

INTRODUCTION TO STATES OF MATTER

WHAT IS MATTER?

'Matter' refers to all substances that make up the universe. Matter is everywhere, except in a vacuum.

The features of a substance and how it behaves are called its properties. Chemistry involves the study of properties of matter.

Matter has chemical and physical properties. Physical properties include density, melting point, boiling point, freezing points, colour and smell. Chemical properties include whether it is a metal or non-metal, an acid or a base, and, importantly, how it combines with other substances in a reaction.

Chemical Properties	Physical Properties
Does it burn?	At what temperature does it melt?
Does it react with air?	At what temperature does it boil?
Does it react with other things?	Does it have a smell?
	What colour is it?
	How hard or strong is it?

Matter can change in two major ways – physically and chemically.

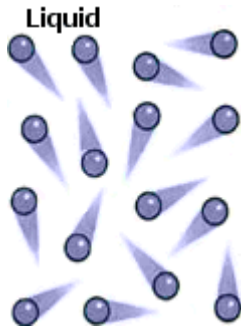
Matter is made up of tiny particles that are constantly moving. These particles can move freely or vibrate around a fixed point. There are attractive forces between these particles holding them together. The more energy these particles have, the faster they move.

SOLIDS, LIQUIDS AND GASES

Matter can exist in different states – as a solid, a liquid or a gas. The state of a substance depends on the energy that the particles have.

In a solid, particles are strongly attracted to each other, and are not able to move about freely so shape and volume do not change in a solid.





In a liquid, particles have more energy than in the solid state so they are able to move over each other and flow to fill the container they are in. The shape of the liquid can change, but the volume is fixed. Liquids will take up the shape of the container they are in.

In a gas, particles have enough energy to escape the attractive forces between them, so they are free to move in all directions at high speed. Particles will move around and fill whatever container they are in. Both the shape and the volume of the gas can be changed. Because particles in a gas are much further apart than in a liquid or a solid, they can be squashed into a smaller space. This is called compression and is an important property of gases.

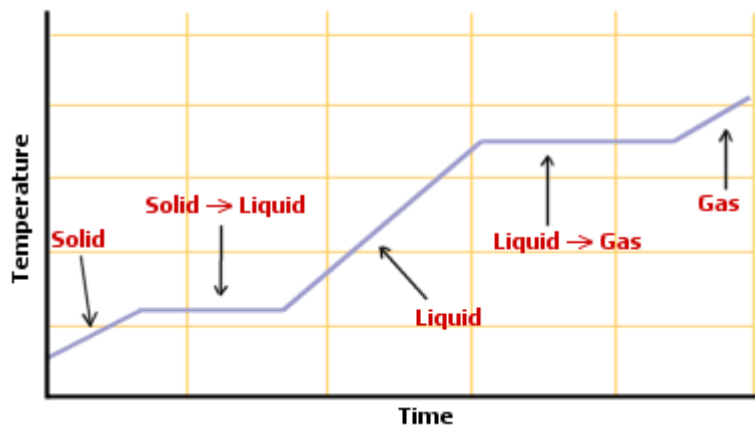


CHANGING STATE

Solids, liquids and gases can change state when energy is given to or taken from the particles.

Have a look at the graph below. It shows what happens to the temperature of water as energy (in the form of heat) is added to it.

Graph Indicating Temperature of a Substance When Heated



As heat energy is supplied to solid water (ice), the particles gain more energy and vibrate more violently until they can overcome the attractive forces and are free to move. This process is called *melting*. During this time, all the extra heat being added goes to overcome the force of attraction (the bonds) between the particles of the solid as it turns into a liquid. This is why the temperature does not go up (at the melting point) even though the substance is still being heated. Once the entire solid has melted, the temperature of the liquid will start to rise. If you continue to heat the liquid, the particles are given more energy and move faster still. Eventually, the fastest ones break away completely from each other and the liquid becomes a gas. This process is called *boiling*.

The amount of energy released or absorbed in a change of state at a fixed temperature (e.g., melting point or boiling point) is called *latent heat*.

