KINETIC THEORY OF GASES

SPEEDS OF GAS MOLECULES

Root Mean Square Speed:

- Square root of mean of square of speed of different molecules.

$$V_{rms} = \sqrt{\frac{V_1^2 + V_2^2 + \ldots\ldots\ldots\ldots + V_n^2}{n}}$$

$$V_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3P}{\rho}}$$

Average Speed:

- Arithmatic mean of speed of molecules of gas at given temperature.

$$V_{avg} = \sqrt{\frac{|\vec{V}_1| + |\vec{V}_2| + \ldots\ldots + |\vec{V}_n|}{n}}$$

$$V_{avg} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8P}{\pi\rho}}$$

Most Probable Speed:

- Speed possessed by maximum number of molecules of gas.

$$V_{mp} = \sqrt{\frac{2RT}{M_o}} = \sqrt{\frac{2P}{\rho}}$$

SPECIAL RELATIONS

- Pressure exerted by a gas.

$$P = \frac{1}{3}\rho V_{rms}^2$$

- Relation between pressure and Kinetic Energy.

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

RELATION BETWEEN KINETIC ENERGY AND TEMPERATURE

- Kinetic Energy = $\frac{3KT}{2} = \frac{1}{2}mv_{rms}^2$

  Kinetic Energy of Gas molecule.

- K.E = $\frac{1}{2}mv_{rms}^2 = \frac{3RT}{2}$

  Kinetic energy of one mole of molecule.

- K.E = $\frac{1}{2}mv_{rms}^2 = \frac{3RT}{2m}$

  Kinetic energy of one gram of gas molecule.

SPECIFIC HEAT CAPACITY

- Specific heat capacity for an ideal gas.

  $C_P - C_V = R$

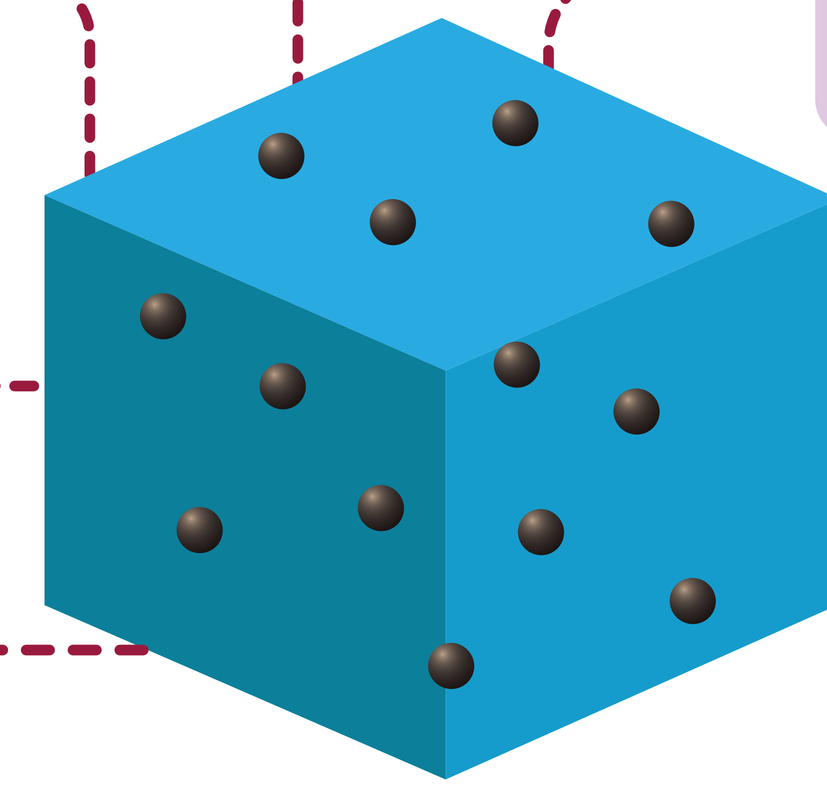
- For diatomic gas. $\frac{C_P}{C_V} = Y = \frac{5}{3}$
- For diatomic gas. $\frac{C_P}{C_V} = Y = \frac{7}{5}$
- For polyatomic gas. $\frac{C_P}{C_V} = Y = \frac{4+f}{3+f}$

  and f is degrees of freedom.

- $C_P = (1 + \frac{f}{2})R$, $C_V = f R/2$
- $Y = \frac{C_P}{C_V} = 1 + \frac{2}{f}$

DEGREES OF FREEDOM

- For monoatomic gas. $F = 3$
- For diatomic gas.
  - (a) at room temperature. $F = 5$
  - (b) at high temperature. $F = 7$
- For polyatomic gas.
  - (a) at room temperature . $F = 6$
  - (b) at high temperature. $F = 8$. f → degree of freedom.



