UNIT

3 Mixtures and Solutions

A mixture of rocks on the beach at Green Point in Gros Morne National Park

Key Ideas

7 **Matter can be classified as mixtures or pure substances.**

7.1 How Mixtures Are Different from Pure Substances

7.2 Classifying Mixtures

8 **Some substances dissolve to form solutions faster and more easily than others.**

8.1 Solutes, Solvents, and Solubility

8.2 Solubility and Concentration

9 **Many useful products depend on technology for separating mixtures and solutions.**

9.1 Processing Solutions and Other Mixtures

9.2 Separating Earth's Mixtures

Getting Started

Gold has been prized for thousands of years by people in nearly every culture.

According to history, King Hiero II was the ruler of Syracuse on the island of Sicily about 2300 years ago. According to legend, one day Hiero had the royal goldsmith make a new crown of gold. Hiero provided pure gold for the task. When the crown was presented to him, however, Hiero became suspicious. The crown looked like gold. It felt like gold to the touch, and it seemed to have the mass of pure gold. Despite these appearances, Hiero believed that the goldsmith had cheated him by mixing silver in with the gold. But how could the deception be found without damaging the crown?

One of the great problem solvers of the time was a distant relative of Hiero named Archimedes. The king asked him to find out if the crown was made of pure gold. Legend has it that Archimedes solved the problem while taking a bath. As he settled into the tub, water spilled out over its sides. Archimedes realized that the volume of water that spilled out was equal to the volume of his body that was under the water. He reasoned that he could find the volume of the crown by measuring the volume of water that the crown displaced. Then, all he had to do was find the mass of the crown and calculate its density. (Density, you may recall, is the amount of mass in a given volume. It is calculated by dividing mass by volume: $D = m/v$.) So thrilled was Archimedes by his discovery that he leaped from the tub and ran through the streets of Syracuse yelling, "Eureka!"

What had he found? Density is a property of matter. Archimedes knew that he could find out if the density of the crown matched the density of pure gold. If it did, the crown was pure gold. If it did not, the king had been cheated. Archimedes found that the crown had a density that was less than that of pure gold. The crown was, in fact, a mixture of gold and silver.

Your study of mixtures in this unit may not be as dramatic as the story of Hiero's crown. However, like Archimedes, you will discover how attention to the properties of matter can help you make, identify, and separate mixtures.

Word Connect

Sometimes people use the word *eureka* when they are excited about something. It comes from a Greek word that means, "I have found it!"

internet connect

Archimedes had much to say "eureka" about in his lifetime. Find out about his inventions and accomplishments. Start your search at **www.discoveringscience.ca.**

Mixed or Pure?

Find Out ACTIVITY

Suppose that you pick up a rock on the beach, in a garden, or on a lawn. You see that some parts of it are grey, some parts are white, and some parts are blue. You conclude that the different-coloured parts of the rock must be different types of matter. Is this a reasonable conclusion?

There are many properties that can help us tell one type of matter from another. In this activity, you will compare the properties of pairs of items.

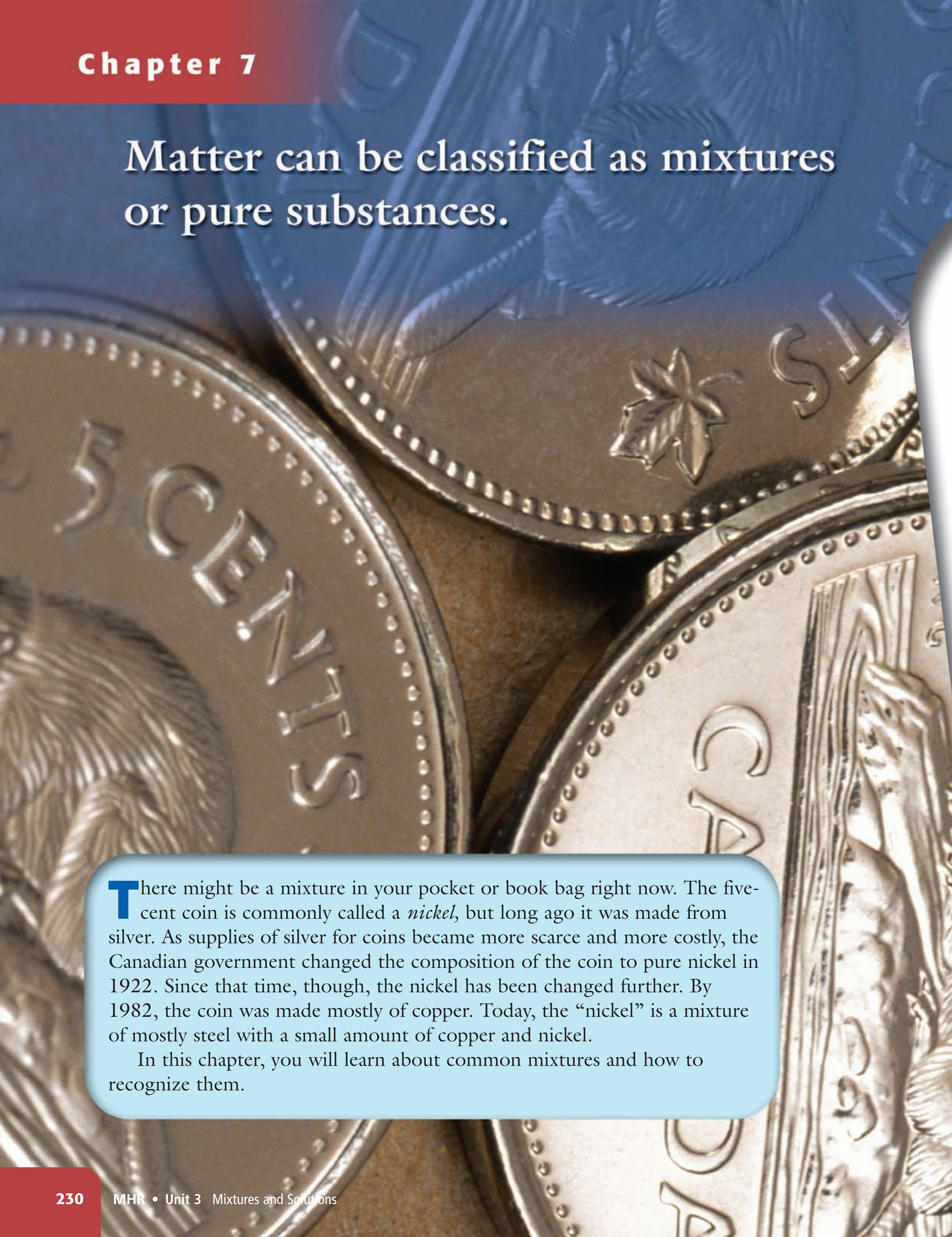
What to Do

1. With a partner, select one of these pairs of items:
   vinegar and water
   aluminium foil and plastic wrap
   stainless steel and glass
   molasses and cooking oil
   metal paper clips and sawdust

   Make a list with as many differences as you can. **Hint:** Some properties that you could include are colour, transparency, hardness, strength, and mass.
2. Repeat step 1 for the other pairs of items.

What Did You Find Out?

