2.2 Mixtures

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.

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.

Classifying Mixtures

Discuss

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.

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**
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.

Analyse 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.

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.

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
Classify the following mixtures as homogeneous or heterogeneous.

a. granite rock (heterogeneous)
b. salt water (homogeneous)
c. paint (heterogeneous)
d. a silver ring (homogeneous)

Separating Mixtures

Metallic Breakfast

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.

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.
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

11. **Key Concept** How are mixtures classified?
12. **Key Concept** What type of properties can be used to separate mixtures?
13. Explain the term phase as it relates to homogeneous and heterogeneous mixtures.
14. Classify each of the following as a homogeneous or heterogeneous mixture.
   a. ice coloring
   b. ice cubes in liquid water
   c. mouthwash
   d. mashed, unpeeled potatoes
15. How are a substance and a solution similar? How are they different?
16. In general, when would you use filtration to separate a mixture? When would you use distillation to separate a mixture?
17. 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.

**Interactive Textbook**

**Assessment 2.2** Test yourself on the concepts in Section 2.2.

Section 2.2 Mixtures

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

**Answers to...**

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