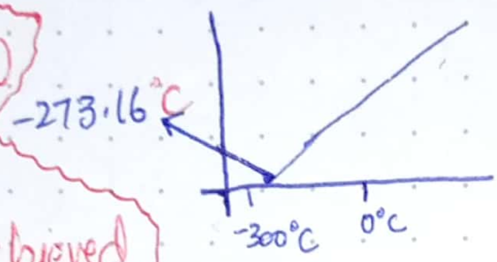
PHYSICAL CHEMISTRY

Page ①

→ GASES:- (i) Boyle's Law $V \propto \frac{1}{P}$ $PV = K$

(ii) Chaele's Law $V \propto T$ $\frac{V}{T} = K$ (T in K)



⊛ Third Law of thermodynamic

⊛ 10^{-5} K is achieved

Units of P for (1 atm)

(i) P = 760 mmHg or 760 Torr

(ii) P = 101325 Nm^{-2} or 1 atm

(iii) P = 14.7 pounds $inch^{-2}$

Mateorologists use millibar

(iii) Avogadro's Law. $V \propto n$

(iv) General Gas Eq $PV = nRT$

$R = 0.0821$ atm dm^3 K^{-1} mol^{-1}

$R = 8.3143$ N m K^{-1} mol^{-1} or J K^{-1} mol^{-1}

$R = 1.98$ cal K^{-1} mol^{-1}

$$R = P \times \frac{V}{nT}$$
$$= \frac{F}{A} \times \frac{V}{nT}$$
$$= \frac{N}{m^2} \frac{m^3}{K^{-1} mol}$$
$$= Nm\, K^{-1} mol^{-1}$$
$$= Energy\, K^{-1} mol^{-1}$$

Molar Volume

(v) Equal volume of gases at STP contains Equal no of molecules.

1 mole O_2 = 6.02×10^{23} molecules of O_2 = 22.414 dm^3

$$1\,dm^3 = \frac{6.02 \times 10^{23}}{22.414} \boxed{= 2.7 \times 10^{22}}$$

At which Temp °C = °F

$$°C = \frac{5}{9}[F - 32]$$

$$°F = \frac{9}{5}°C + 32$$

(VI) Graham's Law $r \propto \frac{1}{\sqrt{d}}$ $\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$

(VII) Gay Lussac's Law:

$P \propto T$ $\frac{P}{T} = K$ $\boxed{\frac{P_1}{T_1} = \frac{P_2}{T_2}}$

⇒ KINETIC MOLECULAR THEORY OF GASES:

(i) Gas → Consisted → Tiny Particles → molecules
He, Ne, O_2, H_2 etc.

(ii) Random motion.

(iii) collision ⟶ Pressure.

(iv) Elastic Collision [K.E before] = [K.E after]

(v) No force of attraction

(vi) Individual volume is negligible as compare to total available volume.

(vii) No effect of gravity.

(viii) K.E ∝ T

$$\boxed{PV = \frac{1}{3} m N \bar{c}^2}$$

⇒ Molecular Velocities:

(i) Root Mean Square Velocity

$PV = \frac{1}{3} m N \bar{c}^2$ for $n = 1$ $N = N_A$

$$\bar{c}^2 = \frac{3PV}{mN_A} \Rightarrow \sqrt{\bar{c}^2} = \sqrt{\frac{3PV}{M}}$$

$PV = RT$ $n = 1$

$$\sqrt{\bar{c}^2} = \sqrt{\frac{3RT}{M}} \Rightarrow \sqrt{\bar{c}^2} = \sqrt{3} \times \sqrt{\frac{RT}{M}}$$

$$\boxed{C_{rms} = 1.73\sqrt{\frac{RT}{M}}}$$

$\bar{c}^2$ = mean Sq Velo

$mN_A = M$

$C_{rms} \propto \sqrt{T}$

$C_{rms} \propto \frac{1}{\sqrt{M}}$

$\bar{c} \propto \sqrt{T}$

$\bar{c} \propto \frac{1}{\sqrt{M}}$

$C_{m.p} \propto \sqrt{T}$

$C_{mp} \propto \sqrt{\frac{1}{M}}$

(ii) Average Velocity:

$$\bar{C} = \frac{C_1 + C_2 + C_3 + \dots + C_n}{n}$$

Maxwell's distribution $\bar{C} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8}{\pi}}\sqrt{\frac{RT}{M}}$

$$\boxed{\bar{C} = 1.59\sqrt{\frac{RT}{M}}}$$

(iii) Most Probable Velocity:

