	INDIAN SCHOOL AL WADI AL KABIR	
Class: XI	**Department of Science 2022 – 23** **SUBJECT : PHYSICS**	**Note:** **A4 FILE FORMAT**
Handouts: Chapter 13	**Chapter: KINETIC THEORY OF GASES**	

Introduction

Kinetic theory is based on an atomic model of matter. The basic assumption of kinetic theory is that the measurable properties of gases, liquids and solids reflect the combined actions of countless numbers which are not directly measurable, to measurable properties (macroscopic) of matter, like temperature and pressure. The kinetic theory of gases is a marvelous structure of interconnecting assumptions, predictions and experiments.

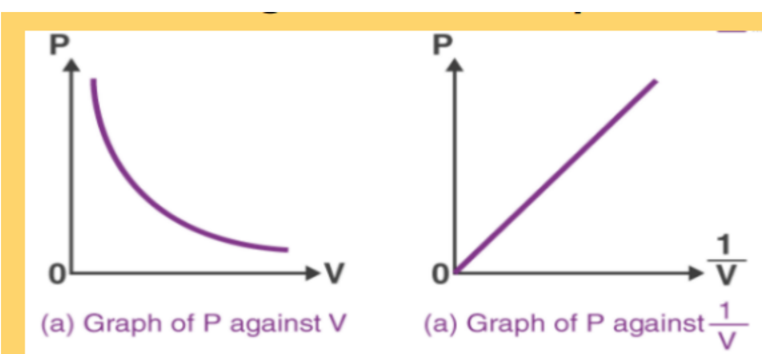
Behaviour of Gases

The relationship between any two physical quantities used to specify the state of gas keeping the 3rd physical quantity constant is known as gas law.

Boyle's Law: States that at constant temperature, the volume of a given mass of the gas is inversely proportional to its pressure.
i.e

$P \propto 1/V$

$\Rightarrow$ PV= constant



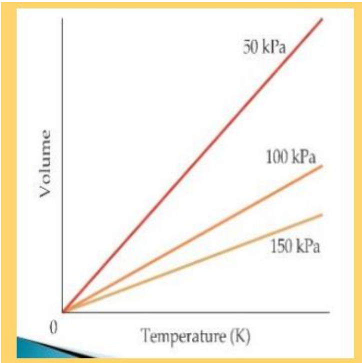
(a) Graph of P against V

(a) Graph of P against $\frac{1}{V}$

Charle's Law : States that At constant pressure, the volume of given mass of gas is directly proportional to its absolute temperature

At constant pressure **V ∝ T**

V/T = CONSTANT



Gay Lussac's Law : States that at constant volume, the pressure of a given mass ofgas is directly proportional to its absolute temperature.
PαT
P/T = CONSTANT

Ideal Gas: A gas in which the molecules do not exert any attractive or repulsive forceon each other is called an ideal or a perfect gas. Ideal gas obeys the gas laws such as Boyle's,Charles and Gay Lussac's law.

Characteristic of Ideal gas:

- The size of the molecule of ideal gas is zero.
- There is no force of attraction or repulsion amongst the molecule of ideal gas.

No real gas is ideal/perfect gas. At extremely low pressure and high temperature some real gases like hydrogen, helium, oxygen obeys gas law to a fair degree of accuracy and hence behave as nearly perfect gas.

Ideal Gas Equation:

PV = *n***RT**

Where R is called as the universal gas constant

R = 8.314 J/mol/K

Boltzmann's constant:

It is the gas constant per molecule of a gas.

If N_A is the Avogadro's number, then

$k_B = R/N_A$

$k_B = 1.38\times10^{-23}$ J/K

Assumptions of Kinetic Theory Of Gases:

1) All the molecules of a gas are identical with regard to their shape and mass. They differ from molecule of other gases.
2) The size of gas molecules is Extremely small as compared to the intermolecular distance.
3) The molecules behave as rigid perfect elastic sphere.
4) The molecules are in constant random motion. the move with all possible velocities in all directions. The velocities of molecules increase with increase in temperature.
5) The molecules collide with one another and also with the walls of the container. The collisions are perfectly elastic.
6) The collisions are instantaneous, i.e the time spent by a molecule in collision is very small compared to the time elapsed between two successive collisions.
7) The number of molecules per unit volume of the gas is very large and remains constant at steady state.
8) Between two successive collisions the molecules with uniform velocity. The distance between the two successive collisions is called free path. The average distance travelled by the molecule during collisions is called mean free path.
9) The molecules do not exert any force of attraction or repulsion on each other except during collisions.

Degrees of Freedom:

The total number of independent quantities or co-ordinates which must be known to completely specify the position or configuration of a system.

OR

The total number of independent ways in which the particle of the system can acquire energy

OR
It is the number of coordinates or independent quantities required to describe completely the position and configuration of the system

In general, Degrees of freedom $f=3N - k$
N is the number of a system and k is the number of common coordinates or independent relation.
Examples:
Monoatomic gas: $N=1$ and $k=0 \Rightarrow f=3(1)-0=3$
Diatomic gas: $N=2$, $k=1$, $\Rightarrow f=3(2)-1=5$

Law of equipartition of energy:

For a dynamical system in thermal equilibrium the energy of the system is equally distributed among its various degrees of freedom and the energy associated with each degree of freedom per molecule is $1/2\ k_BT$

Ratio specific of specific Capacities:

Monoatomic gas:

According to the law of equipartition the energy associated with each degrees of freedom=$1/2\ k_BT$.

Monoatomic gas has 3 degrees of freedom.

Hence the energy associated with 3 degree of freedom for a molecule is $3 \times 1/2\ k_BT$.

Therefore, total energy associated with the one mole (N_A number of molecules) of gas is $U = 3/2\ N_Ak_BT$

$\Rightarrow \Delta U = 3/2\ R\Delta T$

We know $C_v = \Delta U/\Delta T$

$\mathbf{C_v = 3/2\ R}$

We have $C_P - C_V = R$

$\Rightarrow C_P = R + C_V$
$\Rightarrow \mathbf{C_P = 5/2\ R}$
Therefore, $\boldsymbol{\gamma = C_P/ C_V}$
$\boldsymbol{\gamma = 5/3 = 1.67}$

Diatomic gas:

According to the law of equipartition the energy associated with each degrees of freedom=1/2 k_BT.

Diatomic gas has 5 degrees of freedom.

Hence the energy associated with 3 degree of freedom for a molecule is $5 \times 1/2\ k_BT$.

Therefore, total energy associated with the one mole (N_A number of molecules) of gas is $U = 5/2\ N_Ak_BT$

$\Rightarrow \Delta U = 5/2\ R\Delta T$

We know $C_v = \Delta U/\Delta T$

$\mathbf{C_v = 5/2\ R}$

We have $C_P - C_V = R$

$\Rightarrow C_P = R + C_V$

$\Rightarrow \mathbf{C_P = 7/2\ R}$

Therefore, $\boldsymbol{\gamma = C_P / C_V}$

$\boldsymbol{\gamma = 7/5 = 1.4}$

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