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Chemical Eq.

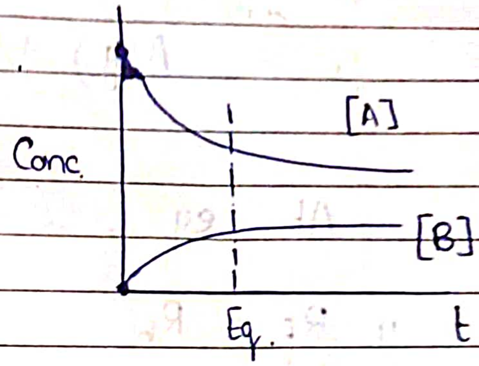
Chemical Rx^n of 2 types: Reversible & Irreversible

Reversible	Irreversible
1) Both forward & backward $dir x^n$.	1) Only in forward $dir x^n$.
Eg: Haber's process $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	Eg: Explosion, Combustion, ... Milk to Curd, ...
2) Occur in closed container.	2) Occur in both area.
3) Eq. is acheived.	3) Eq. NOT acheived
4) All neutralisation rx^ns w/o (strong acid & base) together.	4) Strong Acid + Strong Base Rx^ns.

Types of Equilibrium –
(on basis of extent of rx^n)

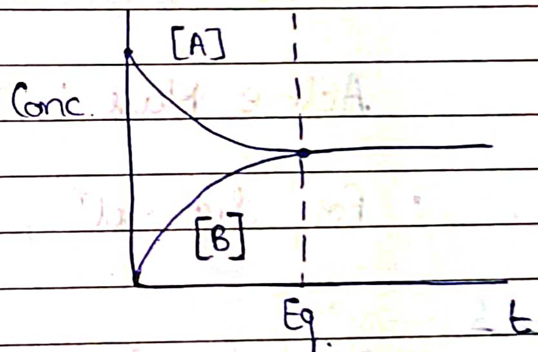
- C1: Rx^n goes little fwrd.

$A \rightleftharpoons B$



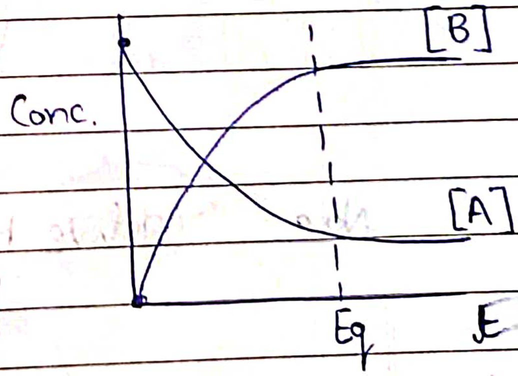
- C2: Rx^n goes exactly 50%

$A \rightleftharpoons B$



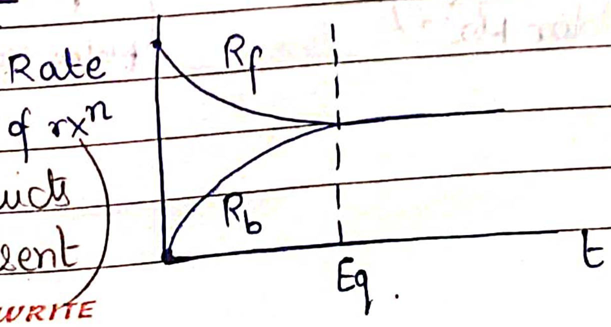
- C3: Rx^n goes very fwrd.

$A \rightleftharpoons B$



- Note –

(If no products initially present)



R_f – frwd rate
R_b – backword rate

Chemical Eq. & Active Mass

Consider homogenous reversible rxn,
same phase

$$A(g) + B(g) \rightleftharpoons C(g) + D(g)$$

At eq.,

1) $R_f = R_b$

2) [Reactant] = Const.
[Product] = Const.

Active Mass : Part of conc. involved in rxn.

- For liq. soln, (Active Mass) = (Molar Conc.) {[A]}
- For gases, (Active Mass) → (Molar Conc.) {[A]} / (Partial Pressure) {[P_A]}

Note: $(\text{Active Mass}) = (\text{Molar Conc.}) = \left(\frac{\text{moles}}{\text{Volume}}\right)$

$$\left(\frac{\text{Density}}{\text{Molar Mass}}\right) = \left(\frac{1}{\text{Molar Mass}}\right)\left(\frac{\text{Mass}}{\text{Volume}}\right)$$

- For solids / excess ~~pure~~ liq.,
density = const.
(molar mass) ~~volume~~ = const.
$\Rightarrow$ active mass = const.

We assume active mass to be 1.

$\Rightarrow$ Active Mass = 1

Law of Mass Action

Consider homogenous reversible rxn,

$$aA(g) + bB(g) \rightleftharpoons cC(g) + dD(g).$$

Acc. the law,

$$R_f \propto [A]^a [B]^b \quad \& \quad R_b \propto [C]^c [D]^d$$

$$\Rightarrow R_f = K_f [A]^a [B]^b \quad \& \quad R_b = K_b [C]^c [D]^d$$

Rate const. frwd rxn

Rate const. back. rxn

Units of Rate = $mol\, L^{-1} s^{-1}$

Units of rate const. = $(mol\, L^{-1})^{1-(a+b)} \cdot s^{-1}$

★ $\boxed{\text{Rate const. depends only on : Temp. \& Catalyst.}}$

Law of Chemical Eq.

Consider homogenous reversible rx^n,

$$aA(g) + bB(g) \rightleftharpoons cC(g) + dD(g)$$

At eq., $R_f = R_b$

(All [ ] taken at eq.) $\Rightarrow$ $k_f [A]^a [B]^b = k_b [C]^c [D]^d$

$\Rightarrow$ $\boxed{K_{eq} = \left(\frac{k_f}{k_b}\right) = \frac{[C]^c [D]^d}{[A]^a [B]^b}}$

Equilibrium Const.

K_{eq}

- In terms of conc. (K_c)

  $\left(\text{Units of } K_{eq}\right) = (mol\,L^{-1})^{(c+d)-(a+b)}$

  $= (mol\,L^{-1})^{\Delta ng}$

  Δng = (Product gas mol) − (Reactant gas mol)

- In terms of partial pressure (K_p)

  $\left(\text{Units of } K_{eq}\right) = (atm)^{\Delta ng}$

- In terms of mol frac. (K_x)

  (Units of K_{eq}) = K_x

Imp. Pts on K_{eq} :-

1) Def^n & value of K_{eq} holds only at eq. cond^n.

2) It is fixed for a rx^n at a particular temp.; i.e. it is temp. dependent only.

3) Indep^n of conc., pressure, vol., catalyst.

Types of Chemical Eq

1) Homogenous Chem. Eq
2) Heterogenous Chem. Eq

1) Homo. Chem. Eq — Reactants and products in same phase.

Eg: $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

$$K_c = \frac{[HI]^2}{[H_2][I_2]}, \quad K_p = \frac{[P_{HI}]^2}{[P_{H_2}][P_{I_2}]}, \quad K_x = \frac{[X_{HI}]^2}{[X_{H_2}][X_{I_2}]}$$

Eg : $CH_3COOH\,(aq.) \rightleftharpoons CH_3COO^{\ominus}_{(aq.)} + H^{\oplus}(aq.)$

Eg : $N_2 + 3H_2 \rightleftharpoons 2NH_3$.

