Kinetic theory of gases (KTG)

① Postulates of KTG

S.T.P $\rightarrow$ $P = 1\,atm = 1.01\times10^5\,Pa = 760\,mm\ of\ Hg$, $1\,torr = 1\,mm\ of\ Hg$

$T = 273\,K$

$V = 22.4\,l$

② Dalton's law of partial pressure $\boxed{P = P_1 + P_2 + \dots + P_n}$

③ Ideal gas eqn – $PV = nRT$

$PV = \frac{N}{N_A} RT$

$\boxed{K = R/N_A}$

Boltzmann const.

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

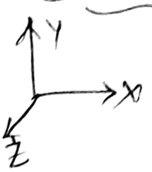
N = no of molecules

$PV = \frac{m}{M} RT$

$r = R/M$ specific gas const (r)

$\left(P + an^2/V^2\right)(V - nb) = nRT$

④ Pressure of ideal gas



$\boxed{P = 1/3\, \rho v_{rms}^2}$

time taken b/w 2 successive collisions is $dt = \frac{2L}{V_x}$ (x)

⑤ $V_{mp} = \sqrt{\frac{2RT}{M}}$, $V_{avg} = \sqrt{\frac{8RT}{\pi M}}$, $V_{rms} = \sqrt{\frac{3RT}{M}}$

$V_{mp} < V_{avg} < V_{rms}$

$KE = 3/2\, nRT$ $\quad nRT = 2/3\, KE$

$\frac{KE}{n} = \frac{3}{2} RT$ $\quad PV = 2/3(KE)$

KE/mole/direction = $1/2\, RT$ (equipartition of energy)

KE/molecule = $3/2\, KT$

⑥ Degree of freedom :

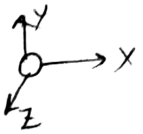
Vibrational — each mode has $f = 2$

Translational

Rotational

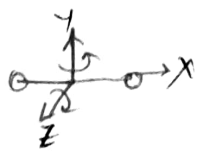
(i) Monoatomic

Ex: all noble gases $f = 3$



(ii) Diatomic

Ex: H_2, O_2, etc...



$I_x = 0$

$I_y = I_z$

$f = \underset{Tran}{3} + \underset{Rotat}{2} = 5$ (low temp)

$f = 3 + 2 + \underset{Vibr}{2} = 7$ (high temp)

(iii) Triatomic

Ex: H_2O, O_3, etc.

$f = \underset{Tr}{3} + \underset{Rot}{3} = 6$

⑦ $\boxed{\gamma = 1 + 2/f}$

Mono - $\gamma = 5/3$
di - $\gamma = 7/5$
tri - $\gamma = 4/3$

	C_p	C_v
Mono $\gamma = 5/3$	$\frac{5}{2}R$	$\frac{3}{2}R$
Di $\gamma = 7/5$	$\frac{7}{2}R$	$\frac{5}{2}R$
tri $\gamma = 4/3$	$4R$	$3R$

$5-3 = 2$
$\cancel{7}-5 = 2$
$4-3 = 1$

⑧ **Mix of gases**

should be considered in insulated vessel.

$$\boxed{T = \frac{n_1 C_{v_1} T_1 + n_2 C_{v_2} T_2}{n_1 C_{v_1} + n_2 C_{v_2}}}$$

$$\boxed{\gamma_{mix} = \frac{n_1 C_{p_1} + n_2 C_{p_2}}{n_1 C_{v_1} + n_2 C_{v_2}}}$$

⑨ **Mean freepath(λ):**

* free path travelled by molecule b/w two successive collisions.

$$\boxed{\lambda = \frac{1}{\sqrt{2}\pi n d^2} = \frac{V}{\sqrt{2}\pi N d^2} = \frac{kT}{\sqrt{2}\pi d^2 P}}$$

Mean free time: $\boxed{\tau = \frac{\lambda}{V_{avg}}}$ $\tau \propto 1/\sqrt{T}$ $V_{avg} \propto \sqrt{T}$