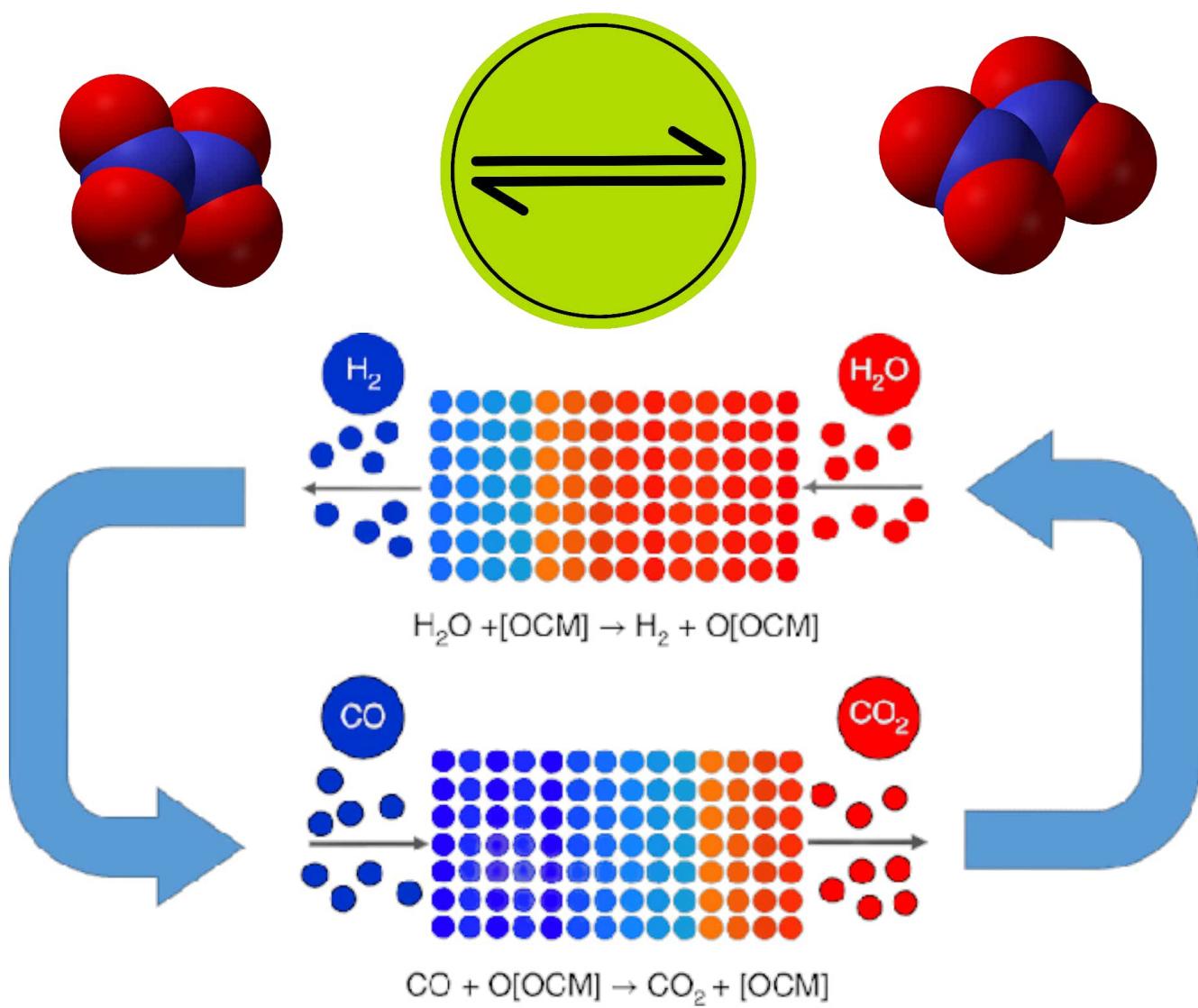


# Chemical Equilibrium

Class:-XI

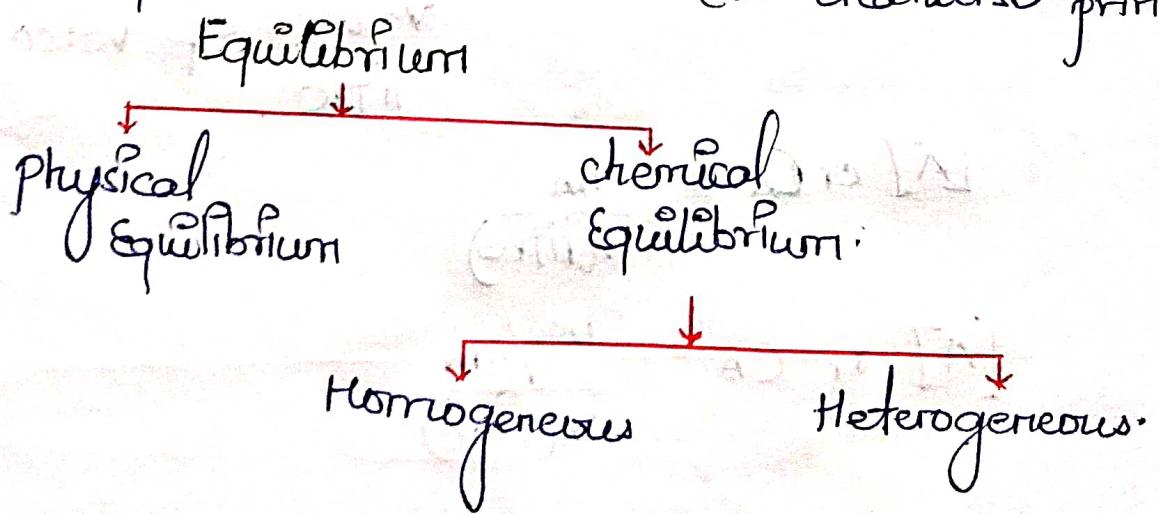


Handwritten Notes With  
Detailed Explanation

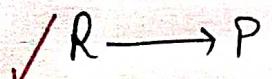
WRITTEN BY - TEJAS KASHYAP  
UNDER THE GUIDANCE OF - MR. SANJEEV SINGH

# equilibrium

- The state of reversible reaction at which the rate of forward reaction becomes equal to rate of backward reaction, is called state of equilibrium i.e.  $v_f = v_b$
- The state of reversible reaction in which the concentration of reactant and product remains constant which do not change with time is called state of equilibrium.
- Equilibrium state is dynamic in nature.
- There is no effect of catalyst on the state of equilibrium but in the presence of catalyst, state of equilibrium comes soon.
- state of equilibrium can be affected by change in temperature, pressure, concentration (Le Chatelier's principle)

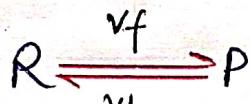


## Reaction



Irreversible reaction

Reversible Reaction



$v_b$

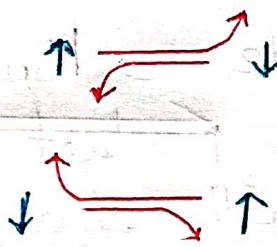
$v_f \rightarrow$  rate of forward reaction

$v_b \rightarrow$  rate of Backward reaction



Initial conc

conc  
time



## Molar Concentration:-

(Active mass)

denoted by  $C$  or  $[ ]$

It is the number of moles of a substance present in litre volume.