- "Velocity Possessed by the greatest fraction of molecules in a gas at any temp^n"

$$\boxed{C_{m.p}} = \sqrt{\frac{2RT}{M}} = \sqrt{2}\sqrt{\frac{RT}{M}} = \boxed{1.414\sqrt{\frac{RT}{M}}}$$

COMPARISON:

$$C_{rms} : \bar{C} : C_{m.p}$$

$$1.73\sqrt{\frac{RT}{M}} : 1.59\sqrt{\frac{RT}{M}} : 1.414\sqrt{\frac{RT}{M}}$$

- For same T & M ratio will be same
- $C_{rms} > \bar{C} > C_{m.p}$

Question:

For H_2 & O_2 at 25°C. The C_{rms}, $\bar{C}$, $C_{m.p}$ of H_2 is how much more or less than O_2?

sol

For What temp C_{rms} of SO_2 be same as O_2 at 27°C?

Sol =

→ Kinetic Energy of one mole of an ideal gas:

$$PV = \frac{1}{3} mN\bar{c}^2 \quad (\because n=1 \quad N=N_A)$$

$$PV = \frac{1}{3} mN_A\bar{c}^2 \quad (\because mN_A = M.)$$

$$PV = \frac{1}{3} M\bar{c}^2 \quad (\because PV = RT)$$

$$RT = \frac{1}{3} M\bar{c}^2 \Rightarrow \frac{2}{3}\left(\frac{1}{2}M\bar{c}^2\right) = RT$$

$$\Downarrow$$

$$\boxed{E_K = \frac{3}{2}RT} \Leftarrow \frac{2}{3}E_K = RT$$

For one Mole

$$\frac{E_K}{N_A} = \frac{1}{N_A}\frac{3}{2}RT$$

$$\epsilon_K = \frac{R}{N_A}\left(\frac{3}{2}T\right)$$

$$\boxed{\epsilon_K = \frac{3}{2}kT}$$

$E_K \propto T$

E_K depends upon Temp not on its nature (molecule)

For diatomic & Polyatomic, rotational & vibrational motion energies are also required

Boltzmann's Constant

$$= \frac{R}{N_A} = K$$

$K = 1.38 \times 10^{-23}$ JK^{-1} molecul^{-1}

→ Heat Capacity of Gases:

- →● Amount of heat requie to ~~raise~~ raise the temp of gas by 1°C (or 1K)

If Substance Quantity is 1 mole, then it is molar heat capacity.

- →● For 1g weight then it is called specific heat.

TYPES C_v at cons ~~tem~~ volume

C_p at cons Pressure

Denoted by C

non S.I units
cal $K^{-1} mol^{-1}$

$S.I = J K^{-1} mol^{-1}$

- For any mono-atomic gas i.e He, Ne, etc and vapours of Hg, K etc, value of $C_v = 12.48\ J K^{-1} mol^{-1}$

For monoatomic gas $\boxed{C_v}$

initial. $E_K = \frac{3}{2} RT$

Final $E_K' = \frac{3}{2} R(T+1)$

$$E_K' - E_K = \frac{3}{2} R(T+1) - \frac{3}{2} R(T)$$

$$\Downarrow$$

$$C_v = \frac{3}{2} R(T+1-T)$$

$$\boxed{C_v = \frac{3}{2} R}$$

$$\boxed{C_v = 12.48\ J K^{-1} mol^{-1}}$$

$\boxed{C_p}$

$PV = RT \quad (n=1)$

$P(V+\Delta V) = R(T+1)$

$PV + P\Delta V = RT + R$

as $(PV = RT)$

$\cancel{(RT)} + P\Delta V = \cancel{(RT)} + R$

$R = P\Delta V$

$C_p = \frac{3}{2} R + R.$

$C_p = \frac{5}{2} R$

$$\boxed{C_p = 20.8\ J K^{-1} mol^{-1}}$$

[1K by one mole along with volume increase.]

