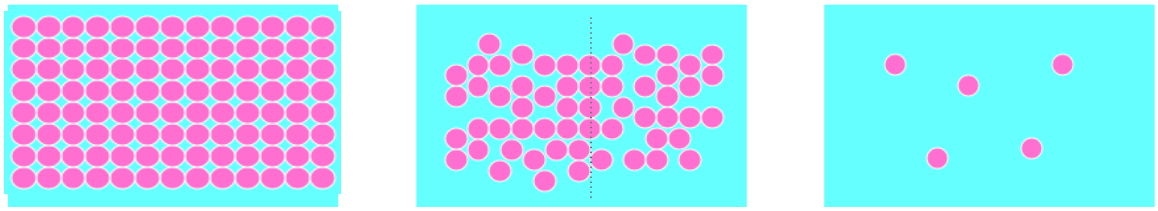
Particles Key Notes

Particles & Particle Arrangement

All materials are made up of particles. The **particle theory** says that all things are made of tiny pieces, called *particles*. Solids, liquids and gasses all have different arrangements of these *particles*, giving them their special properties.

Solids, liquids and gases are the three states of matter



Solids: -

- The particles are very close together
- The particles are arranged in a regular pattern
- The particles cannot move from place to place, but the particles can vibrate in a fixed position
- Solids are held together by strong forces called **bonds**
- Solids have a fixed shape, e.g. wood, plastic, steel, ice (solid water)

Solids have a fixed shape because the particles cannot move from place to place

Solids cannot be compressed because the particles are very close together, and have no space to move into

Liquids: -

- The particles are close together
- The particles are arranged in a random way
- The particles can move around each other - the **bonds** in a liquid are strong enough to keep the particles together, but weak enough to let them move around
- Liquids flow, and can change shape, e.g. water, lemonade, mercury, (all liquids at room temp.)

Liquids can change shape because the particles can move around each other

Liquids cannot be compressed because the particles are close together, and have no space to move into

Gases: -

- The particles are far apart
- The particles are arranged in a random way
- The particles can move quickly, in all directions - there are **no bonds** between the particles in a gas
- Gases flow, and completely fill their container, e.g. air, helium, chlorine (gas at room temp.)

Gases can move quickly in all directions, filling their container

Gases can be compressed because the particles are far apart, and have space to move into

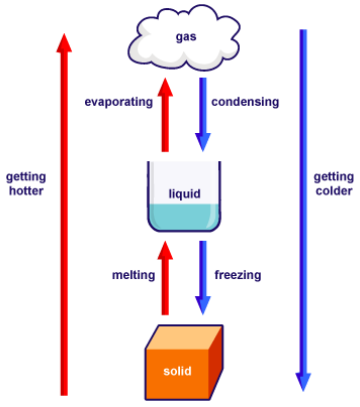
Heat

Melting (solid → liquid) such as ice to water. When a substance melts, the fixed particles become able to move around each other.

Evaporating (liquid → gas) such as water to water vapour. When a substance evaporates, some particles gain enough energy to move fast enough to escape the force of attraction from the other particles and escape.

Condensing (gas → liquid) such as water vapour to water. When a substance condenses, the high energy particles loose energy, and the force of attraction from the other particles becomes sufficient to keep all the particles together (although they can still flow other each other)

Freezing (liquid → solid) such as water to ice. When a substance freezes the particles go from being able to move around each other, to being fixed in place



Boiling is very similar to evaporating (liquid → gas). When you evaporate a liquid, some of the particles get enough energy to escape the force of attraction from the other particles in the liquid.

Boiling is the same as this, but if you heat the liquid even more it will boil - this is where virtually all the particles have enough energy to overcome the forces of attraction and escape.

Expansion: -

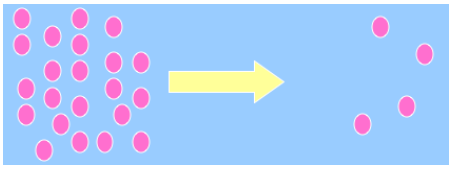
- Substances expand (get bigger) when they are heated up. The particles stay the same (the number of particles + their size is the same). But they take up more room!
- Solids - particles vibrate more and take up more room
- Liquids - move around each other more quickly and take up more room
- Gases - move more quickly in all directions, and take up more room

Contraction: -

- Substances contract (get smaller) when they are cooled down
- When we cool objects, the number of particles and their size remains the same; they just take up less room!

Diffusion

Diffusion is the net movement of particles from an area of high concentration, to an area of low concentration

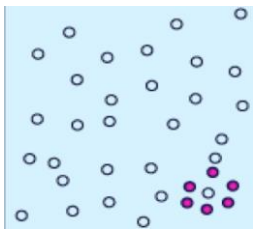


When a smelly gas such as a deodorant is let loose in a room, its particles mix with the particles of air. The particles of smelly gas are free to move quickly in all directions. Eventually they spread through the whole room - this is called diffusion.

