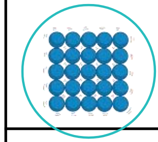
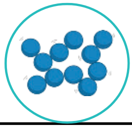
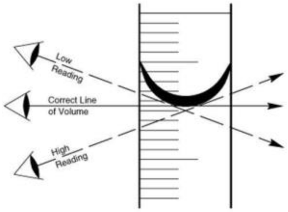
Particle model of matter

State	Pattern	Energy and movement	Forces between particles
Solid 	Ordered and all touching	Vibrate around fixed positions	Strong forces between particles
Liquid 	Random and touching	Move around randomly	Weaker than in a solid
Gas 	Random and far apart	Move around randomly	Weak forces of attraction

Models	+	-
Particle diagrams	Easy to see/draw arrangement	• Can't see the forces between particles • Particles look like flat circles rather than 3D spheres • Movement isn't shown
Kinetic models (eg marbles or animations)	Easy to see particle arrangement Can see the movement of particles	Can't see forces between particles

Zero error

Read the meniscus!



Density

Density is mass per cm^3

It can be calculated using:

Density = mass ÷ volume

$$\rho = m \div V$$

Required practical – measuring the density of different materials.

For regular solids :

Mass measured by **top pan balance**

Volume measured by measuring **length x breadth x height**

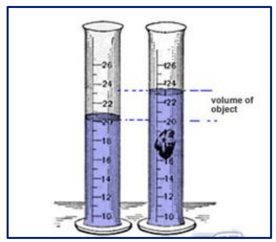
For irregular solids:

Mass measured by **top pan balance**

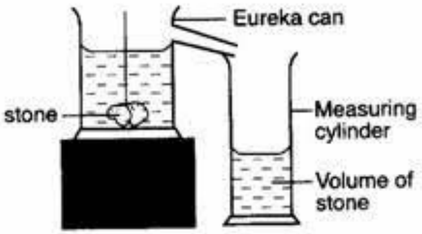
Volume measured by **displacement of water**

This means putting the object into water and measuring the volume of water 'pushed out'

Measure the volume of small objects by putting them into a measuring cylinder with $100cm^3$ water in



Measure the volume of larger objects by putting them into a full eureka can and catching and measuring the water that is displaced



Required practical continued : Density of liquids

1. Find the mass of an empty measuring cylinder using a top pan balance.
2. Pour a known volume (100ml) of liquid into the measuring cylinder.
3. Use the meniscus to measure the volume of the liquid accurately. This is the volume.
4. Now measure the mass of the measuring cylinder + the liquid combined.
5. Subtract the mass of the empty measuring cylinder and this is the mass of the liquid.

Density = mass ÷ volume.

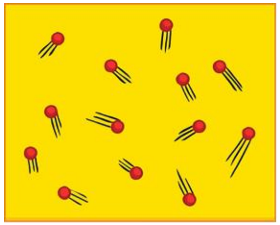
Internal energy

The temperature of any substance is related to the average speed of its particles.

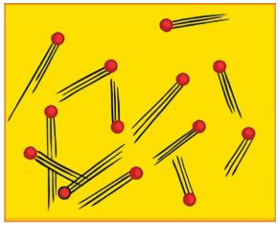
The internal energy of a system is the total kinetic energy and the potential energy of the particles

The particles in a system **<u>vibrate</u>** or **<u>move around</u>** because they have energy in their **<u>kinetic energy stores</u>**

The faster a particle moves, the greater its **<u>kinetic energy store</u>**



Low Temperature



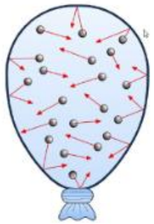
High Temperature

The particles also have energy in their **<u>potential energy stores</u>** due to their position.

As particles **<u>move further apart</u>**, their potential energy stores **<u>increase</u>**

Gas pressure

The particles in a gas are in constant random motion
They collide with the walls of their container
This exerts a force **on the container.**



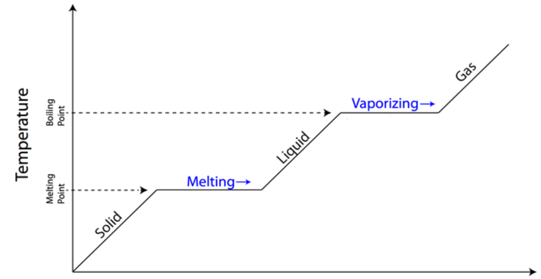
The more energy the particles have, the higher the temperature.
An increase in temperature of a gas causes the particles to move further apart.
If this is not possible, because of the container, then there is an increase in pressure.

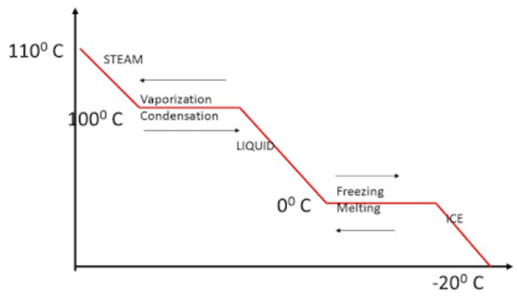
Heating and cooling

When the internal energy of a substance changes, then either :

- **The temperature** of the substance changes
- **The state** of the substance changes

This can be seen by plotting the temperature change during **heating** or **cooling.**
Heating a solid would give us a graph that looks like this:





- The **temperature stays the same**.
- This is when a change of state is happening – for example melting.
- The energy transferred is not increasing the mean particle speed – it is increasing the potential energy of the particles.

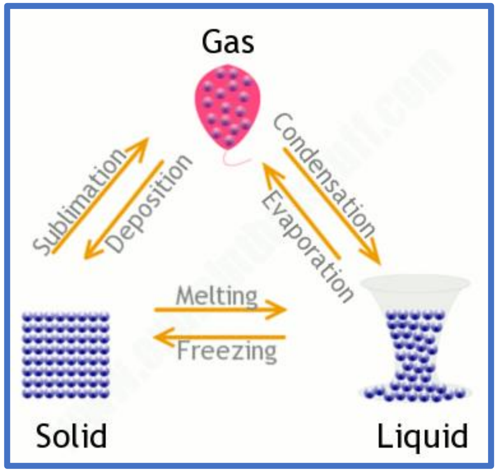
When the line is increasing (heating) or decreasing (cooling)

- The temperature is increasing / decreasing
- The kinetic energy store is increasing /decreasing
- Average particle speed is increasing /decreasing

Specific latent heat

Specific latent heat is the amount of energy needed to **change 1kg of a substance from one state to another** without changing the temperature.
Specific latent heat will be different for different materials.

- Energy needed to change 1kg of Solid → liquid - **specific latent heat of fusion**
- Energy needed to change 1kg of Liquid → gas - **specific latent heat of vaporisation**



The amount of energy needed to change 1Kg of a material is found by the equation:

Energy = mass (kg) x specific latent heat (L)

$E = m L$

Specific heat capacity

This is the among of energy needed to change the temperature of 1Kg of a substance by 1ºC
It is calculated by:

E = specific heat capacity x mass x temp change

$E = SHC \times m \times \theta$