☆ Eg : $NH_3\,(aq.) + H_2O\,(l) \rightleftharpoons NH_4^{\oplus}(aq.) + OH^{\ominus}(aq.)$

$$K_c = \frac{[NH_4][OH^-]}{[NH_3]\underbrace{[H_2O]}_{\text{Since in excess, active mass}=1}} \Longrightarrow K = \frac{[NH_4][OH^-]}{[NH_3]}$$

☆ Eg: $CH_3COOH\,(aq.) + C_2H_5OH\,(aq.) \rightleftharpoons CH_3COOC_2H_5\,(aq.) + H_2O\,(l)$

$$K_c = \frac{[CH_3COOC_2H_5]\overbrace{[H_2O]}^{\text{Since in excess, active mass}=1}}{[CH_3COOH][C_2H_5OH]} = \frac{[CH_3COOC_2H_5]}{[CH_3COOH][C_2H_5OH]}$$

☆ Eg: $CH_3COOH\,(l) + C_2H_5OH(l) \rightleftharpoons CH_3COOC_2H_5\,(l) + H_2O(l)$

$$K_c = \frac{[CH_3COOC_2H_5]\overbrace{[H_2O]}^{\neq 1 \text{ as NOT in excess.}}}{[CH_3COOH][C_2H_5OH]}$$

2) Hetero. Chem. Eq – Reactants & products in diff. phase.

Eg: $CaCO_3\,(s) \rightleftharpoons CaO\,(s) + CO_2\,(g)$

$$K_c = \frac{[CaO][CO_2]}{\underbrace{[CaCO_3]}_{\text{Solids active mass}=1}} \Rightarrow K_c = [CO_2]$$

$$K_p = [P_{CO_2}]$$

Eg: $H_2O\,(l) \rightleftharpoons H_2O\,(g)$

$$K_c = \frac{[H_2O(g)]}{[H_2O(l)]}$$ Liq. active mass=1, if gas present $\Rightarrow$ $K_c = [H_2O(g)]$

$$K_p = [P_{H_2O(g)}]$$

Eg: $Ni(s) + 4CO(g) \rightleftharpoons [Ni(CO)_4](g)$

$$K_c = \frac{[Ni(CO)_4]}{[CO]^4}$$

Eg: $Ag_2O\,(s) + 2HNO_3\,(aq.) \rightleftharpoons 2AgNO_3\,(aq.) + H_2O(l)$

$$K_c = \frac{[AgNO_3]^2}{[HNO_3]^2}$$

★ When aq. species (solute / ions) of gaseous sub. are present together.

Eg: $NH_3\,(g) + H_2O\,(l) \rightleftharpoons NH_4^+\,(aq.) + OH^-\,(aq.)$

$$K_{pc} = \frac{[NH_4^+][OH^-]}{[P_{NH_3}]}$$

Write conc. of aq. & partial pressure of gaseous.

Relⁿ b/w diff. Keq

Consider the homo. reversible rxⁿ,

$$aA(g) + bB(g) \rightleftharpoons cC(g) + dD(g)$$

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

$$K_p = \frac{[P_C]^c [P_D]^d}{[P_A]^a [P_B]^b} \quad ; \quad K_x = \frac{[X_C]^c [X_D]^d}{[X_A]^a [X_B]^b}$$

Now by Dalton's law, $P_A = X_A P_{Total}$

$$\Rightarrow \quad K_p = \frac{[X_C]^c [X_D]^d}{[X_A]^a [X_B]^b} (P_{Total})^{(c+d)-(a+b)}$$

$$\Rightarrow \quad \boxed{K_p = K_x (P_{Total})^{\Delta n_g}}$$

☆

Now by Ideal gas eqⁿ, $PV = nRT$

$$\Rightarrow \quad P = \left(\frac{n}{V}\right) RT \quad (1)$$

$$\Rightarrow \quad P = [conc] RT$$

$$\Rightarrow \quad K_p = \frac{[C]^c [D]^d}{[A]^a [B]^b} (RT)^{(c+d)-(a+b)}$$

$$\Rightarrow \quad \boxed{K_p = K_c (RT)^{\Delta n_g}}$$

C1: $K_p = K_c$, when $\Delta n_g = 0$.

Eg - $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

Both K_p & K_c dimensionless.

