Unit 5 - Gases

5.1 - General Characteristics of Gases and Pressure

Recall that there are 3 main states that matter exists in - solid, liquid, and gaseous.

Solids have definite shape and volume.
Liquids have definite shape, but variable volume.
Gasses variable shape **and** variable volume.

The **kinetic molecular theory** or **K.M.T.** is a theory that explains the movement of particles. The type of the movement of the particles in a substance determines the state of the substance.

The main points of the KMT specific to gases are:

- Gases are made up of exceedingly small particles called molecules.
- The distance between the molecules is very large compared with the size of the molecules themselves.
- The molecules are in continuous motion in a straight line in all directions.
- The kinetic energy of the moving molecules is directly related to the Kelvin temperature of the gas. All gases at the same Kelvin temperature have the same kinetic energy.
- The collision of the molecules among themselves or with the walls of the container are perfectly elastic. This means that no energy is lost from the collisions.

The gaseous state is the simplest of the states to study because of the similarities between **all** gases.

In other words, gases exhibit certain characteristics, no matter what the gas is made of.

The KMT helps explain the following four similar characteristics between all gases:

i. Expansion

gases have no fixed volume. Therefore, they expand indefinitely to occupy the entire volume available to them.

ii. Compressibility

Gases are easily compressed into a fraction of their original volume.

iii. Pressure

Confined gases exert a force on the walls of their container.

iv. Diffusion

When a gas is introduced into a vessel, it distributes itself throughout the entire volume.

This diffusion takes place whether the vessel was originally empty or occupied by another gas.

This process happens quickly for all gases.

Pressure

The collision of the molecules against a container or object provides a force that prevents the walls from collapsing by expanding them outwards.

The force per unit area is called the **pressure** exerted by the gas. Therefore, the greater the force per unit area the higher the pressure will be.

The S.I. unit of measurement for pressure is called the pascal (Pa) and has the force of one newton per square meter.

Imagine we had a sphere with a constant volume and a pressure gauge.

If we introduced 1 gas molecule into the sphere with a constant temperature and pressure the molecule will bounce around in the sphere and produce a force with each collision (pressure). We will just say the pressure here is 1 Pa.

If we introduce a second molecule we would theoretically double the number of collisions within the sphere. Therefore, we would have double the pressure, or 2 Pa (if temperature was kept constant).

If we then introduce two more molecules we would effectively double the pressure to 4 Pa (if temperature is kept constant).

The pressure inside a container of a given volume and temperature will depend on the number of particles or molecules.

Atmospheric pressure or the pressure that the atmosphere exerts on objects will vary with elevation above sea level.

The higher the elevation the less atmospheric pressure.

Sea level is a reference elevation. At sea level, we say that the pressure of the atmosphere is standard. Therefore, this pressure is called **standard pressure**.

We often say that standard pressure is **1 atmosphere** (or 1 atm), which is another measure of pressure. It is roughtly 101.325 kPa.

We call standard pressure and 0° C **standard conditions** for a gas, designated by STP (standard temperature and pressure).