⇒ $\{C_p \;\&\; C_v\}$

$\left(\frac{5}{2} - \frac{3}{2} = \frac{2}{2}\right)$

(i) $C_p - C_v = R \Rightarrow = \frac{5}{2}R - \frac{3}{2}R \Rightarrow \boxed{= R}$

(ii) $\gamma = \frac{C_p}{C_v} = \frac{\frac{5}{2}R}{\frac{3}{2}R} = \frac{5}{3} = 1.666$

Whatever the atomacity, diff remains same

$\boxed{\gamma = 1.666}$

⇒ FOR POLYATOMIC Molecules.

$C_v = \frac{3}{2}R + X \qquad C_p = \frac{5}{2}R + X.$

(i) $C_p - C_v = R$

$= \left(\frac{5}{2}R + X\right) - \left(\frac{3}{2}R + X\right) \Rightarrow = \left(\frac{5}{2} - \frac{3}{2}\right)R + X - X$

$= \frac{2}{2}R \;\boxed{= R.}$

(ii) $\gamma = \frac{C_p}{C_v}$

$\gamma = \frac{\frac{5}{2}R + X}{\frac{3}{2}R + X} < 1.666$

For monoatomic & diatomic or polyatomic molecules, $C_p - C_v = R$

- γ is high (1.666) for monoatomic molecule.
- γ is < 1.666 for di and poly atomic molecules.

new unit (Rankine=R)

HEAT	TEMP
• Form of Energy	• Degree of Hotness or coldness of Body.
• Measured in J	• Measured in K
• Can't measure directly	• Directly measured by Thermometer
• Derived Quantity	• Fundamental Quantity

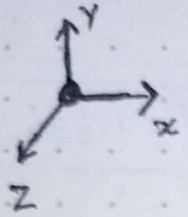
Working ability due to heat not due to temp.

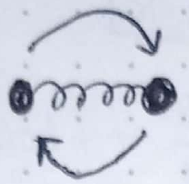
Heat describe transfer of thermal energy within a system.

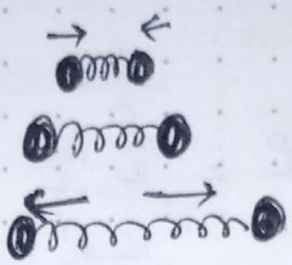
Temp is Average K.E

→ DEGREE OF FREEDOM & ATOMACITY :

Energy goes on increasing as atomacity increase







For Monoatomic Molecule Total Degree = 3x1 = 3.

Translational = 3 ; Rotational = 0 ; Vibrational = 0

$$\boxed{E_K = \frac{3}{2}RT}$$

For Di-Atomic Total Degree = 3 × 2 = 6.

T = 3 ; R = 2 ; V = 1.

$$E_K = 3\left(\frac{1}{2}RT\right) + 2\left(\frac{1}{2}RT\right) + \overset{(Vib)}{\left(\frac{1}{2}RT + \frac{1}{2}RT\right)}$$

$$E_K = \frac{3}{2}RT + RT + RT$$

$$E_K = \left(\frac{3}{2}+1+1\right)RT = \frac{7}{2}RT \Rightarrow \boxed{= 3.5RT}$$

For Tri-Atomic Total Degree = 3x3 = 9.

(i) Linear: [O=C=O]

T=3 , R=2 , V=4.

$$E_K = 3\left(\frac{1}{2}RT\right) + 2\left(\frac{1}{2}RT\right) + 4RT$$

$$E_K = \left(\frac{3}{2}+1+4\right)RT$$

$$= \frac{13}{2}RT \text{ or } \boxed{= 6.5RT}$$

(ii) Non-Linear: [H—O—H]

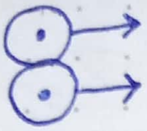
T=3 , R=3 , V=3

$$E_K = \frac{3}{2} + \frac{3}{2} + 6\,[RT]$$

$$\boxed{E_K = 9RT}$$

→ COLLISIONS :

(i) Grazing OR Glancing Collision :

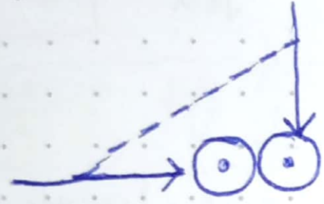


(relative velocity $= \bar{c}$)