1. Compare your list of differences with the rest of the class. How many differences between each item did your class discover?
2. Suppose that you have a bowl filled with a mixture of the paper clips, bits of aluminium foil, and water.
   (a) Describe one way that you could separate the items from each other.
   (b) Describe how your separation technique would change if you added water to the original mixture.



Chapter 7

Matter can be classified as mixtures or pure substances.

There might be a mixture in your pocket or book bag right now. The five-cent coin is commonly called a *nickel,* but long ago it was made from silver. As supplies of silver for coins became more scarce and more costly, the Canadian government changed the composition of the coin to pure nickel in 1922. Since that time, though, the nickel has been changed further. By 1982, the coin was made mostly of copper. Today, the "nickel" is a mixture of mostly steel with a small amount of copper and nickel.

In this chapter, you will learn about common mixtures and how to recognize them.

What You Will Learn

In this chapter, you will
- **identify** different mixtures in your home and in the world around you
- **distinguish** between heterogeneous and homogeneous mixtures
- **distinguish** between mixtures and pure substances
- **distinguish** between mixtures and pure substances using the particle theory of matter

Why It Is Important

You eat, drink, breathe, wear, and use mixtures each day. So knowing about mixtures can help you appreciate and understand more about the world around you.

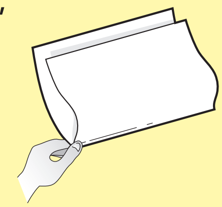
Skills You Will Use

In this chapter, you will
- **observe** properties of mixtures
- **classify** mixtures
- **model** the particles in mixtures
- **communicate** your observations and your understanding of mixtures

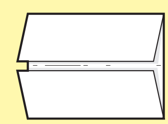
FOLDABLES™
Reading & Study Skills

Make the following Foldable to take notes on what you will learn in Chapter 7.

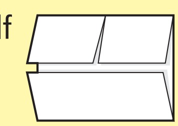
STEP 1 **Using** an 11″ × 17″ sheet of paper with the short side along the top, begin as if you were going to fold the paper in half along the long axis, but instead of creasing the paper, **pinch** it in to show the midpoint.



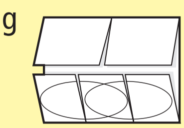
STEP 2 **Fold** the outer edges of the paper in to meet at the midpoint, forming a shutter fold.



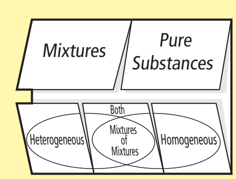
STEP 3 **Cut** the top tab in half to form two equal tabs.



STEP 4 **Draw** two overlapping ovals on the bottom tab and cut the tab into thirds, forming a Venn diagram with three tabs.



STEP 5 **Label** the Foldable as shown.



Organize As you read the chapter, record notes, observations, definitions, and examples of mixtures and pure substances. Distinguish between heterogeneous and homogeneous mixtures.

7.1 How Mixtures Are Different from Pure Substances

Matter can be either mixtures or pure substances. Mixtures may be either homogeneous or heterogeneous. Homogeneous mixtures have the same properties throughout. Heterogeneous mixtures have different visible parts with different properties. All matter is made up of particles. We can classify something as a mixture or as a pure substance based on the types of particles that it is made of.

Key Terms

heterogeneous mixture
homogeneous mixture
mixture
pure substance

Many of the objects that you have at home come with labels that tell you what they contain. You can see these labels on foods, clothes, and cleaning products. Figure 7.1 shows some examples you may have seen.

The labels list all the ingredients in these products. If the label shows more than one ingredient, the product is a mixture. Most of the types of matter that you use each day are mixtures. A **mixture** contains two or more different types of matter.

Most objects that you see or use have an ingredient list. Is a beach a mixture? Is an ocean a mixture? What about air, or even a simple glass of water? How can you tell that something is a mixture if it does not have an ingredient list?

Figure 7.1 What evidence do you see that each of these products is a mixture?

7-1A Now You See It...

Find Out ACTIVITY

Is it possible to make a mixture in which you cannot detect the different parts? Use sugar and water to find out.

Safety

Do not taste, eat, or drink the sugar and water.

Materials

- beaker or plastic cup
- tap water
- white sugar
- measuring spoon
- magnifying lens

What to Do

1. Prepare a table of observations like the one below. Give your table a title.

Observable Properties	Sugar	Water	Sugar-Water Mixture (Initial Appearance)	Sugar-Water Mixture (After 24 h)
Colour				
State (solid, liquid, or gas)				
Transparency (clear, cloudy, or opaque)				

2. Observe the three properties of sugar and water that are listed in the table. Record your observations.
3. Add water to the cup until it is about three-quarters full. Let it sit for a few seconds until the water is still.
4. Gently pour 5 mL (one teaspoon) of sugar into the water. Observe the appearance of the water and the sugar. Record your observations in your table.
5. Place the cup where it can stay untouched for about 24 h.
6. Observe the contents of the cup after 24 h. Record your observations in your table.

What Did You Find Out?

1. The three statements below compare the properties of the sugar-and-water mixture with the properties of the sugar and the properties of the water. Choose the statement that you think is the most accurate. Record it, and give reasons for your choice.
   - The mixture has all the properties of water and only these properties of the water.
   - The mixture has all the properties of sugar and only these properties of the sugar.
   - The mixture has a some of the properties of sugar and some of the properties of water.
2. You know that the mixture you made has two parts: sugar and water. However, the mixture *looks* like it has only one part. Think about what you have learned about the particle model. (Review Section 5.1.) Make a sketch to show what you think the particles in the sugar-water mixture look like. Add labels and a caption to explain your sketch.

Heterogeneous and Homogeneous Mixtures

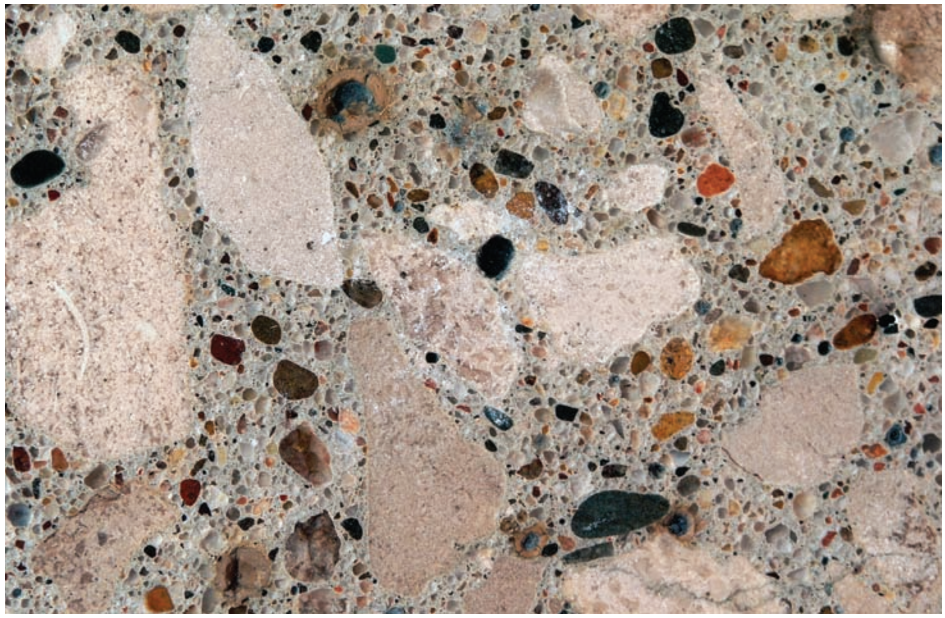


Figure 7.2 Concrete is an example of a heterogeneous mixture. You can easily see the different types of matter. Each type of matter in the mixture has its own distinct set of properties such as colour, size, and shape.

