# 4. States of Matter

### Boyle's Law at constant temperature and amount

 $P_1V_1 = P_2V_2 = Constant$ 

### Charle's Law

V = kT at constant pressure

**k** is the proportionality constant depends upon (i) Amount of Gas (ii) Temperature

### Gay Lussac's Law :

 $\frac{P_1}{T_1} = \frac{P_2}{T_2}$  at constant volume

### Avogadro's Law

(T and P constant) V∝n

V = K₄n

 $\mathbf{V}_1/\mathbf{n}_1 = \mathbf{V}_2/\mathbf{n}_2$  (Constant T and P)

### **Ideal Gas Equation**

### PV = nRT

Where R is Proportionality constant is also known as Gas constant it is same for all Gases

Value of R in different units

Magnitude	Unit
0.0821	Litre-atm K <sup>-1</sup> mol <sup>-1</sup>
82.1	ML-atm K <sup>-1</sup> mol <sup>-1</sup>
62.1	Litre-mm-Hg K <sup>-1</sup> mol <sup>-1</sup>
0.083	Litre bar K <sup>-1</sup> mol <sup>-1</sup>
8.314	Pascal m <sup>3</sup> K <sup>-1</sup> mol <sup>-1</sup>
$8.314 \times 10^{7}$	erg K <sup>-1</sup> mol <sup>-1</sup>
8.314	Joule K <sup>-1</sup> mol <sup>-1</sup>
1.987	Cal K <sup>-1</sup> mol <sup>-1</sup>

Density ; d = PM/RT

$$(d \propto P)$$
;  $(d \propto 1/T)$ 

Graham's Law of Diffusion / Effusion ≻

• Rate of diffusion 
$$R \propto \frac{1}{\sqrt{d}}$$

where d is density of gas at constant temperature and pressure

$$\frac{\mathbf{r}_1}{\mathbf{r}_2} = \sqrt{\frac{\mathbf{d}_2}{\mathbf{d}_1}}$$

 $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$ 

#### **Dalton's of Partial Pressure :** $\geq$

Calculate the total pressure of mixture of nonreacting gas and based on the law of conservation of amount

 $\mathbf{P}_{1}$  is a partial pressure,  $\mathbf{P}_{T}$  $\mathbf{x}_{1}$  is mole fraction)  $\mathbf{P}_{1}$ is

### Total pressure of Gaseous mixture at constant

temperature :  $P_T = \frac{(P_1 V_1 + P_2 V_2)}{(V_1 + V_2)}$ 

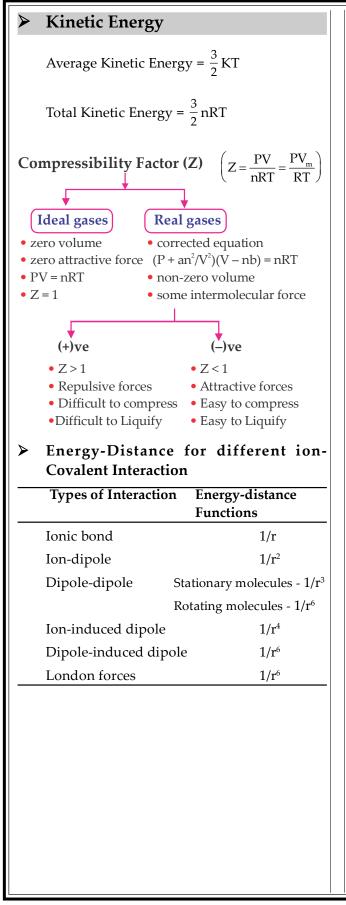
Aqueous Tension :  $P_{moist} = P_{dry gas} + P_{water vapours}$ 

 $RH = \frac{Mass of water vapour present in certain volume of air}{L}$ Maximum Mass of water vapour present in same volume of air saturated by water vapour

#### ≻ **Molecular Speed**

Most probable speed = 
$$\sqrt{\frac{2KT}{m}} = \sqrt{\frac{2RT}{M}}$$
  
Average speed =  $\sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8KT}{m}}$   
Root mean square =  $\sqrt{\frac{3RT}{M}} = \sqrt{\frac{3KT}{m}}$   
 $V_{mp}: V_{av}: V_{rms} = \sqrt{2}: \sqrt{\frac{8}{\pi}}: \sqrt{3}$ 

$$\mathbf{r} = \mathbf{P}_{\mathrm{T}} \times \mathbf{x}_{\mathrm{1}}$$
 (where a Total pressure,



### Critical Constant of the Gases

 $T_c$  or critical temp :  $T_c = 8a / 27Rb$  $P_c$  or critical pressure :  $P_c = a / 27b^2$  $V_c$  or critical volume :  $V_c = 3b$ 

 $Z_{\rm C} = \frac{P_{\rm C}V_{\rm C}}{RT_{\rm C}} = \frac{3}{8}$  (For all real gases)

# > Van der Waal's Equation Real Gas

 $\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$  where a and b are Van der Waal's constant.

## **b** Boyle's Temperature : $T_b = \frac{a}{Rb}$