(ii) Head on collision :

relative velocity $= 2\bar{c}$

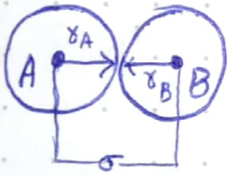
(iii) Right Angled Collision :



relative velocity $= \sqrt{2}\,\bar{c}$

(iv) COLLISION DIAMETER :

closest dist. b/w centre of two



$$\sigma = r_A + r_B$$

(v) COLLISION FREQUENCY (Z_1) :

- Single molecule in one cm^3 faced how many collisions in one second.

$$Z_1 = \sqrt{2}\,\pi\sigma^2\bar{c}n$$

(vi) MEAN FREE PATH (λ) :

- Average distance covered by a molecule b/w two successive collisions.

$$\lambda = \frac{\bar{c}}{Z_1}$$

COMPRESSION TIME is the time foe which two molecules are in contact at the time of collisions.

Elastic Collision no net loss or gain in Energy.

Z_1 depends upon velocity, Size & closeness of molecules in the vessel.

(vii) Collision Number (Z_{11})

- collisions happening in all the molecules in $1cm^3$ of gas in 1 sec.

$$Z_{11} = nZ_1/2$$

EQUATIONS

Collision Frequency

$Z_1 = \sqrt{2}\pi\sigma^2\bar{c}n$

$$\lambda = \frac{\bar{c}}{Z_1}$$

$$\lambda = \frac{\bar{c}}{\sqrt{2}\pi\sigma^2\bar{c}n}$$

Mean free Path

Collision No

$$Z_{11} = \frac{nZ_1}{2} \Rightarrow Z_{11} = \frac{n(\sqrt{2}\pi\sigma^2\bar{c}n)}{2}$$

$$Z = \frac{\pi\sigma^2\bar{c}n^2}{\sqrt{2}}$$

$Z_{11} \propto \sigma^2$	$Z_{11} \propto T$
$Z_{11} \propto \bar{c}$	$Z_{11} \propto n^2$
$\bar{c} = \sqrt{\frac{8RT}{\pi M}}$	$Z_{11} \propto \frac{1}{\sqrt{M}}$

⇒ GAS VISCOSITY:

- The flow of one Layer over the other.

Co-efficient of Viscocity (η)

→ • Force in Newton b/w two Parallel layers one Square metre in area and maintain velocity of 1 m/s.

$$\eta = \frac{1}{3} d\lambda\sqrt{\frac{8RT}{\pi M}}$$

$\eta \propto d$	$\eta \propto \bar{c}$
$\eta \propto \sqrt{T}$	$\eta \propto \sqrt{\frac{T}{M}}$

$$\lambda = \frac{3\eta}{0.921\, d\sqrt{\frac{3RT}{M}}}$$

$\lambda \propto \eta$	$\lambda \propto \frac{1}{d}$
$\lambda \propto \sqrt{T}$	$\lambda \propto \frac{1}{\sqrt{M}}$

Units of "η"

$$\eta = \frac{F}{A \times \frac{du}{dx}}$$

$$= \frac{Nm}{m^2 (m/s)}$$

$= Nm^{-2}s$

$N = kg\, m s^{-2}$

$= kg\, m\, m^{-2} s^{-2} s$

$\boxed{= kg\, m^{-1} s^{-1}}$ Poise

$1\ \text{Poise} = 10^{-1} kg\, m^{-1} s^{-1}$

→ Effect of Pressure and Temp on Viscocity of Gas :

In liquids, viscocity decrease by increase in temperature.

$$\eta = \frac{2}{3}\frac{1}{N\pi\sigma^2}\sqrt{\frac{MRT}{\pi}}$$

- viscocity of ideal gas is independent of P
- $\boxed{\eta \propto \sqrt{T}}$ • $\boxed{\eta \propto \frac{1}{\sigma^2}}$ • $\boxed{\eta \propto \sqrt{M}}$

→ Effect of T & P on mean Free Path (λ).

$n\lambda = cons$ $\frac{1}{n} = \frac{RT}{PV}$ $n = \frac{PV}{RT}$

$\boxed{n \propto P}$ $\boxed{n \propto \frac{1}{T}}$

As $\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 n} \Rightarrow n\lambda = \frac{1}{\sqrt{2}\pi\sigma^2}$ $n\lambda = cons.$

$\lambda = \frac{cons}{n}$ $\left(\lambda \propto \frac{1}{n}\right)$

as $\lambda \propto \frac{1}{n}$ $\boxed{\lambda \propto \frac{1}{P}}$ & $\boxed{\lambda \propto T}$

$(\lambda P = K)$ $\left(\frac{\lambda}{T} = cons\right)$

At ordinary Temp & Pressure, the values of $\lambda = 10^{-7}$ m

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- Rankine invented the apparatus for measuring viscocity in 1910.

