

2.2

1 FOCUS

Objectives

- 2.2.1 Categorize** a sample of matter as a substance or a mixture.
- 2.2.2 Distinguish** between homogeneous and heterogeneous samples of matter.
- 2.2.3 Describe** two ways that components of mixtures can be separated.

Guide for Reading

Build Vocabulary L2

Word Forms Have students look up the term *homogenize* and explain how this process could be used to turn a heterogeneous mixture into one that is more homogeneous.

Reading Strategy L2

Using Context Clues Tie the Reading Strategy to the Build Vocabulary strategy. Have students use the definitions of homogeneous and heterogeneous mixtures to answer the question posed in the Reading Strategy.

2 INSTRUCT

Connecting to Your World

After students read the introduction, ask **What is the result of panning?** (*Gold is separated from a mixture of materials.*) **What property is used to separate the mixture?** (*heaviness of the materials*) Heavier and lighter are used to compare the materials because density isn't discussed until Chapter 3.

Classifying Mixtures

Discuss L2

Bring orange juice or liquid salad dressing to class and compare the properties of these mixtures to those of pure water or pure NaCl. Explain that mixtures are variable in composition.

2.2 Mixtures

Connecting to Your World

In 1848, gold was discovered

in California. This discovery led to a massive migration, or rush, of people to California. Panning is one way to separate gold from a mixture of gold and materials such as sand or gravel. A pan containing the mixture is placed underwater and shaken vigorously from left to right. This motion causes heavier materials, such as gold, to move to the bottom of the pan and lighter materials, such as sand, to move to the top where they can be swept away. In this section, you will learn how to classify and separate mixtures.



Guide for Reading

Key Concepts

- How can mixtures be classified?
- How can mixtures be separated?

Vocabulary

mixture
heterogeneous mixture
homogeneous mixture
solution
phase
filtration
distillation

Reading Strategy

Building Vocabulary After you read this section, explain the difference between homogeneous and heterogeneous mixtures.

Classifying Mixtures

A salad bar, like the one in Figure 2.5, provides a range of items, such as cucumbers and hot peppers. Customers choose which items to use in their salads and how much of each item to use. So each salad has a different composition. A **mixture** is a physical blend of two or more components.

Most samples of matter are mixtures. Some mixtures are easier to recognize than others. You can easily recognize chicken noodle soup as a mixture of chicken, noodles, and broth. Recognizing air as a mixture of gases is more difficult. But the fact that air can be drier or more humid shows that the amount of one component of air—water vapor—can vary. Chicken noodle soup and air represent two different types of mixtures. **Based on the distribution of their components, mixtures can be classified as heterogeneous mixtures or as homogeneous mixtures.**

Figure 2.5 You can choose the amount of each item you select from a salad bar. So your salad is unlikely to have the same composition as other salads containing the same items.



Section Resources

Print

- **Guided Reading and Study Workbook**, Section 2.2
- **Core Teaching Resources**, Section 2.2 Review
- **Transparencies**, T12–T14

Technology

- **Interactive Textbook with ChemASAP**, Problem-Solving 2.10, Assessment 2.2

Quick LAB

Separating Mixtures

Purpose

To separate a mixture using paper chromatography.

Materials

- green marking pen
- filter paper strip
- metric ruler
- clear plastic tape
- pencil
- rubbing alcohol
- clear plastic drinking cup
- clear plastic wrap

Procedure

1. Use the marking pen to draw a line across a strip of filter paper, as shown in the drawing. The line should be 2 cm from one end of the strip.
2. Tape the unmarked end of the filter paper to the center of a pencil so that the strip hangs down when the pencil is held horizontally.
3. Working in a well-ventilated room, pour rubbing alcohol into a plastic cup to a depth of 1 cm.
4. Rest the pencil on the rim of the cup so that the ink end of the strip touches the rubbing alcohol, but does not extend below its surface. Use plastic wrap to cover the top of the cup.
5. Observe the setup for 15 minutes.