When you see a sample of matter that has more than one set of properties, you know for sure that it is a mixture. For instance, the concrete shown in Figure 7.2 is a mixture. You can see that it contains different types of rock with different shapes, sizes, and colours. If you have watched someone make concrete, you may know that it also contains sand, cement powder, and water.

Concrete is an example of a heterogeneous mixture. So is a beach, salad dressing, a computer, and smog-filled air. A **heterogeneous mixture** is a mixture that is made up of two or more parts. Usually, the parts are visible to the eye. Often, you can see the different parts just by looking at the mixture. Sometimes you need a microscope to see them. (You will see an example of a mixture with microscopic parts on page 245.) In a heterogeneous mixture, the different parts of the mixture are combined in a way that each part keeps its own properties.

When you mix sugar with water, the solid grains of sugar seem to disappear. You cannot see them with a hand lens or even with a microscope. A sugar-water mixture is an example of a homogeneous mixture. A **homogeneous mixture** is a mixture in which the parts appear to be the same throughout. The stainless steel frying pan shown in Figure 7.3 is a homogeneous mixture. Other examples include salt water, vegetable oil, and clean air. In a homogeneous mixture, the different parts are combined in a way that their properties are the same throughout the mixture.

Word Connect

Heterogeneous comes from two Greek words that mean "different" (*heteros*) and "kind" (*genos*). So, heterogeneous means "different kind." Homogeneous comes from two Greek words that mean "same" (*homos*) and "kind" (*genos*). So, homogeneous means "same kind."

Figure 7.3 Stainless steel is a homogeneous mixture. Metals such as iron and chromium are used to make this mixture. Non-metals such as carbon and silicon may be added as well.

Reading Check

1. What is a mixture?
2. Write a definition for the term *heterogeneous mixture*. Include two examples in your definition.
3. Write a definition for the term *homogeneous mixture*. Include two examples in your definition.

Suggested Activity

Conduct an Investigation 7-1C on page 238.

7-1B Mixture Match-Up

Find Out ACTIVITY

Your task is to examine five items from a kitchen and five items from a bathroom or laundry room. From the kitchen, you could select ketchup, prepared mustard, spices, soft drinks, dishwashing liquid, cereal, jam, molasses, or bread. From the bathroom or laundry room, you could select shampoo, conditioner, soap, toothpaste, shaving cream, a pumice stone, an emery board, hand lotion, hair gel, or detergent.

Safety

- In this activity, you will be choosing a variety of household products to examine. The suggested products have been chosen as safe for you to examine. Do not use any products other than those listed here. Wash your hands after handling each product.

What to Do

1. Prepare a table of observations like the one below. Give your table a title.

Product	Classification (Heterogeneous, Homogeneous, or Other)	Reasons

2. In the first column, list each product you examine. In the second column, say whether the product is a heterogeneous mixture or a homogeneous mixture. If you can't decide, or if you think the product is some other kind of mixture, record your choice as "Other." In the third column, give reasons for your choice.

What Did You Find Out?

1. What properties did you think were most useful for helping you decide what type of mixture each product is?
2. Compare your choices with choices made by your classmates.
   (a) Which products did the class agree about?
   (b) Which products did the class disagree about?
   (c) Explain why the class disagreed.

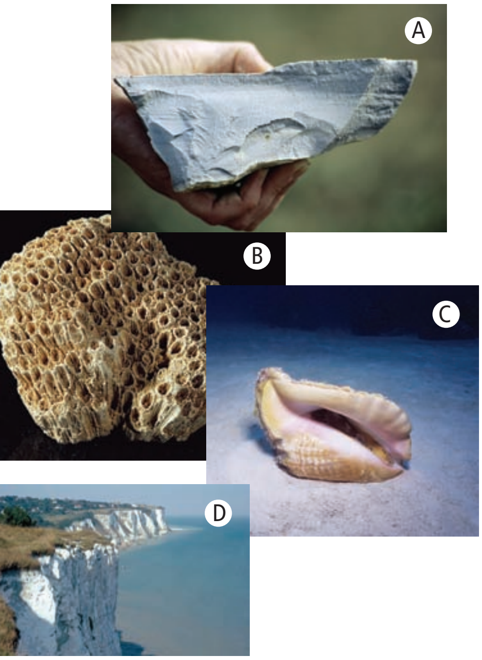


Figure 7.4 Limestone is a common name for a chemical called calcium carbonate. In nature, calcium carbonate (A) is found in many forms. For example, you may find it as coral (B), seashells (C), and the chalky white cliffs of Dover in England (D).

Pure Substances

Is there any kind of matter that is *not* a mixture? Figure 7.4 shows one example: calcium carbonate (limestone). Pure calcium carbonate contains only calcium carbonate. Every sample of calcium carbonate has the same properties as every other sample of calcium carbonate. So, a piece of calcium carbonate from the Northern Peninsula of the island of Newfoundland has the same properties as a piece of calcium carbonate from the Bruce Peninsula in Ontario or the Burren in County Clare, Ireland.

Calcium carbonate is a pure substance. A **pure substance** is matter that is the same throughout. Sucrose (white sugar) is another pure substance. So are copper, pure water, iron, carbon dioxide, and table salt. In a pure substance, each part of the substance has the same properties. So, for instance, the outside of a piece of calcium carbonate has the same colour and other properties as the inside.

Every sample of a pure substance always has the same properties. Why is this the case? In Chapter 5, you learned about the particle theory of matter. One part of the theory explains what pure substances are: *Each pure substance has its own kind of particle. This kind of particle is different from the kinds of particles that make up all other pure substances.* Use Figure 7.5 to help you understand this idea. A pure substance always has the same properties, because it is made up of exactly the same kind of particles.

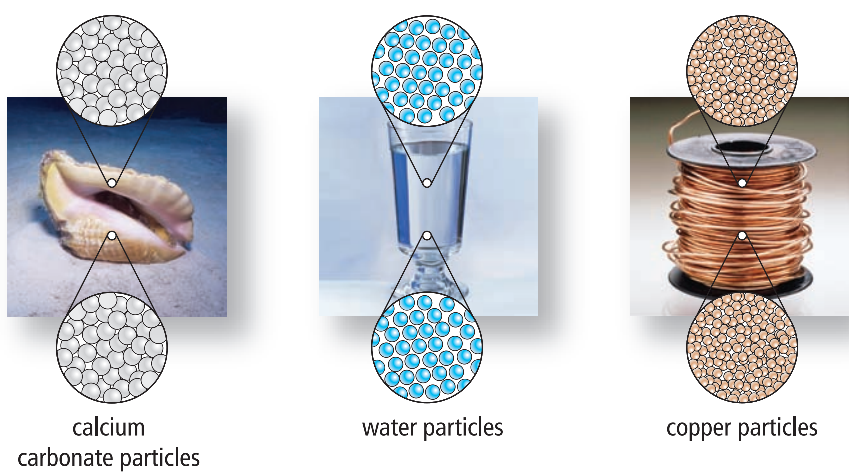


Figure 7.5 Calcium carbonate, pure (distilled) water, and copper are pure substances. See how any part of pure calcium carbonate is made up of only calcium carbonate particles. Any part of pure water is made up of only water particles. Any part of pure copper is made up of only copper particles.

