figure 6). First, a furnace heats petroleum until its components begin to evaporate. The hot gases rise through a tall column that cools the gases. This column is called a "fractional distillation column." Different components of the gas mixture cool (becoming liquids) at different temperatures. The liquids produced settle at different levels in the column. The liquid collected at each level of the column is called a "fraction." Each fraction can be further purified.

Benefits of Refining Petroleum

Natural petroleum is not very useful because it contains many chemicals that behave in different ways. When petroleum is refined, however, you can take advantage of the special characteristics of each fraction. If you need a material for surfacing a road, you would select the heaviest fraction: bitumen. Bitumen is thick and sticky, and good for making asphalt and roadways. If you need a liquid fuel for vehicles, you would choose a lighter fraction such as diesel. You could use the lightest fractions, such as gasoline and propane, as fuels for cars and barbecues, and to make paints, plastics, and medicines.

Petroleum Refining and the Environment

Refining petroleum has risks. Raw petroleum is piped or shipped to oil refineries, and the refined products are transported away again. Leaks and spills sometimes occur during transportation (Figure 7). These can seriously damage the environment, both land and water, and cause health problems for plants and animals. Leaks during the refining process may cause air pollution. The lighter fractions of petroleum catch fire easily, so explosions and fires are a risk. Refining petroleum also produces bad smells and noise. For these reasons, most petroleum industries are located away from areas where people live.

Figure 7 Petroleum spills are difficult to clean up. This petroleum was spilled when a wind storm split an oil tanker in two.

Uranium and Nuclear Power

Ontario uses a lot of electricity for heating, cooling, and powering machines and electrical devices. Ontario's electricity is produced using several energy sources. These include the energy of falling water, the energy in fossil fuels such as natural gas and coal, and the energy in the particles of special pure substances such as uranium. In each case, a machine called an **electric generator** converts the energy into electricity.

electric generator: a machine with moving parts that produce electricity when they spin

Uranium is a **radioactive** substance. This means that, unlike most pure substances, uranium's particles break apart into smaller particles. As uranium particles split, they release a burst of energy called **nuclear energy**. This energy is used to generate electricity in a nuclear power plant.

radioactive: a term used to describe pure substances whose particles naturally split into smaller particles, releasing energy as they break apart

nuclear energy: the energy released when the particles of pure substances like uranium split apart

Uranium occurs naturally in rocks called uranium ore. Uranium is separated from the ore by crushing the ore and adding a solution that dissolves the uranium. The waste rock is sieved out and the uranium-containing solution is collected. When the water evaporates from the solution, a solid remains. This solid is further processed into pure uranium and shaped into small pellets.

Inside a nuclear power plant, the uranium pellets are placed in the centre, or core, of a nuclear reactor (Figure 8). There, the uranium particles split apart and release energy in the form of intense heat and radiation. This energy heats water surrounding the core, and the water evaporates. As the hot water vapour expands, it turns the blades of large, fan-like turbines. The spinning turbines then turn generators that produce electricity.

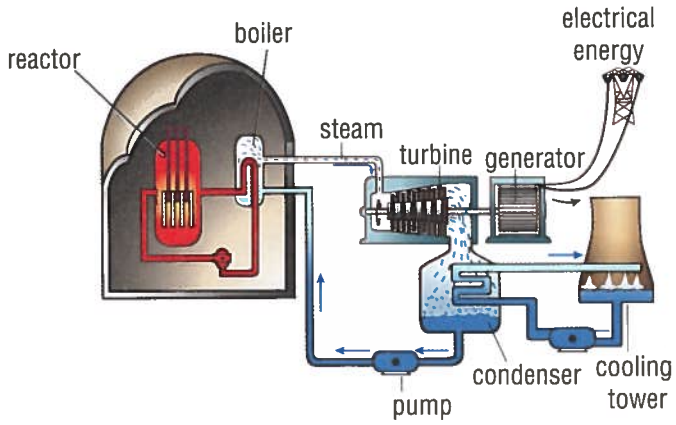


Figure 8 A nuclear power reactor

When a certain fraction of uranium particles has split, the energy production slows down and the "used" uranium has to be replaced with new pellets. Over 90 % of the used uranium is reprocessed and used again in a nuclear reactor. The remainder must be disposed of.

Figure 9 Areas surrounding Chernobyl were deserted after the accident in 1986 due to high levels of radiation.

Nuclear power has two big advantages over energy from petroleum and petroleum products: it does not produce pollution that can lead to acid rain, and it does not release carbon dioxide that causes climate change. So, why do many people oppose nuclear power? There are two main reasons.

First, people are concerned that something could go wrong with the nuclear reactor and radioactive particles could be released into the environment. This happened in 1986 in Chernobyl, Ukraine, when a reactor core exploded and radioactive material contaminated much of eastern and northern Europe (Figure 9). High levels of radiation from radioactive substances can cause serious diseases, like cancer, and can even cause death.

Second, disposing of the used uranium is a problem. Used uranium is still radioactive and continues to release radiation and thermal energy for thousands of years. It cannot just be buried in a landfill, as the surrounding rock, soil, and water would be contaminated. One method of disposal involves mixing used uranium with a form of melted glass, cooling it, and burying the solid mixture in a deep, closed mine. There is still the concern that earthquakes may disturb mines such as these, or that people may accidentally rediscover the buried waste in future centuries. The nuclear waste disposal problem has not yet been resolved, and the debate goes on. Meanwhile, about half of Ontario's electricity continues to come from nuclear power plants.

LINKING TO LITERACY

Compare and Contrast

Comparing and contrasting helps to identify similarities and differences. Create a t-chart to compare and contrast the refining of petroleum and the separation of uranium. How are they the same? How are they different?

To learn more about nuclear power,
Go to Nelson Science

CHECK YOUR LEARNING

1. There were several diagrams in this section.
   (a) Which diagram did you find the hardest to understand? Explain why.
   (b) Where can you find help to understand the diagram?
2. Describe one way to separate each of the following mixtures:
   (a) wheat grains mixed with stones and large sticks
   (b) wheat grains mixed with pieces of metal
   (c) a mixture of different oil components that evaporate at different temperatures
3. List three methods of separating mixtures that are used in the flour industry.
4. (a) Why can uranium be used to produce electricity?
   (b) How is uranium used to produce electricity?
5. What is uranium ore, and how is uranium obtained from it?
6. (a) Why can waste uranium not be treated the same as regular garbage?
   (b) Describe one way in which uranium is disposed of.
7. List two risks and two benefits of nuclear power.

Separating a Complex Mixture

In this activity, you will be given a complex mechanical mixture that has four different components that you must separate.

SKILLS MENU

☐ Questioning	■ Performing
☐ Hypothesizing	■ Observing
☐ Predicting	☐ Analyzing
■ Planning	■ Evaluating
☐ Controlling Variables	☐ Communicating

Purpose

To plan and perform a series of steps to separate the components of a complex mechanical mixture.

Equipment and Materials

- eye protection
- apron
- small beakers
- plastic container
- magnet
- spoon
- sieve
- a pre-mixed mechanical mixture
- water in a wash bottle
- filter paper
- other equipment and materials that you will need


eye protection


apron


small beakers


plastic container


magnet


spoon


sieve


mechanical mixture


water in a wash bottle


filter paper

Procedure

SKILLS HANDBOOK 2.B.4., 2.B.5.

1. Look closely at your mixture to identify the various components. Plan how you will separate each component.
2. Decide in which order you will separate the components. Create a flow chart outlining your plan.
3. Write a detailed procedure, including necessary safety precautions.
4. With your teacher's approval, perform your procedure and collect the separate components of your mixture.

Analyze and Evaluate

SKILLS HANDBOOK 2.B.8.

(a) What components did your mixture contain? How do you know?

(b) Which separation method did you choose for each component? Were these methods appropriate? Why or why not?

(c) If you were to repeat this activity, what would you do differently?

(d) If you had been given the same mixture but with water added, would you have been able to collect all the components? Explain.

Apply and Extend

(e) Suggest an industrial process in which a complex mixture has to be separated. What separation methods could be used?

Unit Task The skills you used in this activity will be useful when you work on the Unit Task.

CHAPTER 3

SUMMARY

Separating Mixtures

BIG Ideas

- Matter can be classified according to its physical characteristics.
- The particle theory of matter helps to explain the physical characteristics of matter.
- Pure substances and mixtures have an impact on society and the environment.
- Understanding the characteristics of matter allows us to make informed choices about how we use it.

Looking Back

The skills of scientific inquiry can be used to learn about methods of separating different mixtures.

- Different types of mixtures can be separated in different ways.
- The properties of the components in a mixture determine the best method of separating the mixture (for example, a mixture of iron filings and sand can be separated using a magnet).

Mechanical mixtures can be separated into their components using methods such as sorting, floating, settling, attracting with a magnet, sieving, and filtering.

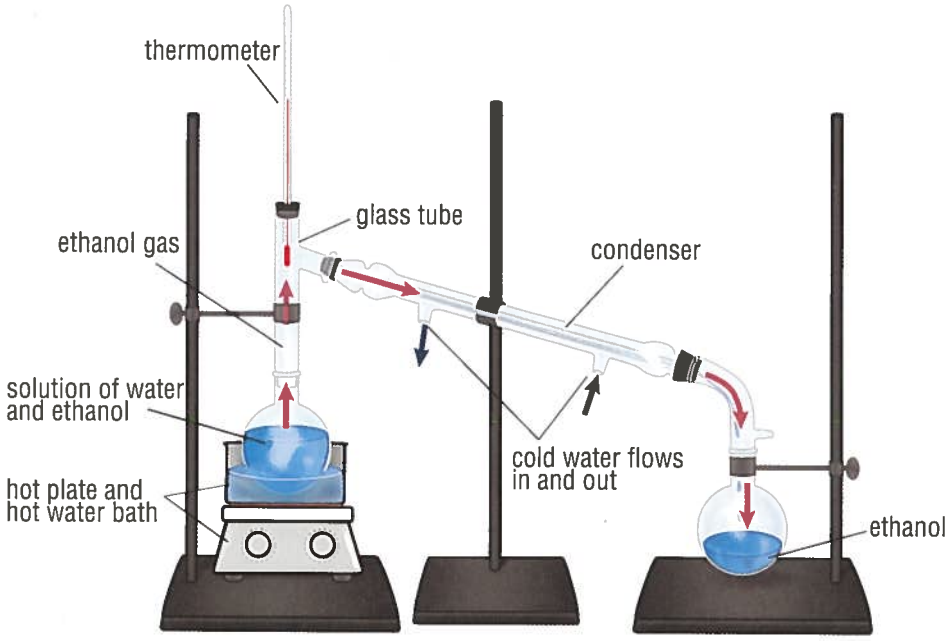
- You can sort a mechanical mixture like a salad with your fingers.
- You can filter a mechanical mixture like pasta and water using a sieve or filter.
- You can use a magnet to remove iron filings from a mixture.
- You can leave a mechanical mixture that includes a liquid to settle, and then skim or pour off the top layer.
- Some pure substances dissolve in water, while others do not. You can use this property to separate a mixture of solids.

Separating waste mixtures into their components protects the environment from toxins and allows valuable components to be reused.

- Garbage is sorted and separated to reduce the quantity that goes to the landfill. Reusable materials are recycled.
- Sewage from sinks and toilets is cleaned before the water is returned to lakes and rivers.
- Oil spills must be cleaned up to protect wildlife and humans that depend on the lakes and oceans.

Solutions can be separated into their components using methods such as evaporation and distillation.

- Salt "disappears" (becomes invisible) when it dissolves in water. Salt can be recovered from a solution by evaporating the water.
- You can separate two liquids by heating them until one liquid evaporates. Then you can cool the gas, condense it, and collect the liquid. This process is called distillation.



Investigation skills can be used to determine the best method to separate mixtures.

- The best method of separating a mixture can be determined by making detailed observations about the components in the mixture.
- Complex mixtures can be separated if you have a plan determining the order in which to separate the components of the mixture.

Many industries separate mixtures when making products.

- The flour industry uses sieves and magnets to separate impurities from wheat grains.
- The petroleum industry uses distillation to separate the fractions of petroleum.
- The nuclear power industry uses dissolving and evaporation to separate uranium from the mixture of pure substances in uranium ore.

VOCABULARY

sorting, p. 58
floating, p. 59
settling, p. 59
sieve, p. 60
sieving, p. 60
filter, p. 60
filtration, p. 60
sewage, p. 64
evaporate, p. 67
evaporation, p. 68
distillation, p. 69
electric generator, p. 75
radioactive, p. 75
nuclear energy, p. 75

CHAPTER 3

REVIEW

The following icons indicate the Achievement Chart categories: K/U Knowledge/Understanding; T/I Thinking/Investigation; C Communication; A Application

What Do You Remember?