- Poiseuille Eq is used.

$$\eta = \frac{\pi(P_1 - P_2)rt}{8vl}$$

→ DALTON'S LAW: Total P = Sum of All Pressure.

$$\boxed{P_A = X_A P_t \quad | \quad P_B = X_B P_t}$$

$X_1 + X_2 = 1$

APPLICATION'S

(i) $P_{moist} = P_{dry} + P_{w.vap}$

Collection of gas over water

$P_{moist} = P_{dry} + \text{Aq. Tension}$

$P_{dry} = P_{moist} - \text{Aq-Tension}$

(ii) **Respiration**

- O_2 Pressure in air = 159 Torr
- O_2 " " Lungs = 116 torr
- CO_2 Pressure in air = 0.3 tor
- CO_2 " " Lungs = 35 torr

(iii) **High Altitudes, Pilots**

- Low Pressure than 159 Torr
- Pressurized cabin is used.

(iv) **Deep Sea Divers,**

- O_2 + He as compare to N_2
- 100 feet depth, 3atm increa
- N_2 pressure increase in depth & can diffuse in Blood.

Diffusion:

- Spontaneous intermixing

high conc → low conc.

$r \propto T$

$r \propto \frac{1}{\sqrt{d}}$

$r \propto \frac{1}{\sqrt{M}}$

Effusion:

One by one escape through tiny hole.

$\text{Effusion} \propto \frac{1}{\sqrt{M}}$

⇒ CRITICAL TEMP & PRESSURE :-

- Highest temp above which a substance never exists as liquid. is called (T_c)
- The corresponding Pressure is called critical Pressure

GAS	Cri Temp °C
O_2	-118.75
NH_3	132.44
CO_2	31.1°C
N_2	-147.06

Critical Volume :

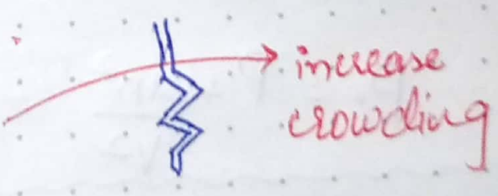
At critical Temp & Pressure 1 mole gas volume is V_c.

$O_2 = 74.42\ cm^3 mol^{-1}$; $CO_2 = 95.65\ cm^3 mol^{-1}$; $H_2 = 64.51\ cm^3 mol^{-1}$

- Polar gases can be liquify at high temp
- non-Polar gases only at low temp.
- For non-Polar gases (Size ∝ T_c)

⇒ Lind's METHOD : (Joule Thomson effect.)

- High Pressure = 200 atm.
- Zig-Zag Spiral nozzle



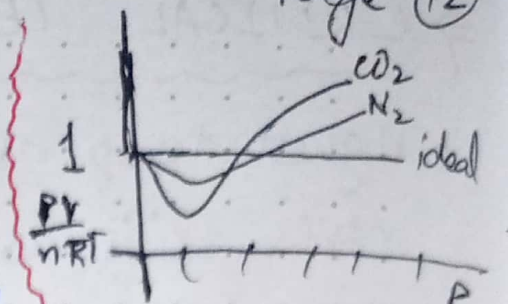
- H_2 & He can't be liquified by this method due to Low critical Temp.
- Adiabatic Demagnetization is used for the liquefaction.

→NON-IDEAL BEEHAVIOUR:

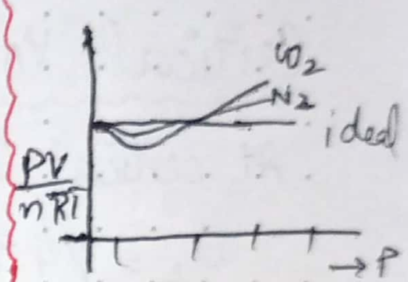
$PV = nRT$

$\frac{PV}{nRT} = 1 \rightarrow$ unity factor or Compressibility factor

- ideal at high temp & low Pressure.
- non-ideal at low temp & high Pressure



T=0°C



T=100°C

⇒ CAUSES OF DEVIATIONS

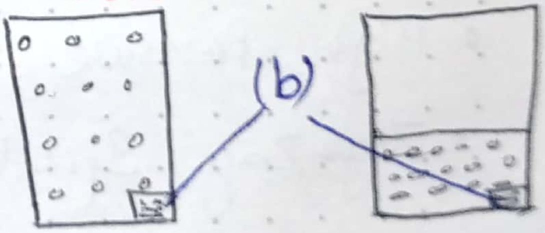
- NO FORCE OF ATTRACTION

Pressure correction

$P_i = P + P'$

$P_i = P + \frac{an^2}{V^2}$

- Actual volume of Gas molecules is neglible as compare to volume of vessel.



- Volume occupied by the gas molecules is not available for free movements of molecules.
- $V_{free} = V_{vessel} - V_{molecules}$ if $\{V_{free} = V\}$ $V_{molecule} = b$

$V = V_v - b$ (for n=1) b = effective Volume.

- b is not actual volume → it is $b = 4V_m$

↳ (vibratory volume)

V_m = actual volume

→ REAL GAS EQUATION :-

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

- → a & b are Van dee Waal's constants.
- → **Units of a**

(non-SI) $P'=\frac{an^2}{V^2} \Rightarrow a=\frac{P'V^2}{n^2}$.

$$a=\frac{atm\,(dm^3)^2}{mol^2} \qquad \boxed{a = atm\ dm^6\ mol^{-2}}$$

(SI)

$$a=\frac{P'V^2}{n^2} \Rightarrow a=\frac{(Nm^{-2})(m^3)^2}{mol^{-2}}$$

$$\boxed{a = N\,m^4\,mol^{-2}}$$

- → **Units of b**

volume mol^{-1} or $\boxed{dm^3\,mol^{-1}}$

$V_{molecules}=n\,b$ $\quad \boxed{b=\frac{V_{molecules}}{n}}$ $\quad$ or $\boxed{m^3\,mol^{-1}}$

→ Validity of Van dee Waal's Eq.

For $n=1$ $\quad \left(P+\frac{a}{V^2}\right)\left(V-b\right)=RT$

$$PV-Pb+\frac{a}{V}+\frac{ab}{V^2}=RT$$

$$\boxed{PV=RT+Pb-\frac{a}{V}-\frac{ab}{V^2}}$$

↓

Eq ①

$$\boxed{PV = RT + Pb - \frac{a}{V} + \frac{ab}{V^2}}$$

→ AT Low Pressure :

at low Pressure volume is very high $V \propto \frac{1}{P}$

$\left\{ Pb \approx 0 \quad \& \quad \frac{ab}{V^2} \approx 0 \right]$ can be neglected

$$PV = RT - \frac{a}{V}$$

Divide by RT

$$\frac{PV}{RT} = \frac{RT}{RT} - \frac{a}{VRT} \Rightarrow \boxed{\frac{PV}{RT} = 1 - \frac{a}{RTV}}$$

$$\frac{PV}{RT} = Z \quad \text{so} \quad \boxed{Z = 1 - \frac{a}{RTV}}$$

So, at low P compressibility factor is <1

→ At high Pressure :

$\frac{a}{V}$ & $\frac{ab}{V^2}$ both ignored.

$$PV = RT + Pb \qquad \frac{PV}{RT} = 1 + \frac{Pb}{RT}$$

$$\boxed{Z = 1 + \frac{Pb}{RT}} \qquad Z > 1$$

→ At high Temp : $V \propto T$ & $P \propto T$

$nb = V$

as $b \approx 0$

$$\boxed{PV = RT}$$

Low value of a & b shows ideal behaviour.

