CHEMISTRY-I

CHEMICAL EQUILIBRIUM AND ACIDS - BASES

Very Short Answer Type Questions

1. **State law of Chemical Equilibrium.**

Ans.

At a given temperature, the product of concentration of the reaction product **raised to the respective stiochiometric coefficients in the balanced chemical equation** divided by the product of concentrations of the reactants **raised to their individual stochiometric coefficients** has a constant value. This is known as the Equilibrium Law (or) Law of Chemical Equilibrium.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

$$K_C = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

2) What is Homogenous Equilibrium? Write two Homogeneous reactions?

Ans.

The Equilibrium in which all the substances are present in the same phase is known as Homogeneous Equilibrium.

Eg: 1. $N_{2(g)} + 3\,H_{2(g)} \rightleftharpoons 2N_{3(g)}$

2. $CH_3COOH_{(l)} + C_2H_5OH_{(l)} \rightleftharpoons CH_3COOC_2H_{5(l)} + H_2O_{(l)}$

3) What is Heterogeneous Equilibrium? Write two Heterogeneous reactions?

Ans.

The Equilibrium in which the substances are present in different phases is called Heterogonous Equilibrium

Ex: 1. $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + Co_{2(g)}$

2. $H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$

4) Define the Equilibrium Constant?

Ans.

The ratio of product of molar concentration of products to the product of molar concentration of reactants at a given temperature is called Equilibrium Constant.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

$$K_C = \frac{[NH_3]^2}{[H_2][H_2]^3}$$

5) Write the relation between K_P and K_C ?

Ans.

$K_P = K_C(RT)^{\Delta n}$

Δn = [Number of moles of gaseous products - Number of moles of gaseous reactants]

6) Can Catalyst disturb the state of Equilibrium?

Ans.

No, **but equilibrium is attained quickly** because the Catalyst increases both the rate of forward and backward reactions.

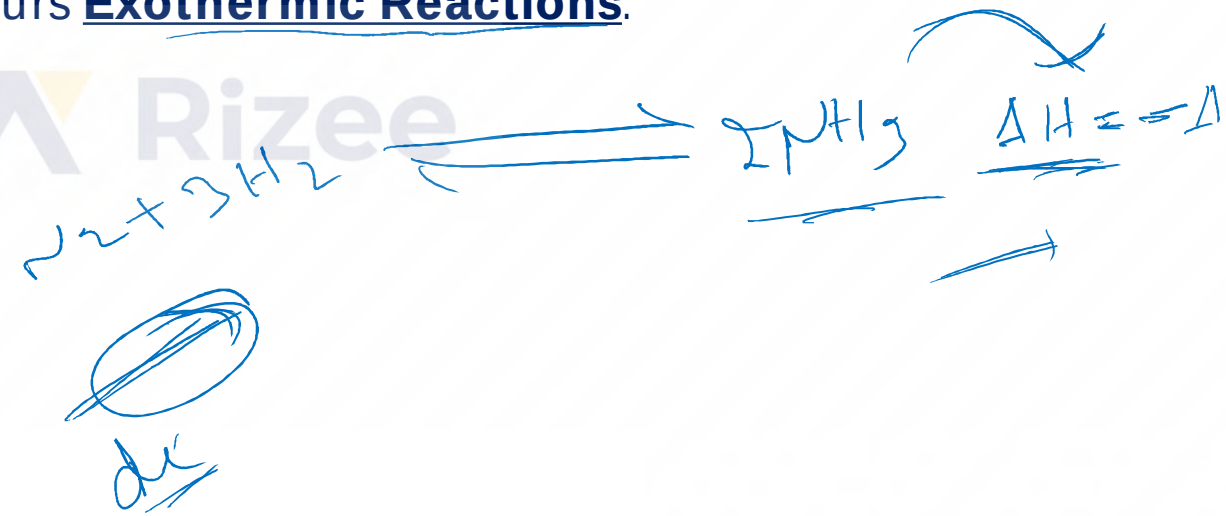
$$N_2 + 3H_2 \underset{}{\overset{Fe}{\rightleftharpoons}} 2NH_3$$

7) What is the effect of temperature on a system at Equilibrium?

Ans.

Increase in temperature favours **Endothermic Reactions**.

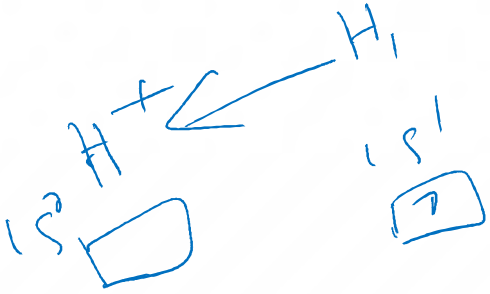
Decrease in temperature favours **Exothermic Reactions**.



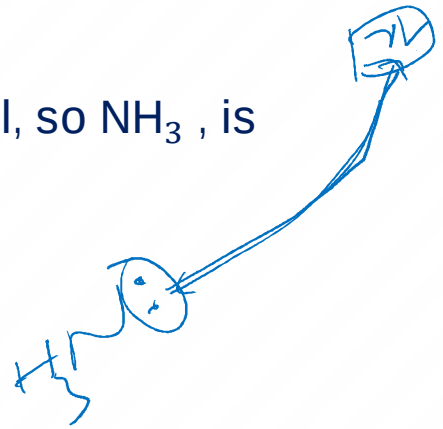
8) What is a Bronsted Base? Give One Example.

Ans.

Proton acceptor is called "Bronsted Base"



$$NH_3 + HCl \rightleftharpoons \overset{\oplus}{N}H_4 + Cl^{\ominus}$$



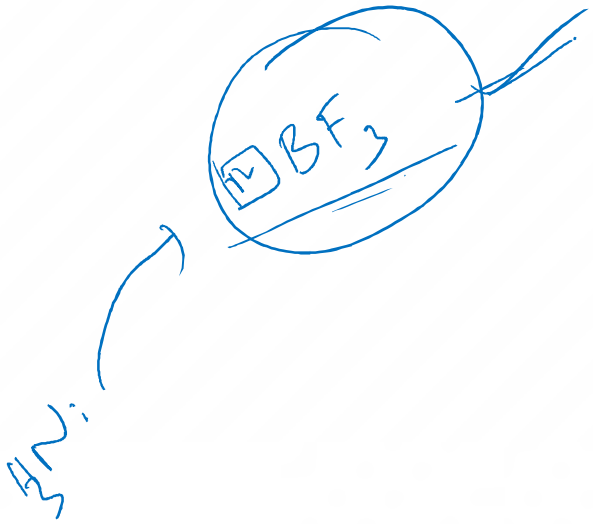
In the above reaction, NH_3 accepts a proton H^+ from HCl, so NH_3 , is a Bronsted Base.

9) What is Lewis acid? Give an example.

Ans.

Lewis acid is the **substance which can accept a pair of electrons**.

Ex: BF_3.



10) All Bronsted bases are Lewis bases. Explain?

Ans.

Bronsted base is a proton acceptor, Lewis base is an electron pair donor. In order to accept a proton by bronsted base, it must be donate an electron pair. Hence, All Bronsted bases are Lewis bases.

Ex: $H_3N: + H^+ \rightarrow [H_3N \rightarrow H]^+$

11) All Lewis acids are not Bronsted acids. Why?

Ans.

Substances **which accept electron pair** are **Lewis acids**.

Ex: BF_3 can accept pair of electrons. