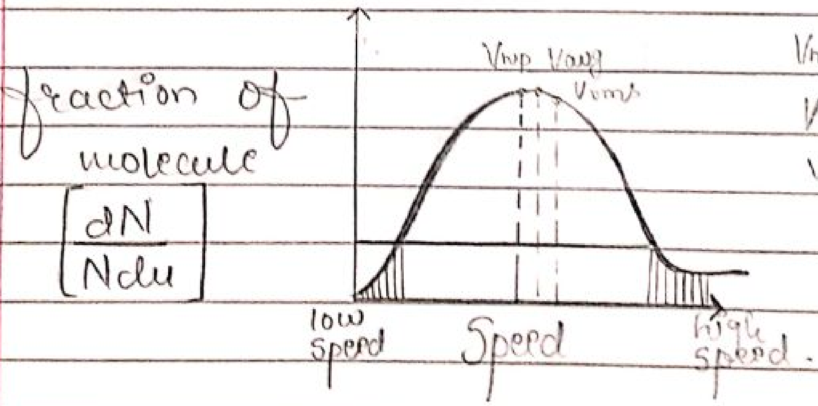
Maxwell distribution graph for speed / velocity of gaseous molecule:

- in gas sample at constant temperature all gaseous molecules do not have same speed but they possess a wide range of molecular speed.

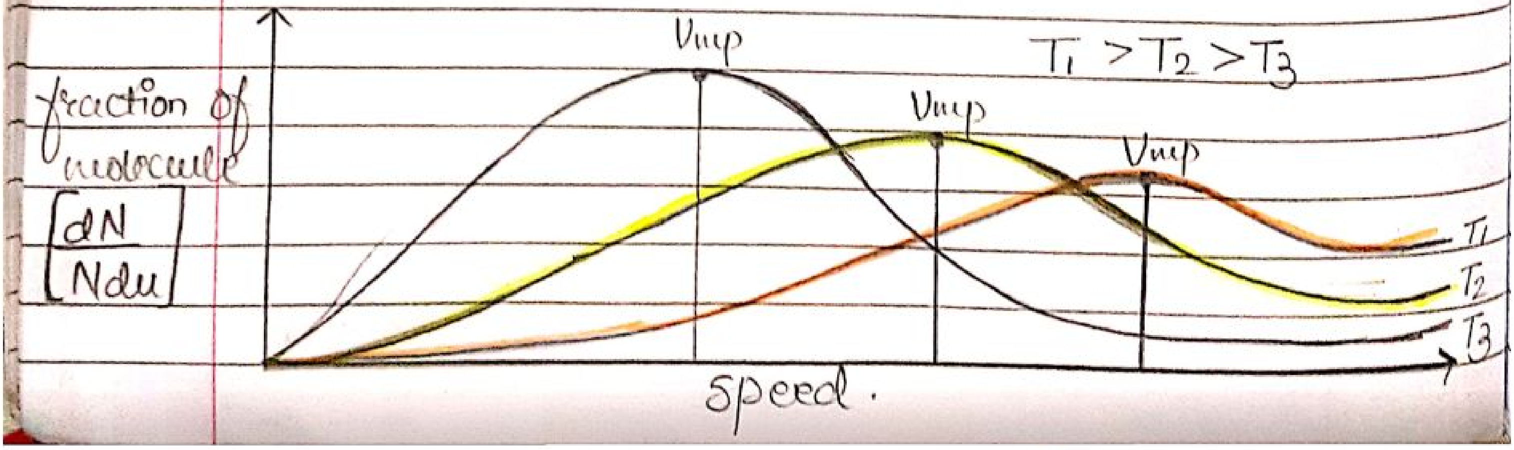
- according to maxwell, in a gas sample at a certain temperature, the number of particles having a particular speed remain constant and can be calculated by Maxwell Differentiation Equation.

eq^n

- on the basis of these equation he plotted a graph between
  - fraction of molecules $\left(\frac{dN}{Ndu}\right)$ & speed of molecule.



Vmp = most probable
Vavg = average
Vrms = root mean square



* temperature बढ़ाने पर Graph flatten होगा।

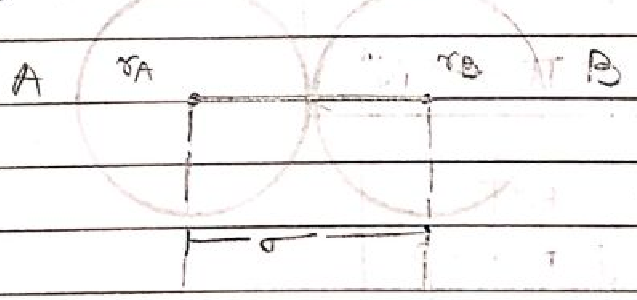
Conclusion:

- small fraction of molecule have very low and very high velocities (speed).
- curve flattens on increasing temperature.
- most of the molecules have most probable velocity.

Collision Parameter: (JEE only)

(A) collision diameter (σ):

- closest distance between centre of 2 molecules taking part in collision



(B). Number density (N^*):

- number of molecules per unit volume of gas.

i.e. $N^* = \frac{N}{V}$

$(n = N/N_A)$

$PV = nRT$

$PV = \frac{N}{N_A} RT$ $\therefore \frac{N}{V} = \frac{P\boxed{N_A}}{\boxed{RT}} \rightarrow KT$

(boltman's constant)

$$\boxed{N^* = \frac{N}{V} = \frac{P}{KT}}$$

(C) Collizion frequency (z):

- number of collision per molecule in per unit tim
- mathematically it can be calculated as;

$$\boxed{z = \sqrt{2}\pi\sigma^2 V_{avg} N^*}$$

(D) Mean free path (λ):

- average distance travelled by a molecule between 2 successive collision:
- it can be calculated as:

$$\boxed{\lambda = \frac{V_{avg}}{z}}$$

$$\boxed{\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 N^*}}$$

$$\boxed{\lambda = \frac{KT}{\sqrt{2}\pi\sigma^2 P}}$$

Q:27 find ratio of root mean path of molecules of 2 gases having molecular diameter 1A° and 2A° respectively at constant temperature and pressure.

→ $\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 N^*}$ $\therefore \frac{\lambda_1}{\lambda_2} = \left(\frac{(\sigma_2)}{(\sigma_1)}\right)^2$

$\boxed{4:1}$

Q:28 if mean free path is (λ) at 1 atm then find value at 5 atm. (at constant temperature)

$\Longrightarrow$ $\lambda \propto \frac{T}{P}$ $\therefore$ $\lambda \propto \frac{1}{P}$

$\frac{\lambda_1}{\lambda_2} = \frac{P_2}{P_1} \longrightarrow \frac{\lambda}{x} = \frac{5}{1}$ $\therefore$ $\boxed{x = \frac{\lambda}{5}}$

Real gas:

- those gases which doesn't follow gaseous law at entire range of pressure. and volume

- all gases are Real Gases; neither of the gas is ideal in nature due to two faulty assumptions of KTG:
  a) volume of gaseous molecule is negligible as compared to total gas volume.

  b) no force of attraction between gaseous molecules.

Compressibility factor:(z):-

- It is a scale to measure deviation of real gas from their ideal behaviour.

$$\boxed{z = \frac{PV}{nRT}}$$

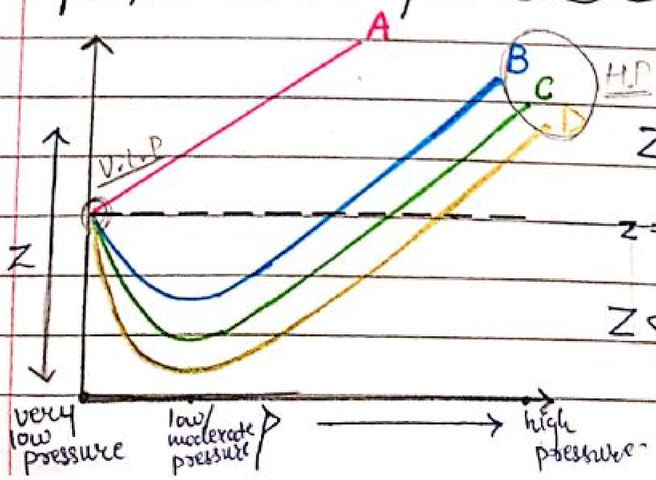
$$\boxed{Z = \frac{PV}{RT} \text{ (for 1mole gas).}}$$

$$\boxed{Z = \frac{V_{obs}}{V_{ideal}}} \quad \text{or} \quad \boxed{Z = \frac{V_{real}}{V_{ideal}}}$$

		$Z \neq 1$ (real gas)	
	$Z=1$ (ideal gas)	$Z>1$ (+ve deviation)	$Z<1$ (-ve deviation)
1.	$PV = RT$	$PV > RT$	$PV < RT$
2.	$V_{real} = V_{ideal}$	$V_{real} > V_{ideal}$	$V_{real} < V_{ideal}$
3.	Repulsive f = Attraction f. (Ideal Gas.)	R.F > A.F (Permanent Gas.)	R.F < A.F. (Liquifiable Gas.)
eg:	N_2; O_2.	H & inert gas	HCl; CO_2; NH_3; SO_2; SO_3; etc.

* N_2 and O_2 (nearly ideal behaviour)

#⇒ Graphical representation of compress factor:



jitna Z<1 उतना curve
Vo उतना ही Heavy
volume उतना ही

At room temp: 298K

Z>1 [PV>RT; RF>AF]

z = 1 [ideal; PV=RT; RF=AF]

Z<1 [PV<RT; RF<AF]

- in this graph;- Gas A shows +ve deviation (always).
  -(it is a permenant gas).
  -(it' is approximately impossible to convert to liquid state).