Analyze and Conclude

1. How did the appearance of the filter paper change during the procedure?
2. What evidence is there that green ink is a mixture?
3. How could you use this procedure to identify an unknown type of green ink?

Heterogeneous Mixtures In chicken noodle soup, the ingredients are not evenly distributed throughout the mixture. There is likely to be more chicken in one spoonful than in another spoonful. A mixture in which the composition is not uniform throughout is a **heterogeneous mixture**.

Homogeneous Mixtures The substances in the olive oil and vinegar in Figure 2.6 are evenly distributed throughout these mixtures. So olive oil doesn't look like a mixture. The same is true for vinegar. Vinegar is a mixture of water and acetic acid, which dissolves in the water. Olive oil and vinegar are homogeneous mixtures. A **homogeneous mixture** is a mixture in which the composition is uniform throughout. Another name for a homogeneous mixture is a **solution**. Many solutions are liquids. But some are gases, like air, and some are solids, like stainless steel, which is a mixture of iron, chromium, and nickel.

The term **phase** is used to describe any part of a sample with uniform composition and properties. By definition, a homogeneous mixture consists of a single phase. A heterogeneous mixture consists of two or more phases. When oil and vinegar are mixed, they form layers, or phases, as shown in Figure 2.6. The oil phase floats on the water phase.

Checkpoint How many phases are there in a homogeneous mixture?

Figure 2.6 Olive oil and vinegar are homogeneous mixtures. The substances in these mixtures are evenly distributed. When olive oil is mixed with vinegar, they form a heterogeneous mixture with two distinct phases.



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Differentiated Instruction

English Learners

Encourage English-learner students to compile a glossary in which they define each key term in English and in their native language. Suggest that students also include illustrations when appropriate.

Facts and Figures

Chromatography

The basis of chromatography is the partitioning of components between a stationary phase and a moving phase based on differences in solubility. The components travel with different speeds in the moving solvent.

Quick LAB

Separating Mixtures

L2

Objective

After completing this activity, students will be able to:

- separate the components of a mixture using paper chromatography.

Skills Focus Observing, inferring, drawing conclusions



Prep Time 15 minutes

Advance Prep

- Cut the paper strips in advance to save time. Strips of paper toweling can be used in place of filter paper.

Class Time 25 minutes

Safety Rubbing alcohol is poisonous and flammable. It is also an irritant when inhaled. Keep containers covered and away from heat. If the room is not well ventilated, use a fume hood.

Expected Outcome Bands of color will separate on the filter paper.

Extension Students could repeat the lab using different brands of markers, different colors, or water in place of rubbing alcohol.

Analyze and Conclude

1. Bands of colors appear as the alcohol moves up the paper.
2. The bands of colors indicate that green ink is a mixture.
3. The color pattern of the unknown ink can be compared with color patterns from known types of green ink.

For Enrichment

L3

Students can research R_f values of different dyes and how they are calculated (ratio of distance traveled by dye to distance traveled by solvent). They can then quantify this lab by calculating the R_f values of the dyes in the ink.

FYI

In Section 15.3, solutions, suspensions, and colloids are compared.

Answers to...



Checkpoint

one

Section 2.2 (continued)

CONCEPTUAL PROBLEM 2.1

Aluminum nails are used on trail markers so that if a tree is harvested, the nail can be sliced through at the lumber mill without causing injury to a worker.

Answers

9. Iron is magnetic; table salt is not. Table salt will dissolve in water; iron will not.
10. By lowering the temperature to below the boiling point of each gas, you could condense each substance and separate the gases.

Practice Problems Plus L2

Classify the following mixtures as homogeneous or heterogeneous.

- granite rock (*heterogeneous*)
- salt water (*homogeneous*)
- paint (*heterogeneous*)
- a silver ring (*homogeneous*)

Separating Mixtures

TEACHER Demo

Metallic Breakfast L2

Purpose Students will observe the separation of iron filings from iron-fortified breakfast cereal.