The energy released as a solid changes to a liquid, or absorbed as a liquid changes to a solid is called the *latent heat of fusion*.

The energy released as a liquid changes to a gas, or absorbed as a gas changes to a liquid, is called the *latent heat of vaporisation*.

Sometimes solids change directly to gases without going through the liquid phase. This is called *sublimation*.

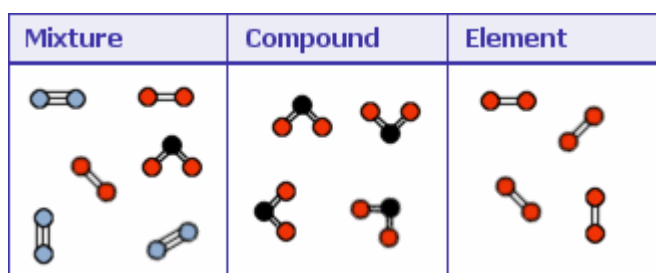
ELEMENTS, COMPOUNDS AND MIXTURES

Every substance on earth is made up from the same building blocks. These building blocks are the 92 elements found on the periodic table.

An element is a substance that cannot be broken down into simpler substances. Elements can combine in different ways to form millions of new substances. For example, water is a compound made up of two elements combined together — hydrogen and oxygen.

When elements combine together chemically they form a *compound*.

Combining elements to form compounds is different from simply mixing them. If you mix substances together, you can usually identify the individual substances in the mixture. However, when you combine substances chemically to form a compound, the compound generally has completely different properties than the elements it is made of.



Mixtures can be made from all sorts of materials; solids with solids, liquids with liquids, gases with gases, solids with liquids and gases with liquids.

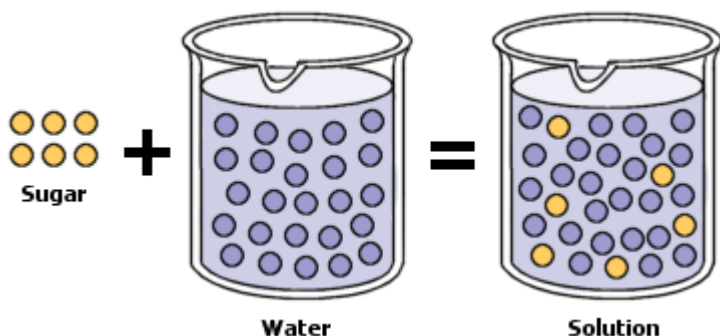
Solids can be made up of elements, compounds, mixtures or combinations of different elements and compounds. Most of the solids you see are mixtures. Most rocks are mixtures of many elements and compounds. Concrete is a good example of a man-made solid mixture.

An alloy is a mixture of two or more metals. Compounds that contain both a metal (or metals) and certain non-metals, particularly those containing carbon, are also called *alloys*.

SOLUTIONS

When you mix two liquids together, they may dissolve in each other. This will result in a single layer. For example, if you add water to alcohol, the resulting mixture remains as one layer. Liquids that dissolve in each other, like water and alcohol, are called miscible. Miscible liquids can be separated by a process called distillation.

Some combinations of liquids, like oil and water, do not dissolve in each other. When you mix them together the resulting mixture remains as two separate layers. Liquids that do not dissolve in each other are *immiscible*.



When you mix a solid and a liquid together, if the solid dissolves in the liquid, the resulting mixture is called a solution. In the case of sugar and water, the sugar is the *solute* and the water is the *solvent*.

Some gases can also dissolve in some liquids forming solutions.

Solutions can be separated from each other by evaporation. When heated gently, the solvent (i.e., water in the example above) can be boiled off. The solute (i.e., sugar in the example above) is left behind as a solid.

If the solid does not dissolve in the liquid, the resulting mixture is called a suspension. Any liquid and insoluble solid mixture (suspension) can be separated using filtration. The liquid (filtrate) moves through the filter paper. But the solid particles (residue) remain behind.