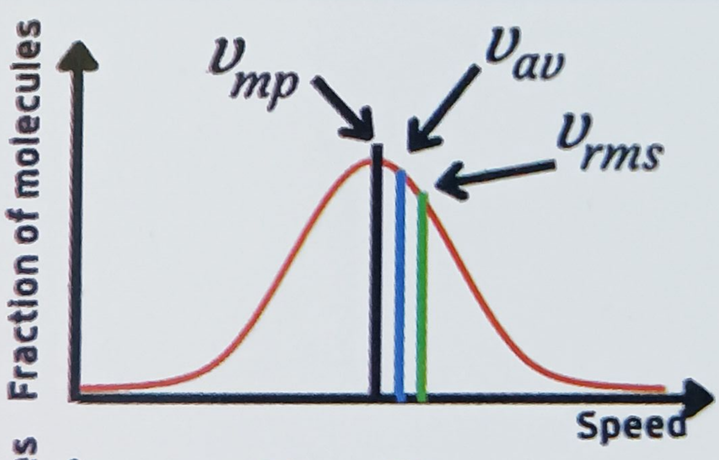
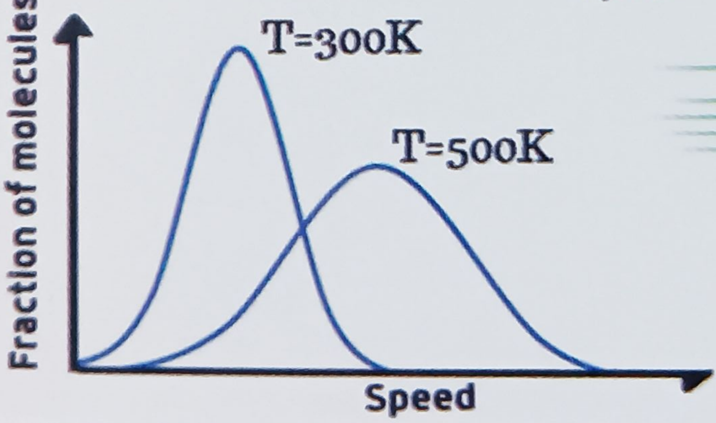
Kinetic Theory of gases

Kinetic Gas equation	$pV = \frac{1}{3} mnu^2_{rms}$	
Average Kinetic Energy	$KE = \frac{3}{2} RT$ (per mole) $KE = \frac{3}{2} k_b T$ (per molecule)	
Different Molecular velocities		
Root Mean Square (rms)	Average	Most probable
$v_{rms} = \sqrt{\frac{3RT}{M}}$	$v_{av} = \sqrt{\frac{8RT}{\pi M}}$	$v_{mp} = \sqrt{\frac{2RT}{M}}$
Relation $(v_{mp} < v_{av} < v_{rms})$ = 1 : 1.128 : 1.224		



Distribution of Molecular Velocities



Maxwell Boltzmann Distribution of speeds

Van Der Waal's Equation

$\left(p+\frac{n^2a}{V^2}\right)(V-nb)=nRT$	$a =$ *Force of attraction measure* (atm L^2 mol^{-2}) $b =$ *Excluded volume* (L mol^{-1})

Degree of Freedom

Degree of Freedom A = Number of Particles in system	$f = 3A - R$
Specific heat at constant volume	$C_V = \frac{f}{2}R$
Specific heat at constant Pressure	$C_P = \left(\frac{f}{2}+1\right)R$

Nature of Gas	$U = \frac{f}{2}RT$	$C_V = \frac{dU}{dT} = \frac{f}{2}R$	$C_P = C_V + R$	$\gamma = \frac{C_P}{C_V} = 1 + \frac{2}{F}$
Monoatomic	$\frac{3}{2}RT$	$\frac{3}{2}R$	$\frac{5}{2}R$	1.67
Polyatomic Linear	$\frac{5}{2}RT$	$\frac{5}{2}R$	$\frac{7}{2}R$	1.4
Polyatomic Non-linear	$3RT$	$3R$	$4R$	1.33

Law of Equipartition of Energy	Energy associated with each molecule per degree of freedom is,
This law states that, for a dynamic system in thermal equilibrium, the total energy is distributed equally amongst all the degree of freedom	$E = \frac{1}{2} k_B T$ $k_B = 1.38 \times 10^{-23}\, JK^{-1}$ (Boltzmann constant)

Mean Free Path (λ or l)	
The average distance travelled by a molecule between two successive collisions.	$\lambda = \frac{1}{\sqrt{2}\, n\pi d^2}$ n = number density d = diameter of the molecule
$\lambda \propto \frac{1}{p} \propto T$	

Liquefication of gases

Critical Temperature	$T_c = \frac{8a}{27Rb}$
Critical Pressure	$P_c = \frac{a}{27b^2}$
Critical Volume	$V_c = 3b$
Compressibility factor (Z_c)	$\frac{P_c V_c}{RT_c} = \frac{3}{8}$

NEET 2023 PYQ'S (Chapter 12 Gaseous State)

- The temperature of a gas is $-50^\circ C$. To what temperature the gas should be heated so that the rms speed is increased by 3 times? : **$3295^\circ C$**