WJEC (Eduqas) Physics GCSE

2: Particle Model of Matter

Detailed Notes

(Content in **bold** is for higher tier **only**)

Changing State

Density

Density is a measure of **mass per unit volume**, measured in kg/cm^3 (sometimes g/cm^3).

$$\rho = \frac{m}{V}$$

ρ is density (kg/m^3), m is mass (kg) and V is volume (m^3)

To calculate the density of an object, its volume must be calculated. For regular objects this can be done by measuring its **dimensions** whereas for irregular objects volume can be measured from **displaced water** in a measuring cylinder.

This principle helps to explain the differences in states of matter. Particles in a **gas** spread out to occupy a **greater volume** meaning they have a **lower density** than solid and liquids, which occupy **smaller volumes** and therefore have **higher densities**.

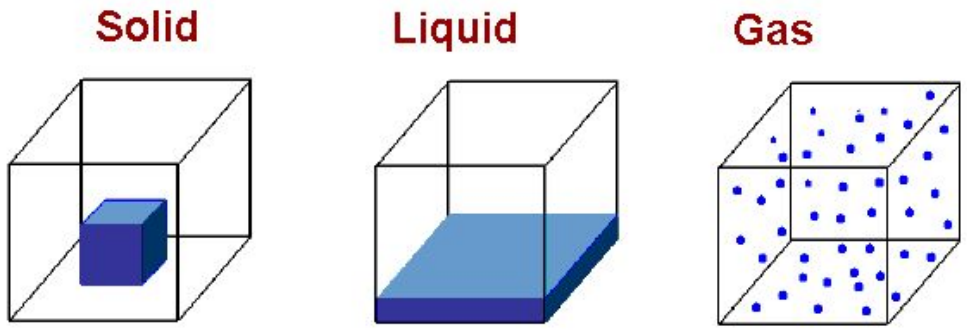


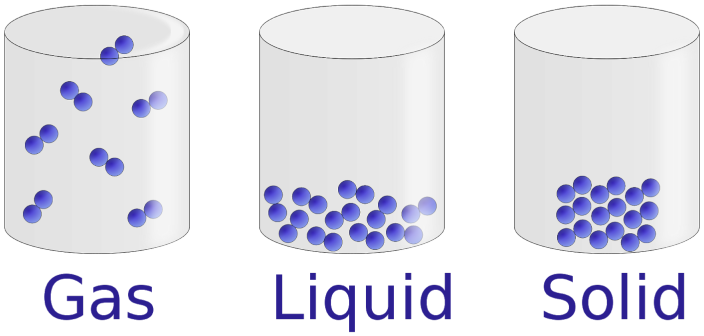
Diagram showing the varying volumes and densities of the three main states of matter (tes.com)

Physical Changes

As a substance changes state, the **quantity** of it remains **fixed**. However, the volume it occupies can change and therefore also its density. This is explained using **kinetic theory**.

As a solid is **heated**, the particles **gain energy** and therefore **vibrate more**. This means they start to take up a greater space, **increasing the volume**. Therefore as a liquid, the same mass of substance will occupy a greater volume. The same is true for the change from liquid to gas. **Gases** occupy the **greatest volume** as the particles **vibrate vigorously** in all directions.

The **chemical properties** of the substance remain the **same** even when state changes, meaning it will still react the same way in any chemical reactions. **Physical properties** do **change** when a substance changes state. These physical changes can be **reversed**, unlike chemical changes, when the substance returns to its **original state**.



Comparing volume of solids, liquids and gases (WAMC.tes.com).

The Behaviour of Gases

Pressure of a gas is caused by the **collision** of molecules with the **container**. These collisions create an **outwards pushing force** (pressure) that is greater than normal atmospheric pressure outside of the container.

Pressure

Pressure is the **force** exerted per **unit area**, measured in pascals.

$$p = \frac{F}{A}$$

p is pressure in Pascals (Pa), F is force in Newtons (N) and A is area in square meters (m^2)

One **pascal** is equal to one newton per square meter **(N/m^2)**. Pressure produces a force acting at right angles to any surface.

Changing Temperatures

When the temperature of a gas is changed but the **volume is fixed**, the **pressure** of the gas changes. If the temperature of the gas **increases**, the gas particles will **gain energy** so they vibrate **faster** and more vigorously. Therefore collisions with the container **increase** and **pressure increases**.

If the temperature of the gas **decreases**, the particles vibrate **slower** and less vigorously so there are less frequent collisions with the container. Therefore **pressure decreases**.

Boyles's Law

This law relates the **volume and pressure** of a gas held at a **constant temperature**. Volume and pressure are **inversely related** so that if the volume of the gas increases, its pressure will decrease. Using this relationship, it is said that the product of pressure and volume of a gas at constant temperature is equal to a constant.

$$pV = k$$

p is pressure (Pa), V is volume (m^3) and k is a constant.

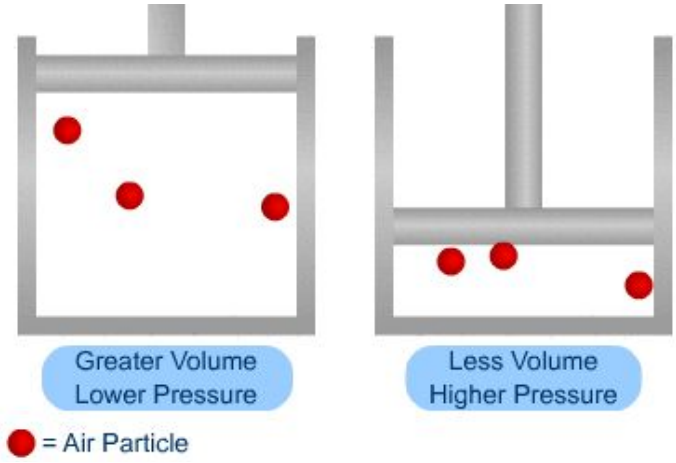
Therefore, for a substance changing state, the pressure and volume of the first state will be equal to the pressure of volume occupied by the second state.

$$p_1V_1 = p_2V_2$$

p is pressure (Pa) and V is volume (m^3).

Work on a Gas

Forces can be applied to a gas, transferring energy to it. As this force is applied, work is done in it. An example of this is compressing a gas by reducing its volume, increasing its pressure as well. Mechanical work done to compress the gas transfers energy from the machine's store of chemical energy to the internal energy of the gas.



Compression of a gas (s-cool.co.uk).

Changes in temperature also change the energy of a gas. Gases will **expand** to occupy a greater volume at **increased** temperatures and will **compress** to occupy a smaller volume at **lower** temperatures.