Its unit =  $\text{mol l}^{-1}$

active mass =  $\frac{\text{no of moles of substance 'A'}}{\text{volume of vessel in litre}}$

$$[A] \text{ or } C_A = \frac{n_A}{V(\text{litre})}$$

$$[A] \text{ or } C_A = \frac{w_A/m_A}{V(\text{litre})}$$

$$[A] \text{ or } C_A = \frac{\omega_A}{m_A \times V(\text{litre})} = \frac{\omega_A \times 1000}{m_A \times V(\text{ml})}$$

Que 30 gm of acetic acid and 46 gm ethanol are taken in a 500 ml container. Find the active masses.

$$\text{CH}_3\text{COOH} = \frac{30 \times 1000}{60 \times 500} = 1 \text{ mol L}^{-1}$$

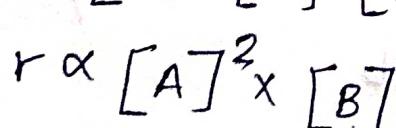
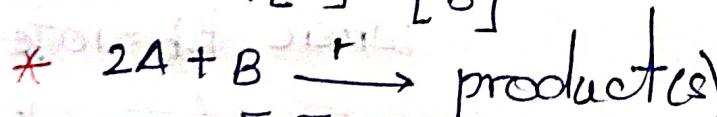
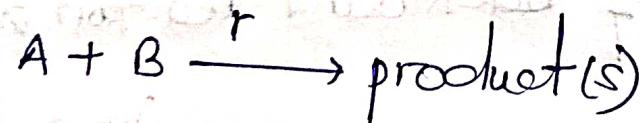
$$\text{C}_2\text{H}_5\text{OH} = \frac{46 \times 1000}{46 \times 500} = 2 \text{ mol L}^{-1}$$

### Law of mass Action :-

Given by :- Guldberg and Waage.

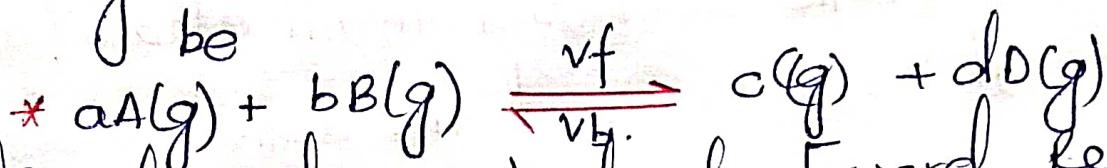
- The rate at which a substance reacts, is directly proportional to its active.

If more than one Reactants taking part in the chemical reaction, Rate of such Reaction is directly proportional to the product of their active masses.

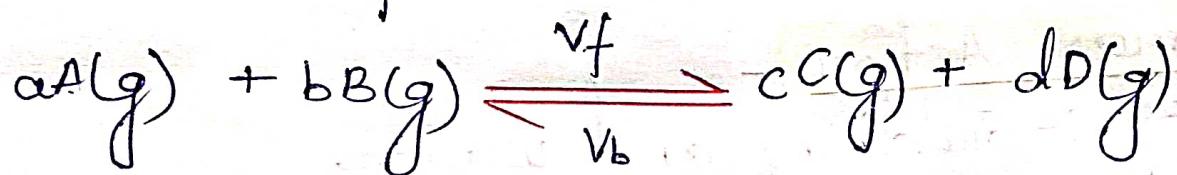


## Equilibrium Constant

Let a gaseous reversible reaction at constant temp. be



Ratio of rate constant of forward reaction  $[K_f]$  to rate constant of backward reaction  $[K_b]$  of a reversible reaction at constant temperature is always constant and such constant is called Equilibrium Constant.



Rate of forward reaction  $\propto [A]^a \propto [B]^b$

$$V_f = K_f [A]^a \propto [B]^b$$

where  $K_f$  = rate constant for forward reaction

Rate of Backward reaction  $\propto [C]^e \propto [D]^d$

$$V_b = K_b [C]^e \propto [D]^d$$

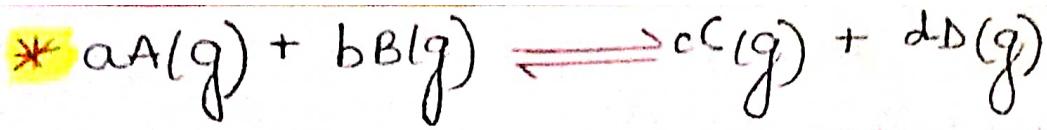
where  $K_b$  = rate constant for Backward reactions.

of equilibrium

$$V_f = V_b$$

$$K_f [A]^a \times [B]^b = K_b [C]^c \times [D]^d$$

$$K_c = \frac{K_f}{K_b} = \frac{[C]^c \times [D]^d}{[A]^a \times [B]^b} = \frac{[C]^c \times [D]^d}{[A]^a \times [B]^b}$$



$$K_c = \frac{[C]^c \times [D]^d}{[A]^a \times [B]^b} = \frac{C^c \times D^d}{A^a \times B^b}$$

we know that

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

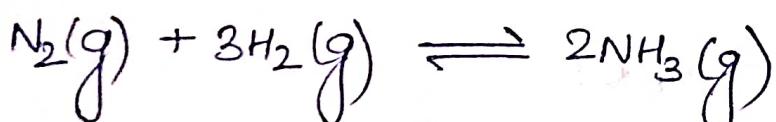
$$P = CRT \text{ constant}$$

$$P \propto C$$

partial pressure of a gas is directly proportional to its active mass of constant temp

$$K_p = \frac{P_C^c \times P_D^d}{P_A^a \times P_B^b}$$

Ex



$$K_c = \frac{[NH_3]^2}{[N_2] \times [H_2]^3} = \frac{CNH_3^2}{CN_2 \times CH_2^3}$$

or

$$K_p = \frac{PNH_3^2}{PN_2 \times PH_2^3}$$

## Relation b/w $K_p$ and $K_c$

Let a gaseous reversible reaction at constant temp. be



$$K_c = \frac{[C]^c \times [D]^d}{[A]^a \times [B]^b} = \frac{c^c \times C_B^d}{c_A^a \times C_B^b} \quad \text{--- (1)}$$

$$K_p = \frac{P_C^c \times P_D^d}{P_A^a \times P_B^b} \quad \text{--- (2)}$$

we know that

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

$$P = CRT \quad \therefore c = \frac{n}{V}$$

for gas A,  $P_A = C_A RT$

For gas B,  $P_B = C_B RT$

For gas C,  $P_C = C_C RT$

For gas D,  $P_D = C_D RT$

Putting the values of  $P_A, P_B, P_C, P_D$  in ex(1)

$$K_p = \frac{(C_C RT)^c \times (C_D RT)^d}{(C_A RT)^a \times (C_B RT)^b}$$

$$K_p = \frac{c^c \times (RT)^c \times C_D^d \times (RT)^d}{c_A^a \times (RT)^a \times C_B^b \times (RT)^b}$$

$$K_p = \frac{C_c^c \times C_D^d \times (RT)^{c+d}}{C_A^a \times C_B^a \times (RT)^{a+b}}$$

$$K_p = K_c \times (RT)^{(c+d)-(a+b)}$$

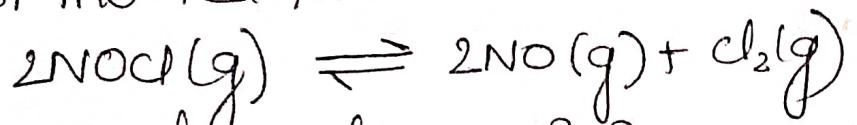
$$K_p = K_c \times (RT)^{\Delta nq}$$

\* If  $\Delta nq = \text{Zero}$   
 $\therefore [K_p = K_c]$

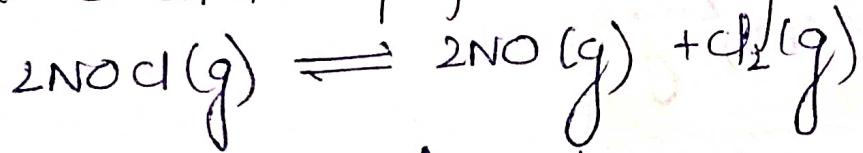
\* If  $\Delta nq = +\text{ve}$   
 $\therefore [K_p > K_c]$

\* If  $\Delta nq = -\text{ve}$   
 $\therefore [K_p < K_c]$

Q For the reaction:



the value of equilibrium constant  $K_c$  is  $3.75 \times 10^{-6}$  at 1069 K. Calculate  $K_p$  for this temperature?