C2: $K_p > K_c$, when $\Delta n_g > 0$ $\{RT > 1\}$

Eg - $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

C3: $K_p < K_c$, when $\Delta n_g < 0$ $\{RT > 1\}$

Eg - $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

☆ C4: $K_p = K_c$, $\forall \Delta n_g$ if $\boxed{T = \frac{1}{R}}$

Q) A mix. of SO_3, SO_2 & O_2 gases is maintained at eq. in 10L flask at temp. at which K_c for rxn $2SO_2 + O_2 \rightleftharpoons 2SO_3$ is 100 $mol^{-1}L$.

At eq, a) if #mol (SO_2) = #mol(SO_3), find #mol (O_2)
b) if #mol(SO_3) = 2 #mol(SO_2), find #mol(O_2)

A) a) $K_c = 100 = \frac{(n_{SO_3}/10)^2}{(n_{SO_2}/10)^2(n_{O_2}/10)} \Rightarrow n_{O_2} = 0.1$

b) $K_c = 100 = \frac{(n_{SO_3}/10)^2}{(n_{SO_2}/10)^2(n_{O_2}/10)} \Rightarrow n_{O_2} = 0.4$

☆Q) The eq. const. for $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$ at 100°C is 16. Initially equal moles of A_2 & B_2 are taken in 2L container. Find mole % of A_2 in eq. condⁿ?

A) Let 'n' mol be present initially.

$$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$$
$$(n) \quad (n) \quad (0)$$

☆ $\cancel{16 = \frac{(2n/2)^2}{(n/2)(n/2)}}$ ← wrong. Can't apply at initial condⁿ.

At. eq, $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$

$$(n-n') \quad (n-n') \quad (2n')$$

Now,

$$16 = \frac{(2n'/2)^2}{\left(\frac{n-n'}{2}\right)\left(\frac{n-n'}{2}\right)} = 4\left(\frac{n'}{n-n'}\right)^2$$

$$\Rightarrow \left(\frac{n'}{n-n'}\right) = 2 \Rightarrow n' = \frac{2n}{3}$$

At eq., $A_2 + B_2 \rightleftharpoons 2AB$
$(n/3) \quad (n/3) \quad\quad (4n/3)$

$$\begin{pmatrix}\text{Mole \%}\\ \text{of } A_2\end{pmatrix} = \left(\frac{n/3}{n/3 + n/3 + 4n/3}\right) \cdot 100\% \Rightarrow \boxed{\begin{pmatrix}\text{Mol \%}\\ \text{of A}\end{pmatrix} = 16.6\%}$$

Factors affecting K_{eq}

1) Mode of representation :-

Eg : $A(g) + B(g) \rightleftharpoons C(g) + D(g)$

$$K_c = \frac{[C][D]}{[A][B]}$$

$$C(g) + D(g) \rightleftharpoons A(g) + B(g)$$

$$K'_c = \frac{[A][B]}{[C][D]}$$

$$\Rightarrow \quad K'_c = \frac{1}{K_c}$$

2) Stoichiometry of rxn :-

If we multiply rxn by 'n'.

Eg: $nA(g) + nB(g) \rightleftharpoons nC(g) + nD(g)$

$$K''_c = \frac{[C]^n[D]^n}{[A]^n[B]^n} \Rightarrow K''_c = K_c^n$$

3) By addⁿ & subⁿ of rxⁿ :-

Eg: $NO_2(g) \rightleftharpoons NO(g) + \frac{1}{2}O_2$, $K_1 = \frac{[O_2]^{1/2}[NO]}{[NO_2]}$

$SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$, $K_2 = \frac{[SO_3]}{[O_2]^{1/2}[SO_2]}$

$NO_2 + SO_2 \rightleftharpoons NO + SO_3$, $K = \frac{[SO_3][NO]}{[NO_2][SO_2]}$

$\Rightarrow \quad K = K_1 K_2$

If we subtract rxⁿs, we get $K = \frac{K_1}{K_2}$

4) Effect of Temp :-

$$\boxed{\log(K_{eq}) = \frac{\Delta S}{2.303R} - \frac{\Delta H}{2.303RT}}$$

ΔS = Change in Entropy $\quad \Delta H$ = Change in Enthalpy

$$\Rightarrow \boxed{\log\left(\frac{K_2}{K_1}\right) = \left(\frac{\Delta H}{2.303R}\right)\left[\frac{1}{T_1} - \frac{1}{T_2}\right]}$$

(Don't Read!)