How Pure Substances Are Different from Mixtures

Figure 7.6 shows two clear, colourless, and odourless liquids. Suppose that someone told you that one of the liquids is a salt-water mixture and the other is the pure substance, water. Could you tell which is which just by looking at them? It is very unlikely that you can. To tell the two liquids apart, you would have to observe more of their properties. For example, you could measure their boiling points—the temperature at which each liquid changes state from a liquid to a gas. Pure water has a boiling point of 100°C. If you knew that either one of the liquids in Figure 7.6 boils at this temperature, you could be fairly sure that it is water.

Figure 7.6 Which pure substances and mixtures could these two liquids be? How could you tell whether one, both, or neither is a pure substance or a mixture?

Pure substances are different from mixtures, because their compositions are different. As you know, a pure substance is composed of only one type of particle. A mixture, on the other hand, is composed of two or more types of particles. Figure 7.7 models how the particles in a pure substance are different from the particles in a mixture.

The different particles in a mixture keep their own properties. So, for example, a mixture of salt and water may have a boiling point of 103°C. The mixture has a different boiling point from pure water because salt has a very high boiling point: 1465°C. When salt is mixed with water, the properties of the salt affect the temperature at which the mixture can boil.

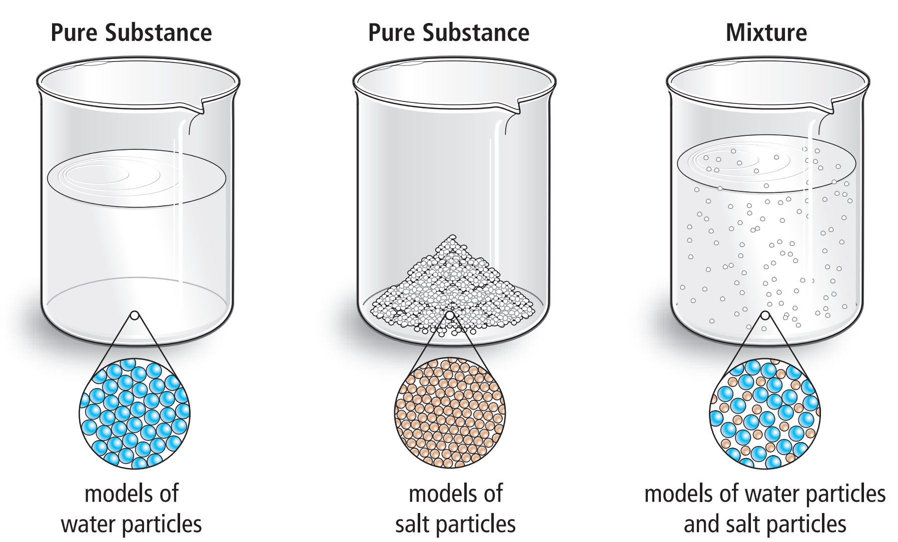


Figure 7.7 Pure substances have only one type of particle, while mixtures have two or more types of particles.

Explore More

Use sketches, drawing software, or solid objects such as marbles or bolts to model the particles that make up two mixtures and two pure substances of your choice. Add labels to explain your models.

Reading Check

1. What are two examples of pure substances?
2. Use the particle theory of matter to explain what a pure substance is.
3. Use the particle theory of matter to explain how a pure substance is different from a mixture.

Connection

You can review the particle theory of matter in Section 5.1.

7-1C Examining Three Common Beverages

Skill Check

- Observing
- Measuring
- Classifying
- Evaluating information

Safety

- It is not safe to taste these common beverages in the science classroom. Laboratory containers that look clean may still contain invisible traces of harmful chemicals left over from a previous activity.

Materials

- 3 clean test tubes
- marking pen and masking tape (for labels)
- test tube rack
- magnifying glass
- eye dropper
- watch glass or Petri dish
- homogenized milk
- orange juice (fresh or from concentrate)
- soda water

Science Skills

Go to Science Skill 8 for information about how to use a microscope.

Is your favourite beverage heterogeneous or homogeneous? In this investigation, you will inspect three common beverages—milk, orange juice, and soda water—and classify them based on your observations.

Question

On what basis can you classify milk, orange juice, and soda water?

Procedure

Beverage	Method of Observation	Observations	Inference	Reasons
Milk	Unaided eye			
	Hand lens			
	Microscope			
Orange Juice	Unaided eye			
	Hand lens			
	Microscope			
Soda Water	Unaided eye			
	Hand lens			
	Microscope			

1. Your teacher will give you a copy of the table of observations. Give your table a title.
2. Label the three test tubes M (for milk), O (for orange juice), and S (for soda water). Fill half of each test tube with the correct beverage, and place it in the test tube rack.
3. Using only your unaided eye, examine the beverage in each test tube. Can you see any bits that are different from the rest of the beverage? Record your observations for each beverage in your table.
4. Based only on what you see for yourself, infer whether each beverage is heterogeneous or homogeneous. Record your inference in the correct row of your table. Include the reasons for your inference in the last column.
5. Place a small amount of one of the beverages on a watch glass or Petri dish. Using the magnifying glass, examine the beverage again. Record your observations in your table. Repeat for the other two beverages.
6. Infer whether each beverage is heterogeneous or homogeneous. Remember to include your reasons.

7. Your teacher will set up three compound light microscopes for inspecting each of the beverages. Observe the beverages using the low power objective lens of the microscope.
8. What new observations might lead you to reconsider some of your previous inferences? Record your new observations in your table.
9. Next, observe what each beverage looks like under the microscope at high power. Note the sizes and shapes of any different materials that you see. Also note whether or not they are evenly spaced throughout the liquid.
10. Make your final inferences, based on the microscopic evidence. Record them in your table.
11. Clean up and put away the equipment you have used.

Analyze

1. When you examined the beverages with your unaided eye, you looked for different types of matter with different properties within each liquid.
   (a) Which types of matter were big, small, or microscopic?
   (b) Were the types of matter all the same shape?
   (c) Explain which types of matter were solids, liquids, or gases.
2. Describe what, if anything, you were able to see with the magnifying glass that you could not see with your unaided eye:
   (a) in the milk
   (b) in the orange juice
   (c) in the soda water
3. **(a)** Which beverage appeared to be homogeneous until you saw what it looked like under the microscope?
   (b) Describe the new evidence that you observed.
   (c) Under high power, you could see bits of different matter with different properties, but the bits were not all exactly the same size and shape. What reasons can you give to explain the differences?
4. Summarize your findings. Write one or two sentences about each beverage. Be sure to state whether it is heterogeneous or homogeneous. Give reasons for your answers.

Conclude and Apply

1. What would you have to observe before you would be willing to identify a mixture as homogeneous? Explain your answer.

Wild, Weird, Wonderful

www Science

What's the Metal in the Ice Man's Axe?

