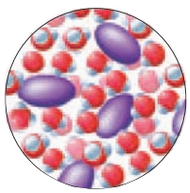
18

HOW CHEMICALS MIX



THE BIG IDEA

Most everything is a mixture.

▲ A mixture of fish in a mixture of water, salt, and many other components.

Is it true that a fish can drown in water? When you stir sugar into water, the sugar crystals disappear, but where do they go? What are clouds made of, and what do they have in common with the blood that runs through our veins? When tap water is left boiling on the stove too long, it evaporates completely but leaves a chalky residue in the pot. What is this residue and where did it originate? The answers to these questions involve an understanding of mixtures.

DISCOVER!

Does Sugar Disappear When It Dissolves in Water?

Observe and Record

1. Fill a glass almost to the top with warm water. Mark the water level with tape or a marker and then carefully pour all this warm water into a larger container without spilling a drop.
2. Add about 3 tablespoons of sugar to the emptied glass.
3. Return about half of the warm water to the glass and stir to dissolve all the sugar.
4. Return the remaining water, and as you get close to the mark, predict whether the water level will be lower than before, about the same as before, or higher than before.

Analyze and Conclude

1. **Observing** Did the water return to its original level? If not, how does the new level relate to the volume of the sugar?
2. **Predicting** Would you get the same results if you instead added the sugar directly to the water in the glass? What if you added sand instead of sugar?
3. **Making Generalizations** Does a solid dissolved in a liquid occupy any volume of space? Is this volume of space more than, less than, or the same as the volume it occupies as an undissolved solid? Which do you suppose displaces more water: a rock or the same rock crushed into powder? (Assume no rock material is lost during the crushing process.) Which dissolves faster in water: a large crystal of sugar or the same crystal crushed into a powder?

18.1 Most Materials Are Mixtures

A **mixture** is a combination of two or more substances in which each substance retains its own properties. Most materials we encounter are mixtures: mixtures of elements, mixtures of compounds, or mixtures of elements and compounds. Stainless steel, for example, is a mixture of the elements iron, chromium, nickel, and carbon. Seltzer water is a mixture of a liquid compound, water, and a gaseous compound, carbon dioxide. Our atmosphere, as Figure 18.1 illustrates, is a mixture of the elements nitrogen, oxygen, and argon, plus small amounts of such compounds as carbon dioxide and water vapor.

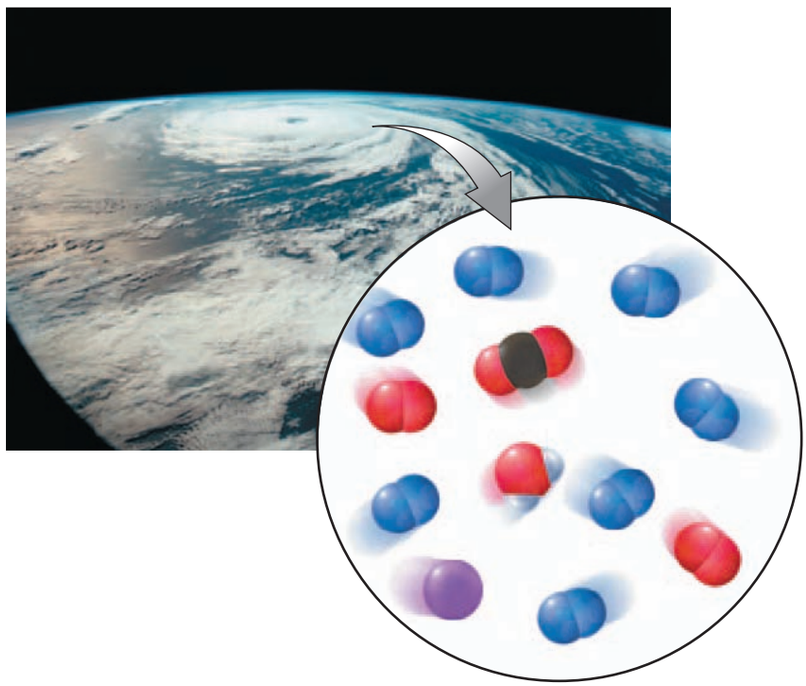


FIGURE 18.1 ▶
Earth's atmosphere is a mixture of gaseous elements and compounds. Some of them are shown here.