C1: $\Delta H < 0 \Leftrightarrow$ Exothermic

- If $\boxed{T_2 > T_1}$ (Temp ↑) $\Rightarrow$ $K_1 > K_2$ (K_{eq} dec.)

  $\Rightarrow$ Rx^n shifts in back dirx^n.

  $\Rightarrow$ $\boxed{\text{Rx}^n \text{ shifts towards Endothermic.}}$

- If $\boxed{T_1 > T_2}$ (Temp ↓) $\Rightarrow$ $K_2 > K_1$ (K_{eq}. inc.)

  $\Rightarrow$ Rx^n shifts frwd dirx^n

  $\Rightarrow$ $\boxed{\text{Rx}^n \text{ shifts towards Exothermic}}$

C2: $\Delta H > 0 \Leftrightarrow$ Endothermic.

- If $\boxed{T_2 > T_1}$ (Temp ↑) $\Rightarrow$ $K_2 > K_1$ (K_{eq} inc.)

  $\Rightarrow$ $\boxed{\text{Rx}^n \text{ shifts towards Endothermic}}$

- If $\boxed{T_1 > T_2}$ (Temp ↓) $\Rightarrow$ $K_1 > K_2$ (K_{eq} dec.)

  $\Rightarrow$ $\boxed{\text{Rx}^n \text{ shifts towards Exothermic}}$

☆ In general, in any rx^n

Temp. ↑ ⇒ Rx^n towards **Endo**.

Temp. ↓ ⇒ Rx^n towards **Exo**.

Q) $A \rightleftharpoons 2B + C$, $K_1 = 16$

$D \rightleftharpoons \frac{C}{2} + E$, $K_2 = 9$

Find Keq for, $\frac{1}{2}A + E \rightleftharpoons B + D$.

A) $\left(\frac{A}{2} \rightleftharpoons B + \frac{C}{2}\right) - \left(D \rightleftharpoons \frac{C}{2} + E\right)$

$\Rightarrow \quad K_{eq} = \left(\frac{16}{9}\right)^{1/2} \Rightarrow \boxed{K_{eq} = \frac{4}{9}}$

Rx^n Quotient (Q)

$aA(g) + bB(g) \rightleftharpoons cC(g) + dD(g)$

$\binom{rx^n}{\text{quotient}} \rightsquigarrow Q = \dfrac{[C]^c[D]^d}{[A]^a[B]^b}$

at any pt. of time.

C1: $Q > K_{eq} \Rightarrow$ Rx^n shifts backword

C2: $Q < K_{eq} \Rightarrow$ Rx^n shifts fwd

C3: $Q = K_{eq} \Rightarrow$ Rx^n at eq.

Q) $A(g) + B(g) \rightleftharpoons C(g) + D(g)$, $K_c = \frac{1}{4}$

Init. mol. of A, B, C, D are 1 each and vol. of container is 1 L. find —

1) dirxn of rxn

2) # mol. of each at eq.

A) 1) $Q = \dfrac{(1)(1)}{(1)(1)} = 1 > \dfrac{1}{4} = K_c \Rightarrow$ Backwrd

2)

	A	+	B	$\rightleftharpoons$	C	+	D
R:	A	+	B	$\rightleftharpoons$	C	+	D
I:	1		1		1		1
E:	1+x		1+x		1−x		1−x
C:	1+x		1+x		1−x		1−x

$K_c = \dfrac{(1-x)(1-x)}{(1+x)(1+x)} = \dfrac{1}{4} \Rightarrow \left(\dfrac{1-x}{1+x}\right) = \dfrac{1}{2} \Rightarrow x = 1/3$

Degree of Dissociation (α)

No. of moles dissociated out of 1 mol of a species.

