THERMAL EXPANSION OF GASES

Matter in different states has different characteristics which differ from one state to another. Those in solids differ from the one in liquids and those in liquids from the one in gases.

The main physical properties of gases are

1. Expansion
2. Compression
3. Diffusion

Others include

1. Pressure
2. Low density
3. Indefinite shape
4. Indefinite volume

The physical behavior of gases was studied by early scientists such as Charles, Boyle, and more.

They studied the gases and gave their laws on them.

Before we go into the gas laws we would talk about the types of gases

TYPES OF GASES

There are two major types of gases

IDEAL GASES

These gases are also called perfect gases. These are the theoretical substances that help to establish a relationship between the variables pressure (P), volume (V), amount of gas [mole] (n) and temperature

CHARACTERISTICS OF IDEAL GASES

1. The particles in the gas are extremely small so the gases do not occupy any space.
2. They have constant, random and straight-line motion.
3. No forces between the particles of the gas. Particles only collide elastically with each other and with the walls of the container

REAL GASES

Real gases on the other hand have real volumes and the collision of the particles is not elastic because there are attractive forces between the particles. As a result, the volume of the real gas is much larger than the volume of the ideal gas and the pressure of the real gas is lower than that of the ideal gas.

NB: All gases tend to behave as ideal gases generally at low pressure and high temperature

GAS LAWS

BOYLE’S LAW

In 1662, Robert Boyle discovered the relationship between the pressure and volume of a gas at constant temperature.

It therefore states that

The pressure of a given mass of gas is inversely proportional to the volume of the gas at a constant temperature and a constant mole number

For two or more gases,

You just need to equate any two

CHARLES’ LAW

In 1787, Charles a French physicist understood the relationship between the temperature of a gas and the volume of a gas.

His law therefore states

The temperature of a given mass of gas is directly proportional to the volume of the gas at constant temperature

PRESSURE LAW

This is also called Amoton’s Law or Gay-Lussac’s Law

He discovered the relationship between the pressure and temperature

Gay-Lussac Stated that

The pressure of a given mass of gas is directly proportional to temperature at a constant volume and constant amount

For two or more cases,

AVOGADRO’S LAW

In 1811, Amedeo Avogadro found the connection between amount of gas (n) and the volume of the gas at constant temperature and pressure

GENERAL GAS EQUATION

This is the combination of Boyle’s Law, Charles’ Law and Pressure Law

The general gas law states that the pressure and volume of a given mass of gas is directly proportional to the temperature

The general gas law is therefore

For two or more cases

IDEAL GAS EQUATION

This is the combination of the four stated above laws

It states that

Pressure and Volume are directly proportional to the amount of the gas and the temperature

Here, R is a constant called the gas constant. It has two values depending on the units of the calculation

Normally it has an SI unit of the constant R is

VANDER WAALS’ EQUATION OF REAL GASES

This law was named after the Dutch scientist Johannes Diderik Van Der Waals. This equation is an equation of state that generalizes the ideal gas law based on reasons that real gases do not act ideally. The ideal gas law treats gas molecules as point particles that interact with their container but not with each other meaning that they neither take up space nor change kinetic energy during collisions (i.e. all collisions are perfectly elastic)

To account for the volume that a real gas molecule occupies, the Van der Waals equation replaces V in the ideal gas law with. Here,is the molar volume of the gas andis the volume that is occupied by one mole of the molecules. This leads to

The second modification made to the ideal gas law accounts for the fact that gas molecules do in fact interact with each other (they usually experience attraction at low pressures and repulsion at high pressures) and that real gases therefore show different compressibility than ideal gases. Van der Waals provided the intermolecular interaction by adding to the observed pressure in the equation of state a term. Here, “a” is a constant whose value depends on the gas.

The Van der Waals’ equation is therefore written as

It can also be written as

COMPRESSIBILITY FACTOR

This is also known as compression factor or the gas deviation factor. It is a correction factor which describes the deviation of a real gas from an ideal gas behavior. It is simply defined as the ratio of the molar volume of a gas to the molar volume of an ideal gas at the same temperature and pressure

This tells us how much the real gases differ from the ideal gases.