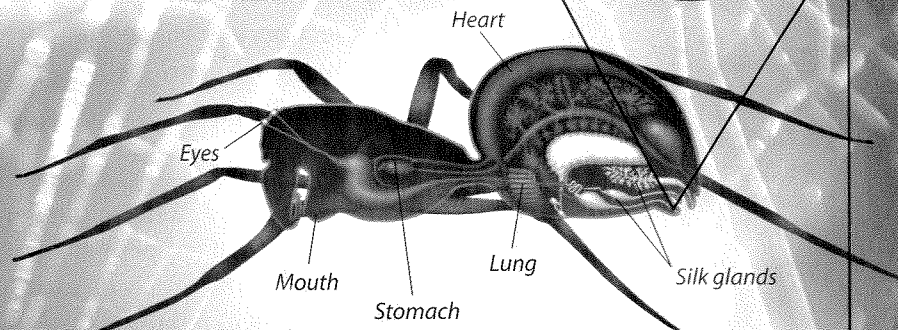


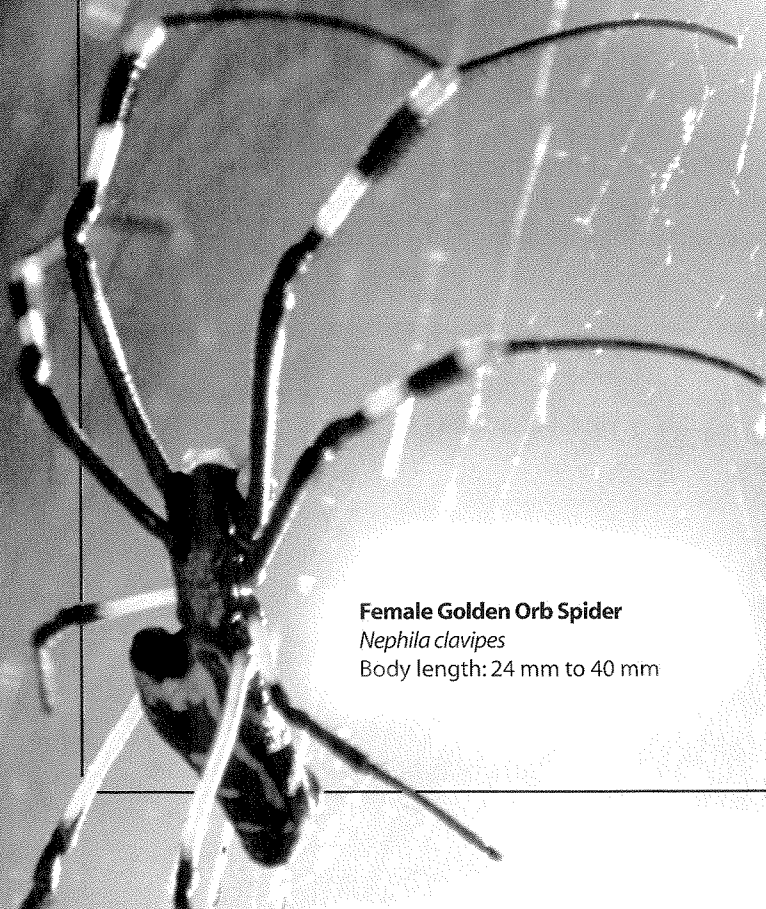
## Hanging by a Thread

Strands in a spider web are about one tenth the diameter of a human hair. Yet a golden orb spider web can withstand the impact of an insect, or even a small bird, flying at high speed because the silk in the web's frame and spokes is stronger than steel, more elastic than nylon, and tougher than rubber. Scientists are always looking for lightweight materials with these properties, but they cannot set up farms to harvest spider silk because a spider will fight to defend its territory. Instead, scientists use biotechnology to produce spider silk. **Interpreting Diagrams** *Where are the silk glands located in a spider?*

**Spinnerets**  
(magnification: 110,000×)

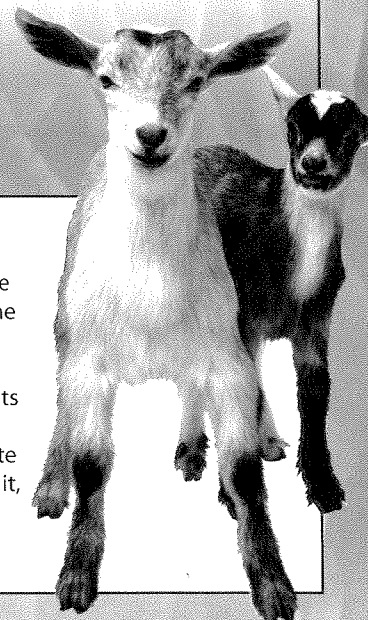


**Spider anatomy** A spider releases its silk through spinnerets at the tip of its abdomen. Inside each spinneret are tens or hundreds of spigots. Silk travels from a silk gland through a duct to a spigot. As the silk is released from a spigot, it changes from a liquid to a solid.