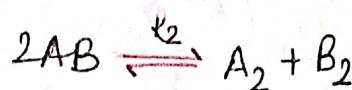
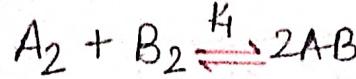


$$\Delta n_g = 1$$

$$\begin{aligned} K_p &= K_c \times (RT)^{\Delta n_g} \\ &= 3.75 \times 10^{-6} \times 0.083 \times 1069 \\ &= 2.9 \times 10^{-4} \times 10^{-6} \end{aligned}$$

$$K_p = 2.9 \times 10^{-11}$$

### Type 1<sup>st</sup>



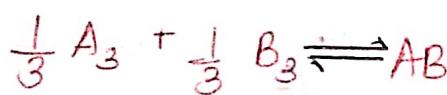
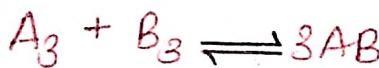
$$K_1 = \frac{[AB]^2}{[A_2] \times [B_2]} - \textcircled{I}$$

$$K_2 = \frac{[A_2] \times [B_2]}{[AB]^2} - \textcircled{II}$$

$\textcircled{I} \times \textcircled{II}$

$$K_1 \times K_2 = 1$$

### Type 3<sup>rd</sup>



$$K_1 = K_2^3$$

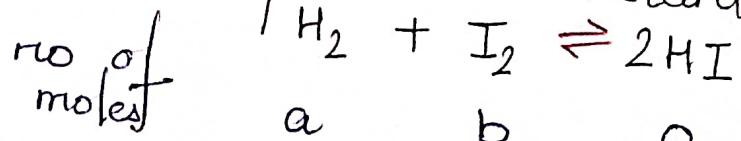
$\stackrel{Q}{=} a$  mol of dihydrogen and  $b$  of iodine are taken in a  $V$ -litre flask at equilibrium it is found that  $x$ -mole of hydrogen iodide formed. Calculate equilibrium constant  $K_C$ .



a mole  $H_2$

$b$  mol  $I_2$

$V$ -litre flask



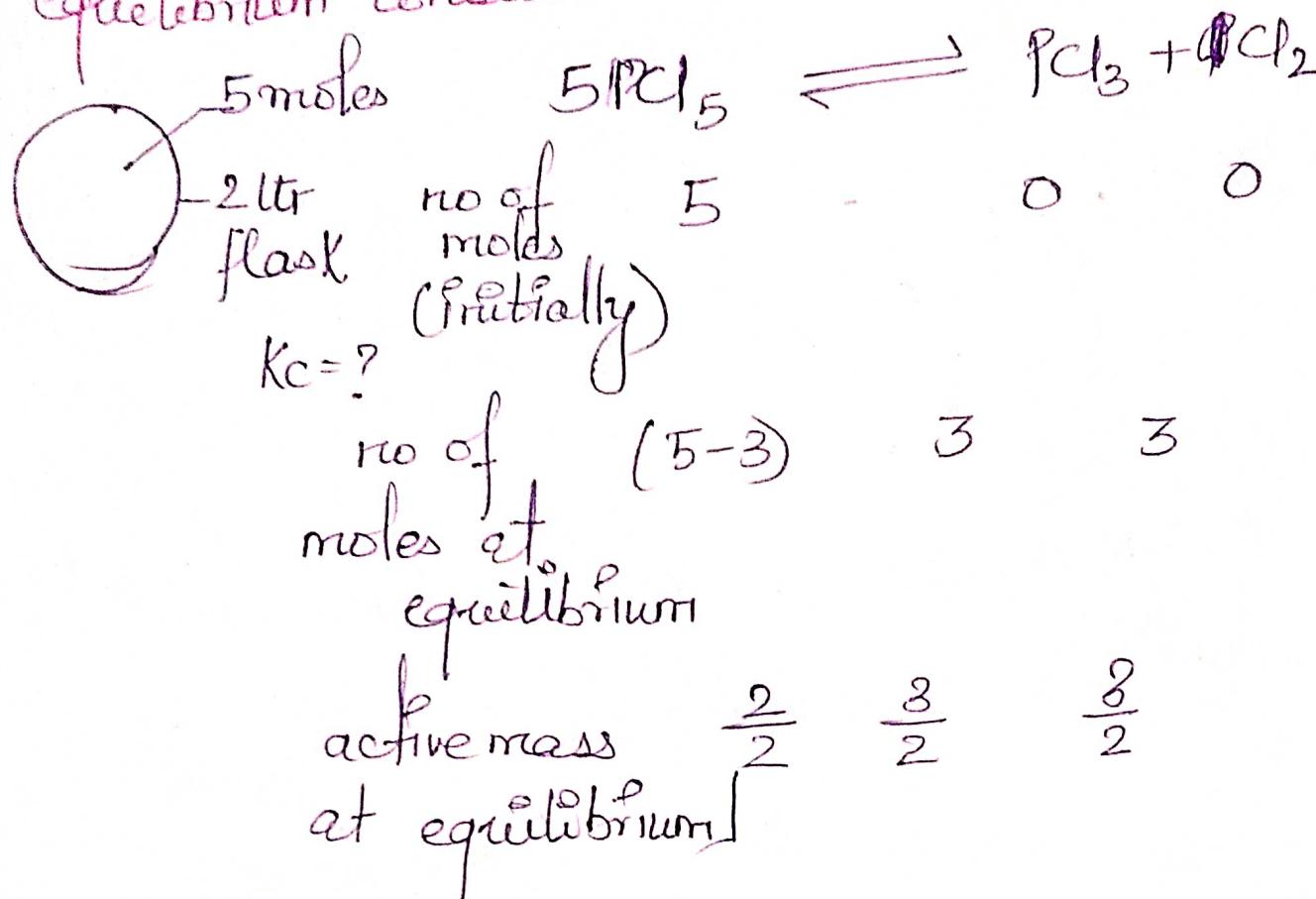
no of moles  $(\frac{a-x}{2}) (\frac{b-x}{2})$   $x$   
at equilibrium

active mass  $(\frac{a-x}{V}) (\frac{b-x}{V}) x_V$   
at equilibrium

$$K_C = \frac{[HI]^2}{[H_2] \times [I_2]} = \frac{x_V \times x_V}{\left(\frac{a-x_V}{V}\right) \left(\frac{b-x_V}{V}\right)}$$

$$K_C = \frac{x^2}{\left(\frac{a-x}{2}\right) \left(\frac{b-x}{2}\right)}$$

5 moles of  $\text{PCl}_5$  taken in a 2 ltr flask are heated at equilibrium it is found that 60% of  $\text{PCl}_5$  is dissociated into  $\text{PCl}_3$  and  $\text{PCl}_2$ . find equilibrium constant  $K_c$ .



