

Matter is the material of which the universe is composed. It has two characteristics:

- It has mass; and
- It occupies space (i.e., it has a volume).

Matter can be found in three generic states:

- Solid;
- Liquid; and
- Gas.

Note however, these three states are not necessarily sufficient to describe the state of a system. For example, at room temperature and pressure, pure carbon may be found in two forms, graphite and diamond. Both are composed of carbon atoms alone, but they have completely different physical appearances. The difference is the organisation of the carbon atoms in the solid. Both solid forms are different states of carbon.

Solids are generally rigid and maintain their shape and size.

Liquids take on the shape of their container but do not change their volume. For example,

also result when physical stresses are placed on a system. The difference between physical changes and chemical changes is that in chemical changes, new substances are formed. Chemical changes are not often easily reversible. For example, if a mixture of hydrogen gas and oxygen gas is heated strongly, water will be produced. This will be recognised as a chemical change because cooling back the water produced will not regenerate the original hydrogen gas and oxygen gas. Chemical changes can usually be identified by observing one or more of the following changes:

- a spontaneous change of colour
- spontaneous formation of a gas
- spontaneous formation of a solid
- spontaneous change in temperature.

Exercise: Classify the following changes as physical or chemical.

1. Iron rusts.
2. Grape juice turns to wine.
3. Photographic film is exposed to light.
4. Water begins to boil.
5. Grass grows.
6. An infant gains 10 lbs.
7. A broken leg mends itself.
8. Wood burns to ashes.
9. Rock is crushed to powder.
10. Salt dissolves in water.

Elements are substances that cannot be chemically broken down into other substances. There are now about 110 known elements of which 92 are naturally occurring. The remainder of the elements have been produced artificially. Elements are composed of identical units called atoms (i.e., elements consist of only one type of atom).

Compounds (molecules) are chemical combination of atoms of different elements. A compound always consists of a chemical association of atoms of different elements. Their physical and chemical properties are different from their constituent elements. Compounds can be broken down through chemical changes into their elements. A compound always has the same chemical combination of atoms. For example, the compound carbon dioxide, one of the so-called greenhouse gases and a product of respiration, consists of one atom of carbon chemically combined with two atoms of oxygen. It is written as  $\text{CO}_2$ . All samples of carbon dioxide, regardless of their origin, consist of exactly one atom of carbon and two atoms of oxygen.

A pure substance always has the same composition. There are two classes of pure substances:

- elements
- compounds

A sample of a pure substance contains only one type of compound or element. Pure substances are rarely found in nature.

Mixtures are by far the most common way that chemicals are found. They are a physical combination of different compounds or elements (i.e., physically combining different pure substances). Mixtures may be either homogeneous or heterogeneous.

(referred to as solutions) are uniform in composition throughout. For example, when table salt (sodium chloride) is dissolved in pure water, the resulting salt water has a uniform appearance. No part of this mixture differs from any other part, so salt water is a homogeneous mixture.

do not have a uniform appearance. Parts of such mixtures appear as



