KS3 States of Matter **Knowledge Organiser**

Three States of Matter

There are three main states of matter: **solid**, **liquid** and **gas**.

All matter is made up of tiny parts called particles. How they are arranged determines the state of matter and the properties of the material.

	Solid	Liquid	Gas
particle model diagram			
particle arrangement	regular structure no space between particles	irregular structure very little space between particles	irregular structure large space between particles
volume and shape	fixed volume fixed shape	fixed volume shape changes to fill bottom of container	volume increases to fill capacity shape changes to fill capacity
able to flow	no (forces between particles are very strong and hold them in fixed positions)	yes (forces between particles are weak and particles slide over one another)	yes (forces between particles are very weak and particles move randomly and rapidly)
density	high cannot be compressed (particles are already tightly packed)	high cannot be compressed (particles are already tightly packed)	low can be compressed (particles are forced closer together)
particle energy levels	low (particles vibrate around a fixed point only)	moderate (particles can move and flow but slowly)	high (particles moving rapidly and freely)
examples	wood, metal, stone, plastic	water, milk, bleach, acid	air, oxygen, carbon dioxide

matter - any substance that has mass and takes up space (volume)

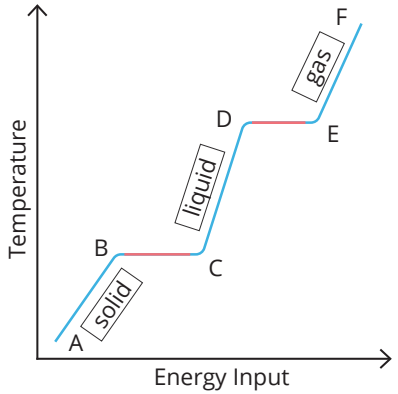
properties – characteristics or features

density - the mass of a substance per volume **(density = mass ÷ volume)**

Melting and Boiling Points

B – C When a solid substance is heated, the particles gain energy and begin to move around more.

When a solid reaches its melting point, the particles begin to break off from the uniform structure and are free to flow. The solid melts into a liquid.



D – E When a liquid substance is heated, the particles gain energy and begin to move around more. When a liquid reaches its boiling point, evaporation occurs and the liquid boils. Liquid particles break free and evaporate into a gas.

Every pure substance has a specific melting and boiling point. The purity of a substance can be checked for using knowledge of these specific melting and boiling points.

For example, pure water boils at 100°C whereas pure ethanol boils at 78°C.

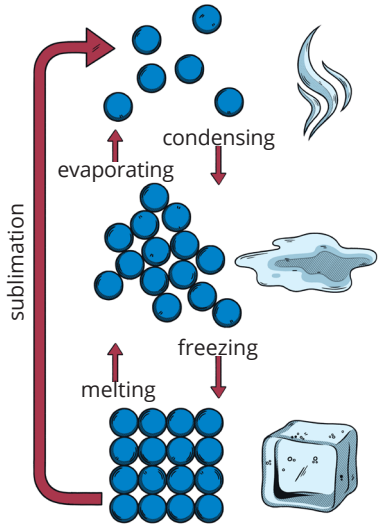
Ice melts at 0°C, and iron has a melting point of 1538 °C.

If a substance contains any impurities (dissolved solids), then its melting and boiling point will extend over a range of temperatures.

Changes of State

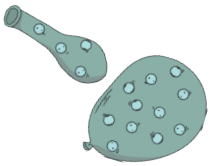
The arrangement of particles changes when the substance changes state.

Sublimation is when a solid changes to a gas, without going through the liquid phase.



Gas Pressure

Gas pressure is the force exerted by the gas particles on the wall of the container it is in. The more frequently air particles hit the walls, the higher the pressure rises.



Gas pressure is affected by:

- amount of gas;
- volume of container;
- temperature.

High gas pressure can be created by a high volume of particles in a small space, or with a high temperature.

An inflated balloon will shrink if placed in ice water and expand when placed in hot water.

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Dissolving

Dissolving is the process of mixing a **soluble solute** into a solvent until it is fully incorporated to create a **solution**.

Solutes dissolve faster with increased **temperature**, greater **surface area** and **stirring**.

soluble – able to be dissolved

solvent – the substance that something dissolves in

solute – the substance that is dissolved

solution – a liquid containing a dissolved solid or another liquid

Compounds and Mixtures

Compounds contain two or more different **elements chemically bonded** together, for example, carbon dioxide contains carbon and oxygen.