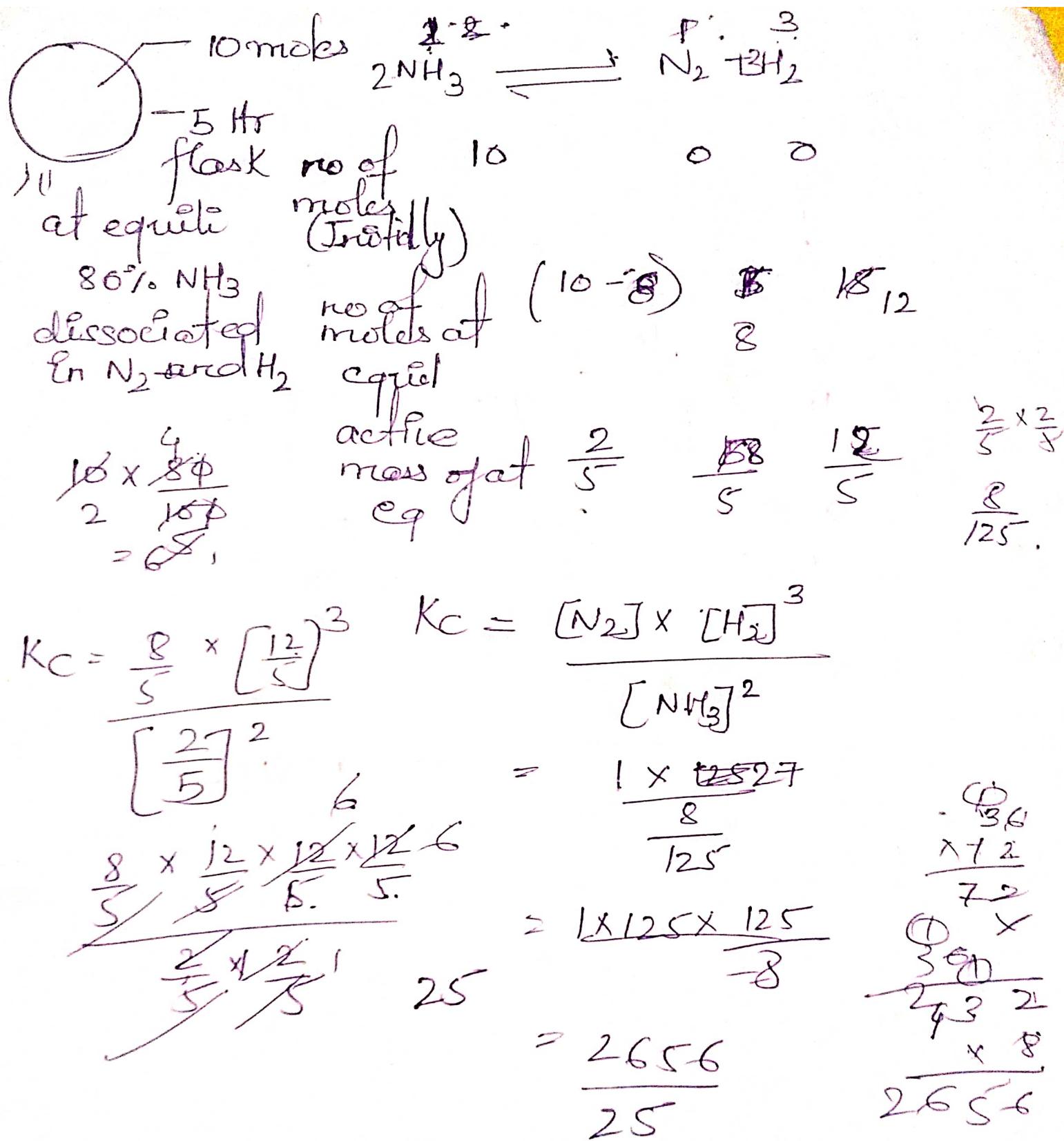
$$K_c = \frac{[\text{PCl}_3] \times [\text{Cl}_2]}{[\text{PCl}_5]}$$

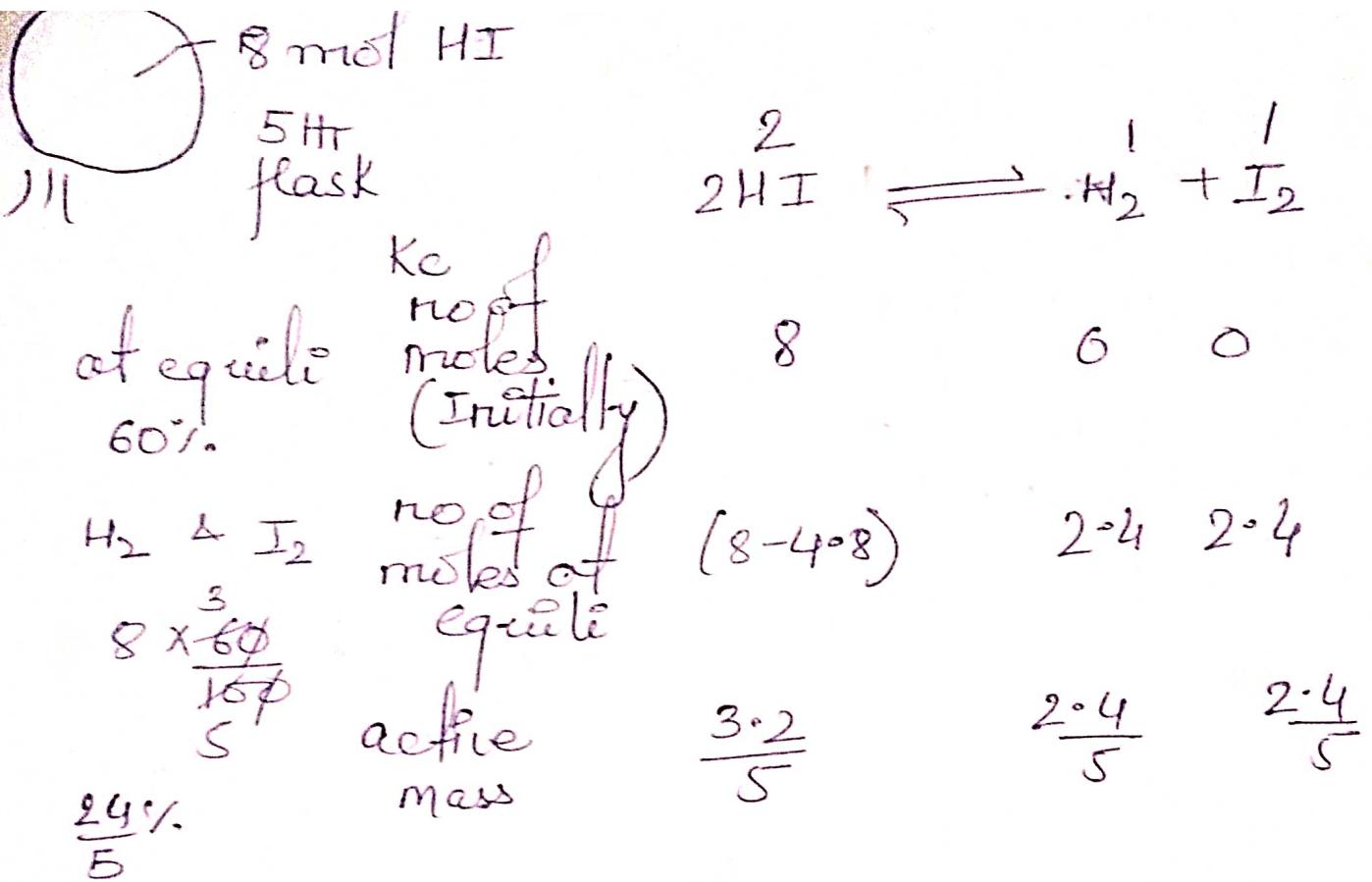
$$= \frac{\frac{3}{2} \times \frac{3}{2}}{1}$$

$$= \frac{9}{4}$$

$$K_c = 2.25 \text{ mol/L}$$

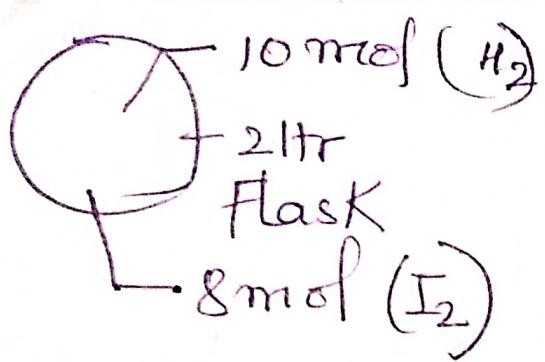
no of moles  
 $\text{PCl}_5$  dissociate  
 $5 \text{moles} \times \frac{60}{100}$   
 $= 3 \text{ moles}$





