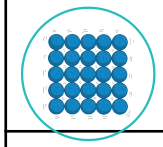
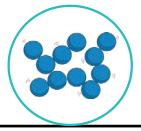
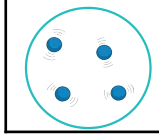
Particle model of matter

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

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**

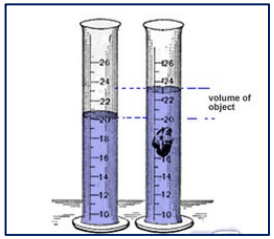
For irregular solids:

Mass measured by **top pan balance**

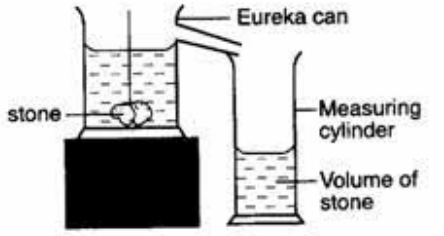
Volume measured by **displacement of water**

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

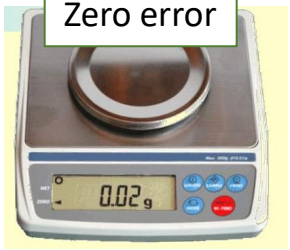
Measure the volume of small objects by putting them into a measuring cylinder with 100cm^3 water in



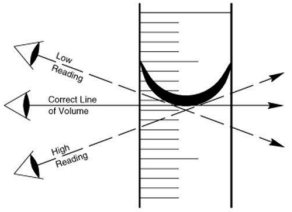
Measure the volume of larger objects by putting them into a full eureka can and catching and measuring the water that is displaced



Zero error



Read the meniscus!



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.

Particle model

1. Describe the arrangement of the particles in a solid, a liquid and a gas
2. Describe the movement of the particles in a solid, a liquid and a gas
3. In which state of matter are the forces between the particles the weakest?
4. In which state of matter are the forces between the particles the strongest?
5. Give one advantage of using particle diagrams to show the different states of matter
6. Give three disadvantages of using particle diagrams to show the different states of matter
7. Give two advantages of using kinetic models to show the different states of matter
8. Give one disadvantages of using kinetic models to show the different states of matter

Density

1. Give the formula that links density, mass and volume?
2. Give a unit for density
3. Which piece of equipment is used to measure mass of an object?
4. What type of error is it if a balance reads 0.03g when nothing is resting on it?
5. What term is used to describe when water is pushed out of the way by a solid object?
6. Name two pieces of equipment that could be used to measure the volume of an irregular object
7. What three measurements do you need to calculate the volume of a regular object?

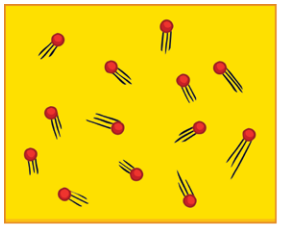
Internal energy

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

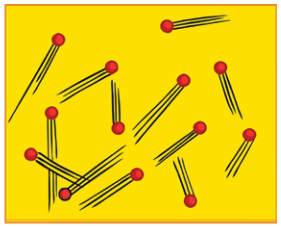
The internal energy of a system is the total kinetic energy and the potential energy of the particles

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

The faster a particle moves, the greater its **kinetic energy store**



Low Temperature



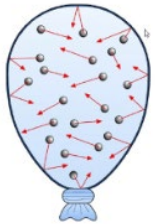
High Temperature

The particles also have energy in their **potential energy stores** due to their position.

As particles **move further apart**, their potential energy stores **increase**

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.**



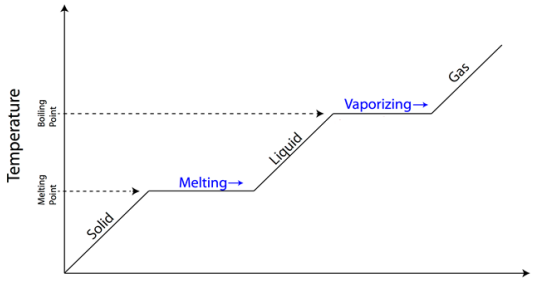
The more energy the particles have, the higher the temperature.
An increase in temperature of a gas causes the particles to move further apart.
If this is not possible, because of the container, then there is an increase in pressure.