Eg:

Init. mol	Mol. diss.	D.O.D.
1	a	a
2	a	a/2
a	α	α/a
☆ a	$a\alpha$	α

Q) $$2A\ (g) \rightleftharpoons 3B\ (g) + C\ (g)$$

Init. mol. of A = 3. DOD (A) = α.

Calc. total no. of moles at eq.

A)

R:	$2A$ $\rightleftharpoons$	$3B$ +	C
I:	3	0	0
E:	$3(1-\alpha)$	$\left(\frac{9\alpha}{2}\right)$	$\left(\frac{3\alpha}{2}\right)$

$$\boxed{\left(\begin{matrix}\text{Total mol.}\\ \text{at eq.}\end{matrix}\right) = 3\alpha + 3}$$

☆Q) Similarly for $2A\,(g) + 3B(g) \rightleftharpoons 4C\,(g) + 5D\,(g)$

Init mol (A, B) = (3, 2) D.O.D. (A) = 0.3

A) ☆ (Assume new variable to red. calc.)

R:	$2A$	$+$	$3B \rightleftharpoons$	$4C$	$+ 5D$
I:	3		2	0	0
E:	$3-2y$		$2-3y$	$4y$	$5y$

(Total mol. at eq.) $= 4y+5$

Now, $2y = 3(0.3)$

$\Rightarrow \boxed{R_{eq} = 23}$

$\Rightarrow \boxed{y = 0.45}$

Application of Chem Eq. (Don't learn)

C1: $\Delta n_g = 0$

Q) 'a' mol of HI are taken in a container of vol 'V'. If DoD of HI is α, and total pressure at eq. is P, find K_c & K_p in terms a, V, P, α.

$$2HI \rightleftharpoons H_2 + I_2$$

(g)

A)

R:	$2HI \rightleftharpoons$	H_2	$+ I_2$	Total	
I:	a	0	0	a	Same
E:	$a(1-\alpha)$	$a\alpha/2$	$a\alpha/2$	a	
C:	$a\left(\frac{1-\alpha}{V}\right)$	$\left(\frac{a\alpha}{2V}\right)$	$\left(\frac{a\alpha}{2V}\right)$		

Since $\Delta n_g = 0 \Rightarrow \boxed{K_p = K_c}$

$$K_c = \frac{(a\alpha/2V)(a\alpha/2V)}{\left(\frac{a(1-\alpha)}{V}\right)^2} \Rightarrow \boxed{K_c = \left(\frac{\alpha}{2(1-\alpha)}\right)^2}$$

Const.

- If $\alpha << 1 \Rightarrow (1-\alpha) \approx 1$
- Since DoD independent of init. mol. & vol. taken, assume them to be 1

C2: $\Delta n_g > 0$

Q) 'a' mol PCl_5 taken in container of vol. V. If DoD of PCl_5 is α and total pressure at eq. is P, find K_c, K_p in terms of a, V, P, α.

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

A)

R:	$PCl_5 \rightleftharpoons$	PCl_3 +	Cl_2	Total
I:	a	0	0	a
E:	$a(1-\alpha)$	$a\alpha$	$a\alpha$	$a + a\alpha$
C:	$a\left(\frac{1-\alpha}{V}\right)$	$\left(\frac{a\alpha}{V}\right)$	$\left(\frac{a\alpha}{V}\right)$	

Diff

$$K_c = \frac{(a\alpha/V)(a\alpha/V)}{a\left(\frac{1-\alpha}{V}\right)} \Rightarrow \boxed{K_c = \frac{a\alpha^2}{V(1-\alpha)}}$$

Const.