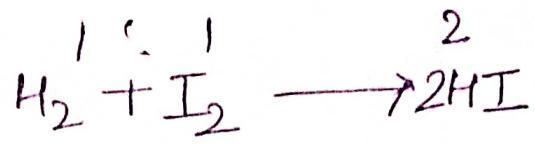
4.8%       $K_c = \frac{\frac{2.4}{5} \times \frac{2.4}{5}}{\frac{3.2}{5} \times \frac{3.2}{5}} = \frac{576}{1024} \text{ mol/L}$   
 0.5625

$$\begin{aligned}
 & \frac{2.4}{5} \times \frac{2.4}{5} \\
 & \frac{9.6}{25} \\
 & \frac{9.6}{576} \\
 & \cancel{\frac{9.6}{576}}
 \end{aligned}$$



at equilibrium

$$\begin{array}{c}
 6 \text{ mol HI} \\
 \underline{(\frac{3}{2})^2} \\
 \underline{\frac{7}{2} \times \frac{5}{2}}
 \end{array}$$

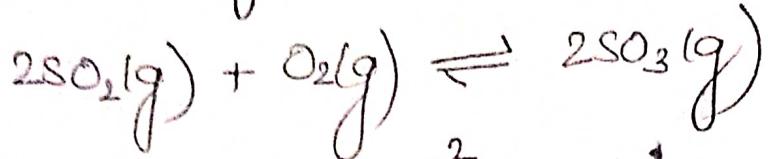
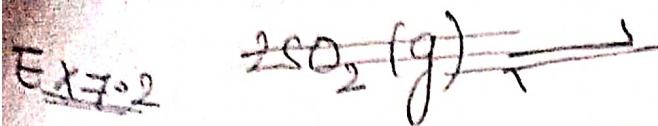


$$\begin{array}{ccccc}
 \text{no of} & 10 & 8 & 0 \\
 \text{moles} & & & \\
 (\text{initial}) & 3 & 3 & 6
 \end{array}$$

$$\begin{array}{ccccc}
 \text{no of} & & & & \\
 \text{moles} & & & & \\
 \text{at equi} & \frac{3}{2} & \frac{3}{2} & \frac{6}{2} = 3
 \end{array}$$

$$\frac{[\frac{3}{2}]^2}{[\frac{3}{2} \times \frac{3}{2}]} = \frac{9}{9} = 1$$

$$\frac{9 \times 4}{4} = \frac{36}{4}$$



$$\therefore K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 \times [\text{O}_2]} = \frac{1 \cdot 9 \times 1 \cdot 9}{0 \cdot 6 \times 0 \cdot 6 \times 0 \cdot 82} = K_c = n$$

Ex 7.3

$$P_{\text{total}} = 10^5 \text{ Pa}, K_p = ?$$

Iodine vapour = 40% by volume of I-atoms contains



$$K_p = \frac{P_{\text{I}}^2}{P_{\text{I}_2}} \quad \left| \begin{array}{l} P_{\text{I}} = \frac{40}{100} \times 10^5 = 4 \times 10^4 \text{ Pa} \\ P_{\text{I}_2} = \frac{60}{100} \times 10^5 = 6 \times 10^4 \text{ Pa} \end{array} \right.$$

$$K_p = \frac{4 \times 10^5 \times 4 \times 10^4}{6 \times 10^4}$$

$$K_p = 2.67 \times 10^4 \text{ Pa.}$$



$$K_c = [\text{CO}_2]$$

solid

$$\text{or } = \frac{\text{molar mass}}{\text{m solid} \times V(\text{ml})} \times 1000$$

liquid

$$= \frac{\text{density (s)} \times 1000}{\text{m solid}} \times \frac{1000}{V(\text{ml})}$$

$$= \frac{\text{density (s)} \times 1000}{\text{m solid}}$$

\* Temp  $\uparrow$   $\longleftrightarrow$  heat is being absorbed

Temp  $\downarrow$   $\longleftrightarrow$  heat is evolved  
being

\* Pre  $\uparrow$   $\longleftrightarrow$  volume gets decreased

Pre  $\downarrow$   $\longleftrightarrow$  volume gets increased

### Conclusions

① On Increasing the temperature, the reaction or equilibrium will shift in that reaction direction, where Heat is being absorbed and vice-versa.

② On Increasing the pressure, the reaction or equilibrium will shift in that direction where Volume get decreased and vice-versa.

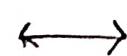
### Note

If there is no change in volume in a chemical reaction, there is effect of pressure observed.

③ On Increasing the concentration, the reaction or of a substance in a reaction, the reaction or equilibrium will shift in that direction, where that substance gets consumed and vice-versa.

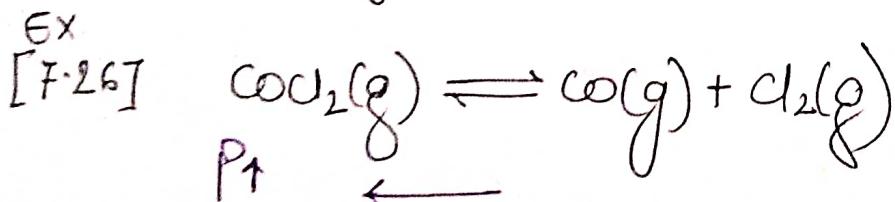
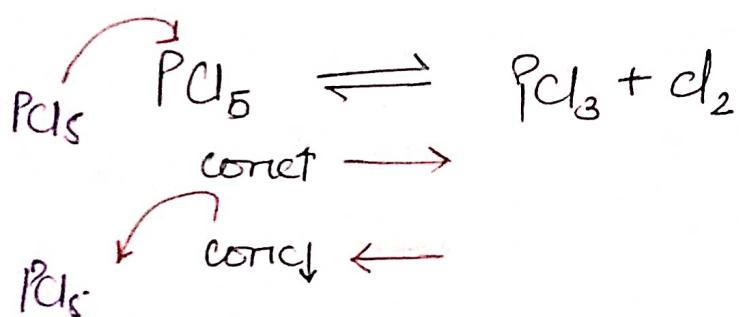
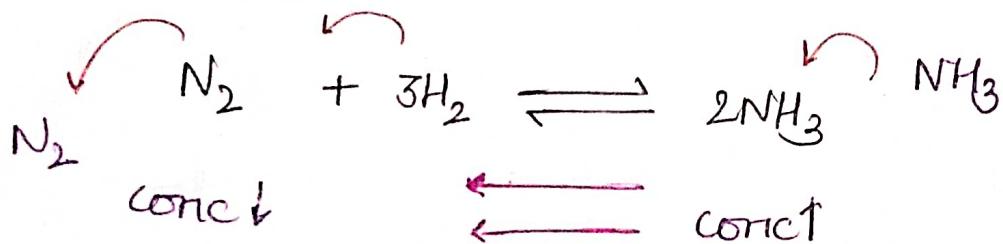
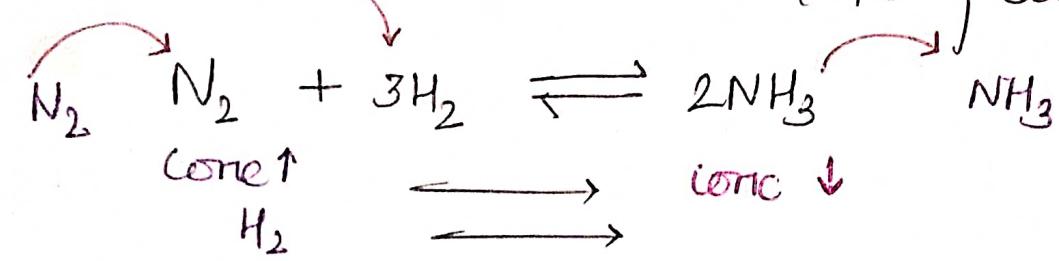
### Effect of concentration

cone of a substance  $\uparrow$



consumption of that substance takes place

cone of a substance ↓ ↔ formation / production of that substance takes place.



## Electrolytes

Those substance which conduct electricity either in their molten states or in their aqueous solution due to the presence of free ions, are called Electrolytes.

