# States of Matter

**Boyel's law** (Pressure - Volume Relationship)

$P \propto \frac{1}{V}$ (At constant T and n) $\Rightarrow$ $P = K_1 \frac{1}{V}$

$P_1 V_1 = P_2 V_2$ OR $\frac{P_1}{P_2} = \frac{V_2}{V_1}$

$K_1$ = Proportionality constant, T = Temperature
V = Volume, m = Mass
P = Pressure

**Density** $d = \frac{m}{V}$

From boyel's law, $d = \left[\frac{m}{K_1}\right] P$

**Charle's law** (Temperature - Volume Relationship)

$V \propto T$ (At constant P and n) $\Rightarrow$ $V = K_2 T$ OR $\frac{V_2}{V_1} = \frac{T_2}{T_1}$

$K_2$ = constant
n = no. of moles

**Avagadro's law** (Volume - amount Relationship)

$V \propto n \Rightarrow V = K_4 n$

**Ideal gas equation** $PV = nRT$

R = gas constant ($8.20578 \times 10^{-2}$ $L \cdot atm \cdot Mol^{-1} K^{-1}$)

**Combined gas law** $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

**Gay Lussac's law** (Pressure - Temperature Relationship)

$P \propto T$

$\frac{P}{T}$ = constant = $K_3$

**Molar mass of gaseous substance** $M = \frac{dRT}{P}$

M = Molecular mass
d = density

**Dalton's law of partial pressure** $P_{total} = P_1 + P_2 + P_3 + \ldots$ (At constant T and V)

**Pressure of dry gas** $P_{dry\ gas} = P_{total}$ - aqueous density

**Partial Pressure in terms of mole fraction** $P_i = x_i P_{total}$

$P_i$ = Partial Pressure
$x_i$ = Mole fraction

**Average speed of molecules** $u_{av} = \frac{u_1 + u_2 + \ldots u_n}{n}$ OR $u_{av} = \sqrt{\frac{8RT}{\pi M}}$

**Root mean square velocity** $u_{rms} = \sqrt{\overline{u^2}} = \sqrt{\frac{u_1^2 + u_2^2 + \ldots + u_n^2}{n}}$ OR $u_{rms} = \sqrt{\frac{3RT}{M}}$

$u_{rms} > u_{av} > u_{mp}$

$u_{mp} : u_{av} : u_{rms} :: 1 : 1.128 : 1.224$

n = no. of molecules
$u_1, u_2, u_3 \ldots u_n$ = individual speeds
$u_{rms}$ = root mean square speed
$u_{av}$ = average speed
$u_{mp}$ = most probable speed

**Viscocity** $F = \eta A \frac{du}{dz}$

$\eta$ = cofficient of viscocity
A = Area of contact
$\frac{du}{dz}$ = velocity gradient

**Most Probable Speed** $u_{mp} = \sqrt{\frac{2RT}{M}}$

**Compressibility factor** $Z = \frac{PV}{nRT}$

For ideal gas Z = 1 and $Z = \frac{V_{real}}{V_{ideal}}$

Graham's diffusion law

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$$

r = Speed of diffusion
d = density of gas
M = Molecular mass of gas

Kinetic gas Equation

$$PV = \frac{1}{3} mnu^2$$

P = Pressure of gas
V = Volume of gas
m = weight of single molecule of gas
n = number of molecules present in the volume
V = Volume
u = Root mean square velocity of molecules
K = $\frac{R}{N}$ (Boltzmann's constant)

Kinetic Energy of one molecule of gas

$$E_K = \frac{3}{2} KT$$

Vanderwaals Equation

$$\left[P + \frac{a}{V^2}\right](V - b) = RT$$

for n = 1

Maxwell velocity distribution

$$\frac{dn_c}{n} = 4\pi \left[\frac{M}{2\pi RT}\right]^{1/2} c^2 e^{-Mc^2/2RT} dc$$

$dn_c$ = The number of molecules whose speed is between c and c + dc
T = Absolute temperature

$$\text{fludity} = \frac{1}{\eta}$$