

States of Matter

There are three different states of matter: *solids, liquids and gases*.

These three states of matter behave differently in space, due to the fact that:

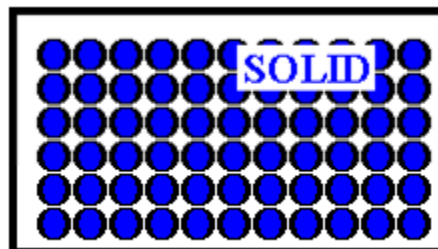
- Solids have got a both a fixed volume and fixed shape. It can increase and decrease slightly in size with changes in the temperature.
- Liquids have got a fixed volume but they would take the shape of the container. A change in temperature would have a change in volume.
- Gases have got no fixed volume nor shape and a change in temperature would have a very big change in volume.

Different states of matter would have different energies and thus it can be noted that each particle would be able to react differently to different conditions. This can be explained by the kinetic theory:

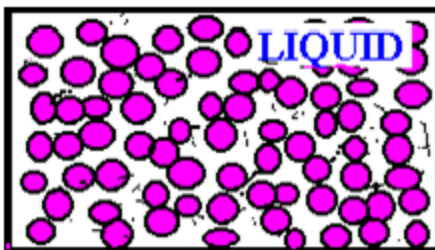
- All matter is made up of particles.
- The particles are moving all the time.
- Heavier particles move slower than lighter particles.

This can then be used to analyse the forces found in each of the states of matter.

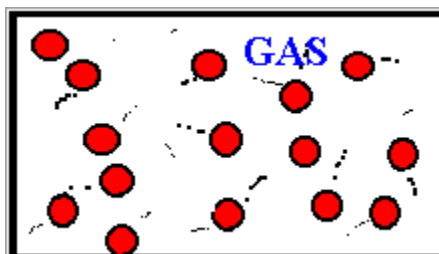
- Solids would have their particles very close together which would be held by very strong forces making it very difficult for individual particles to be able to roam freely, but these particles can vibrate.



- Liquids would still have forces between separate particles, but they would be much weaker, allowing individual particles to roam around in a random way.

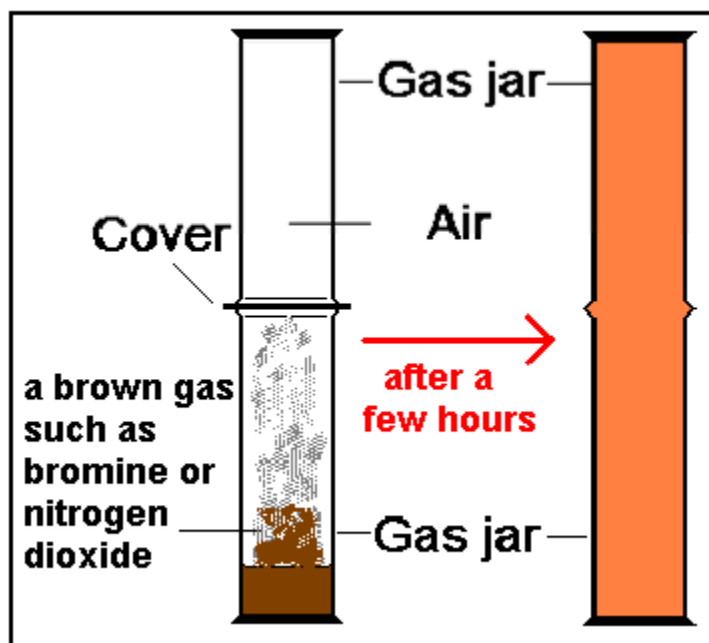


- In gases no forces are found between separate particles allowing the particles to roam around freely and at very high velocities.



