

# CHEMICAL EQUILIBRIUM



## EQUILIBRIUM CONSTANT 'K'

For a General Reaction  $aA + bB \rightleftharpoons pP + qQ$

The **equilibrium constant** expression is  $K_c = \frac{[P]^p [Q]^q}{[A]^a [B]^b}$  where  $K_c$  is the **Equilibrium Constant** (or  $K_p$  if they are all gases)

## RELATION BETWEEN $K_p$ AND $K_c$

For the Reaction  $aA + bB \rightleftharpoons cC + dD$

$$K_p = \frac{[p_C]^c \times [p_D]^d}{[p_A]^a \times [p_B]^b} = \frac{[C]^c [D]^d}{[A]^a [B]^b} \frac{(RT)^{c+d}}{(RT)^{a+b}}$$

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

$$\text{if } \Delta n_g = 0 \Rightarrow K_p = K_c$$

Where,  $\Delta n_g = (c+d) - (a+b)$

= no. of moles of gaseous products - no. of moles of gaseous Reactants

## WHAT DOES THE VALUE OF 'K' MEAN ?

(a)  $K \gg 1$

Reactants



Products

If  $K \gg 1$ , the reaction is product-favoured; product predominates at **Equilibrium**.

(a)  $K \ll 1$

Reactants



Products

If  $K \ll 1$ , the reaction is reactant-favoured; reactant predominates at **Equilibrium**.

(a)  $K = 1$

The **reaction lies** in the middle (mix of reactants and products)

## MAGNITUDE OF 'K'

Small ( $K < 10^{-3}$ )



Mostly Reactants

Intermediate ( $10^{-3} \leq K \leq 10^3$ )



Significant amounts of reactants and products

Large ( $K > 10^3$ )



Mostly Products

# It's Le Chatelier's Principle



If a dynamic equilibrium is disturbed by changing the conditions, the position of equilibrium moves to counteract the change.



i will destroy your equilibrium

i will re-establish it



Reactants

Products

Change



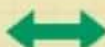
Counteract

I will increase reactant concentration



Then I will shift the reaction forward

I will steal products



I will shift the reaction forward

I will increase pressure



I will reduce number of moles

I will decrease pressure



Then I'll increase number of moles

I will heat up your exothermic reaction



I'll shift the reaction backward

I will put your endothermic reaction in ice



I'll warm it up by forward reaction

I will catalyze your reaction



Hahaha.... It won't disturb my equilibrium

I will add noble gases to your reaction



Hahaha.... It won't disturb my equilibrium

How did you bypass my tricks ?



It's Le Chatelier's principle dear !