The Particulate Nature of Matter

Matter:

Matter is defined as anything that has mass and takes space.

There are 3 states of matter:

- Solids
- Liquids
- Gases

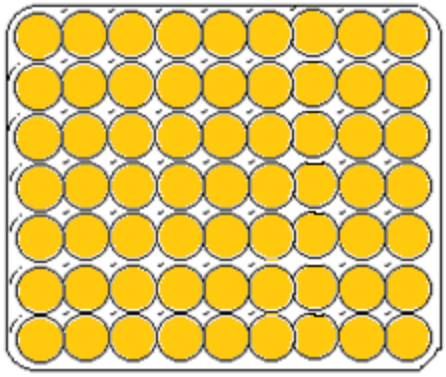
Scientists have developed a model called the kinetic theory, which explains how solids, liquids and gases behave.

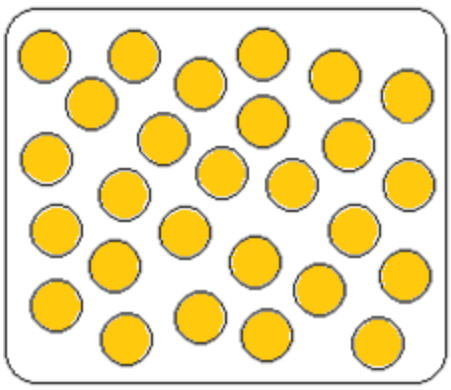
Some of its main points are:

- All matter is made up of very small particles.
- The particles are moving all the time.
- Heavier particles move more slowly than lighter particles at the same temperature.

The particles also attract each other when close, but these attractions are weakened when the particles are far apart.

The 3 states of matter also show different properties:





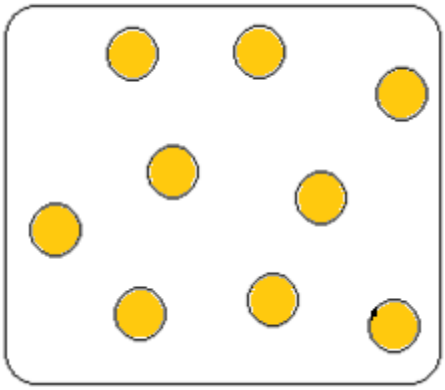
- Solids:

- Volume: Has a fixed volume. Not affected by changing pressure.
- Density: High density compared to liquids and gases of the same element.
- Shape: Has definite shape.
- Does not flow.

- Liquids:

- Volume: Has a fixed volume, with a slight effect of pressure on it.
- Density: Moderate to high.
- Shape: No definite shape, takes the shape of the container.

- It is a fluid; can flow.



- Gases:

- Volume: No fixed volume, expands to fill the conatiner.
- Density: Low.
- Shape: No definite shape.
- It is a fluid; can flow.

These also show differences in how they respond to a change of pressure or temperature:

Generally, all shoe an increase in volume when the temperature is increase. They decrease in volume when their temperatures are lowered.

But they have different magnitudes of expansion:

Gases	Ammount of expansion ↑ ↑
Liquids	
Solids	INCREASES UPWARDS

The kinetic theory explanation of thermal expansion:

“When, for example, a steel bar is heated, its particles speed up. They vibrate more and more, taking more space. As they do, they take up more space, so the bar expands in all directions slightly.

If the temperature falls, the reverse happens.”

They also show differneces in their responds to pressure changes:

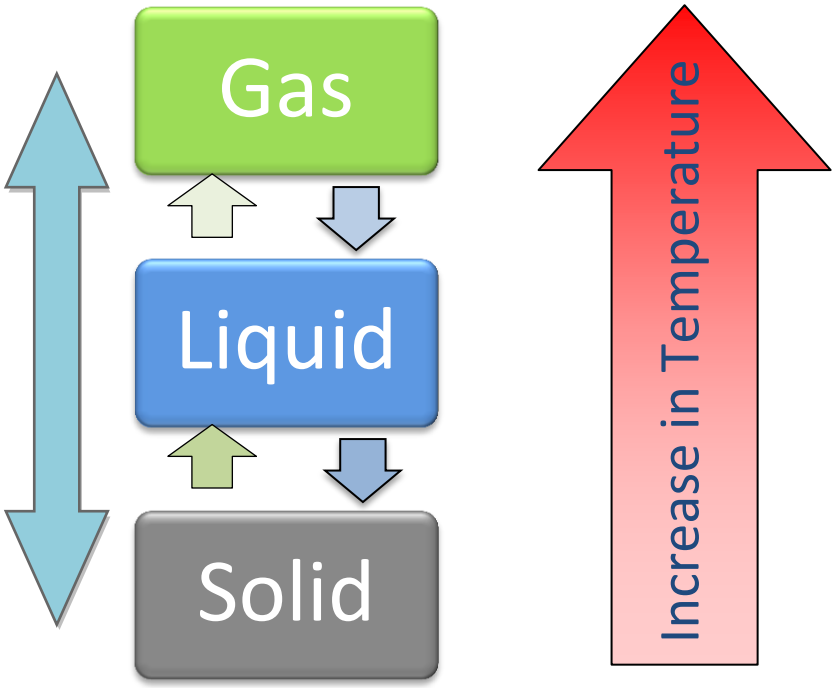
The volume of the gas at a fixed temperature can be easily reduced by increasing the pressure on the gas.