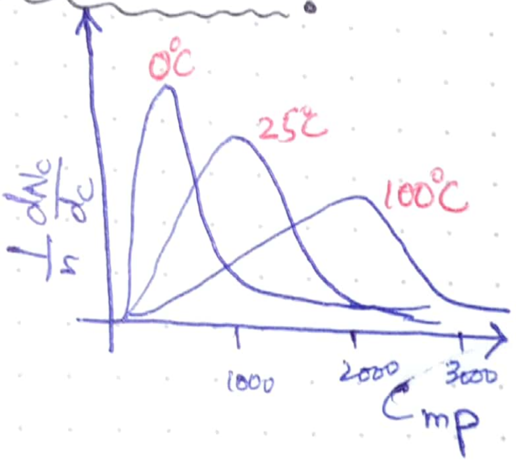
→ DISTRIBUTION OF MOLECULAR VELOCITIES :-

Probability Considerations.

$$\frac{dN_c}{N} = 4\pi \left[\frac{M}{2\pi RT}\right]^{3/2} \left(e^{-Mc^2/RT}\right) c^2 \, dc.$$

- $\left[\frac{dN_c}{N} \times \frac{1}{dc}\right]$ is Probability of finding molecules of velocity "c" and "c + dc"

→ EFFECT OF TEMP. :



wider distributin at higher Temp

MULTIPLE CHOICE QUESTIONS

1. The root mean square velocity of an ideal gas in a closed container of fixed volume is increased from 1×10^4 cm s^{-1} to 2×10^4 cm s^{-1}. Which of the following statements might correctly explain how the change is accomplished by

   (a) heating the gas, the pressure is doubled

   (b) heating the gas, the volume is tripled

   (c) heating the gas, the temperature is doubled

   [✓ (d)] heating the gas the pressure is made four times

   [Hint: $V = \sqrt{\frac{3PV}{M}}$. Thus, $\frac{V_2}{V_1} = 2 = \sqrt{\frac{P_2}{P_1}}$ or $4 = \frac{P_2}{P_1}$ or $P_2 = 4P_1$]

   $C_{rms} = \sqrt{\frac{3PV}{M}}$ $C_{rms} \propto \sqrt{P}$

   $\frac{{}_1C_{rms}}{{}_2C_{rms}} = \frac{2\times10^4}{1\times10^4} = \sqrt{\frac{P_2}{P_1}}$

   $\sqrt{\frac{P_2}{P_1}} = 2$ $\boxed{P_2 = 4P_1}$

2. At standard temperature and pressure the order of mean square velocity of molecules H_2, N_2, O_2 and HCl is?

   (a) $N_2 > O_2 > H_2 > HCl$

   (b) $HCl > H_2 > O_2 > N_2$

   (c) $HCl > O_2 > N_2 > H_2$

   [✓ (d)] $H_2 > N_2 > O_2 > HCl$

   [Hint: Keep in mind their molar masses].

   mean velocity decrease with M.mass increase

3. Which of the following methods is wrong to raise the volume of a gas four times:

   $V = nR\frac{T}{P}$

   (a) Keeping temperature constant, pressure is reduced to 1/4 of its initial value

   [✓ (b)] Temperature is doubled and pressure is also doubled

   (c) Keeping pressure constant, temperature is raised by four times

   (d) Temperature is doubled and pressure is halved

   [Hint: Consider general gas equation].

4. One of the following is not the basic assumptions of the kinetic theory of gases. Indicate that

   (a) The molecules move in a straight line with uniform velocity between two collisions

   [✓ (b)] The molecules exert appreciable attractions on each other, therefore energy is lost due to collision or mutual attraction

(c) The molecules of the gas are always in the state of ceaseless haphazard motion

(d) Molecules of the gas are perfectly elastic, hard spherical particles and are all alike

[**Hint:** Look at the postulates of K.T of gases].

5. Which of the following statements is false?

(a) Equal masses of the same gas at the same T and P occupy equal volumes

[✓ (b)] Equal masses of different gases at the same T and P contain equal number of molecules

(c) At S.T.P. one mole of any ideal gas has same number of molecules

(d) One mole of any gas contains a constant number of molecules

[**Hint:** Avogadro's Law and concept of molar volume].

6. Which one of the following statements is correct for a gas:

(a) There is no mathematical relationship between mean free path and collision diamater.

(b) The mean free path is nearly equal to molecular diameter

[✓ (c)] The mean free path is very much larger than the molecular diameter

(d) The mean free path is less than the molecular diameter

[**Hint:** Relationship of M.F.P and collision diameter].

7. According to Maxwell-Boltzmann law of distribution of molecular velocities, maximum point in the curve in the graph shows highest fraction of molecules possessing,

(a) average velocity

[✓ (b)] most probable velocity

(c) root mean square velocity

(d) all of these

[**Hint:** Maxwell's plots at various temperatures].