1. Describe one method used to separate the following mixtures into the products indicated:
   (a) sewage → cleaner water
   (b) wheat grains → white flour
   (c) petroleum (crude oil) → gasoline K/U
2. (a) Name a way to separate a solution that contains two liquids.
   (b) Name a way to reclaim solid solute from a solution. K/U
3. Suggest a mechanical mixture (not already mentioned) that could be separated into its parts by each of the following methods: K/U
   (a) sorting
   (b) floating or settling
   (c) using a magnet
   (d) using a filter or a sieve
   (e) dissolving soluble parts of the mixture
4. How does a filter work to separate the components of a mechanical mixture? K/U
5. Could you use a magnet to separate any kind of mixture? Why or why not? K/U
6. Draw a diagram showing how you would reclaim salt from a salt-and-water solution. Explain your diagram. K/U C
7. Why is it important to remove harmful materials from waste before putting the waste in the environment? K/U

What Do You Understand?

8. Describe one way to separate each of the following mechanical mixtures:
   (a) air and dust
   (b) paper clips and erasers
   (c) mud (soil and water)
   (d) sugar and sand
   (e) sawdust and sand T/I A
9. Which methods of separating mechanical mixtures do you think would be most useful in separating garbage that includes compost, waste paper, steel cans, and plastic bottles? Explain why. K/U A
10. (a) Wheat grains might arrive at a flour mill mixed up with stones, sticks, and so on. What kind of mixture is this?
    (b) When the wheat grains have been crushed, what kind of mixture is this?
    (c) When petroleum arrives at an oil refinery, what kind of mixture is this? K/U

Solve a Problem!

11. Joshua mixed sand with water. Describe two ways to separate Joshua's mixture. C A
12. The town of Sunnydale is on an ocean coast. The sewage from the town is dumped directly into the ocean with no treatment. Today, Sunnydale is having a meeting about whether to start sewage treatment. There are three speakers at the meeting:

    Speaker 1: The mayor of Sunnydale is worried that if they put a lot of money into expensive sewage treatment, there may not be enough money for the town's hospital.

    Speaker 2: A local scientist says that the sewage is harming the environment. The number of fish in the ocean nearby is decreasing.

    Speaker 3: A sewage treatment expert says that Sunnydale has two options: primary treatment, or both primary and secondary treatment. Just primary treatment is less expensive, but only removes 60 % of the waste. Using both treatments is more expensive, but will purify the water better.

    Do you think Sunnydale should start sewage treatment? If so, which kind? Explain your answer. T/I A C

13. Chang poured salt into his glass of juice by accident. Can Chang remove all the salt by pouring his juice through a filter? Explain why or why not. A T/I

14. Jayanthy has a mixture of sawdust, gravel, and salt. Create a flow chart to describe how Jayanthy can separate her mixture. T/I A

15. Perform research to find out
    (a) what is, and what is not, recycled in your home town (Figure 1)
    (b) how you can reduce the quantity of waste material that is sent to landfills A

Go to Nelson Science

Figure 1

16. Millions of people around the world, including some in parts of Canada, do not have easy access to clean, fresh water. Research answers to the following questions. Present your findings to your class as a speech, song, story, electronic presentation, or in some other way:
    (a) Where, on Earth, is there no access to clean water?
    (b) Why is clean water not available?
    (c) How does this relate to pure substances and mixtures?
    (d) What, if anything, is being done to solve the problem? K/U T/I C

Go to Nelson Science

Create and Evaluate!

17. Create a flow chart to show the changes that happen to uranium, from when it is mined to when it is finally disposed of. Evaluate this process in terms of potential hazards to the environment and living things, and its cost. Is nuclear power a benefit to society? A T/I C

18. "People often separate mechanical mixtures in their daily lives." Do you agree or disagree with this statement? Explain why. A

Reflect on Your Learning

19. There were three main concepts in Chapter 3:
    - You can separate mechanical mixtures using sorting, sieving/filtration, settling, floating, and magnetism.
    - You can separate solutions using distillation, and reclaim solid solutes by evaporation.
    - Industries separate mixtures to process raw materials and make new products.

    (a) Which of these concepts was the easiest to understand?
    (b) Which concept was the hardest to understand?
    (c) List one thing you can do to help you understand this concept better.
    (d) Did anything not make sense to you in this chapter?
    (e) Explain your answer to part (d) to a classmate or your teacher. Do they agree, or do they have a different opinion?

