

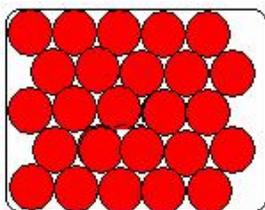
Classification of Matter

Before we classify the matter, let us understand the meaning of matter. **Matter** is anything that occupies the space and has a mass. For example, your textbook, trees, table, etc. Then what is the mass? The **mass** is the amount of matter in an object, which is not the same thing as its weight. The **weight** is a measure of the gravitational force exerted on an object. As long as the gravity is uniform (earth's surface), the weight does not change. Hence, we can freely use the word mass or weight; it does not make any difference. However, if the gravitational forces are not the same (earth vs. moon), the weight differs from the mass. For example, the same astronaut (same mass) weighs differently on earth and on moon.

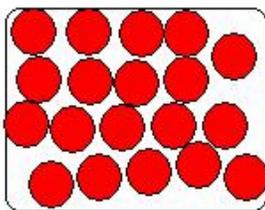
The matter can be classified in two different ways; (a) according to its state, and (b) according to its composition.

The States of Matter: Solid, Liquid, and Gas

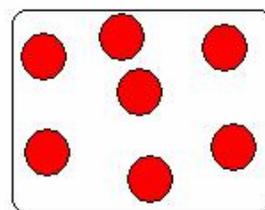
Matter can exist in three different states, solid, liquid, and gas, based on the way the atoms and molecules are arranged inside them. These three states are known as *three different states of matter*. In **solids**, atoms or molecules are tightly bound to one another thereby creating a rigid nature. Each atom or molecule is caged by its neighbors creating non-mobility, although they might vibrate around the equilibrium position. Here attractive forces are very strong. Consequently, solids have definite shapes and volumes. Some examples of solids are diamond, metals, and ice.



Solid



Liquid



Gas

In **liquids**, the atoms or molecules are not as tightly bound as in solids and due to that they have some freedom to move around. They still experience attractive forces but not as strong as solids. In addition, they also begin to experience some repulsive forces. Thus, liquids have definite volume but not definite shape- they assume the shape of the container. Due to their flexibility, the liquids can be poured from one container to another. Some common examples are water, gasoline, and alcohol at room temperature.

In **gases**, the atoms or molecules are far apart due to they are not bounded at all, meaning, they do not have any attractive forces but only repulsive forces. Due to that they can occupy a large volume. They do not have their own shape or volume, but assume the shape and the volume of the container. Some common examples are oxygen, hydrogen, and helium at room temperature.

Think: Why are you able walk freely in air, with some difficulty in liquids, and not all through solids?

Example

Classify each of the following substances as solid, liquid, or gas.

- (a) Gold
- (b) Water
- (c) Helium
- (d) Alcohol
- (e) Salt

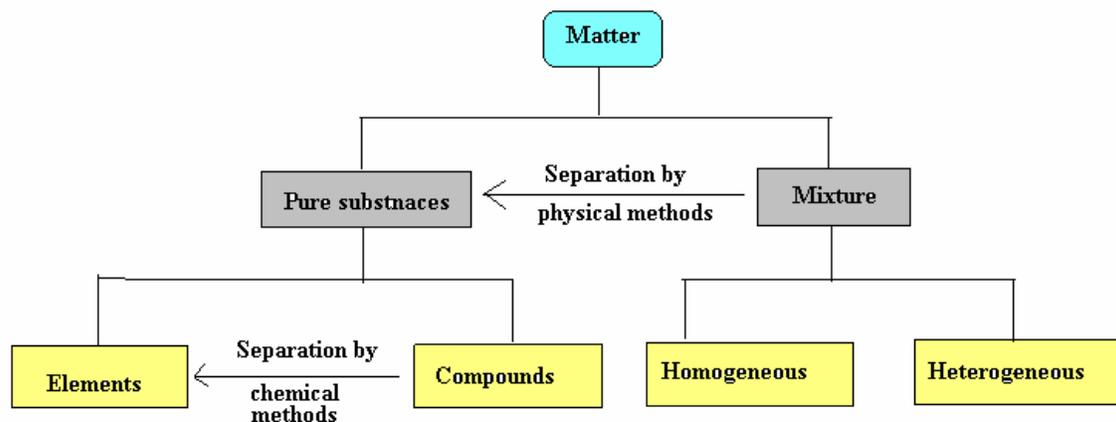
Answer

(a) solid, (b) liquid, (c) gas, (d) liquid, (e) solid

Classification of Matter based on Composition

When we talk about matter, usually we talk about a substance, which possesses distinct properties and has a definite composition. For example, sugar (sucrose), table salt (sodium chloride), water, gasoline, etc. All substances do not have the same composition but yet can be identified by their unique properties.