- Gas D shows maximum negative (-ve) deviation. and it is more liquified gas as compared to gas B and C.

★- At low pressure and high temperature real gas behaves as nearly ideal.(due to for. of. att. ↓)

Q:29 Arrange following gases in increasing order of:
(A) deviatin from ideal ~~be~~behaviour.
(B) liquification.

Gas	A	B	C	D	E
Z	0.8	0.3	1.3	1.2	1.5
deviation of	-0.2	-0.7	0.3	0.2	0.5

⟹

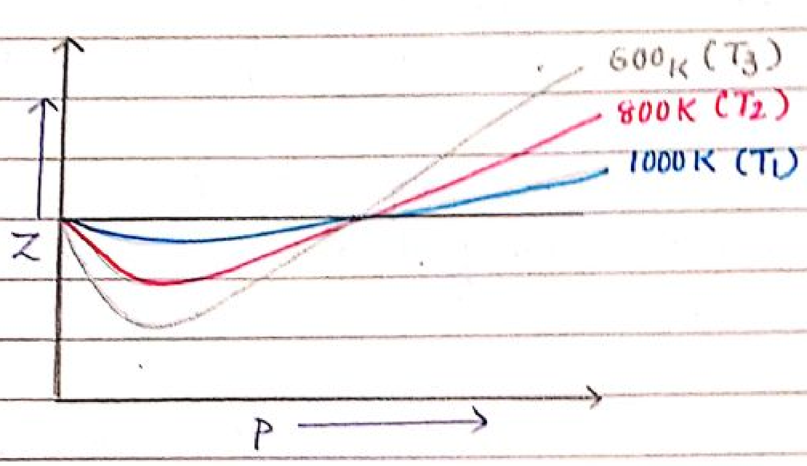
∴,

Gas	A	B	C	D	E
Z	0.8	0.3	1.3	1.2	1.5
deviation	-0.2	-0.7	+0.3	+0.2	+0.5

∴, (A) max deviation; B>E>C>A≃D.
(B) liquification; B>A>D>C>E.

-ve ↑ to liquification easy.
+ve ↑ to liquification difficult.

At high temperature: [Z vs P]



- at very high temperature, real gas acts nearly same to ideal behaviour due to lessening or decreasing of force of attraction at high temperature to negligible.

Pressure and Volume Correction:

(A) **Pressure Correction** - due to force of attraction available in real gas molecules so, pressure correction is required in ideal gas ~~condition~~ equation.

$$P_{gas} = P_{ideal} - \frac{an^2}{V^2}$$

$$\therefore \boxed{P_i = P_{gas} + \frac{an^2}{V^2}}$$

- $\frac{an^2}{V}$ = pressure due to force of attraction
- a = vanderwall constant w.r.t liquification.

[value of 'a' different for variable gases]

(B) - Volume correction

Actual Volume of a gas =
Vol. of container - Vol. of gaseous particles.

$$\therefore \boxed{\text{Actual Vol} = V - nb}$$

excellent

here, nb = exclude volume or covolume or abundance volume.
b = vanderwall constant. w.r.t size of molecule.

* calculation for value of 'b':

$$b = \underbrace{4}_{\text{voids}} \times \underbrace{\frac{4}{3}\pi r^3}_{\text{vol. of sphere (shape of gas molecule)}} \times \underbrace{N_A}_{\text{mole}}$$

04/10

Real gas equation: (Van-der-wall gas equation):.

- after correction of the pressure and volume, vanderwall modified the ideal gas equation and give real gas equation.

$$\boxed{\left(P + \frac{an^2}{V}\right)(V - nb) = nRT}$$

for 1 mole gas:

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

→ unit of 'a':

Pressure = $\frac{an^2}{V}$ ∴ $\boxed{a = \frac{atm\ lit^2}{mole^2}}$

∴ in MKS = $\frac{Pa(m^3)^2}{mole^2}$ ∴ $\boxed{a = \frac{Pa\,m^6}{mole^2}}$ (MKS).

→ unit of 'b':

Volume = nb   ∴ $\boxed{b = \frac{ltr}{mole}}$ or $\boxed{b = \frac{m^3}{mole}}$

Value of 'z' at different pressure:

(a) Z at very low pressure: p = very low ↓↓↓ v = very high. ↑↑↑

- in that case;

a = 0 b = 0.

$$\left[P+\cancelto{0}{\frac{a}{V^2}}\right](V-\cancelto{0}{nb}) = RT$$

(n = 1 mole).

∴ $\boxed{PV = RT}$ (z = 1; gas show ideal behaviour in this case)

(b) Z at low pressure: p = moderate ↓ v = moderate. ↑

- in that case;

b = negligible.

$$\left[\frac{PV^2+a}{V^2}\right](V-\cancelto{0}{nb}) = RT$$