Ex:-  $\text{NaCl}$ ,  $\text{CaCl}_2$ , etc

## Non-Electrolytes

Those substance which doesn't conduct Electricity either in their molten states or in their aqueous solution due to the absence of free ions, are called Non-Electrolytes.

Ex:-  $\text{C}_6\text{H}_{12}\text{O}_6$ , sucrose, urea, etc

## Ionisation

When an electrolyte is dissolved in water, it splits up into two oppositely charged species called ions and this process is known as Ionisation.

## Degree of Ionisation ( $\alpha$ )

It is the ratio of no of moles of an Electrolyte Ionised to total no of ~~that~~ moles of that Electrolyte before ionisation.

i.e  
degree of ionisation

Total

$$\frac{\text{no of moles of an electrolyte ionised}}{\text{Total}}$$

\* Electrolytes are of two types

### weak electrolytes

- ① Those electrolytes which ionise partially in their aqueous solution are called weak electrolyte
- ② conduction of electricity is low
- ③  $\alpha \ll 1$
- ④ Equilibrium exists b/w ionised and unionised parts of an electrolyte.
- ⑤  $\text{CH}_3\text{COOH}$ ,  $\text{HCN}$ ,  $\text{NH}_4\text{OH}$ , etc

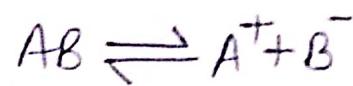
### strong electrolytes

- ① Those electrolytes which ionise completely or almost completely in their aqueous solution's are called strong electrolytes.
- ② conduction of electricity is high.
- ③  $\alpha = 1$
- ④ Equilibrium doesn't exists.
- ⑤ e.g.  $\text{HCl}$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{NaOH}$  etc.

Ostwald's dilution law :-

## Ostwald's dilution law.

Let a binary weak electrolyte be AB whose initial concentration C at constant temperature and  $\alpha$  is its degree of ionization



Initial conc (t=0)

$$c \quad 0 \quad 0$$

conc at equilibrium  $(c - c\alpha) \quad c\alpha \quad c\alpha$

$$K = \frac{[A^+] \times [B^-]}{[AB]}$$

$$K = \frac{c\alpha \times c\alpha}{c(1-\alpha)}$$

$$K = \frac{c\alpha^2}{(1-\alpha)} \quad \text{This is Ostwald's dilution expression.}$$

$\therefore$  AB is a weak electrolyte  
 $\therefore \alpha \ll 1$

$$\therefore (1-\alpha) \approx 1$$

$$K = c\alpha^2$$

$$\alpha = \sqrt{\frac{K}{c}}$$

$$\alpha = \sqrt{\frac{1}{Kc}}$$

$$\uparrow \quad \cancel{d} = d - \frac{d}{\sqrt{2}} \downarrow$$

↑      ↓  
2

at constant temperature degree of ionization  
of binary weak electrolyte is inversely propor-  
tional to square root of its initial concentration

## Limitation

Limitation

① Ostwald's dilution law is not applicable for strong Electrolyte.

三

Common ion Effect.

In the presence of a common ion, the dissociation of weak electrolyte is further suppressed, this is called common ion Effect.

$\text{CH}_3\text{COOH}$   
a weak  
electrolyte  
solution

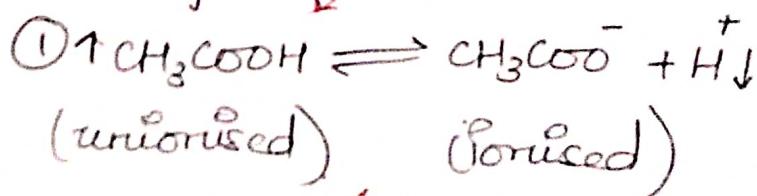
$\text{CH}_3\text{COONa}$   
a strong electrolyte  
solution  
having a common ion

$$\text{Ponisation} = \frac{\text{PH}}{\downarrow}$$

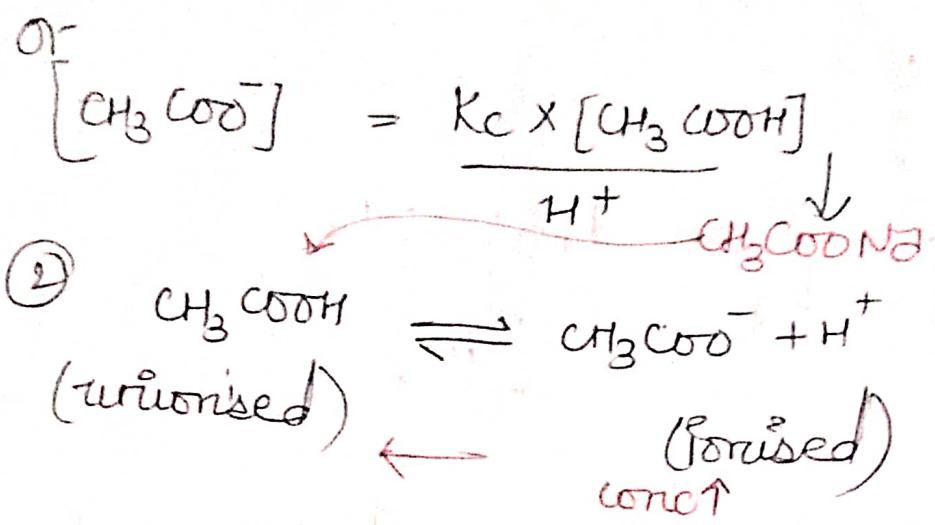
## ओर दूसी कम

# Explor

$$-\text{CH}_3\text{COONa}$$



$$K_C = \frac{[\text{CH}_3\text{COO}^-] \times [\text{H}^+]}{[\text{CH}_3\text{COOH}]}$$



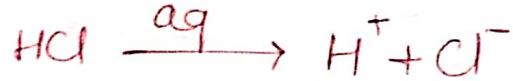
Let's discuss about chandler's principle! -

① If a system in equilibrium is subjected to a change of concentration, temperature, or pressure, the equilibrium shifts in a direction that tends to undo the effect of the change.

## Acid-Base concept

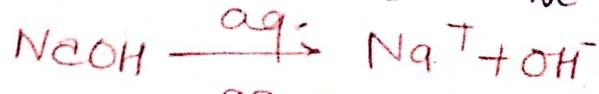
① According to Arteries:-

Acids Acids are those substances which give  $H^+$  ion when dissolved in water.



## Bases !

Bases are those substance which give  $\text{OH}^-$  ion when dissolve in water.



According to Bronsted Lowry



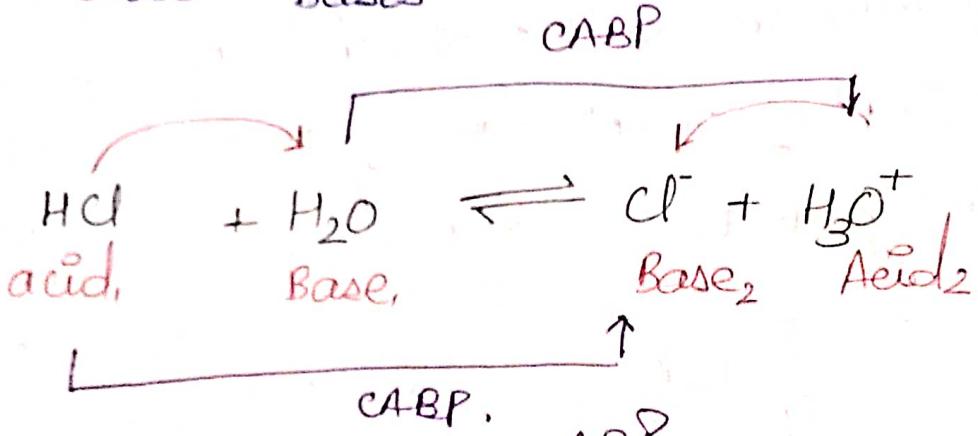
Acid, proton donors are acid . OR

Those substances which donate a proton ( $\text{H}^+$ ) to other substance , are called acids