20. Think back to the Key Question on the first page of this chapter.
    (a) In a brief paragraph, answer the Key Question. You may use diagrams.
    (b) Write one or two more questions about the topic of this unit that you would like answered.

UNIT A

Unit Task

Test a Sample of Industrial Waste

At the beginning of Chapter 1, you read about an environmental scientist testing the water in a river for contaminants—pure substances and mixtures that should not be there. Scientists use these tests to help stop pollution and to protect plants and animals living in natural ecosystems (Figure 1).

Figure 1 This environmental scientist is taking a sample of water to test for pollutants.

Scenario

You will play the role of an environmental scientist. You have been called in to investigate a river that may be polluted. There is a natural woodland on one side of the river and a factory on the other side of the river. Some of the waste from the factory runs into the river.

Design Brief

Your task is to separate and identify the components of a sample of contaminated river water taken from just below the factory's waste pipe. Your procedure should be efficient (have the fewest possible steps) and effective (separate as many components as possible).

You will determine whether the factory waste contains pollutants that might be harmful to local wildlife. You will also suggest how the factory could remove these pollutants from its water before letting the water run into the river. Finally, you will consider the costs and benefits of your suggestion.

Equipment and Materials

SKILLS HANDBOOK 4.B.3.

Several identical samples of contaminated river water are available for you to work with. Choose the equipment and materials for your procedure, including safety equipment.

Research and Consider

Examine the mixture and think about the characteristics of the components of the mixture. If necessary, place the mixture under bright light or stir it to explore its components further. You may want to use a magnifying glass.

Plan and Construct

SKILLS HANDBOOK 4.B.2., 4.B.4

1. Plan how you will separate a sample of the mixture into its components. Assume that the mixture may have components that you cannot see. You may choose to use the technique shown in Figure 2.

Figure 2 One technique for removing water from a mixture

2. Write a detailed procedure. You may use a flow chart.
3. Have your teacher check and approve your procedure.
4. Assemble your equipment and materials, and perform your procedure. Record your observations.

Test and Modify

- Did your procedure separate all possible components of the mixture?
- Should you change the sequence of steps in your procedure?
- Can you reduce the number of steps in your procedure?

If necessary, modify your procedure and try it again.

Evaluate

Compare how well your procedure meets the requirements of the Design Brief:

- How well were you able to separate all of the components of the contaminated river water?
- What were the components?
- What characteristics of the components did you use to separate them?
- How could you improve your procedure, or make it more effective and more efficient?
- Are any of the components damaging to the environment? If so, how should they be removed from the factory's waste? If necessary, perform research to answer these questions.

Communicate

Draw a detailed flow chart showing all the steps that you used to separate the mixture's components. This should be an expansion of the one you created for Plan and Construct. Label each step with the following information:

- the separation method that you used
- the components that you obtained
- the characteristics of the components that allowed you to separate them from each other

Indicate, on your flow chart, which components may have been damaging to the environment, and how they should be removed from the factory's waste.

Present your findings in the form of a poster, report, or oral presentation.

Assessment

You will be assessed on how well you

- identify characteristics of components that allow separation
- plan a procedure for separating the components that is
  - safe
  - effective
  - efficient
- test the procedure as planned
- make any necessary changes to the procedure, and then retest
- communicate your best procedure as a flow chart
- identify dangerous components
- recommend a technique for removing dangerous components from the factory's waste

UNIT A

Unit Review

Pure Substances and Mixtures

Make a Summary

Figure 1 shows the start of a concept map. Copy this onto the centre of a large piece of paper. Work with a partner or small group to complete the concept map. Try to include all the vocabulary terms in this unit. Your concept map should include explanations for the connections between terms.

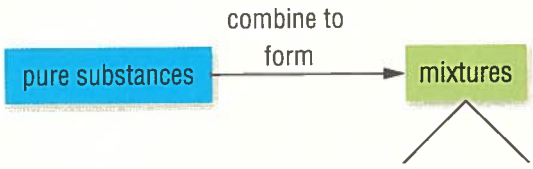


Figure 1 Make a concept map starting with these terms.

Unit A Review Questions

The following icons indicate the Achievement Chart categories: K/U Knowledge/Understanding; T/I Thinking/Investigation; C Communication; A Application

What Do You Remember?