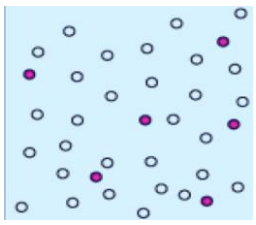
You don't need to wave your arms around to mix the smelly particles - it mixes on its own. Diffusion in gases is very quick, because the particles in a gas move quickly, so they can get from one side of the class to the other quickly.

Diffusion is the mixing of particles, which occurs in gases and liquids but not solids

Diffusion can occur in gases and in liquids, because their particles are able to move
Diffusion is slower in liquids than in gases because the particles move more slowly
But diffusion cannot occur in solids - this is because the particles are fixed in place - they are not able to move (they can only vibrate), so do not mix



Before diffusion



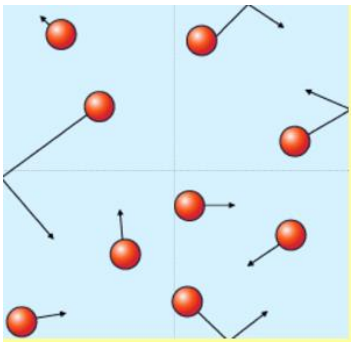
After diffusion

Adding heat to the gas or liquid causes diffusion to happen quicker. This is because the particles have even more energy, and move around much quicker (mixing quicker)

Gas Pressure

Gas pressure causes a balloon / tyre to keep its shape

The pressure is caused by the trapped gas particles colliding into the sides of the container they are in
The more particles there are in there, the greater the pressure becomes (until you try to put too many particles in, when often the balloon pops)!



If a gas is heated up, its particles move around more quickly. They will hit the sides of the balloon harder, and more often. This will then increase the pressure (and the balloon expands)

Heat it up too much, and you'll create too much pressure inside, causing the container to explode.

The opposite happens when you cool it - the particles move slower, crash into the sides with less force, and less often, decreasing the pressure (so the balloon shrinks)

Solute, Solvent & Solution Key Terms

- Solution - the mixture formed when a substance dissolves in it
- Solute - the substance that dissolves
- Solvent - the liquid in the solution
- Dissolve - mixing of a substance in a liquid
- Soluble - a substance which can dissolve (mix in a liquid)
- Insoluble - a substance which cannot dissolve (mix in a liquid)
- Saturated – the point at which no more solute can dissolve in the solvent
- Solubility – the amount of solute which can dissolve in our solvent

A solution is always transparent - even it has a colour. If our liquid remains cloudy, then the solute has not completely dissolved. If a substance will not dissolve (insoluble) then it will settle and be obvious.

When something dissolves its particles spread throughout the solvent, forming a solution

The particles diffused quicker when they were heated - more heat gives them more energy, so the move (and mix) quicker

The solubility of most substances increases as the temperature does

This means most substances become more soluble in hot water, rather than cold water, meaning it becomes easier to wash our dishes!

Separating

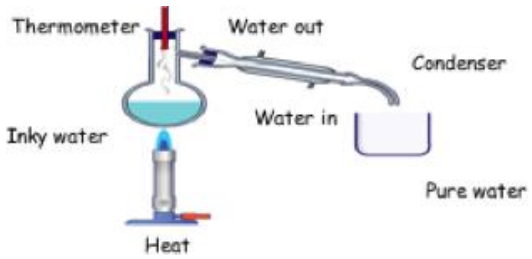
Filtration can separate an insoluble solid from a liquid (remember insoluble means it does not dissolve).

Evaporation can separate a soluble solid from a liquid (a soluble substance dissolves in water to form a solution).

Evaporation helps us separate because some water particles are given enough energy to escape the attraction of the other particles. If we heat the water for a long enough, eventually all our particles are given enough energy to escape, just leaving salt

Salt cannot be separated using filtration, because the particles are too well mixed - this means that they would pass straight through the filter paper.

Distillation can separate a liquid from a solution (water from salty water). Distillation works by evaporating the liquid from the solution. It is then *cooled* and *condensed* into a separate container. The salt does not evaporate, so we have successfully separated the two



It is really important you know the boiling temperature of the liquid you want

The liquid will only be removed once it reaches this boiling point (at which point it can be condensed and collected)

This means different substances can be separated, based on their boiling temperature - this is the science behind distillation

Chromatography is a way to separate dissolved substances, which have different colours, such as ink and plant dyes

It works because some substances dissolve in the liquid better than the others. The better a substance dissolves, the higher up the filter paper it travels

- The start line is drawn in **pencil** so more colour spots are not added!
- The molecules moved upwards
- The ink is drawn well above the solvent level to stop it dissolving in the solvent