

# AQA Physics (Combined Science) Unit 3: Particle Model of Matter

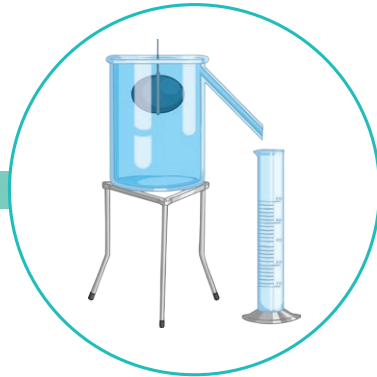
## Required Practical

### Measuring the density of a regularly shaped object:

- Measure the mass using a balance.
- Measure the length, width and height using a ruler.
- Calculate the volume.
- Use the density ( $\rho = m/V$ ) equation to calculate density.

### Measuring the density of an irregularly-shaped object:

- Measure the mass using a balance.
- Fill a eureka can with water.
- Place the object in the water - the water displaced by the object will transfer into a measuring cylinder.
- Measure the volume of the water. This equals the volume of the object.
- Use the density ( $\rho = m/V$ ) equation to calculate density.



## Density

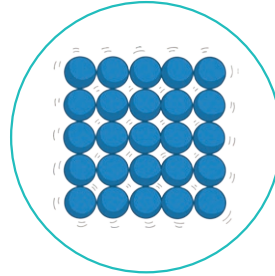
Density is a measure of how much mass there is in a given space.

$$\text{Density (kg/m}^3\text{)} = \text{mass (kg)} \div \text{volume (m}^3\text{)}$$

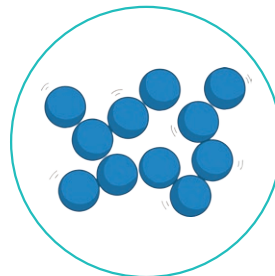
A more dense material will have more particles in the same volume when compared to a less dense material.

## Particles

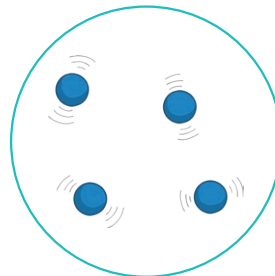
**Solids** have strong forces of attraction. They are held together very closely in a fixed, regular arrangement. The particles do not have much energy and can only vibrate.



**Liquids** have weaker forces of attraction. They are close together, but can move past each other. They form irregular arrangements. They have more energy than particles in a solid.



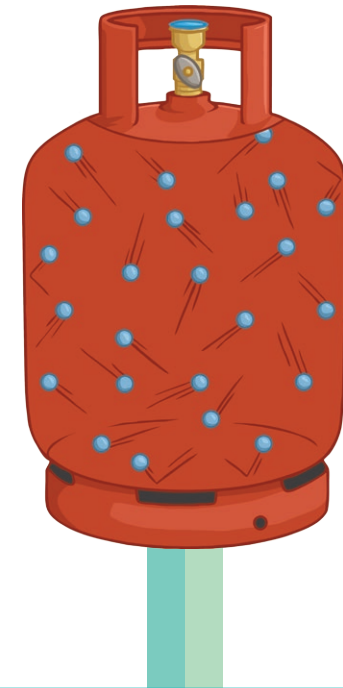
**Gases** have almost no forces of attraction between the particles. They have the most energy and are free to move in random directions.



## Particles

Gas particles can move around freely and will collide with other particles and the walls of the container. This is the pressure of the gas.

If the temperature of the gas increases, then the pressure will also increase. The hotter the temperature, the more kinetic energy the gas particles have. They move faster, colliding with the sides of the container more often.



## Density

The density of an object is  $8050\text{kg/m}^3$  and it has a volume of  $3.4\text{m}^3$  - what is its mass in kg?

$$8050 = \text{mass} \div 3.4$$

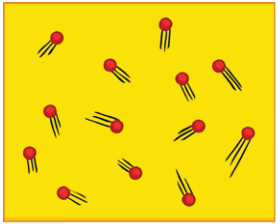
$$8050 \times 3.4 = \text{mass}$$

$$27\,370\text{kg}$$

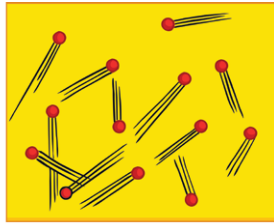


### Internal Energy

Particles within a system have kinetic energy when they vibrate or move around. The particles also have a potential energy store. The total internal energy of a system is the kinetic and potential energy stores.



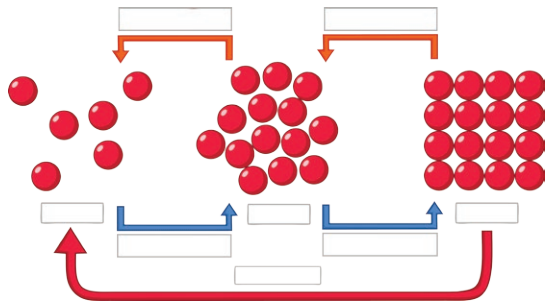
Low Temperature



High Temperature

If the system is heated, the particles will gain more kinetic energy, so increasing the internal energy.

### Changing State

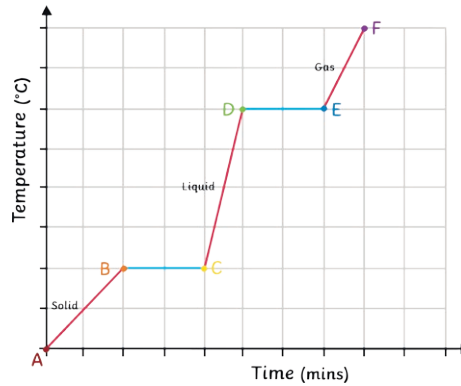


If a system gains more energy, it can lead to a change in temperature or change in state. If the system is heated enough, then there will be enough energy break bonds.

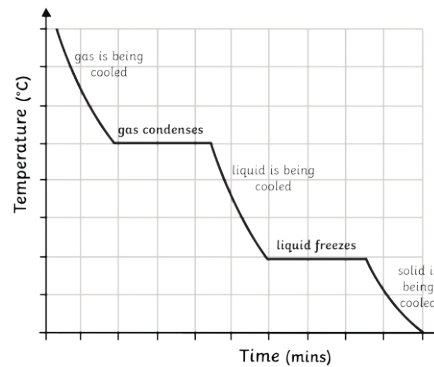
When something changes state, there is no chemical change, only physical. No new substance is formed. The substance will change back to its original form. The number of particles does not change and mass is conserved.

### Specific Latent Heat

Energy is being put in during melting and boiling. This increases the amount of internal energy. The energy is being used to break the bonds, so the temperature does not increase. This is shown by the parts of the graph that are flat.



When a substance is condensing or freezing, the energy put in is used to form the bonds. This releases energy. The internal energy decreases, but the temperature does not go down.



The energy needed to change the state of a substance is called the 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.

- solid → liquid - specific latent heat of **fusion**
- liquid → gas - specific latent heat of **vaporisation**

### Specific Latent Heat Equation

The amount of energy needed/released when a substance of mass changes state.

$$\text{energy (E)} = \text{mass (m)} \times \text{specific latent heat (L)}$$

$$E = mL$$