1. Write a definition of matter. K/U
2. What is matter made of? K/U
3. Write, in your own words, the five main ideas of the particle theory. K/U
4. What is the difference between the particles of a solid and the particles of a liquid? K/U
5. (a) What are the three states of matter?
   (b) Use the particle theory to describe each of the three states of matter. K/U
6. (a) What is the difference between a pure substance and a mixture?
   (b) Give one example of each. K/U
7. (a) Name the two types of mixtures and explain how they are different.
   (b) Give one example of each. K/U
8. Can you tell if a sample of matter is a pure substance or a solution by looking at it? Explain why or why not. K/U
9. Name two industries that separate mixtures. K/U A
10. Can you tell if a mixture is a mechanical mixture by looking at it? Explain. K/U C
11. Identify each of the following kinds of matter as a pure substance, a mechanical mixture, or a solution:
    (a) salt
    (b) clear shampoo
    (c) table sugar
    (d) a salad
    (e) 14-karat gold
    (f) soil K/U
12. Distinguish between a homogeneous mixture and a heterogeneous mixture. K/U
13. Is air a solution or a pure substance? Explain your answer. K/U
14. (a) What is the difference between a solute and a solvent?
    (b) Give one example of each. K/U
15. Draw a model that shows the particles of a gas. Explain your model. K/U C
16. Is a piece of paper a solid, a liquid, or a gas? Explain your answer. K/U

17. List three different ways pollutants get into the water system. K/U

18. (a) List three solutions in your home. A

    (b) What is the solvent of each solution? A

19. Devawn says, "Solutions can be solids, liquids, or gases." Do you agree? Explain. K/U C

20. Describe what happens to the sewage that goes down your drain and toilet before it is released into the environment. K/U A

21. (a) Aluminum foil is a solid pure substance. Draw a model of the particles of a piece of aluminum.

    (b) Brass is a solid solution. Draw a model of the particles of a piece of brass. K/U C

22. Distilled water is a pure substance.

    (a) Draw a model showing the particles of liquid distilled water.

    (b) Draw a model showing the particles of solid distilled water (ice). K/U C

23. You dissolve 10 mL of sugar in 30 mL of water. The total volume is less than 40 mL. Use the particle theory to explain this observation. K/U

24. Salt does not dissolve well in oil. The salt tends to settle to the bottom of the container.

    (a) What kind of mixture is this?

    (b) Draw a model showing the particles of a mixture of salt and oil. K/U C

What Do You Understand?

25. Describe one way to separate each of the following mixtures into its components. Describe the characteristics that make each separation possible.

    (a) iron filings and sand

    (b) sugar and water

    (c) tea leaves and water T/I

26. (a) What methods does a flour mill use to separate wheat grains from other kinds of matter?

    (b) What method does a flour mill use to separate the different parts of the wheat grains after they are ground up? K/U A

27. Use the particle theory to explain each of the following observations:

    (a) Sugar dissolves in water even if you do not stir or heat the mixture.

    (b) Stirring or heating makes sugar dissolve in water faster.

    (c) You add a drop of red food colouring to a glass of water. You do not stir the mixture, but the food colouring spreads throughout the water. T/I C

28. Give one reason why someone might want to separate a mechanical mixture. A

29. "Pure orange juice" may contain water, pieces of orange pulp, sugar, vitamin C, potassium, protein, and flavour particles.

    (a) Is pure orange juice a pure substance, a mechanical mixture, or a solution? K/U

    (b) Suggest two methods that could be used to separate some of the components of orange juice. T/I A

30. A red solid dissolves in a glass of water. Draw a picture of what the solution actually looks like, and then draw a model of the particles of the solution. K/U C

31. Figure 2 shows one step in the process of refining sugar. Research and report on the process of refining table sugar from raw materials. C A

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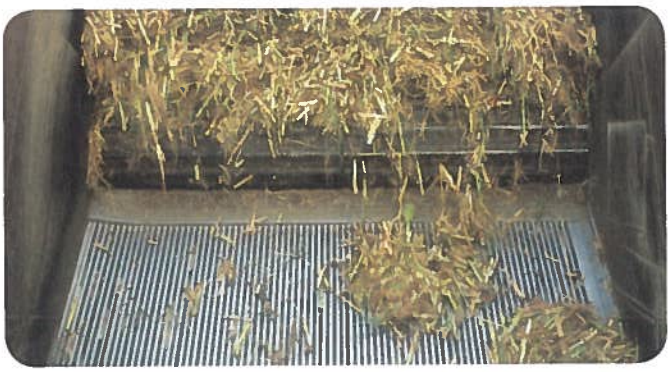

Figure 2

32. Explain why water is an important solvent in

(a) your body

(b) the environment K/U A

33. (a) When you boil a mixture of sugar maple sap to make maple syrup, what part of the mixture are you removing?