8. Gases deviate from ideal behaviour at high pressure. Which of the following is the reason for that?

[✓ (a)] At high pressure the intermolecular interactions become significant

(b) At high pressure, the volume of gas becomes insignificant

(c) At high pressure, the gas molecules move only in one direction

(d) At high pressure, the collision between the gas molecules become enormous

[**Hint:** Non-ideal behaviour of gases].

9. The Van der Waal's equation for real gas is

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

(b) $\left(P + \frac{an^2}{V^2}\right)(b + nV) = nRT$

(c) $\left(P + \frac{a}{V^2}\right)(V + b) = nRT$

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

[Hint: Look at Van der Waal's equation]

10. The critical temperature of a gas

(a) depends upon the critical pressure

(b) does not depend upon the nature of the gas

(c) is lower than the inversion temperature

[✓ (d)] is higher than the inversion temperature.

[Hint: Critical phenomenon of gases].

ANSWERS:

1.	(d)	2.	(d)	3.	(b)	4.	(b)	5.	(b)
6.	(c)	7.	(b)	8.	(a)	9.	(d)	10.	(d)

V. Imp

EXERCISE

Q1: Select the correct answer out of the following alternative suggestions.

(i) Pressure remaining constant, at which temperature the volume of a gas will become twice of what it is at 0°C.

a. 546°C b. 200°C [✓ c. 546K] d. 273K

(ii) Number of molecules in one dm^3 of water is close to

a. $\frac{6.02}{22.4} \times 10^{23}$ b. $\frac{12.04}{22.4} \times 10^{23}$ c. $\frac{18}{22.4} \times 10^{23}$ d. $55.6 \times 6.02 \times 10^{23}$

(iii) Which of the following will have the same number of molecules at STP?

[✓ a.] 280 cm^3 of CO_2 and 280 cm^3 of N_2O

b. 11.2 dm^3 of O_2 and 32 g of O_2

c. 44g of CO_2 and 11.2 dm^3 of CO

d. 28g of N_2 and 5.6 dm^3 of oxygen

because
No. of mole of gas = Volume
equal

(iv) If absolute temperature of a gas is doubled and the pressure is reduced to one half, the volume of the gas will

a. remain unchanged [✓ b.] increase four times

c. reduce to 1/4 d. be doubled

(v) How should the conditions be changed to prevent the volume of a given gas from expanding when its mass is increased?

[✓ a.] Temperature is lowered and pressure is increased.

b. Temperature is increased and pressure is lowered.

c. Temperature and pressure both are lowered.

d. Temperature and pressure both are increased.

(vi) The molar volume of CO_2 is maximum at

a. STP [✓ b. 127°C and 1atm] c. 0°C and 2atm d. 273°C and 2atm

(vii) The order of the rate of diffusion of gases NH_3, SO_2, Cl_2 anCO_2 is:

a. $NH_3 > SO_2 > Cl_2 > CO_2$ [✓ b. $NH_3 > CO_2 > SO_2 > Cl_2$]

c. $Cl_2 > SO_2 > CO_2 > NH_3$ d. $NH_3 > CO_2 > Cl_2 > SO_2$

(viii) Equal masses of methane and oxygen are mixed in an empty container at 25°C. The fraction of total pressure exerted by oxygen is

[✓ a. $\frac{1}{3}$] b. $\frac{8}{9}$ c. $\frac{1}{9}$ d. $\frac{16}{17}$

Mole fraction of O = $\frac{\text{Moles of } O_2}{\text{Total moles}}$ $= \frac{1}{3}$

ix) Gases deviate form ideal behaviour at high pressure. Which of the following is correct for non-ideality?

a. At high pressure, the gas molecules move in one direction only.

b. At high pressure, the collisions between the gas molecules are increased manifold.

c. At high pressure, the volume of the gas becomes insignificant.

[✓ d. At high pressure, the intermolecular attractions become significant.]

) The deviation of a gas from ideal behaviour is maximum at

[✓ a. -10°C and 5.0atm] b. -10°C and 2.0atm

c. 100°C and 2.0atm d. 0°C and 2.0atm

i) A real gas obeying van der Waals equation will resemble ideal gas if

a. both 'a' and 'b' are large [✓ b. both 'a' and 'b' are small]

c. 'a' is small and 'b' is large d. 'a' is large and 'b' is small

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

a = 0, b = 0

Fill in the blanks