- If $\alpha << 1 \Rightarrow (1-\alpha) \approx 1$
- $\alpha \propto \sqrt{V}$ if $\Delta n_g = 1$
- $\alpha \propto \frac{1}{\sqrt{P}}$ if $\Delta n_g = 1$

C3: $\Delta n_g < 0$

- If $\alpha << 1 \Rightarrow (1-\alpha) \approx 1$
- $\alpha \propto \frac{1}{\sqrt{V}}$ if $\Delta n_g = (-1)$
- $\alpha \propto \sqrt{P}$ if $\Delta n_g = (-1)$

Eg: $\frac{1}{2}N_2 + \frac{3H_2}{2} \rightleftharpoons NH_3$

16|9|22

Q) $NH_3(g)$ at 15 atm is intro. in rigid vessel at 300 K. At eq., total prsre of vessel is 40.11 atm. at 300°C. ~~The~~ find DoD of NH_3.

A) Rx^n: $2NH_3 \rightleftharpoons N_2 + 3H_2$

	$2NH_3$	N_2	$3H_2$	Total
Init:	n	0	0	n
Eq:	$n(1-\alpha)$	$\frac{n\alpha}{2}$	$\frac{3n\alpha}{2}$	$n+n\alpha$

By $PV = nRT$, $\quad n = \dfrac{(15)}{(300)}\left(\dfrac{V}{R}\right)$

$$n(1+\alpha) = \left(\frac{40.11}{573}\right)\left(\frac{V}{R}\right)$$

$$\Rightarrow \quad (1+\alpha) = \left(\frac{40.11}{573}\right)\left(\frac{300}{15}\right) = \frac{802.2}{573}$$

$$\Rightarrow \quad \boxed{\alpha = 0.4}$$

Q) ☆ At 400K, $\quad NH_4I(s) \rightleftharpoons NH_3(g) + HI(g)$

$K_p = 16$ atm. $\quad$ Under catalyst,

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

If partial prsre of H_2 at this temp. is 1 atm, when both eq. exist simultaneously. Calc. Kp of second rxn.

A)

Initial	$\xrightarrow[\text{rx}^n]{\text{1st}}$	$\xrightarrow[\text{rx}^n]{\text{2nd}}$
0 (NH_3)	P (NH_3)	P (NH_3)
0 (HI)	P (HI)	$P - P_0$ (HI)
0 (H_2)	0 (H_2)	$P_0/2$ (H_2)
0 (I_2)	0 (I_2)	$P_0/2$ (I_2)

Final Composition.

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for 1st rx^n : $P(P-P_0) = 16 \Rightarrow \boxed{P = 5.1}$

We know, $P_0/2 = 1$ (for H_2) $\Rightarrow \boxed{P_0 = 2}$

for 2nd rx^n : $K_p = \frac{(P_0/2)^2}{(P-P_0)^2} = \frac{1}{(5.1-2)^2}$

$\Rightarrow \boxed{K_p = 0.1}$

Le Chatlier's Principle —

If system in eq and subjected to external change (like conc., P, V, ...) then system will oppose it, and rx^n will shift so as to nullify the external effect.

1) Effect of Conc :

$$A(g) \rightleftharpoons B(g)$$

If $\boxed{\text{conc. A} \downarrow \text{(or} \uparrow)}$ $\Rightarrow$ conc. B $\downarrow$ (or $\uparrow$)

So as to $\uparrow$ (or $\downarrow$) conc. of A.

$\Rightarrow$ $\boxed{Rx^n \text{ shift backword (or frwd).}}$

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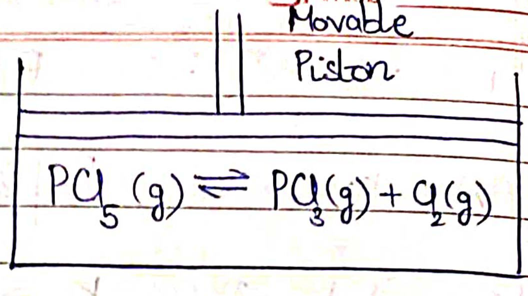
2) Effect of Prsre :



If $\boxed{P \uparrow \ (\text{or } \downarrow)}$ $\Rightarrow$ (Total gaseous moles) $\downarrow$ (or $\uparrow$)

so as to $\downarrow$ (or $\uparrow$) P.