Diffusion

As discussed in the kinetic theory particles in liquids and gases are constantly on the move. This would result in the migration of particles from one place to another resulting in the process of diffusion which can be observed as migration of chemicals from a high concentration to a place of a lower concentration. This process of diffusion can be observed as:



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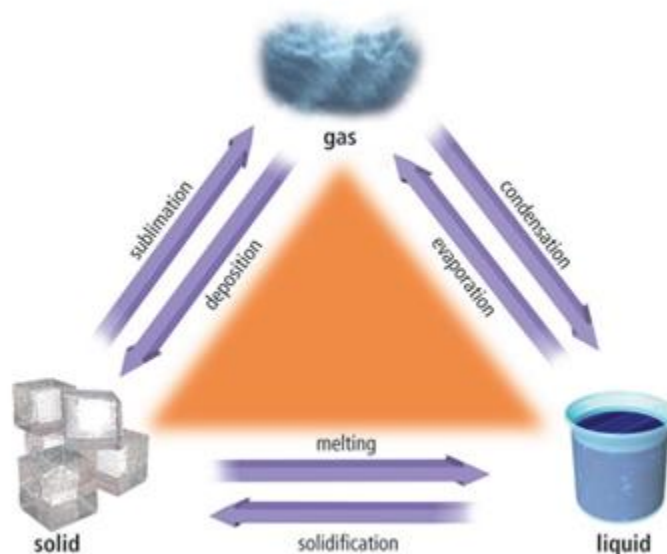
A **coloured gas, heavier than air** (greater density), is put into the bottom gas jar and a **second gas jar of lower density colourless air** is placed over it separated with a glass cover.

If the glass cover is removed then (i) the colourless air gases diffuses down into the coloured brown gas and (ii) bromine diffuses up into the air. The particle movement leading to mixing **cannot be due to convection because the more dense gas starts at the bottom!**

No 'shaking' or other means of mixing is required. The **random movement of both lots of particles is enough to ensure that both gases eventually become completely mixed by diffusion.**

This is **clear evidence for diffusion** due to the random continuous movement of all the gas particles and, initially, the net movement of one type of particle from a higher to a lower concentration (**'down a diffusion gradient'**). When fully mixed, no further colour change distribution is observed BUT the random particle movement continues! See also **other evidence in the liquid section** below.

Changes of states



Matter can easily interchange between different states of matter, with the most important changes being between solids and liquids and liquids and gases, although it must be noted that solids can sublime to form a gas without forming liquid as an intermediate

On heating the energy of the particles would increase and once enough energy is given to the particles they would be able to overcome the strong forces between the particles to melt and produce a liquid. This would be the **melting temperature**. If the temperature is increased then the particles would obtain even more energy and until the energy is high enough for each particle to escape the effects of the other particles to form a gas. This temperature would be the **boiling point**

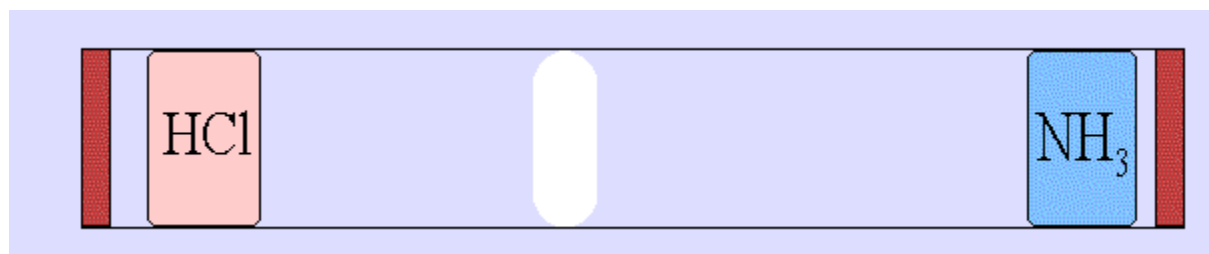
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When the temperature is reduced the gases would go back to being a liquid while liquids would form a solid, with the processes being known as condensation and solidification respectively.

In some special cases solids can form gases without the formation of liquids, with such an example being Carbon Dioxide. The temperature at which this process occurs is called the sublimation point while the reverse process is called deposition.

Rates of Diffusion

The rate of diffusion is related to the mass of the molecules. The bigger the mass, the slower the rate of diffusion. An experiment to show the difference in the rate of diffusion is the following:



The two gases will diffuse at different rates, and thus they would meet at a point closer to the hydrogen chloride rather than at the center.