In September 1991, hikers in the Alps, near the border between Austria and Italy, discovered the body of a man. But this was no ordinary discovery. The man had been trapped in a glacier for thousands of years. He was almost perfectly preserved. With him was an assortment of tools, including an axe with a metal blade.

Scientists were especially interested in the axe. At first, they thought that the metal axe blade was bronze, which is a mixture of copper and tin. This was not possible, though. The Iceman and his clothing had been dated to be about 5200 years old. Scientists believe that bronze was invented only about 4000 years ago. So, the axe blade could not be bronze.

Scientists then hypothesized that the blade could be copper. People have been using copper for at least the past 6000 years. To test their hypothesis, scientists exposed the axe blade to X-ray radiation. When metals are exposed to high-energy radiation, their particles vibrate very energetically. As the vibration of the particles slows down, the particles give off energy that can be examined with specialized equipment. Scientists use this "energy signature" to identify the type of particle that is giving off the energy.

Analysis using this technique confirmed the scientists' hypothesis. The metal of the axe blade was almost pure copper.

Checking Concepts

1. Identify each of the following as a mixture or a pure substance, and give a reason to explain your choice. If you are not sure, write "unsure," and give a reason to explain why.
   (a) oxygen gas
   (b) air
   (c) whipped cream
   (d) slush
   (e) garden soil
   (f) iron
   (g) sandwich
   (h) chocolate chip cookie
   (i) pencil
   (j) freshly squeezed orange juice
2. Classify each of the mixtures you identified in question 1 as homogeneous or heterogeneous. Explain your decisions.
3. Make a sketch to show the particles that make up a pure substance. Add any labels that you think are needed to make your ideas clear.
4. Make a sketch to show the particles that make up a mixture. Add any labels that you think are needed to make your ideas clear.

Understanding Key Ideas

5. When you first open a bottle of pop, the liquid is filled with tiny bubbles.
   (a) Is the pop homogeneous or heterogeneous? Explain your answer.
   (b) If you let the pop sit for a day, what happens? Is the liquid homogeneous or heterogeneous now? Explain your reasoning.
6. The photo below shows polluted air—smog. Smog is air that contains solid and gaseous pollutants. Is smog a heterogeneous or homogeneous mixture? Explain your answer.

Pause and Reflect

Think about your experiences so far in this chapter. At this time, do you think that most materials on Earth are homogeneous or heterogeneous? Explain why you think so.

7.2 Classifying Mixtures

Mixtures may be classified as heterogeneous and homogeneous. The different types of matter in a heterogeneous mixture usually are easy to see. Solutions are homogeneous mixtures in which two or more substances combine to form a mixture that looks the same throughout. Some mixtures are neither clearly heterogeneous nor clearly homogeneous. They are, instead, mixtures of mixtures.

Key Terms

alloy
solution

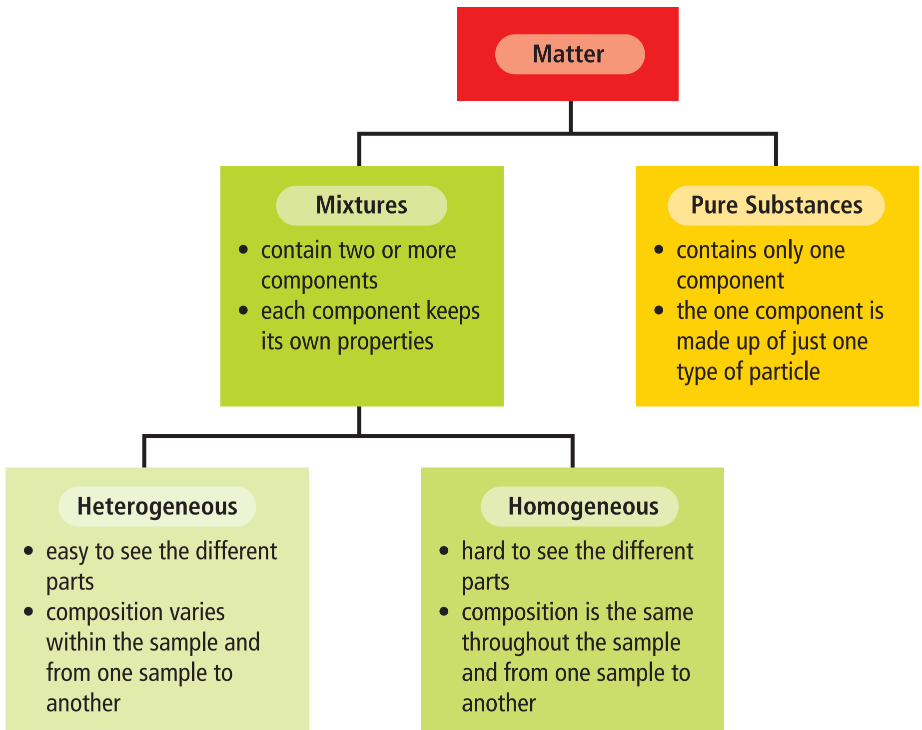


Figure 7.8 A classification of matter

In the previous section, you classified matter as either a mixture or a pure substance. The flowchart in Figure 7.8 summarizes this sorting of matter into two broad categories. You also learned that mixtures may be heterogeneous or homogeneous. The flowchart includes this information, too.

Mechanical Mixtures

Mixtures that are obviously heterogeneous (you can easily see the different types of matter) are sometimes called mechanical mixtures. These mixtures are easy to separate by hand or by mechanical means such as filtering. Many foods are mechanical mixtures. Think of sandwiches, salads, salsa, and stir-fried vegetables, for instance. Figure 7.9 shows another great example: pizza.

Figure 7.9 A pizza is a mechanical mixture because you can easily see the different parts: the crust, sauce, cheese, and toppings.

Solutions

If a mixture is homogeneous, it is a **solution.** Household vinegar, tap water, and household hydrogen peroxide (for disinfecting cuts) are all solutions. So is the window cleaner shown in Figure 7.10. A solution is made when two or more substances combine to form a mixture that looks the same throughout, even under a microscope.

You encounter solutions everywhere. Seawater is a solution of salts and water. Clean air is a solution of nitrogen gas, oxygen gas, and tiny amounts of other gases, including carbon dioxide and water vapour. There are even solutions of solids, such as the objects shown in Figure 7.11. Solutions that are made from two or more metals are called **alloys.** You will learn more about solutions in Chapter 8.

Figure 7.10 Window cleaners are solutions of ammonia (or vinegar, in some cases) and other substances in water.