Materials iron-fortified breakfast cereal, 400-mL beaker, distilled water, magnetic stirrer with stirring bar

Safety Remind students not to eat the cereal.

Procedure Place a stirring bar in a 400-mL beaker. Add about 30 g of cereal to the beaker and add distilled water until the beaker is about half full. Using a magnetic stirrer, mix gently for about 20 minutes. Retrieve the stirring bar and observe the black iron filings attached to it.

Expected Outcome Iron filings will cover the stirring bar. They are added to cereal as an iron supplement. Explain that stomach acid changes the iron into a form the body can use.

CONCEPTUAL PROBLEM 2.1

Separating a Heterogeneous Mixture

Sometimes plastic signs are used to mark trails used by hikers or vehicles. The sign in the photo is used to mark locations along a trail where an all terrain vehicle (ATV) is permitted. Aluminum nails are used to attach signs at eye level to trees or posts. How could a mixture of aluminum nails and iron nails be separated?



1 Analyze Identify the relevant concepts.

List properties of aluminum and iron.

Aluminum:	Iron:
• metal	• metal
• gray color	• gray color
• doesn't dissolve in water	• doesn't dissolve in water
• not attracted to magnet	• attracted to magnet

2 Solve Apply concepts to this situation.

Identify a property that can be used to separate iron and aluminum objects. The ability to be attracted by a magnet is a property that iron and aluminum do not share. You could use a magnet to remove the iron nails from a mixture of iron and aluminum nails.

Practice Problems

9. What physical properties could be used to separate iron filings from table salt?
10. Air is mainly a mixture of nitrogen and oxygen, with small amounts of other gases such as argon and carbon dioxide. What property could you use to separate the gases in air?



Problem Solving 2.10 Solve Problem 10 with the help of an interactive guided tutorial.

with ChemASAP

Separating Mixtures

If you have a salad containing an ingredient you don't like, you can use a fork to remove the pieces of the unwanted ingredient. Many mixtures are not as easy to separate. To separate a mixture of olive oil and vinegar, for example, you could decant, or pour off, the oil layer. Or you might cool the mixture until the oil turned solid. The first method takes advantage of the fact that oil floats on water. The second method takes advantage of a difference in the temperatures at which the olive oil and vinegar freeze.

Differences in physical properties can be used to separate mixtures.

Filtration The colander in Figure 2.7 can separate cooked pasta from the cooking water. The water passes through the holes in the colander, but the pasta does not. The holes, or pores, in a coffee filter are smaller than the holes in a colander to retain coffee grains. But the holes are not small enough to retain the particles in water. The process that separates a solid from the liquid in a heterogeneous mixture is called **filtration**.



Figure 2.7 A colander is used to separate pasta from the water in which it was cooked. This process is a type of filtration.

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Facts and Figures

Distillation

A working distillation apparatus was described in the writings of Maria of Alexandria, an alchemist who lived and worked nearly two thousand years ago. The city of Alexandria, located on the Nile River in North

Africa, was a world center of science and culture at that time. Maria of Alexandria is also credited with inventing other chemical apparatus, such as the water bath, which to this day bears her name: the *bain marie*.

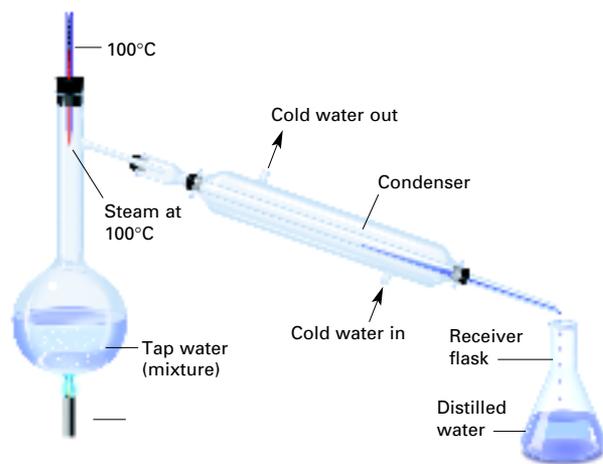


Figure 2.8 A distillation can be used to remove impurities from water. As liquid water changes into water vapor, substances dissolved in the water are left behind in the distillation flask. **Inferring** What can you infer about the boiling points of substances dissolved in the impure water?

