Section 3
Mixtures

Key Concept A mixture is a combination of two or more substances that are not chemically combined.

What You Will Learn
- Mixtures can be separated by physical means, such as distillation, filtration, and evaporation.
- A solution is a mixture that appears to be a single substance but is composed of a solute dissolved in a solvent.
- Concentration is a measure of the amount of a solute dissolved in a given amount of solvent.

Why It Matters
Most everyday materials are mixtures, so it is helpful to know the characteristics of mixtures.

Imagine that you roll out some dough, add tomato sauce, and sprinkle some cheese on top. Then, you add mushrooms, olives, and pepperoni! What have you just made? A pizza, of course! But that's not all. You have also created a mixture!

Properties of Mixtures
All mixtures share certain properties. A **mixture** is a combination of two or more substances that are not chemi cally combined. When two or more materials are put together, they form a mixture if they do not react to form a compound.

No Chemical Changes in a Mixture
No chemical change happens when a mixture is made. So, each substance in a mixture has the same chemical makeup it had before the mixture formed. That is, each substance in a mixture keeps its identity. In some mixtures, such as the pizza in **Figure 1,** you can see each of the components. In other mixtures, such as salt water, you cannot see all the components.

Figure 1 You can see each topping on this mixture, which is better known as a pizza.

Standards Check Describe one property of all mixtures.

Separating Mixtures Through Physical Methods

If you don't like mushrooms on your pizza, you can just pick them off. This change is a physical change of the mixture. The identities of the substances do not change. But not all mixtures are as easy to separate as a pizza. You cannot just pick salt out of salt water. One way to separate the salt from the water is to heat the mixture until the water evaporates. The salt is left behind. Other ways to separate mixtures are shown in **Figure 2.**

Figure 2 Common Ways to Separate Mixtures

Distillation (DIS tuh LAY shuhn) is a process that separates a mixture based on the boiling points of the mixture's components. Pure water (flask on the right) is being distilled from salt water (flask on the left). Also, distillation is used to separate crude oil into components, such as gasoline.

A **magnet** can be used to separate a mixture of the elements iron and aluminum. Iron is attracted to the magnet, but aluminum is not.

Blood is separated into its parts by a machine called a **centrifuge** (SEN truh FYOOJ). In the test tube of blood at left, a layer of plasma rests atop a layer of red blood cells. A centrifuge separates mixtures by the densities of the components.

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The Ratio of Components in a Mixture

A compound is made of elements that are mixed in a specific mass ratio. However, the components of a mixture do not need to be mixed in a definite ratio. For example, granite is a mixture made of three minerals: feldspar, mica, and quartz. Feldspar is pink. Mica is black. Quartz is colorless. Look at the egg-shaped paperweights in **Figure 3.** The granite of the pink one has more feldspar than it does mica or quartz. So, this paperweight is pink. The granite of the black one has more mica than it does other minerals. The granite of the gray one has more quartz than it does other minerals. Even though the proportions of the minerals change, the combination of minerals is always a mixture called *granite*. **Table 1** summarizes the differences between mixtures and compounds.

Figure 3 These paperweights are made of granite. Their colors differ because the granite in each paperweight has ratios of minerals that differ from the ratios in the other paperweights. **Based on this information, how can you tell that granite is not a compound?**

Table 1 Mixtures and Compounds	
Mixtures	**Compounds**
Made of elements, compounds, or both	Made of elements
No change in original properties of components	Change in original properties of components
Separated by physical means	Separated by chemical means
Formed using any ratio of components	Formed using a set ratio of components

Solutions

A **solution** is a homogeneous mixture that appears to be a single substance. A solution is composed of particles of two or more substances that are distributed evenly among each other. Solutions have the same appearance and properties throughout the mixture.

The process in which particles of substances separate and spread evenly throughout a mixture is known as *dissolving.* In solutions, the **solute** is the substance that is dissolved. The **solvent** is the substance in which the solute is dissolved. A solute must be *soluble,* or able to dissolve, in the solvent. A substance that is *insoluble,* or unable to dissolve, forms a mixture that is not a solution.

Salt water is a solution. Salt is soluble in, or can dissolve in, water. So, salt is the solute, and water is the solvent. When two liquids or two gases form a solution, the substance that is present in the largest amount is the solvent.

Examples of Solutions

You may think that all solutions are liquids. Tap water, soft drinks, gasoline, and many cleaners are liquid solutions. But, solutions may also be gases. Air is a solution that is a gas. Solutions may even be solids—steel is a solid solution. *Alloys* are solid solutions in which metals or nonmetals are dissolved in metals. Brass is an alloy of the metal zinc dissolved in copper. Steel is an alloy of the nonmetal carbon and other elements dissolved in iron. **Table 2** lists more examples of solutions.