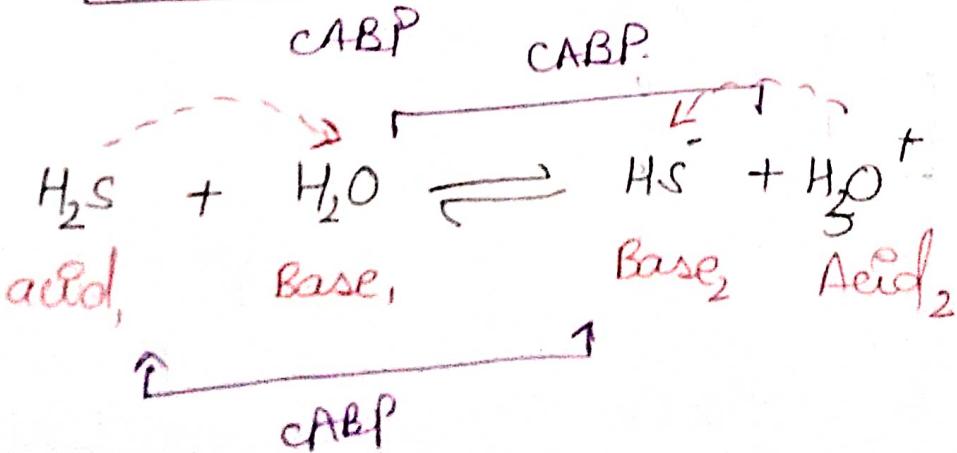
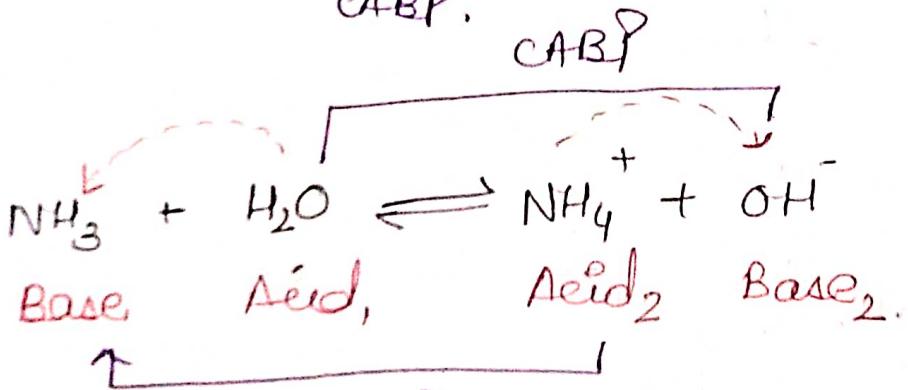
Base, proton acceptors are bases OR

Those substances which accept a proton ( $\text{H}^+$ ) from other substance , are called bases

Ex



Ex



## Conjugate Acid Base pair [CABP]

A pair of an acid and a base which differs by a proton ( $H^+$ ) only, is called CABP.

Note

- ① given species  $\xrightarrow{+H^+}$  conjugate acid of given species
- ② given species  $\xrightarrow{-H^+}$  conjugate base of given species

According to Lewis

Acid → Electron pair acceptors are called Lewis Acids

Ex -  $H^+$ ,  $CH_3^+$ ,  $BeH_2$ ,  $BeCl_2$ ,  $BF_3$

Base → Electron pair acceptors donors are called Lewis Base.

Ex -  $H^-$ ,  $\overline{CH}_3$ ,  $\overset{\circ}{N}H$ ,  $H\ddot{O}$ ,  $\ddot{O}Cl^-$  etc.

Tonic product of water

- It is denoted by  $\text{Kw}$
  - pure water is a weak electrolyte



$$K_C = \frac{[H^+] \times [OH^-]}{[H_2O]}$$

$$K_w \times [H_2O] = [H^+] \times [OH^-]$$

$$\text{constant} \times \text{constant} = [\text{H}^+] + [\text{OH}^-]$$

$$\text{new constant} = [\text{H}^+] \times [\text{OH}^-]$$

$$K_w = [H^+] \times [OH^-]$$

"The product of the concentrations of  $H^+$  and  $OH^-$  ions present in water is always constant at constant temperature such constant is called Ionic Product of water"

$$k\omega = 1.0 \times 10^{-14} m_0 |^2 L^{-2}$$

Since pure water is neutral

$$\text{ie } [\text{H}^+] = [\text{OH}^-]$$

$$\Rightarrow [H^+] = [OH^-] = 10^{-7} \text{ mol/L}$$

~~pH = 7~~

$\rightarrow$  pH  $\rightarrow$  Value

$$[H^+] = 10^{-pH}$$

taking log on Both the sides

$$\log [H^+] = \log 10^{-pH}$$

$$\log [H^+] = -pH \log 10$$

$$\therefore \log [H^+] = -pH$$

$$\boxed{pH = -\log [H^+]}$$

$$\text{or } pH = \log \frac{1}{[H^+]}$$

Similarly

$$[OH^-] = 10^{-pOH}$$

$$pOH = -\log [OH^-]$$

$$pOH = \log \frac{1}{[OH^-]}$$

## Relation b/w pH and $p^{OH}$

We know that

$$K_w = [H^+] \times [OH^-]$$

$$10^{-14} = [H^+] \times [OH^-]$$

at 298 K

Taking log on both the sides

$$\log 10^{-14} = \log[H^+] + \log[OH^-]$$

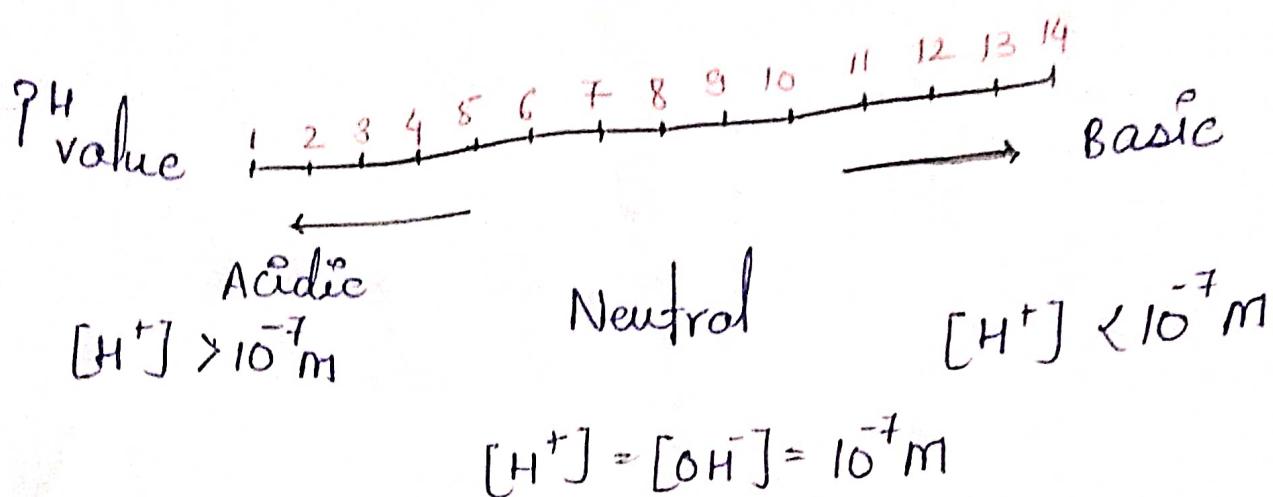
$$-14 \log 10 = \log[H^+] + \log[OH^-]$$

