9.1: Mixtures and Solutions

Learning Objectives

- Describe the difference between homogenous and heterogenous mixtures.
- Distinguish a homogenous mixture as a solution or colloid.

As introduced previously, *mixtures* are combinations of two or more substances that each retain their individual physical properties. A mixture can be classified as either *heterogenous* or *homogenous*. In a heterogeneous mixture, the composition is *not* uniform throughout the sample, and sometimes the individual substances that make up the mixture can be differentiated by eye. Trail mix, salad, and blood (which is also called a suspension) are examples of heterogenous mixtures. Homogenous mixtures are uniform and have the same composition throughout. Air, simple syrup, and seawater are examples of homogenous mixtures.

Homogenous mixtures can be further classified, based on the *size* of their particles, as solutions or colloids. **Solutions** are composed of particles the size of an ion or small molecule, ~0.1-2.0 nm. The examples provided above are all considered solutions; air is a solution of small gas molecules, simple syrup is a solution of sucrose in water, and seawater is a solution of ions and water. Homogenous mixtures with larger particles, ~2.0-500 nm, are classified as **colloids**. Milk, fog, and butter are all considered colloids. Mixtures with particles larger than 500 nm are called **suspensions** and are considered to be heterogenous mixtures in which the particles will settle upon standing. Many medications are classified as suspensions that need to be re-mixed before taking in order to redistribute the particles throughout the mixture. Some examples and distinguishing characteristics of solutions, colloids, and suspensions are listed in Table 9.1.1 below.

Table 9.1.1: Properties of Liquid Solutions, Colloids, and Suspensions

Type of Mixture	Approximate Size of Particles (nm)	Characteristic Properties	Examples
solution	< 2	not filterable; does not separate on standing; does not scatter visible light	air, white wine, gasoline, salt water
colloid	2–500	scatters visible light; translucent or opaque; not filterable; does not separate on standing	smoke, fog, ink, milk, butter, cheese
suspension	500–1000	cloudy or opaque; filterable; separates on standing	muddy water, hot cocoa, blood, paint

The major component of a solution, called the **solvent**, is typically the same phase as the solution itself. Each minor component of a solution (and there may be more than one) is called the **solute**. In most of the solutions we will describe in this textbook, there will be no ambiguity about whether a component is the solvent or the solute. For example, in a solution of salt in water, the solute is salt, and solvent is water.

Solutions come in all phases, and the solvent and the solute do not have to be in the same phase to form a solution (such as salt and water). For example, air is a gaseous solution of about 80% nitrogen and about 20% oxygen, with some other gases present in much smaller amounts. An alloy is a solid solution consisting of a metal (like iron) with some other metals or nonmetals dissolved in it. Steel, an alloy of iron and carbon and small amounts of other metals, is an example of a solid solution. Table 9.1.2 lists some common types of solutions, with examples of each.

Table 9.1.2: Types of Solutions

Solvent Phase	Solute Phase	Example
gas	gas	air
liquid	gas	carbonated beverages

Solvent Phase	Solute Phase	Example
liquid	liquid	ethanol (C_2H_5OH) in H_2O (alcoholic beverages)
liquid	solid	saltwater
solid	gas	H_2 gas absorbed by Pd metal
solid	liquid	Hg(ℓ) in dental fillings
solid	solid	steel alloys