(b) Is the process of making maple syrup likely to harm the environment? Explain why or why not. K/U C A

34. Uranium is a pure substance that is radioactive. Use the Internet to research uranium. K/U T/I A

(a) Why is uranium harmful to humans?

(b) What is uranium used for?

(c) What are the benefits of using uranium?

(d) How do people dispose of uranium?

(e) Do you think humans should continue to use uranium? Explain why or why not.

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35. Jason says, "I can separate a solution of sugar and water even though I can't see the different parts of the mixture." Yousif says, "I can only separate a mixture if I can see the different parts." Do you agree with Jason or with Yousif? Explain your answer. K/U

36. (a) Matt mixes 5 g of sugar with 10 g of water. Can he accurately predict the total mass of the mixture? Explain.

(b) Raven mixes 5 mL of sugar with 10 mL of water. Can she accurately predict the total volume of the mixture? Explain. K/U T/I A

37. (a) Kemisha's glass of ice water has a mass of 35 g. Will the mass change as the ice melts? Explain.

(b) Kemisha left her glass of water outside in the sun for the whole day. Will the mass of the water in the glass change? Explain. K/U T/I

38. (a) How does the petroleum industry separate petroleum into different parts? K/U

(b) What effects does the petroleum industry have on the environment? K/U

(c) Would you want a petroleum refinery near your home? Why or why not? A

39. *Exxon Valdez* was a ship carrying oil across the ocean. Use the Internet to research what happened to *Exxon Valdez* in 1989.

(a) What happened to *Exxon Valdez*?

(b) What did people do to solve the problem?

(c) How well did the solution(s) work?

(d) What were the long-term effects?

(e) Do you think oil should be carried across oceans in ships? Why or why not? Suggest alternatives to ocean transport of oil. K/U

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Solve a Problem!

40. The town of Jonesburg is considering building a petroleum refinery in the middle of town. You have been asked to advise the city on the best path to take. Write a report to the city, outlining the pros and cons of this proposal, and make your recommendation. T/I A C

41. Ali dissolves 3 g of sugar in water to make 10 mL of solution. What is the concentration of Ali's solution in grams per 100 mL? K/U

42. Ling left a glass with some water in it on a counter overnight. The next day, the glass was empty.

(a) What happened to the water?

(b) Ling noticed a tiny bit of white solid left in the bottom of the glass. Where might the white solid have come from?

(c) What could Ling have done to prevent the glass of water from emptying? T/I A

43. At 20 °C, you can dissolve no more than 36 g of salt in 100 mL of water.

(a) How many grams of salt can you dissolve in 50 mL of water?

(b) If you dissolve 20 g of salt in 100 mL of water, is the solution saturated or unsaturated? Explain.

(c) If you dissolve 1 g of salt in 100 mL of water at 20 °C, is the solution concentrated or dilute? Explain why. K/U A

Create and Evaluate!

44. Sugar dissolves easily in water. It does not dissolve easily in ethanol.

(a) Write a short story that explains why sugar dissolves in water but not in ethanol.

(b) Does your story describe the dissolving process accurately? Explain.

(c) Modify your story so that it describes the dissolving process better. K/U C

45. "Mixtures have benefits and costs." Write a short paragraph explaining what this sentence means. Provide examples of the benefits and costs of using specific mixtures. K/U C A

Reflect on Your Learning

46. Review the particle theory in Section 1.1.

(a) How well do you think you understand the particle theory?

(b) How much does the particle theory help you to understand dissolving?

(c) Here are some things you can do to understand the particle theory better:

- Read Section 1.1 again.
- Discuss the particle theory with a friend.
- Review all the diagrams showing models of particles in this unit.
- Use a physical model to help you think about particles.
- Draw a picture (model) that shows the particles of a solution. Carry out two of the ideas listed. Did the ideas help? Why or why not?