Mixtures contain substances that are **not chemically bonded**. Mixtures can be **separated** easily.

A **pure** element or compound contains only one substance, with no other substances mixed in. Impure materials are mixtures of elements, compounds, or both.

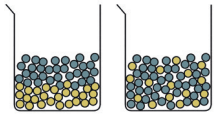
Examples of different types of mixtures:

	gas	liquid	solid
gas	air		
liquid	aerosols and foams	solutions, e.g. beer	
solid	smoke	solutions, e.g. salt water	metal alloys

Diffusion

When a **liquid** or **gas** is mixed into another, the particles will flow and move about until they are **evenly spread** throughout.

The particles move from an area of high concentration to an area of low concentration.



This process is called **diffusion**.

The rate of diffusion is affected by:

- concentration gradient;
- temperature.

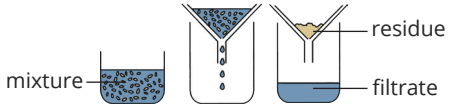
Diffusion will occur at a faster rate when the concentration gradient is steep, or the solution is at a higher temperature.

Separating Rock Salt

Rock salt is a mixture of sand and salt. Sand is **insoluble** and salt is soluble, which means they can be separated easily **using** several separation **techniques**.

1. Create a **solution** of the rock salt with water. Only the salt will **dissolve** into the water.
2. **Filter this solution**. The insoluble sand will collect as **residue** in the filter paper. The salt will pass through, dissolved in the water. The **filtrate** collected is a salt water solution.
3. Heat the salt water solution, **evaporation** or **simple distillation** can be used to collect either the salt crystals or the water.

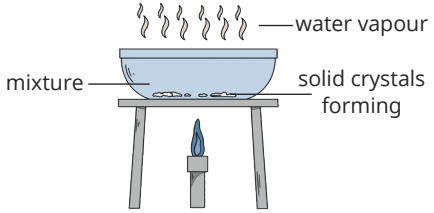
Filtration



This method is used to separate an **insoluble solid** from a **liquid**. The solution is passed through a filter paper and a funnel.

The **residue** remains in the filter paper, and the part which passes through the filter is called the **filtrate**. A mixture of sand and water can be separated by filtration.

Evaporation



This method is used to separate a **soluble solid** from a **solvent**. The solution is heated, the liquid evaporates and the solid crystallises.

If the **evaporation** and **crystallisation** occur quickly, the crystals formed will grow rapidly and will be small.

If it can occur slowly, such as on a windowsill, then the crystals will have more time to form and be larger in size.

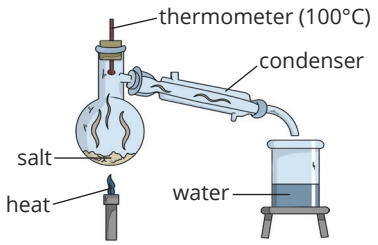
A solution of salt water can be separated using the evaporation method.

Chemical and Physical Changes

When a **chemical reaction** occurs, there is a **chemical change**. New **compounds** or different **elements** are formed in the reaction.

Physical changes do not form any new chemical substances. The substance simply **changes physical state**, for example, from a solid to a liquid, or a liquid to a gas.

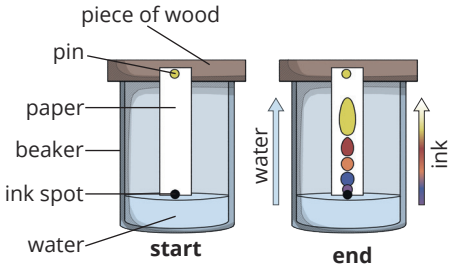
Distillation



This method is used to separate a solvent from a solution. It can separate the same type of solution as in evaporation, e.g. salt water, but retrieving the other component of the mixture.

As the water is **heated** and evaporates from the flask, it flows upwards and into the **condenser**. The condenser is surrounded by cool water which causes the water vapour to **condense** back into a liquid, this flows down the tube and into the beaker. The water collected in the beaker is **distilled water**.

Chromatography



Chromatography can be used to separate, for example, different dyes in ink. The colours are separated because they have varying **solubilities**.

The separate inks are carried different distances up the **stationary phase** (filter paper) by the **mobile phase** (solvent).