12 KINETIC THEORY

1 OMQ + 1 VSAQ + 1 SAQ [1 M + 2M + 4M = 7 M]

CONCEPTS & DEFINITIONS

1. Kinetic theory explains the behaviour of gases based on the idea that the gas consists of rapidly moving atoms or molecules.

2. **Atomic Hypothesis**: All things are made of atoms, little particles that move in space in any matter, attracting each other when they are a little distance apart, but repelling when they come closer than a particular distance.

3. **Mean free path:** The average distance covered by a molecule between two successive collisions is called "mean free path". $\bar{l} = \frac{1}{\sqrt{2}n\pi d^2}$

4. **Gas Laws :** Under certain conditions,the gas laws establish various relations between Pressure(P),Volume (V), Temperature (T) and number of moles (n).

4.1 **Boyle's law (VP relation):** "At **constant temp**erature, the **volume** of a given mass of a gas is **inversely** proportional to the **pressure** of the gas". $V \propto \frac{1}{P} \Leftrightarrow PV = k \Rightarrow P_1V_1 = P_2V_2$

Isotherms: The curves of graphs, plotted between V and P of a gas, at constant temperature.

4.2.1 **Charles' law(VT Relation):**"At **constant pres**sure, the **volume** of a given mass of gas is **directly** proportional to its absolute **temperature**". $V \propto T \Leftrightarrow \frac{V}{T} = k \Rightarrow \frac{V_1}{T_1} = \frac{V_2}{T_2}$

Isobars: The curves of graphs, plotted between V and T of a gas, at constant pressure.

4.2.2 **Charles-Gay Lussac law:**"At constant pressure, the volume of a given mass of a gas at 0ºC increases or decreases by 1/273 part of its original volume at 0ºC for every one degree rise or fall of temperature"

4.3. **Avogadro's law(V n relation) :**
"Under the same conditions of temperature and pressure, equal volumes of all gases contain equal number of molecules (or) moles". $V \propto n \Leftrightarrow \frac{V}{n} = k$

4.4.1 **Ideal / Perfect gases:** Gases which obey, all gas laws at all temperatures and pressures are called Ideal gases.

4.4.2 **Real gases:** Gases which do not obey, all gas laws at all temperatures and pressures are real gases.

4.4.3 **Ideal gas equation :** $PV = nRT \Leftrightarrow \frac{PV}{T} = k \Rightarrow \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$.

4.4.4 In the ideal gas equation**, R** is called **Universal gas constant**

4.4.5 **Boltzman constant :**Gas constant per molecule is called **Boltzman constant.** $K_B = \frac{R}{N_A}$

5.1 The postulates of kinetic molecular theory of gases:

1) Every gas contains large number of **tiny particles** called **molecules**.
2) The gas molecules move **randomly** in **all directions** with **high velocities**.
3) There will be **no attractive** or **repulsive forces** among gas molecules.
4) There will be **no** effect of **gravitational force** on the movement of gas molecules.
5) The total volume of gas molecules is **negligible** when compared to the entire volume of the container.
6) Pressure of gas is due to collisions of the gas molecules on the walls of the container.
7) All collisions are perfectly elastic.
8) The average kinetic energy of a gas is directly proportional to the absolute temperature. Thus, KE $\propto$ T

5.2 Kinetic theory of an ideal gas gives the relation $P = \frac{1}{3} nm\bar{v}^2$

where n is number density of molecules, m the mass of the molecule and $\bar{v}^2$ is the mean of square speed.

5.3. Law of Equipartition of Energy: "According to law of equipartition of energy, each translational and rotational degree of freedom of molecule contributes $\frac{1}{2}K_BT$ to its energy."

6. If a gas has 'f ' degrees of freedom then $\gamma = 1 + \frac{2}{f}$

7.1. Number of degrees of freedom (f) for monoatomic gas f=3
7.2. Number of degrees of freedom (f) for diatomic gas f=5
7.3. Number of degrees of freedom (f) for tri (or) poly atomic gas f=6

Imp.Formulae

1. $PV = nRT = k_BNT$; $k_B = \frac{R}{N_A} = 1.38\times10^{-23} JK^{-1}$, R = 8.314 J mol^{-1} K^{-1}.

2. $P = \frac{1}{3} nm\bar{v}^2$

3. Translational kinetic energy $E = \frac{3}{2}K_BNT$

4. $PV = \frac{2}{3}E$

5. Mean free path = $\bar{l} = \frac{1}{\sqrt{2}n\pi d^2}$