$\Rightarrow$ $\boxed{\text{Rxn shifts to reduce (or inc.) no. of gaseous mols.}}$

☆ If $\Delta n_g = 0$, then no effect of P on shifting $_{rxn}$.

3) Effect of Vol. :

Vol. bada diya $\Rightarrow$ Prsre ghata diya.

- Vol. ghata diya $\Rightarrow$ Prsre bada diya.

Hence, $\boxed{V \uparrow \ (\text{or } \downarrow) \Rightarrow \left(\text{Total no. of gas mol.}\right) \uparrow \ (\text{or } \downarrow)}$

4) Add^n of Inert gas :

Case 1 : $\boxed{\text{At const. Vol.}}$

Since no. of mol. of react. & prod same
$\Rightarrow$ their Conc. same $\Rightarrow$ K_c, K_p, K_x same.

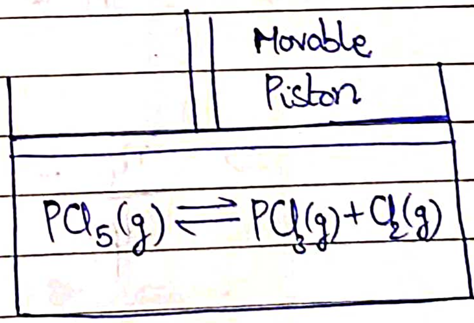
$\Rightarrow$ $\boxed{\text{No Change}}$

Case 2 : $\boxed{\text{At const. Prsre}}$ & $\boxed{\text{Const. Vol.}}$

Inert gas added $\Rightarrow$ Gaseous mol $\uparrow$

$\Rightarrow$ $\boxed{\text{Rx}^n \text{ shifts to } \downarrow \text{ no. of gas mol.}}$

Case 3 : $\boxed{\text{At. const. Prsre}}$



Inert gas added $\Rightarrow$ Prsre $\uparrow$ $\Rightarrow$ Vol $\uparrow$ to nullify effect

$\Rightarrow$ $\boxed{\text{Rx}^n \text{ shifts to } \uparrow \text{ no. of gas mol.}}$

☆ If we add solid, then NO EFFECT.

Vapor Density — (formula valid only if 1 species with stoich. coeff = 1)

R:	$A(g)$	$\rightleftharpoons$	$n\,B(g)$
I:	a		0
E:	$a(1-\alpha)$		$na\alpha$

Initally, only A present. $\Rightarrow \begin{pmatrix}\text{V.D.}\\ \text{of A}\end{pmatrix} = D$ Theoretical

At Eq., both A & B present $\Rightarrow \begin{pmatrix}\text{V.D.}\\ \text{of mix.}\end{pmatrix} = d$ Observed

For any pt. in rxn, mass consrv.

$$\therefore\ n = \frac{W}{M} \text{ Const.} \Rightarrow n \propto \frac{1}{M}$$

$$\Rightarrow \frac{n_i}{n_f} = \frac{M_f}{M_i} = \frac{d}{D} \Rightarrow \frac{a}{a+(n-1)a\alpha} = \frac{d}{D}$$

$$\Rightarrow \boxed{\alpha = \frac{D-d}{(n-1)d}}$$

Physical Eq. —

Eg: $H_2O(g) \rightleftharpoons H_2O(l)$; $\Delta H < 0$

Favorable Condts for frwd rx^n : Temp. ↓ Prsre ↑

Eg: $H_2O(s) \rightleftharpoons H_2O(l)$; $\Delta H > 0$

Favorable Condts for frwd rx^n : Temp. ↑ Prsre ↑

(as Vol : water < Ice
prsre ↑ ⇒ vol. ↓)

Eg: Graphite (s) $\rightleftharpoons$ Diamond (s) ; $\Delta H > 0$

Favorable Condts for frwd rx^n : Temp. ↑ Prsre ↑

(as Vol. : Diamond < Graphite
prsre ↑ ⇒ vol. ↓)

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Imp. Pts —

1) In simultaneous eq., apply all formula using final values. (See Pg 376)