Distillation Tap water is a homogeneous mixture of water and substances that dissolved in the water. One way to separate water from the other components in tap water is through a process called distillation. During a **distillation**, a liquid is boiled to produce a vapor that is then condensed into a liquid. Figure 2.8 shows an apparatus that can be used to perform a small-scale distillation.

As water in the distillation flask is heated, water vapor forms, rises in the flask, and passes into a glass tube in the condenser. The tube is surrounded by cold water, which cools the vapor to a temperature at which it turns back into a liquid. The liquid water is collected in a second flask. The solid substances that were dissolved in the water remain in the distillation flask because their boiling points are much higher than the boiling point of water.

2.2 Section Assessment

- Key Concept** How are mixtures classified?
- Key Concept** What type of properties can be used to separate mixtures?
- Explain the term *phase* as it relates to homogeneous and heterogeneous mixtures.
- Classify each of the following as a homogeneous or heterogeneous mixture.
 - food coloring
 - ice cubes in liquid water
 - mouthwash
 - mashed, unpeeled potatoes
- How are a substance and a solution similar? How are they different?
- In general, when would you use filtration to separate a mixture? When would you use distillation to separate a mixture?

- Describe a procedure that could be used to separate a mixture of sand and table salt.

Writing Activity

Writing to Persuade Write a paragraph in support of this statement: Dry tea is a mixture, not a substance. Include at least two pieces of evidence to support your argument.



Assessment 2.2 Test yourself on the concepts in Section 2.2.

with **ChemASAP**

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Section 2.2 Assessment

- as heterogeneous or homogeneous
- differences in physical properties
- A phase is any part of a sample with uniform composition. There is one phase in a homogeneous mixture and two or more phases in a heterogeneous mixture.
- a.** homogeneous **b.** heterogeneous
c. homogeneous **d.** heterogeneous
- Both have a uniform composition throughout. A substance has a definite composition; a solution has a variable composition.
- Filtration separates solids from a liquid in a heterogeneous mixture. Distillation can separate a liquid from substances dissolved in the liquid.
- Add water to dissolve the salt. Pour the resulting mixture onto a piece of closely woven cloth. The sand will remain on the cloth, and the salt solution will pass through.

Use Visuals

L1

Figure 2.8 Review the distillation process, and describe the components of the apparatus. Ask, **What might be an advantage to having a long condenser in a distillation apparatus?** (There would be more surface area on which the vapor can condense.) **Is distilled water that contains dissolved gases a pure substance?** (No, distilled water is not pure unless the dissolved gases are removed.)

ASSESS

Evaluate Understanding

L2

Have students identify five items that fit each of the following categories.

- substance
- homogeneous mixture
- heterogeneous mixture
- solution

Have students select three items (one each from categories b, c, and d). For each item selected, students should outline a method for separating the components.

Reteach

L1

Explain that distillation can be used to separate a mixture of gases. Show students the drawing of the fractional distillation of liquid air on R24 of the Elements Handbook. Ask, **What physical property is used to separate the gases?** (boiling point)

Writing Activity

Possible evidence includes the fact that only some substances in the tea leaves dissolve in water, and tea is sold both with and without caffeine.



If your class subscribes to the Interactive Textbook, use it to review key concepts in Section 2.2.

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Answers to...

Figure 2.8 They are much higher than the boiling point of water.