Table 2 Examples of Solutions in Various States

States	Examples
Gas in gas	dry air (oxygen in nitrogen)
Gas in liquid	soft drinks (carbon dioxide in water)
Liquid in liquid	antifreeze (alcohol in water)
Solid in liquid	salt water (salt in water)
Solid in solid	brass (zinc in copper)

Particles in Solutions

The particles in solutions are so small that they will not come out of solution. They also cannot be removed by filtering. Solute particles are so small that they do not scatter light. Both jars in **Figure 4** contain mixtures. The mixture in the jar on the left is a solution of salt in water. The jar on the right holds a mixture—but not a solution—of gelatin in water.

Figure 4 Both of these jars contain mixtures. The mixture in the jar on the left, however, is a solution. The particles in solutions are so small that they do not scatter light. Therefore, you can't see the path of light through the solution.

Standards Check What property of the mixture of gelatin in water tells you that the mixture is not a solution?

Concentration of Solutions

A measure of the amount of solute dissolved in a given amount of solvent is **concentration.** Concentration can be expressed in grams of solute per milliliter of solvent (g/mL). Solutions can be described as being concentrated or dilute. In **Figure 5,** the two solutions have the same amount of solvent, but different amounts of solute. The solution

on the left contains less solute than the solution on the right. The solution on the left is dilute. The solution on the right is more concentrated than the solution on the left. The terms *dilute* and *concentrated* do not tell you the concentration of solute.

Figure 5 The dilute solution (left) contains less solute than the concentrated solution (right).

Solubility

If you add too much sugar to a glass of lemonade, some of the sugar cannot dissolve. Some of it sinks to the bottom. To find the maximum amount of sugar that can dissolve, you must know the solubility of sugar. **Solubility** refers to the ability of a solute to dissolve in a solvent at a certain temperature. **Figure 6** shows how temperature affects the solubility of several solid substances.

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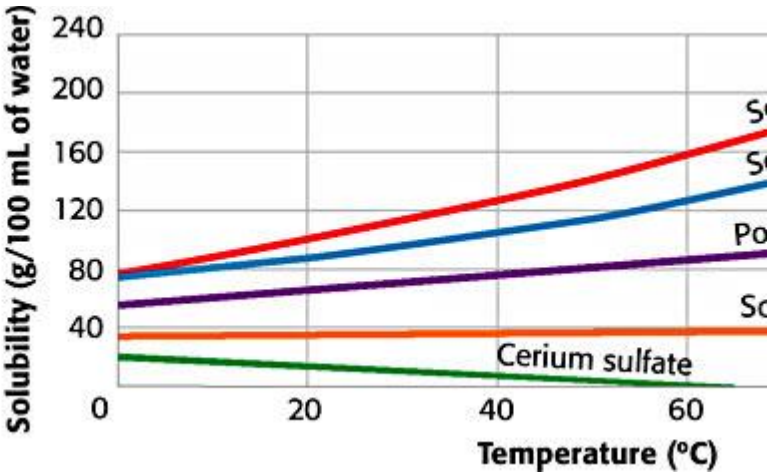
Figure 6 Solubility of Different Solids In Water

For most solids, solubility increases as temperature increases. So, the amount of solute that can dissolve increases as temperature increases. But, some solids, such as cerium sulfate, become less soluble as temperature increases.



Section Summary

- A mixture is a combination of two or more substances, each of which keeps its own characteristics.
- Mixtures can be separated by physical means, such as filtration and evaporation.
- A solution is a mixture that appears to be a single substance but is composed of a solute dissolved in a solvent.
- Concentration is a measure of the amount of solute dissolved in a given amount of solvent.
- The solubility of a solute is the ability of the solute to dissolve in a solvent at a certain temperature.

Section Review

To answer questions online, click here.

Chapter Summary

The Big Idea

Matter can be classified into elements, compounds, and mixtures.

Section 1
Elements

Key Concept An element is made up of only one type of atom and can be classified by a unique set of properties.

- An element is a pure substance in which there is only one kind of atom.
- An element cannot be broken down into a simpler substance by physical or chemical means.
- Each element can be classified by a unique set of physical and chemical properties.
- Based on their properties, elements are classified as metals, nonmetals, or metalloids.

Each element has a unique set of properties that sets it apart from other elements.

Section 2
Compounds

Key Concept A compound is formed by chemically combining two or more elements.

- A compound is made up of two or more elements that are chemically combined to form a new substance with different properties.
- During a chemical reaction, the reactant atoms of two or more elements interact and join to form molecules of one or more compounds.
- Each compound has a unique set of physical and chemical properties that differ from the properties of the elements that make up the compound.

The properties of a compound differ from the properties of the elements it is composed of.

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Substances in mixtures can be separated by physical means.

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