$$-14 = \log[H^+] + \log[OH^-]$$

$$14 = -\log[H^+] + \log[OH^-]$$

$$[14 = pH + p^{OH}]$$

## pH scale



Ex - 7.65

$$K_w = 2.7 \times 10^{-14} \text{ at } 310\text{K}$$

pH of neutral water = ?  
at 310K

$$\text{① } K_w = [\text{H}^+] \times [\text{OH}^-]$$

$$K_w = [\text{H}^+] \times [\text{H}^+]$$

$$\text{pH} = -\log [\text{H}^+]$$

$$\text{water is neutral} \quad 2.7 \times 10^{-14} = [\text{H}^+]^2$$

$$\text{pH} = -\log(1.643 \times 10^{-7})$$

$$\therefore [\text{H}^+] = 1.643 \times 10^{-7} \text{ M}$$

$$= -[\log 1.643 + \log 10^{-7}]$$

$$\therefore [\text{H}^+] = [\text{OH}^-]$$

$$= -[0.2156 - 7]$$

$$\text{pH} = 6.7844$$

Ex 7.41

soft drink

$$[\text{H}^+] = 3.8 \times 10^{-3}$$

$$\text{pH} = ?$$

$$\text{pH} = -\log [\text{H}^+]$$

Ex-7.42

Vinegar pH = 3.76

$$[H^+] = ?$$

$$[H^+] = 10^{-\text{pH}}$$

$$[H^+] = 10^{-3.76}$$

taking log on both sides

$$\log [H^+] = \log 10^{-3.76}$$

$$\log [H^+] = -3.76$$

$\therefore [H^+] = \text{anti log}$

$$= 3.76 + 4.4$$

$$[H^+] = 1.738 \times 10^{-4} \text{ M}$$

Ex-48

a) 0.003 M HCl

$$\text{pH} = ?$$



$$M = 3 \times 10^{-3} \quad \therefore [H^+] = 3 \times 10^{-3} \text{ M}$$

7.48

a) 0.003M HCl



0.003

$$\text{e}^{-} 3 \times 10^{-3} = [H^+] \quad pH = \log [H^+]$$

$$pH = -\log [3 \times 10^{-3}]$$

b) 0.005M NaOH



$$pH = -[\log 3 + \log 10^{-3}]$$

$$[OH^-] = 5 \times 10^{-3} \quad pOH = -\log [OH^-]$$

$$pH = -[0.4771 + (-3)]$$

$$pOH = -\log [5 \times 10^{-3}]$$

$$pH = -[-2.5529]$$

$$pOH = -[\log 5 + \log 10^{-3}] \quad pH = +2.5529$$

$$pOH = -[0.6989 - 3]$$

$$pOH = -(-2.3011)$$

$$pOH + pH = 14$$

$$pOH = 2.3011$$

$$pH = 14 - pOH$$

$$pH = 14 - 2.3011$$

c) 0.002M HBr



$$pH = 11.70$$

$$[H^+] = 2 \times 10^{-3}$$

$$pH = -\log [H^+]$$

$$pH = -[\log 2 + \log 10^{-3}]$$

$$pH = -[0.3010 - 3]$$

$$pH = 2.69 \approx 1.70$$

d)

$0.002 \text{ M KOH}$



$$[\text{OH}^-] = 2 \times 10^{-3}$$

$$\text{pOH} = -\log [\text{H}^+]$$

$$\text{pOH} = -[\log 2 + \log 10^3]$$

$$\text{pOH} = -[0.3010 + 3]$$

$$\text{pOH} = -[2.70]$$

$$\text{pOH} = 2.70$$

$$\text{pOH} + \text{pH} = 14$$

$$\text{pH} = 14 - 2.70$$

$$\text{pH} = 11.30$$

~~4.40~~ ~~7.55~~ a) Human - muscle - fluid  $\rightarrow 6.83$

$$[\text{H}^+] = ?$$

$$\text{pH} = -\log_{10} [\text{H}^+]$$

$$6.83 = -\log_{10} [\text{H}^+]$$

$$-6.83 = \log_{10} [\text{H}^+]$$

$$\text{Antilog}(-6.83) = [\text{H}^+]$$

$$\text{Antilog}(7.17) = \text{H}^+$$

$$[\text{H}^+] = 1.47 \times 10^{-7}$$

$$[\text{H}^+] = 1.48 \times 10^{-7} \text{ M}$$

b) Human stomach fluid 1.2

$$pH = -\log_{10} [H^+]$$

$$\text{Anti}^\circ (-1.2) = [H^+]$$

$$\text{AL}(2.8) = [H^+]$$

$$[H^+] = 6.31 \times 10^{-2}$$

c) Blood 7.38

$$[H^+] = 0.063 \text{ M}$$

$$pH = -\log_{10} [H^+]$$

$$\text{Anti}^\circ (-7.38) = [H^+]$$

$$\cancel{[H^+]} \text{ AL}(8)$$

d) Human saline 6.4

$$pH = -\log_{10} [H^+]$$

$$\text{Anti}^\circ (-6.4) = [H^+]$$

$$\cancel{[H^+]} \text{ Anti}^\circ (7.6) = [H^+]$$

$$[H^+] = 3.98 \times 10^{-7} \text{ M}$$

7.56 milk 6.8

$$pH = -\log_{10} [H^+]$$

$$6.8 = -\log_{10} [H^+]$$

$$\text{Anti}^\circ (-6.8) = [H^+]$$

$$\text{Anti}^\circ (7.2) = [H^+]$$

$$[H^+] = 1.8 \times 10^{-7} \text{ M}$$

(i) Black coffee 5.0

$$pH = -\log_{10}[H^+]$$

$$5.0 = -\log_{10}[H^+]$$

$$\text{Anti}(-5.0) = [H^+]$$

$$\cancel{\text{Anti}} \underset{+}{[H^+]} = 10^{-5} M$$

(ii) Tomato Juice

4.2

$$pH = -\log_{10}[H^+]$$

$$4.2 = -\log_{10}[H^+]$$

$$\text{Anti}(-4.2) = [H^+]$$

$$\cancel{[H^+]} =$$

$$\text{Anti}(-5.8) = [H^+]$$

$$[H^+] = 6.31 \times 10^{-5} M$$

(iv) Lemon Juice

2.2

$$pH = -\log_{10}[H^+] \quad [H^+] = 0.2 - 8$$

$$2.2 = -\log_{10}[H^+] \quad 1.585 \times 10^{-8}$$

$$\text{Anti}(-2.2) = [H^+]$$

$$\text{Anti}(-3.8) = [H^+]$$

(v) Egg white

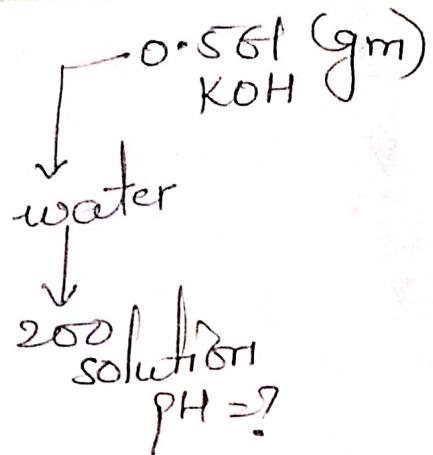
$$[H^+] = 6.31 \times 10^{-3} M$$

$$pH = -\log_{10}[H^+] \quad [H^+] = 6.31 \times 10^{-8} M$$

$$7.8 = -\log_{10}[H^+]$$

$$\text{Anti}(-7.8) = [H^+]$$

39  
57



$$pOH + pH = 14$$

$$1.30 + pH = 14$$

$$pH = 14 - 1.30$$

$$pH = 12.70$$

$$\begin{aligned} m &= \frac{w \times 1000}{m \times V(\text{ml})} \\ &= \frac{0.561 \times 1000}{56 \times 250} \\ &= 2.8 \cdot 0.5 \end{aligned}$$



$$pOH = -\log[OH^-]$$

$$pOH = -\log[0.5]$$

$$pOH = -\log[5 \times 10^{-2}]$$

$$pOH = [\log 5 + \log 10^{-2}]$$

$$pOH = [0.699 - 2]$$

$$pOH = 1.301$$