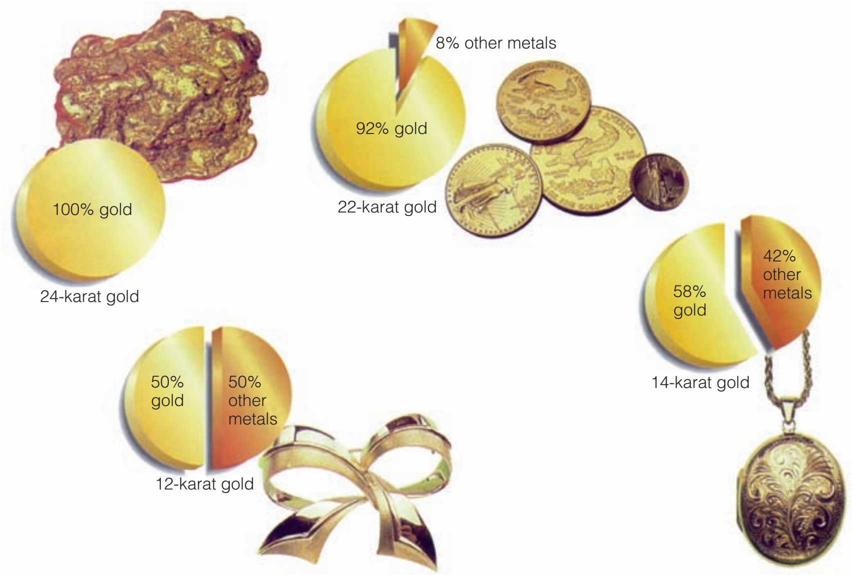


Figure 7.11 The pie graphs show the percentages of gold and other metals in different "gold" objects. Which of the objects shown here are pure substances? Which are homogeneous mixtures (solutions)?

Solution or Heterogeneous Mixture?

How can you tell if a mixture is a solution or a heterogeneous mixture? Often you can tell just by looking. But what if you can't? There are a few techniques that can help you decide.

Figure 7.12 Which of the two mixtures in this photo is homogeneous? (Re-read the third bulleted point in the text area of the page for help if you are not sure.)

- Use a microscope. If the mixture is a solution, you will be able to see only one type of matter, even with a microscope.
- If the mixture is a liquid, pour it through a filter. If anything is caught in the filter, then the mixture is definitely heterogeneous (a mechanical mixture).
- Shine a light through the mixture. Figure 7.12 shows an example of this technique. Solutions do not scatter light. So you will not see a beam of light as it passes through a solution. A heterogeneous mixture such as muddy water or dusty air, however, *does* scatter light.

Figure 7.13 Many juices are solutions of concentrated juice, water, flavourings, and vitamins.

Suggested Activity

Conduct an Investigation 7-2A on page 246

Combinations of Mixtures

Some mixtures are clearly heterogeneous (mechanical mixtures). You can easily see the separate parts that make up a tossed salad, for instance. What about solutions? As you can see in Figure 7.13, you can use a food product label to help you tell that this juice is a solution.

Sometimes, though, you cannot tell whether something is homogeneous or heterogeneous just by looking at it. For example, is milk homogeneous or heterogeneous? Milk looks as if it is homogeneous. But under a microscope, you can see that milk contains "blobs." These "blobs" are globules of fat. Figure 7.14A shows a sample of milk under a microscope. One single drop of milk contains about 100 000 000 (one hundred million) fat globules. The globules are so tiny that milk seems to be homogeneous when you look at it with the unaided eye.

Does this mean that milk is really a heterogeneous mixture? No. There are other substances in milk, too. You can see this in Figure 7.14B. The Figure shows that some parts of milk are homogeneous (solutions). Other parts of milk are heterogeneous. So, milk is really a mixture of mixtures!

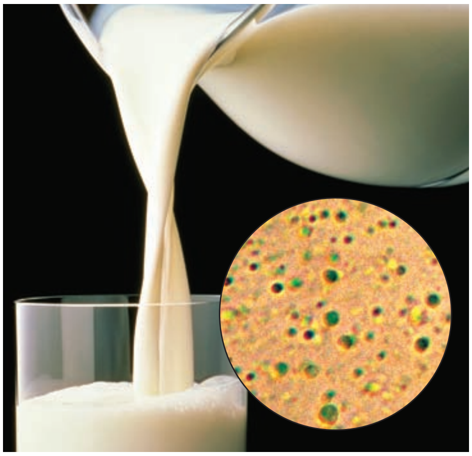


Figure 7.14A The round photograph shows how milk looks under a microscope. The milk is magnified about 400 times. How can you tell, from this image, that milk is not homogeneous?

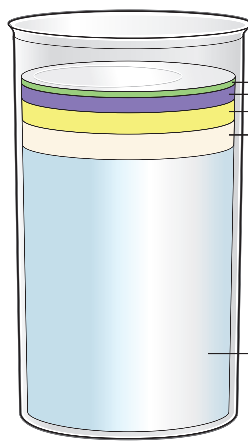


Figure 7.14B Milk is a mixture of different mixtures. The liquid part of milk is mostly water. The solid parts of milk are either dissolved in the liquid (homogeneous), or they are suspended in it (heterogeneous).

There are other mixtures that are hard to classify. For instance, is freshly squeezed orange juice heterogeneous or homogeneous? Orange juice tastes sweet, so you know there are sugars in it. You cannot see them, so you can infer that they are dissolved. This would lead you to say that freshly squeezed orange juice is a solution. But what about the pulp or other solid bits that might get into the juice? You can see them, so that would make the juice a heterogeneous mixture. Which type of mixture is it, then? Both. Freshly squeezed orange juice is a mixture of mixtures.

Reading Check

1. Give two examples of a solution.
2. A mechanical mixture is heterogeneous, while a solution is homogeneous. Explain why.
3. Describe what you will see if you shine a beam of light through a solution.
4. Give two examples of mixtures that are mixtures of mixtures.

Explore More

There are other kinds of heterogeneous mixtures besides mechanical mixtures. Find out about these mixtures—called colloids and suspensions—by going to **www.discoveringscience.ca.**

internet connect

Many years ago, when you poured yourself a glass of milk, the fat globules floated to the top. There, they clumped together to form a layer of cream. Today, milk is homogenized. What does that mean? Is homogenized milk really homogeneous? Begin your research at **www.discoveringscience.ca.**

Suggested Activity

Conduct an Investigation 7-2B on page 247

7-2A Shine On

Conduct an INVESTIGATION

SkillCheck

- Observing
- Predicting
- Classifying
- Explaining systems

Safety

Materials

- 3 clean 250 mL beakers or jars
- 5 mL (one teaspoon) fine-grained starch
- 5 mL (one teaspoon) table salt
- water
- 2 stirring rods
- masking tape (for labels)
- marker
- flashlight
- additional mixtures for testing

In this activity, you will shine a light through a selection of mixtures to decide which ones are homogeneous and which ones are not. Mixtures that are heterogeneous will scatter the light as it passes through, so you will see a beam of light through the mixture. Mixtures that are homogeneous will not scatter the light, so no beam will be visible through the mixture.

What to Do

1. Prepare a table of observations like the one below. Give your table a title.

Beaker	Appearance After Stirring	Appearance With Beam of Light
1 (starch and water		
2 (salt and water)		
3 (water)		

2. Add the starch to one of the beakers. Add the salt to a second beaker.
3. Pour water into each beaker until it is about three-quarters full. Stir the mixtures well. Record their appearance in the second column of your table.
4. Use the masking tape and marker to label each beaker.
5. Fill a third beaker about three-quarters full of water, and label it. Stir the water. Record its appearance in your table.
6. The lights in the classroom will be turned out. Shine the flashlight through the beakers, one at a time. Observe the contents of each beaker. Record your observations.
7. Your teacher may supply you with additional mixtures to test. Predict which ones are heterogeneous and which ones are homogeneous. Then test your predictions. Make a table to record your predictions and observations of these mixtures.

What Did You Find Out?

