P3 Density of materials

The density of a material can be calculated using the equation

$$\text{Density} = \frac{\text{mass}}{\text{Volume}}$$

Density is how much of something there is in a given space and it has units of **kg/m^3**

Mass is a measure of how much of something there is, it is measured in **kg**

Volume is a measure of how much space something takes up, it is measured in **m^3**.

Solids are drawn with all particles regularly arranged and touching.

Liquids are drawn with particles randomly arranged **but still touching**.

Gases are drawn with the particles randomly arranged and far apart.

Density is the amount of particles in a given space, because particles are packed closer together in solids, solids are denser than liquids and gases. Particles in a liquid are more closely packed than those in a gas, therefore liquids are denser than gases.

Substances can change state (melt, freeze, boil, evaporate, condense or sublimate), when they do mass is conserved. The same particles still exist.

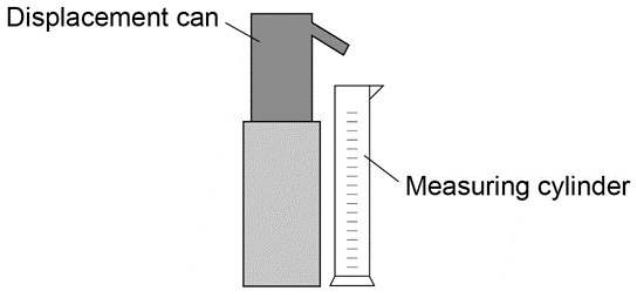
Changes of state are a physical change - the material has the same properties once the change is reversed..

Volume of a regularly shaped object

1. For each object measure the length, width and height.
2. Calculate the volume.
3. Measure the mass of each object using the digital balance.
4. Calculate the density using the equation shown above.

Volume of an irregularly shaped object

1. Measure the mass of the object using the digital balance.
2. Place a displacement can on your desk. Put an empty beaker under the spout and fill the can with water. Water should be dripping from the spout, wait for this to stop.
3. Then place a measuring cylinder under the spout instead of the beaker. Choose the measuring cylinder you think will give the most precise reading.



4. Slowly and carefully lower the object into the displacement can until it is fully submerged.
5. Measure the volume of the collected water, this volume is equal to the volume of the submerged object.
6. Calculate the density using the equation shown above.

P3 Internal energy

A system is an object or a group of objects.

Energy is stored in a system inside the particles, this is called the internal energy.

Internal energy is the total kinetic and potential energy of all the particles in a system.

Heating gives the particles more energy, it can either:

- Increase the temperature of the system
- Change the state

In a system where the temperature of a system increases, the increase depends on mass of substance, the type of material and energy put into the system.

$\Delta E = m\ c\ \Delta\theta$

ΔE in change in energy (measured in J)
m is mass (measured in kg)
c is specific heat capacity (J/kg °C)
$\Delta\theta$ = change in temperature (°C)

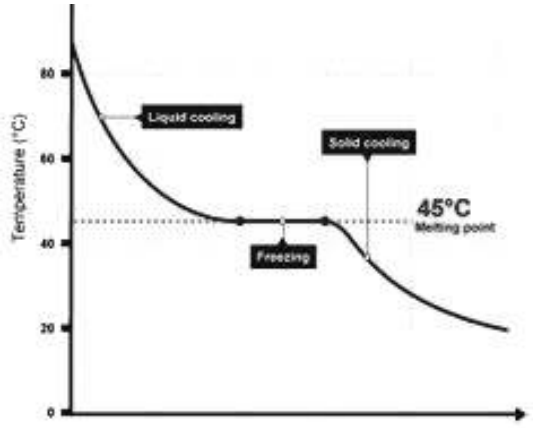
The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.

For a **change of state** a certain amount of energy called **latent heat** is needed.

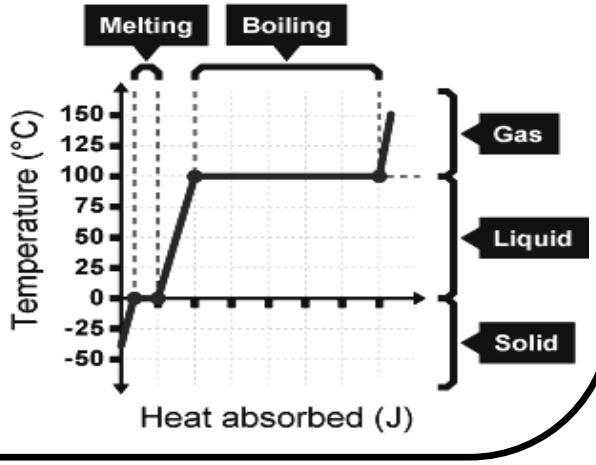
When changing state the energy supplied is used to change the state, therefore the temperature of the system stays the same whilst its changing state.

$E = m\ L$

E is the energy needed for a change of state (measured in J)
m is the mass if the substance (measured in kg)
L is the specific latent heat (measured in J/kg)



Specific latent heat of fusion (change of state from solid to liquid)
Specific latent heat for vaporisation (change of state from liquid to gas)



P3 Particle model and pressure

Molecules in a gas are in constant, random motion.

The higher the temperature of a gas the higher the average kinetic energy of the molecules.

Increased temperature: particles move faster → more collisions

Increased pressure: particles are closer together→ more collisions

(Triple only)
Changing pressure on a substance can compress or expand the substance.

Pressure produces a force at a right angle to the wall of a container.

Increasing the volume of a container while keeping the temperature the same, decreases the pressure as the particles are more spread out and so collide with the sides of the container less.

pV = constant

p is the pressure (measured in Pa)
V is the volume (measured in m^3)

(Triple only)
Work done means the same thing as energy transferred,

Doing work on a gas increases its internal energy, this may cause an increase in temperature (or a change of state).