This is because the intermolecular space between the particles is huge, and so the particles can be easily brought together by decreasing the size of their container (appling pressure).

Liquids on the other hand can only be slightly compressed, because they have very small intermolecular spaces between the particles.

Solid’s volumes are unaffected by changing atmospheric pressure on them.

Changes in physical states of substances:



- Evapouration and condensation:

These happen between a liquid and a gas. The change of a liquid into a gas is called evapouration. Condenstation is the reverse. These happen on a range of tempertures.

- Boiling:

This takes place at a specific temperature called a boiling point. It is the rapis change of a liquid into a gas at a certain temperature.
The boiling point of a substance decreases if the pressure decreases.
Impurities in the liquid can increase the boiling point.

- Melting and freezing:

These happen at a particular temperature called the melting/freezing point.
Melting is the change of solid into a liquid and freezing is the reverse.
Impurities in the solid/liquid can decrease the melting point.

- Sublimation:

A few solids like carbon dioxide and iodine, do not melt when heated, but change directly into a gas.
This also happens at a specific temperature.

Pure and impure substances:

A pure substance consists of one substance only. There is nothing else in it – it has no contaminating impurities.

A pure substance melts and boils at definite temperatures.

An impure substance (that has impurities in it) like sea water has salts and other impurities dissolved in it. This make the sea water have a lower melting point and a higher boiling point.

Types of mixtures:

There are 2 ways in which mixtures can be formed between 2 substances:

1. Homogeneous mixtures, where the substance are totally mixed together and are indistinguisable, e.g. salt dissolved in water.

   There are many mixtures that are homogeneous:
   - Solution of a soluble solid in a liquid
   - Solution of 2 miscible liquids
   - Solution of a gas in a liquid
   - Mixture of a gas in a gas
   - Alloy of two metals

2. Hetrogeneous mixtures, where the substances remain seperated and one substance is spread throughout the other as small particles, droplets or bubbles, e.g. suspensions of insoluble solids in water.

   Some of these mixtures are:
   - Suspension of a solid in a liquid
   - Gel
   - Emulsion of 2 immiscible liquids
   - Aeorsol of either a liquid or a solid in a gas
   - Foam of a gas in a liquid
   - Solid foam of a gas in a solid

Diffusion:

It is the spreading out of particles in a liquid or a gas, which is cause by the random movement of particles.

It is also the movement of particles from a region of higher concentration to a region of lower concentration.

Diffusion in liquids is much slower than in gases.

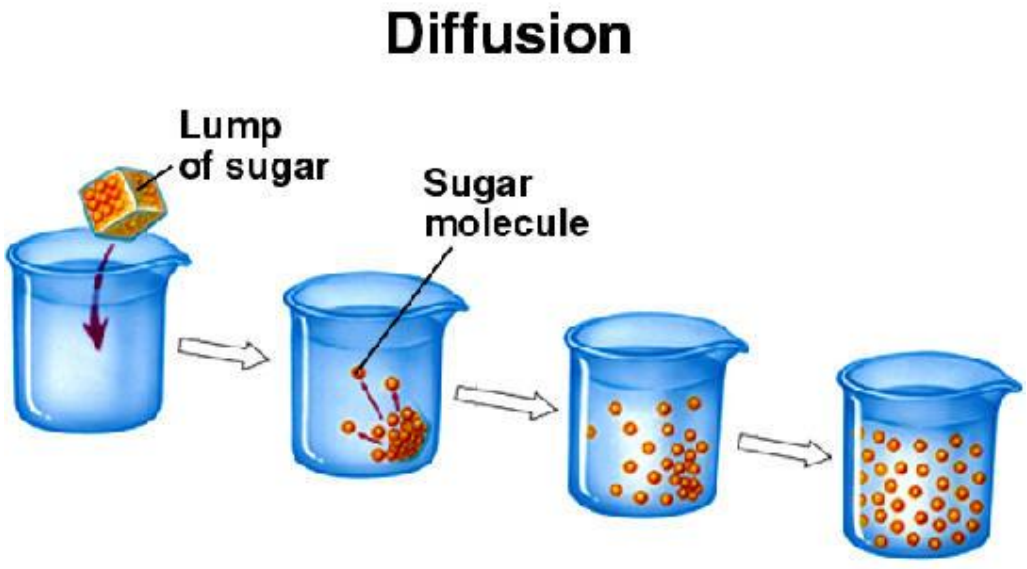
Diffusion in liquids is also called dissolving.