1. Is the starch-water mixture homogeneous or heterogeneous? Give evidence to support your answer.
2. Is the salt-water mixture homogeneous or heterogeneous? Give evidence to support your answer.
3. For any additional mixtures your teacher gave you, how did your predictions compare with your observations?

7-2B What Kind of Mixture?

Conduct an INVESTIGATION

Inquiry Focus

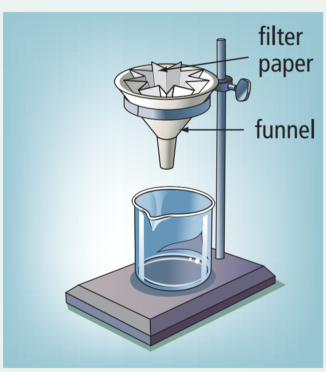
Skill Check

- Observing
- Predicting
- Communicating
- Explaining systems

Safety

Materials

- 4 mixtures
- 4 beakers or jars
- 4 pieces of filter paper
- ring stand and ring clamp
- funnel



One way to tell whether a mixture is a solution or a heterogeneous mixture is to pour it through a filter. In this investigation, you will practise using a filter.

Question

How can you tell if a mixture is a solution or a heterogeneous mixture?

Procedure

1. Prepare a table of observations like the one below.

Mixture	Prediction: Heterogeneous Mixture or Solution	Observations Before Filtering	Observations After Filtering	
			On Filter Paper	In Beaker
1				
2				
3				
4				

2. Your teacher will give you four mixtures of common substances.
3. Observe each mixture. Predict whether it is heterogeneous or a solution. Write your prediction in your table. If you cannot decide, record your prediction as "unsure."
4. Set up the materials as shown in the diagram.
5. Pour each mixture through a clean filter.
6. For each mixture, observe the substance that went through the filter. Was anything left on the filter? Record your observations in your table.
7. Wipe up any spills. Clean up and put away the equipment you have used. Wash your hands thoroughly.

Analyze

1. Which of your observations matched your predictions? Did any observations surprise you? Explain why or why not.

Conclude and Apply

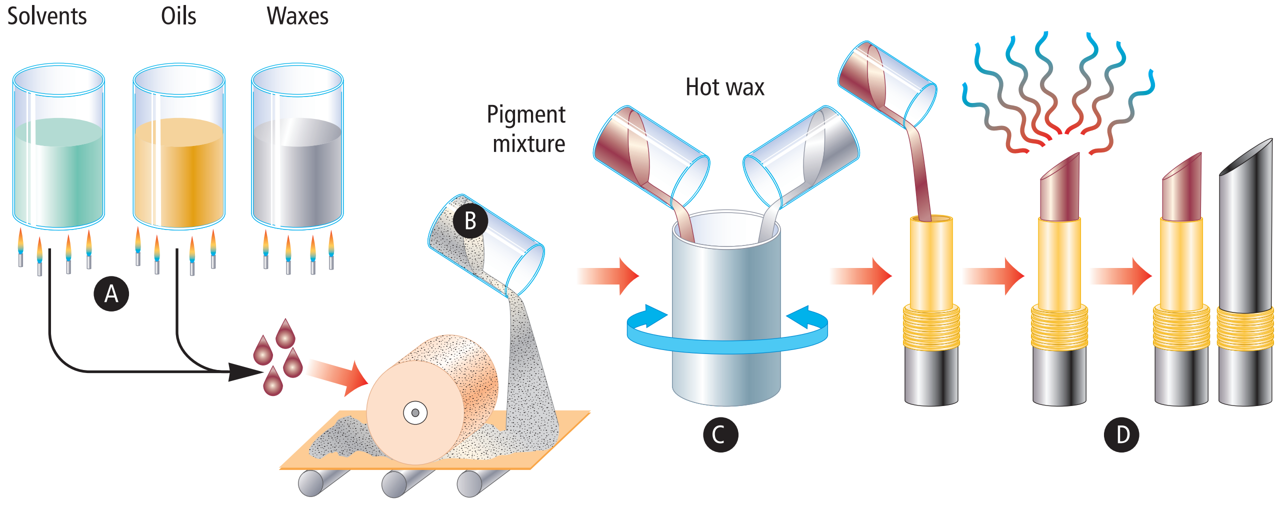
1. If you observe matter on the filter, can you state that the mixture is definitely heterogeneous? Explain your answer.
2. If you do not observe any matter on the filter, can you state that the mixture is definitely a solution? Explain your answer.

Science Watch

A Mix for Lips

Lipstick is a mixture of heterogeneous and homogeneous mixtures. Unlike nail polish and mascara, which are sold in liquid form, lipstick is solid when it is sold. Therefore, it is necessary to modify the ingredients during the manufacturing process so that they can be combined. Then, the final mixture can be poured into a mould to get a distinctive shape.

Lipstick is an elaborate mixture of ingredients, including a wide range of pigments (colouring agents).



The manufacture of lipstick involves heating, dissolving, melting, mixing, grinding, pouring, and cooling.

- **A** Two mixtures are prepared. One contains oils and other oily ingredients such as sunblock chemicals and fragrances. The second mixture contains dissolving ingredients. Both of these mixtures are heated separately, and then they are blended together with pigments and passed through a large roller mill to grind the grainy pigment to ensure a smooth product.
- **B** A wax mixture is heated and melted in a separate container. Waxes, such as beeswax and carnauba wax, enable the final product to hold its distinctive "stick" shape.
- **C** The warm pigment mixture (from A) is added to the hot wax (from B) and stirred until a smooth mixture results. The molten lipstick is strained and poured into a tube.
- **D** After cooling, the lipsticks are inspected for undesirable characteristics such as air holes. If they are acceptably smooth and clean, they are inserted into their containers, capped, and packaged. If not, they are removed, remelted, and remoulded.

Questions

1. Why is lipstick best described as a mixture of mixtures?
2. How likely is it that the mixture created in step C in the diagram is a solution (homogeneous)? Give reasons to justify your opinion.
3. The two mixtures in step A and step B are heated separately. What do you think the purpose of this is? (Hint: Think about any cooking you have done.)

Check Your Understanding

Checking Concepts

1. Classify each of the following mixtures as a heterogeneous mixture or a solution.
(a) bran cereal with raisins and nuts
(b) soil mixed with water
(c) oil mixed with vinegar
(d) clean air
(e) an aluminium frying pan
(f) a brass doorknob

2. Give an example of a heterogeneous mixture that is made up of
(a) a solid mixed with a liquid
(b) a solid mixed with another solid
(c) a solid mixed with a gas

3. Read the properties below for Mixture A and Mixture B. Then state which mixture is a heterogeneous mixture and which is a solution.
- Mixture A is transparent and its parts are not visible to the unaided eye.
- Mixture B is not transparent and has parts that are visible to the unaided eye.

4. What evidence would you need to collect to be able to classify something as a solution?

Understanding Key Ideas

5. Suppose that your teacher gives you a liquid mixture. You cannot see any small pieces of different matter in the mixture. When you pass the mixture through a filter, nothing is left on the filter paper.
(a) Is the mixture a solution or a heterogeneous mixture? Justify your answer.
(b) How could you be more certain about your inference?

6. The photo below shows the air in a room where a projector is being used. Based on what you see in the photo, is the air in the room a solution? Give reasons to justify your answer.

