

Notes – Classifying Matter

The tendency to wrinkle when washed is a property of cotton. The tendency not to wrinkle when washed is a property of polyester. The tendency to shrink when washed is a property of wool. Cotton, wool, and polyester have different properties because they have different compositions. The word *composition* comes from a Latin word meaning “a putting together,” or the combining of parts into a whole. Based on their compositions, materials can be divided into pure substances and mixtures.

Pure Substances

Matter that always has exactly the same composition is classified as a pure substance, or simply a substance. Table salt and table sugar are two examples of pure substances. Every pinch of salt tastes equally salty. Every spoonful of sugar tastes equally sweet. Every sample of a given substance has the same properties because a substance has a fixed, uniform composition. Pure Substances can be classified into two categories – elements and compounds.

1. Elements

Although there are millions of known substances, there are only about 100 elements. An element is a substance that cannot be broken down into simpler substances. Imagine cutting a copper wire into smaller and smaller pieces. Eventually you would end up with extremely tiny particles called copper atoms. An atom is the smallest particle of an element. An element has a fixed composition because it contains only one type of atom.

No two elements contain the same type of atom. In chapter 4 you will find out more about atoms, including how the atoms in an element differ from the atoms of every other element.

Examples of Elements

At room temperature (20°C, or 68°F), most elements are solids, including the elements aluminum and carbon. You have seen aluminum foil used to wrap food. Most soft drink cans are made from aluminum. Carbon is the main element in the marks you make with a pencil on a piece of paper. Some elements are gases at room temperature. The elements oxygen and nitrogen are the main gases in the air you breathe. Only two elements are liquids at room temperature, bromine and mercury, both of which are extremely poisonous.

Symbols for Elements

In 1813 Jöns Berzelius, a Swedish chemist, suggested that chemists use symbols to represent elements. Many of the symbols he assigned to elements are still used. Each symbol has either one or two letters. The first letter is always capitalized. If there is a second letter, it is not capitalized.

It is easy to see why C and Al are used to represent Carbon and Aluminum. But why does gold have the symbol Au? The symbols that Berzelius chose were based on the Latin names of the elements. The Latin name for gold is *aurum*.

The symbols allow scientists who speak different languages to communicate without confusion. For example, nitrogen is known as *azote* in France, as *stickstoff* in Germany, and as *nitrogeno* in Mexico. But scientists who speak English, French, German, and Spanish all agree that the symbol for the element nitrogen is N.

Sometimes an element's name contains a clue to its properties. For example, the name hydrogen comes from the Greek words *hydro* and *genes*, meaning "water" and "forming."

2. Compounds

Water is composed of the elements hydrogen and oxygen. When electricity passes through water, bubbles of oxygen and hydrogen gas form and rise to the surface of the water. If the gases are collected in a container and a flame is brought near the mixture, the hydrogen and oxygen react and form water. Water is classified as a compound. A compound is a substance that is made from two or more simpler substances and can be broken down into those simpler substances. The simpler substances are either elements or other compounds.

The properties of a compound differ from those of the substances from which it is made. For example, oxygen and hydrogen are gases at room temperature, but water is a liquid. Hydrogen can fuel a fire, and oxygen can keep a fire burning, but water does not burn or help other substances to burn. In fact, water is one of the substances completely used to put out fires.

A compound always contains two or more elements joined in a fixed proportion. For example, in silicon dioxide, there are always two oxygen atoms for each silicon atom. (*Di-* means "two.") In water, there are always two hydrogen atoms for each oxygen atom.

Mixtures

Mixtures tend to retain some of the properties of their individual substances, but the properties of a mixture are less constant than the properties of a substance. The properties of a mixture can vary because the composition of a mixture is not fixed.

No matter how well you stir a batch of salsa, the ingredients will not be evenly distributed. There may, for example, be more onion in one portion of the salsa than another. Mixtures can be classified by how well the parts of the mixture are distributed throughout the mixture. Mixtures can be either heterogeneous or homogeneous.

1. Heterogeneous Mixtures

If you look at a handful of sand from a beach, the sand appears to be all the same material. However, if you use a hand lens, you will notice that the sample of sand is not the same

throughout. Grains of sand vary in size. Also, some grains are light in color and some are dark. Sand is an example of a heterogeneous mixture. Heterogeneous comes from the Greek words *hetero* and *genus*, meaning “different” and “kind.” In a heterogeneous mixture, the parts of the mixture are noticeably different from one another.

2. Homogeneous Mixtures

If you collect water from both the shallow end and the deep end of a swimming pool, the water samples will appear the same. The water in a swimming pool is a homogeneous mixture of water and substances that dissolve in water. In a homogeneous mixture, the substances are so evenly distributed that it is difficult to distinguish one substance in the mixture from another. A homogeneous mixture appears to contain only one substance. The solute (solid) dissolves and disperses in the solvent (the liquid). One example of this is sugar mixed into water.

Mixtures can be further classified as Solutions, Suspensions, and Colloids

It isn't always easy to tell a homogeneous mixture from a heterogeneous mixture. You may need to observe the properties of a mixture before you decide. **The size of the particles in a mixture has an effect on the properties of the mixture. Based on the size of its largest particles, a mixture can be classified as a solution, a suspension, or a colloid.**

Solutions

If you place a spoonful of sugar in a glass of hot water and stir, the sugar dissolves in the water. The result is a homogeneous mixture of sugar and water. When substances dissolve and form a homogeneous mixture, the mixture that forms is called a solution.

Liquid solutions are easy to recognize. They do not separate into distinct layers over time. If you pour a liquid solution through a filter, none of the substances in the solution are trapped in the filter. You can see through solutions that are liquids because light passes through them without being scattered in all directions (No Tyndall Effect). These three properties of liquid solutions can be traced to the size of the particles in a solution. The particles in a solution are too small to settle out of the solution, be trapped by a filter, or scatter light.

Suspensions

Have you ever seen the instruction: “shake well before using” on a bottle? This instruction is a clue that the material in the bottle is a suspension. A suspension is a heterogeneous mixture that separates into layers over time. For example, if you shake up a container of sand and water, the sand mixes with the water and forms a suspension. Over time, the suspended particles of sand settle to the bottom of the container.

You could use a filter to separate the sand from the water, the water would pass through the filter, but the sand would remain in the filter paper. Suspended particles settle out of a mixture or

are trapped by a filter because they are larger than the particles in a solution. Because larger particles can scatter light in all directions, suspensions are cloudy and often create the Tyndall Effect.

Colloids

Milk is a mixture of substances including water, sugar, proteins, and fats. When fresh cow's milk is allowed to stand, a layer of cream rises to the top. This layer contains much of the fat in the milk. In the milk you buy at the store, the cream does not form a separate layer. The milk has been processed so that the fat remains dispersed throughout the milk. The result is homogenized milk, which is a colloid.

A colloid contains some particles that are intermediate in size between the small particles in a solution and the larger particles in a suspension. Like solutions, colloids do not separate into layers. You cannot use a filter to separate the parts of a colloid. Fog is a colloid of water droplets in air. Automobiles have headlights with low beams for normal driving conditions and high beams for roads that are poorly lit. With the high beams, a driver can see a bend in the road or an obstacle sooner. But the high beams are not useful on a foggy night because the water droplets scatter light back toward the driver and reduce visibility. With the low beams, much less light is scattered. The scattering of light (the Tyndall Effect) is a property that can be used to distinguish colloids and suspensions from solutions.