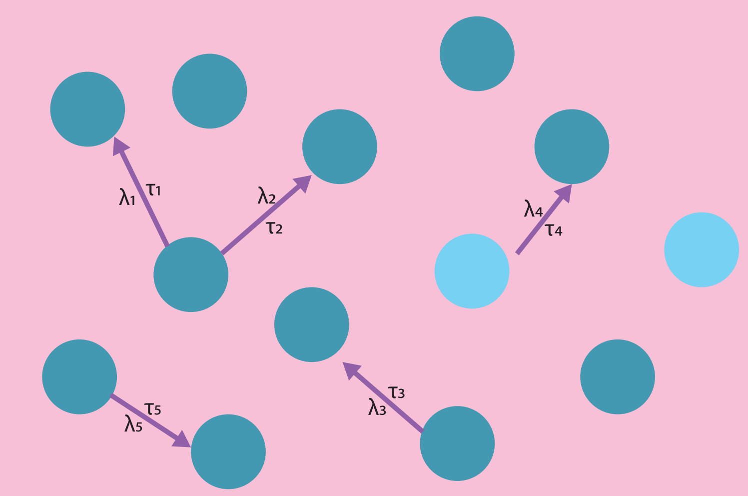
Mean free path

Average distance travelled by molecules between two successive collision

$$\lambda_{mean} = \frac{1}{\sqrt{2}\,\pi d^2 n}$$

d = diameter of molecules.

n = no. of molecules per unit volume



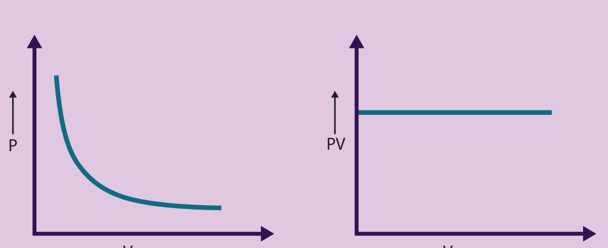
ASSUMPTIONS IN KINETIC THEORY OF GASES

- Gas consists of small particles known as molecules.
- Molecular of gas are identical rigid sphere and elastic points mass.
- Molecular of gas moves randomly in al directions with possible velocity.

IDEAL GAS LAWS

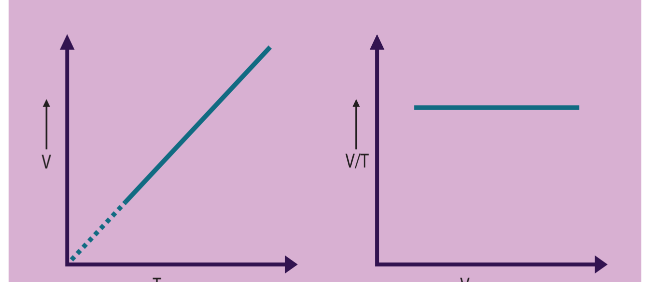
- Pressure, Temperature and volume of Gas are related to each other by following equation. PV = nRT.
- P – pressure, V – volume, n – no. of moles: R = Universal Gas Constant = 8.314 J/mol.k : T – Temperature.
- PV = $\frac{m}{m_A}$RT ; PV = $\frac{n}{n_A}$KT

Boyle's Law



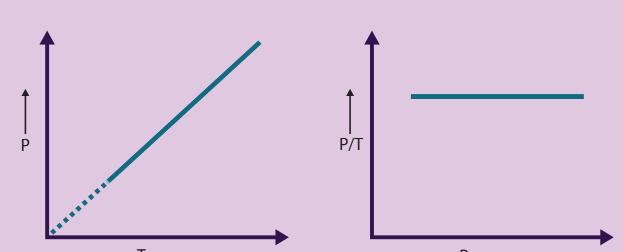
- For fixed mass, pressure of gas is inversely proportional to volume.
- PV = constant, if T = Cosntant
- $P_1V_1 = P_2V_2$ when gas changes it's state under constant temperature.

Charlee's Law



- For a fixed mass, volume of gas is directly proportional to temperature.
- V α T: = constant: P = constant.
- $\frac{3}{2}$PV .when gas change its state under constant pressure.

Gay lussac's law



- For a fixed mass, pressure of a gas is directly proportional to its temperature.
- P α T: = constant: V = constant.
- when gas change its state under constant volume.

LAW OF EQUIPARTITION OF ENERGY

- The total Kinetic energy of a gas molecule is equally distributed among it's all degrees of freedom.

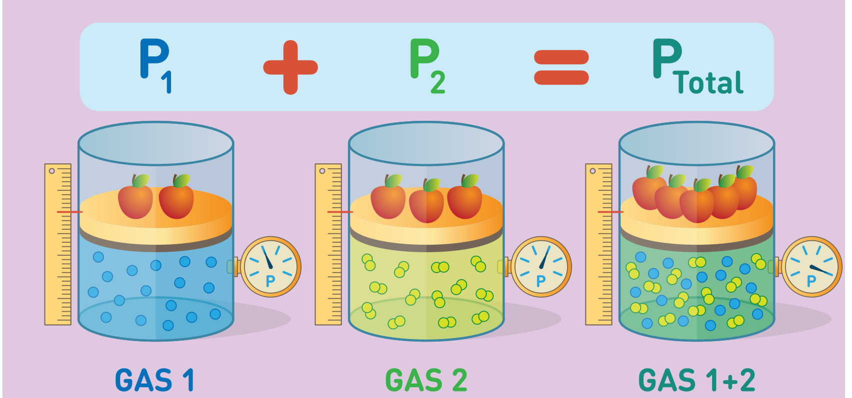
  $U = \frac{f}{2}K_BT$

  f = degrees of freedom.

  K_B = Boltzmann Constant.

- For monoatomic gas. $U = \frac{3}{2}K_BT$
- For diatomic gas. $U = \frac{5}{2}K_BT$

DALTON'S LAW OF PARTIAL PRESSURE



Total pressure of a mixture of non – reacting gas is equal to summation of pressure of individual gasses.

P = P1 + P2 + P3 +.........+ P_n