Pause and Reflect

A few coloured, solid crystals of iodine are dissolved in colourless liquid alcohol. The liquid that results is purple. Each sample taken from the liquid has the same colour. No solid pieces are visible.

(a) In your notebook, draw a simple labelled sketch to represent the mixture.

(b) Use your sketch to explain why the mixture has properties of the solid iodine crystals and the liquid alcohol.

(c) Use the particle theory of matter to explain the properties of the mixture. (Don't worry if your answer is right or not. You will learn the "right answer" in a later chapter. For now, use the science that you know to help you imagine what happens when one substance dissolves in another.)

Chapter Review

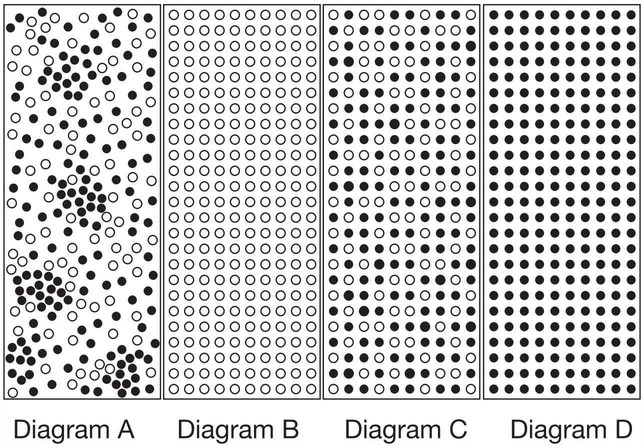
Prepare Your Own Summary

In this chapter, you investigated mixtures and their classification, and you were introduced to pure substances. Create your own summary of the key ideas from this chapter. You may include graphic organizers or illustrations with your notes. (See Science Skill 9 for help with using graphic organizers.) Use the following headings to organize your notes:

1. How Mixtures Are Different from Pure Substances
2. Heterogeneous and Homogeneous Mixtures
3. Classifying Mixtures
4. Combinations of Mixtures

Checking Concepts

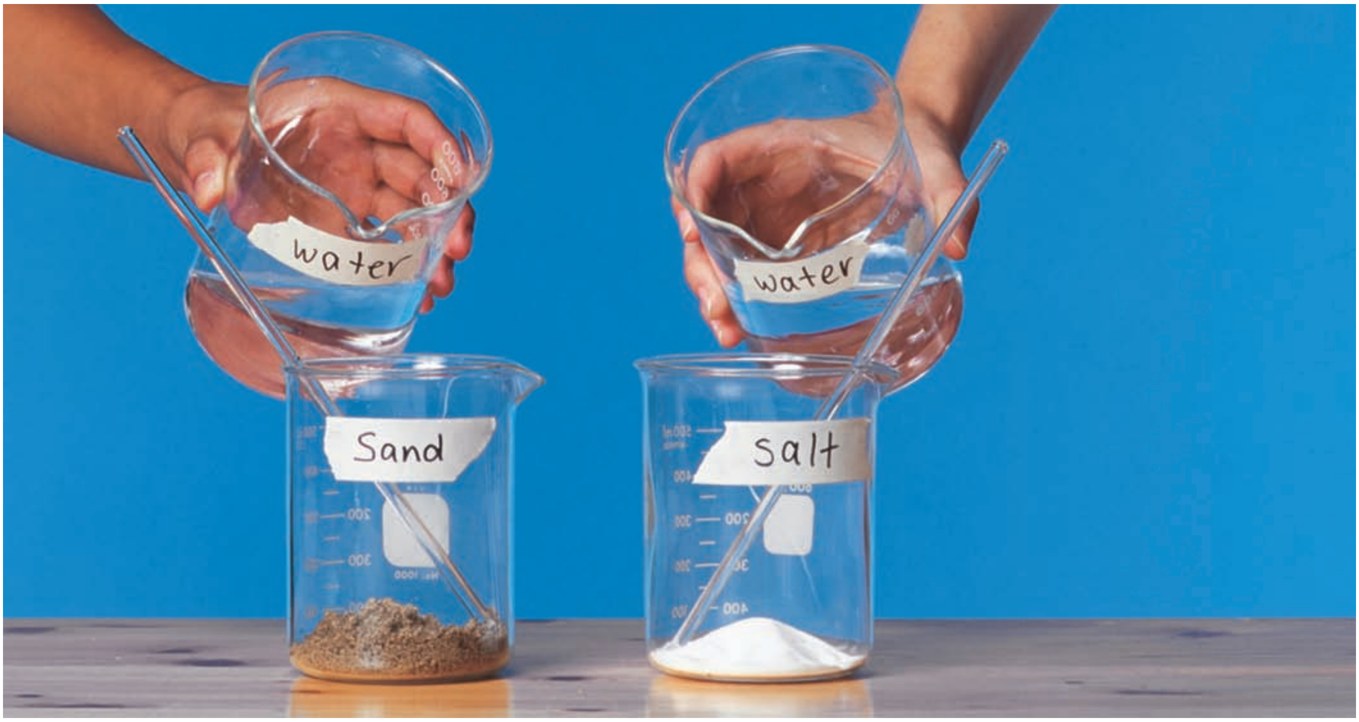
1. Identify the following mixtures items as heterogeneous mixture, homogeneous mixture, or a pure substance.
   (a) percolated coffee
   (b) instant coffee
   (c) Ranch salad dressing
   (d) milkshake
   (e) clean air
   (f) oatmeal-raisin cookie
   (g) shortbread cookie
   (h) oxygen
2. What is the relationship between the following pairs of terms?
   (a) mixture, solution
   (b) solution, homogeneous
   (c) pure substance, mixture
   (d) mixture, heterogeneous
   (e) particle, pure substance
3. Properties of matter often can help you to classify it as homogeneous or heterogeneous.
   (a) Give one example of a mixture that is definitely homogeneous.
   (b) Give one example of a mixture that is definitely heterogeneous.
   (c) Easily observed properties can be misleading. What is an example of a mixture that looks homogeneous but is actually heterogeneous?
4. Examine the diagrams below. Identify which diagram represents
   (a) a homogeneous mixture
   (b) a mechanical mixture
   (c) a pure substance
   (d) a different pure substance



5. Explain how you arrived at your answers for question 4.

Understanding Key Ideas

6. Katie says that sugar and water make a heterogeneous mixture. Mike says that they cannot. Decide who is right, explain why, and give evidence to support your answer.
7. In this chapter, you read that pure water is a pure substance. The water that comes out of a tap is clean and safe to drink, but it is not pure water.
   (a) If tap water is not a pure substance, then what is it?
   (b) Use your answer in part (a) to explain how it is possible for the water from one source to taste different from the water from another source.
8. How would you classify a soft drink when the sealed bottle is on the store shelf? Use the particle theory of matter to support your answer.
9. How would you classify a soft drink when it is poured into a glass? Use the particle theory to support your answer.
10. Classify and describe the mixture that each beaker in the photo will contain after the water is poured and mixed.



Pause and Reflect

Very few of the metals that you use or come in contact with are pure substances. Most are alloys—homogeneous mixtures of two or more different metals. This is certainly true of coins such as the nickel you read about at the start of this chapter. Give three reasons why you think that alloys of metals are used more often than pure-substance metals.