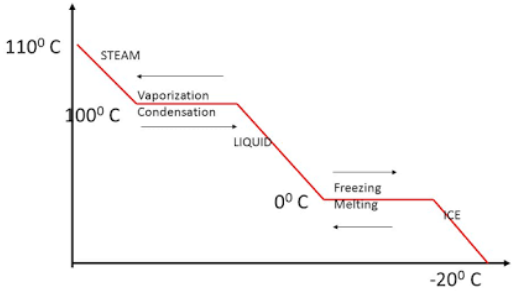
Heating and cooling

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.

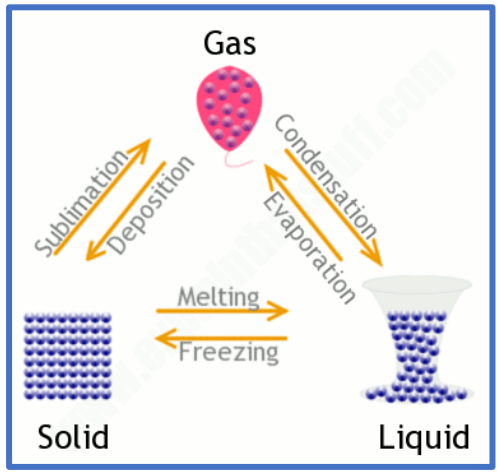
When the line is increasing (heating) or decreasing (cooling)

- 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 x m x θ

Internal energy

1. What two stores of energy make up internal energy?
2. Which energy store is linked with particle movement?
3. Which energy store increases if the particles in a substance move further apart?
4. What happens to the temperature when the kinetic store of the particles increases?

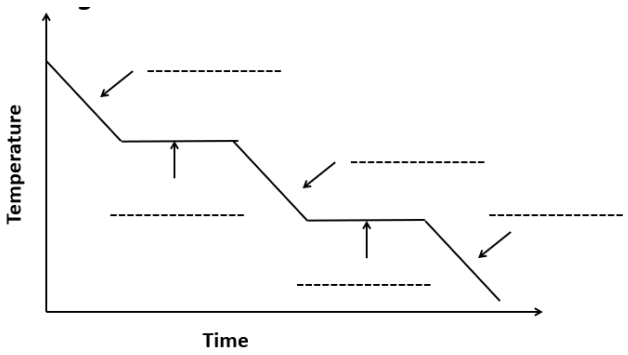
Gas pressure

1. What causes gas pressure?
2. What happens to the temperature of a gas if the kinetic energy store of the particles increases?
3. What happens to the space between particles in a gas as it heats up?
4. If the volume of the gas is kept constant, what happens to the pressure?

Heating and cooling

1. What two things can happen to a substance when the internal energy changes?
2. Label the graph below using the words given:

   liquid, gas, solid, condensing, freezing

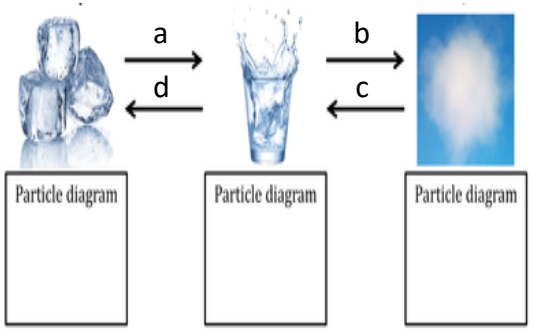


3. What is happening to temperature when the line is flat on a heating or cooling curve?

4. What is happening to the substance when the line is flat?

Specific latent heat

1. What is specific latent heat?
2. What is the term given to the amount of energy needed to change 1kg of a liquid into a solid?
3. What is the specific latent heat of vaporisation?
4. Label the changes of state below
   a.
   b.
   c.
   d.



5. Draw the particle diagrams in the boxes