**Female Golden Orb Spider**  
*Nephila clavipes*  
Body length: 24 mm to 40 mm

**Spider silk from goat's milk**  
Scientists have identified the spider genes that contain the instructions for producing silk. When these genes are transferred to goats, the goats produce milk containing spider silk. Scientists separate the silk from the milk, purify it, and spin it into fibers.



## 2.2 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.

**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.

### 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 under water 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.**



## Quick LAB

### Separating Mixtures

#### Purpose

To separate a mixture using paper chromatography.

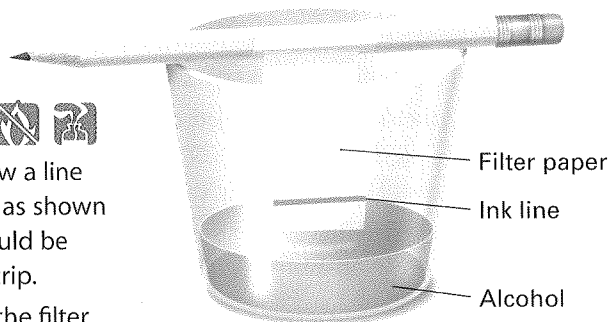
#### Materials

- 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

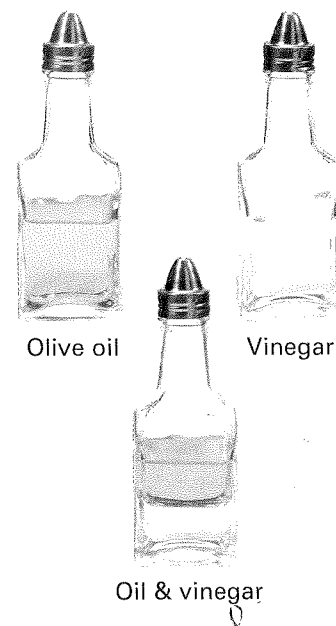
1. How did the appearance of the filter paper change during the procedure?
2. What evidence is there that green ink is a mixture?
3. How could you use this procedure to identify an unknown type of green ink?

**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?



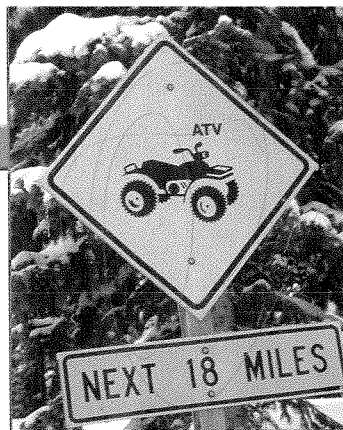
**Figure 2.6** Olive oil and vinegar are homogeneous mixtures. The substances in these mixtures are evenly distributed. When olive oil and vinegar are mixed, they form a heterogeneous mixture with two distinct phases.



## 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

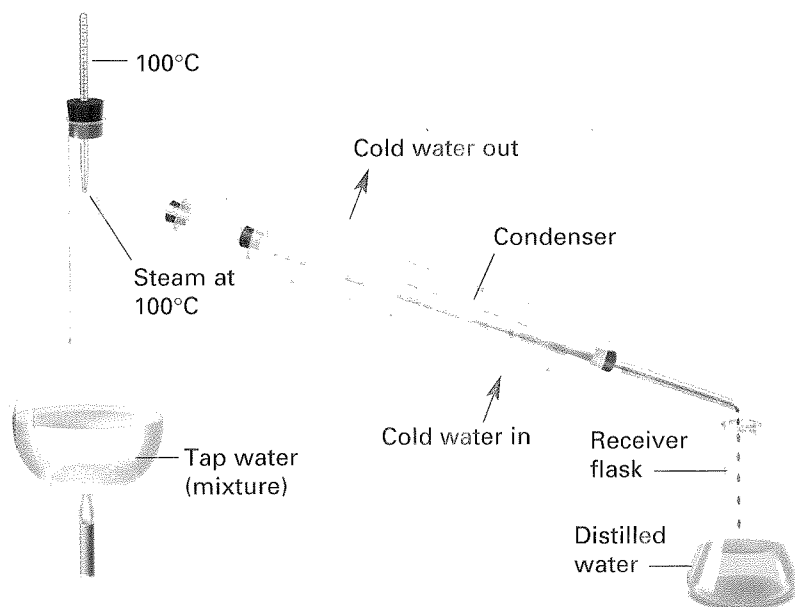
If you have a salad containing an ingredient you don't like, you can use a fork to remove the pieces of the unwanted ingredient. Many mixtures are not as easy to separate. To separate a mixture of olive oil and vinegar, for example, you could decant, or pour off, the oil layer. Or you might cool the 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.



**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.

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