Chapter Three: Particle Model of Matter

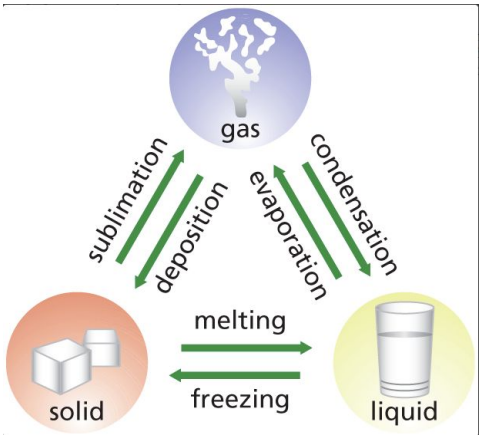
States of Matter

-Solids are of fixed size and shape, they have particles which can vibrate but they do not change their positions, these are held together by strong bonds / forces of attraction

-A liquid is of fixed size but will take the shape of the container that it is in, the bonds are weaker, with the particles moving around with a random motion

-A gas has no fixed shape or size, they take the shape of the container that it is in, the particles will move quickly, colliding with one another and with the side of the container of which they are in

-Collectively, gas and liquids are known as fluids



-Changes of state are physical changes as there is not a new substance produced, the molecules are unchanged

-The energy change of a change of state depends on the state change, if the particles are moving more slowly (e.g. gas to liquid), there will be a decrease in internal energy, so energy will be given out

Density

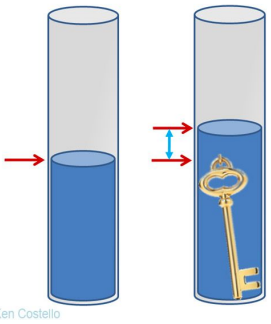
-**Density is the mass per unit volume of a substance**

$$\rho = m / V$$

Density = Mass / Volume

-To find out the density of an irregularly shaped object, Archimedes came up with the principle of displacement, when put into water, the object will displace the same amount of volume of the object

-The mass of the object can then be found and divided by the volume



Internal energy

-**Internal energy is the total kinetic and potential energy of all of the particles within a system**

-The kinetic energy comes from the movement of the particles, the potential energy is present as their motion keeps them separated

-The hotter an object is, the more internal energy it has, the cooler an object is, the less internal energy it has

-The increase in internal energy is used to break bonds between the particles to allow the state change

Specific Heat Capacity

-**Specific heat capacity is a measure of how much energy is needed to raise 1 kg of substance by 1^{o}C**

-It is a different value for different materials, lowest for solids, higher for liquids

-This means liquids can absorb a large amount of energy, making liquids such as water useful for coolants and to transfer heat energy around a house

Change in energy = mass x specific heat capacity x temperature change

$$\Delta E = mc\Delta\theta$$

Latent Heat

-**Specific latent heat is the amount of energy needed for a substance to change state**

-Latent heat of vaporisation is the energy needed to change from a solid to a liquid

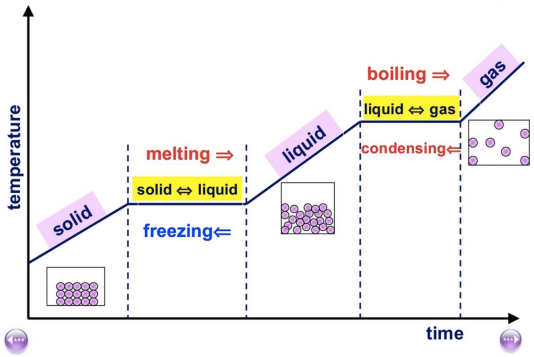
-Latent heat of vaporisation is the energy needed to change a liquid to a gas

-Latent heat of vaporisation is a greater value as energy is needed to separate the particles, but also to push back the atmosphere as the gas forms

$$E = m L$$

Energy = Mass x Latent heat

-When a change of state occurs (at a boiling point or melting point) the temperature will stay the same until all of the state change has occurred (e.g. all of the ice has melted to form water)
-When there is a change of state, there is no change in temperature
-The energy supplied changes the internal energy, but not the temperature when a change of state occurs



Particles in Gases

-**Gas pressure is the total force exerted by all of the molecules inside the container that strike a unit area of the wall**
-Particles inside a gas move randomly (Brownian motion), meaning that they collide with the wall of the container as well as each other (pressure is only affected by collisions with the container not each other)
-The higher the temperature, the more kinetic energy each molecule of gas has, meaning that it will hit the wall of the container with an increased force, meaning a higher pressure
-Pressure is directly proportional to the temperature of the gas (as long as the volume and mass of gas is kept the same)
-If a gas is compressed (same amount put into a smaller area) the pressure increases
-If a gas is expanded (same amount put into a larger area) the pressure decreases
-For a fixed mass of gas at a constant temperature, when the pressure or volume are changed:

$$P_1 \times V_1 = P_2 \times V_2$$

$\text{Pressure}_1 \times \text{Volume}_1 = \text{Pressure}_2 \times \text{Volume}_2$

-Work is done on a gas when it is compressed (work done is equal to energy transferred)
-The internal energy increases as the pressure increases, the molecules have more kinetic energy
-As temperature is related to kinetic energy, the more kinetic energy, the higher the temperature, so when a gas is compressed, the temperature will increase