Chemistry Study Materials for Class 11
(NCERT Based Notes of Chapter- 04)
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States of Matter

IDEAL GAS EQUATION

The combination of the three gas laws (Boyle's law, Charles' and Avogadro law) give a single equation which is known as **ideal gas equation**.

According to Boyle's law: V α 1/P (At constant T and n)

According to Charles' Law: $V \propto T$ (At constant p and n)

According to Avogadro Law: $V \propto n$ (At constant p and T)

On combining these three laws we get:

$V \propto n \times T \times 1/P$

Or, V = R x n x T x 1/P (where R is a constant called **universal gas constant**)

Or, **PV = nRT** ………………….. (1)

This equation is known as **ideal gas equation**.

From equation (1), $R = \frac{PV}{nT}$

The value of R depends upon units in which P, V and T are measured.

Values of R in different units

1.	L atm/K/mol	0.0821
2.	L bar/K/mol	0.08314 (8.314×10^{-2})
3.	Pa m^3/K/mol	8.314
4.	J/K/mol	8.314

Ideal gas equation is a relation between four variables and it describes the state of any gas, therefore, it is also called **equation of state**.

Combined Gas Law

From ideal gas equation, PV = nRT, $\frac{PV}{} = \frac{nR}{T}$

If temperature, volume and pressure of a fixed amount of gas vary from T_1, V_1 and P_1 to T_2, V_2 and P_2 then we can write,

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

This equation is known as **combined gas law**. By knowing the values of any 5 parameters, we can determine the sixth one.

5) Dalton's Law of Partial Pressures

This law states that at constant temperature, the total pressure exerted by a mixture of non-reacting gases is equal to the sum of the partial pressures of the component gases. The partial pressure of a gas in a mixture of gases is the pressure that the gas would exert, when it alone occupies the whole volume. Mathematically,

$$P_{Total} = P_1 + P_2 + P_3 + ... \text{ (at constant T, V)}$$

Where P_{Total} is the total pressure exerted by the mixture of gases and P_1, P_2, P_3 etc. are partial pressures of gases.

Application of Dalton's law:

Dalton's law can be used to calculate the pressure of a gas collected over water surface. Here the gas is always moist. Therefore, pressure of dry gas can be calculated by subtracting vapour pressure of water from the total pressure of the moist gas. Pressure exerted by saturated water vapour is called **aqueous tension**.

$$P_{Dry\ gas} = P_{Total} - \text{Aqueous tension}$$

Partial pressure in terms of mole fraction

Consider three gases at constant temperature T and constant volume V, exert partial pressures P_1, P_2 and P_3.

From ideal gas equation, P =nRT/V

So, $P_1 = n_1RT/V$, $P_2 = n_2RT/V$ and $P_3 = n_3RT/V$

The total pressure exerted by the mixture,

$P_{Total} = P_1+P_2+P_3$

$= n_1RT/V+ n_2RT/V + n_3RT / V$

$= (n_1+n_2+n_3) RT / V$ —

On dividing P_1 by P_{Total}, we get, $P_1/P_{Total} = n_1/ (n_1+n_2+n_3)$

Or, $P_1/P_{Total} = x_1$ Or, $P_1 = x_1.P_{Total}$

Similarly, $P_2 = x_2.P_{Total}$ and $P_3 = x_3.P_{Total}$

In general, $P_i = x_i. P_{Total}$

Where P_i and x_i are partial pressure and mole fraction of i^{th} gas respectively

KINETIC MOLECULAR THEORY OF GASES

In order to explain the gas laws theoretically Maxwell, Boltzmann, Claussius etc. put forward a theory called *kinetic molecular theory of gases or microscopic model of gases*. The important postulates of this theory are:

1. Every gas contains a large number of minute and elastic particles (atoms or molecules). The actual volume of the molecules is negligible compared to the volume of the gas.
2. There is no force of attraction between the gas particles.
3. The particles of a gas are in constant and random motion in straight line. During this motion they collide with each other and also with the walls of the container.
4. The pressure of a gas is due to the wall collisions of the particles.
5. All collisions are perfectly elastic. i.e. the total energy of particles before and after collisions remains the same.
6. At any particular time, different particles of a gas have different speed and hence different kinetic energy.
7. The average kinetic energy of gas molecules is directly proportional to absolute temperature.

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