Matter is classified into two broad categories, namely, pure substances and mixtures. Mixtures can be separated into pure substances by physical methods. Pure substances are further divided into categories as elements and compounds. Similarly, mixtures are also classified into types; homogeneous mixtures and heterogeneous mixtures:



A pure substance can be either an element or a compound. First of all, the elements are the building blocks of our nature. An **element** is a substance that is either discovered in

nature or synthesized in the laboratory in pure form that cannot be separated into simpler substances by chemical methods. Currently, there are about 118 elements discovered; some are found in nature and some are man-made. In order to call it as an element, its properties must be unique; no two elements are alike. Elements carry the names and symbols. Some common elements and their symbols are listed in the following table in alphabetical order.

Aluminum	Al	Fluorine	F	Oxygen	O
Arsenic	As	Gold (Aurum)	Au*	Phosphorous	P
Barium	Ba	Hydrogen	H	Platinum	Pt
Bromine	Br	Iodine	I	Potassium(Kalium)	K*
Calcium	Ca	Iron(ferrum)	Fe*	Silicon	Si
Carbon	C	Lead(Plumbum)	Pb*	Silver(Argentum)	Ag*
Chlorine	Cl	Magnesium	Mg	Sodium(Natrium)	Na*
Chromium	Cr	Mercury(Hydragyrum)	Hg*	Sulfur	S
Cobalt	Co	Nickel	Ni	Tin(Stannum)	Sn*
Copper(Cuprum)	Cu*	Nitrogen	N	Zinc	Zn

* derived from the Latin names, Latin names are given in the parenthesis

Few things to know about the elements:

- **Names** of the elements are given by its inventor(s). Some times, they are named after the place like an element Berkelium (Bk) after its discovery in Berkeley (University of California, Berkeley). Some times, their names are based on planet, like element Mercury (Hg) named after the planet mercury. Some times, the name is given to honor the great scientist, like Curium (Cm) after Madame Curie.
- **Symbols** are the short-hand notations for elements consisting of one or two letters. The first letter is always in upper case and the second one in lower case. Most of the symbols are derived from their English names except few that are derived from their Latin names (see the above table). One-letter symbols are taken from the first letter of the name. The two-letter symbols are derived in various ways. Some symbols are derived by the combination of the first letter and the second letter (e.g. Ba for Barium), some are of the first letter and the third letter (e.g. Cl for chlorine), etc.

A compound is the substance formed by the chemical union of two or more elements in a definite ratio, which is fixed by the nature. We cannot change this ratio, no matter who does it. For example, water is made up of one part oxygen and two parts hydrogen. This ratio is fixed by the nature and we cannot alter this. When the compound is formed, altogether a new substance is formed and the properties of which are quite different from its reacting elements. Like elements, compounds also carry names and symbols that you come across in a later chapter.

Compounds can be separated into elements using chemical methods but not the physical methods.

Example

In the followings, identify which is an element and which is a compound.

- (a) Silver metal
- (b) Table salt
- (c) Oxygen gas
- (d) Stainless steel
- (e) Iron

Answer

(a) element, (b) compound, (c) element, (d) compound, (e) element.

A **mixture** is a *physical combination of two or more substances where the substances retain their original identity*. Some examples are air, milk, various fruit drinks. The most important aspect of the mixture is that it has no definite or constant composition. Mixture is further classified as either homogeneous or heterogeneous based upon its uniformity. A **homogenous mixture** is a *solution that has a uniform consistency (composition) throughout*, for example, a salt solution after dissolving and mixing it thoroughly. Not only that but also the individual components cannot be identified. A **heterogeneous mixture** *does not have uniform composition* like homogeneous mixture where the individual components can be identified, for example, a mixture of sand and salt.

Example

Classify each of the following as homogeneous or heterogeneous mixture

- (a) Wine
- (b) Chicken soup
- (c) Unopened Carbonated soda
- (d) Creamy peanut butter
- (e) Minestrone soup

Answer

(a) homogeneous, (b) heterogeneous, (c) homogeneous, (d) homogeneous, (e) heterogeneous.

Example

Classify each of the following as an element, compound, or a mixture

- (a) Gold ring on your finger
- (b) Sugar
- (c) French salad dressing
- (d) Helium
- (e) Sand

Answer

(a) element, (b) compound, (c) mixture, (d) element, (e) compound