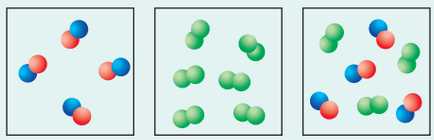
Tap water is a mixture containing mostly water but also many other compounds. Depending on your location, your water may contain compounds of calcium, magnesium, chlorine, fluorine, iron, and potassium; trace amounts of compounds of lead, mercury, and cadmium; organic compounds; and dissolved oxygen, nitrogen, and carbon dioxide. Although it is surely important to minimize any toxic components in your drinking water, it is unnecessary, undesirable, and impossible to remove all other substances from it. Some of the dissolved solids and gases give water its characteristic taste, and many of them promote human health: fluoride compounds protect teeth, chlorine destroys harmful bacteria, and as much as 10% of our daily requirement for iron, potassium, calcium, and magnesium is obtained from drinking water (Figures 18.2 and 18.3).

◀ **FIGURE 18.2**
Tap water provides us with H_2O as well as a large number of other compounds, many of which are flavorful and help us grow, as Graham demonstrates at ages 7 and 21. Bottoms up!

FIGURE 18.3 ▶
Most of the oxygen in the air bubbles produced by an aquarium aerator escapes into the atmosphere. Some of the oxygen, however, mixes with the water. It is this oxygen that fish depend on to survive. Without this dissolved oxygen, which fish extract from the water with their gills, the fish would promptly drown. So fish don't "breathe" water. They breathe the O_2 that is dissolved in the water.

CHECK YOUR THINKING

So far, you have learned about three kinds of matter: elements, compounds, and mixtures. Which box in the following figure contains only an element? Which contains only a compound? Which contains a mixture?



Answer

The molecules in box A each contain two different types of atoms, so they represent a compound. The molecules in box B each consist of the same atoms, so they represent an element. Box C is a mixture of the compound and the element.

Note how the molecules remain intact in the mixture. That is, upon the formation of the mixture, there is no exchange of atoms between the components.

There is a difference between the way materials combine to form mixtures and the way elements combine to form compounds. Each substance in a mixture retains its chemical identity. The sugar molecules in the teaspoon of sugar in Figure 18.4, for example, are identical

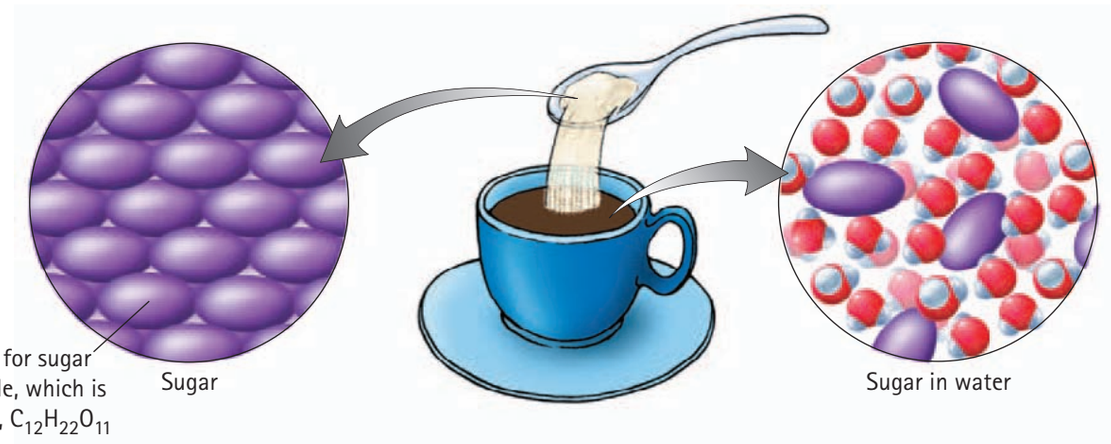


FIGURE 18.4 ▲
Table sugar is a compound consisting only of sucrose molecules. Once these molecules are mixed into hot tea, they become interspersed among the water and tea molecules and form a sugar–tea–water mixture. No new compounds are formed, so this is an example of a physical change.