e.g. Copper (II) Sulphate crystals in water:

A copper 2 sulphate cyrstal is put in water beaker. It is then left to stand. At first the water next to the crystal becomes blue as the solid dissolves.

Particles move off the surface of the crystal.

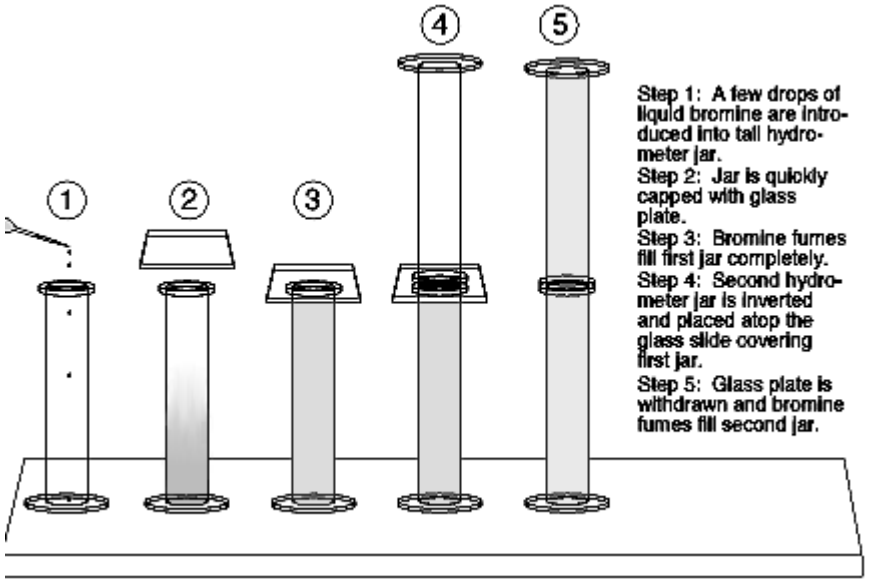
Eventually the crystal dissolves completely and the whole solution become blue. The particles of the crystal have spread out evenly in the liquid.



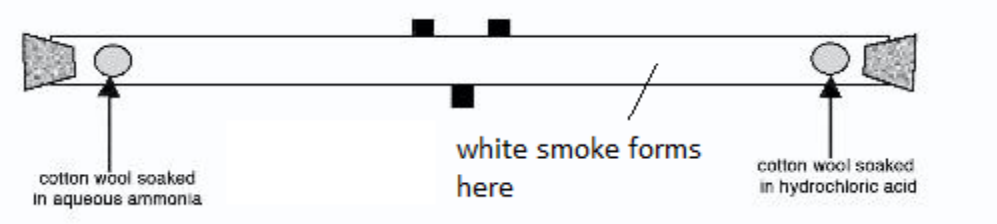
Diffusion in gases:

e.g.1 When a few drops of liquid bromine are put in gas jar and the lid is placed, the gas jar soon gets fully brown.

Bromine vapourises easily and fills all the available space completely.



e.g.2 Not all gases diffuse at the same rate, ammonia and hydrochloric acid put in cotton wool on either side of a closed glass tubing create some smoke near to the cotton wool soaked in HCl, as shown:



M_r NH_3 = 14 + 1x3 = 17 (Ammonia)

M_r HCl = 1 + 35.5 = 36.5 (Hydrochloric Acid)

This shows that HCl molecules are heavier than NH_3 molecules.

Factors affecting the rate of diffusion: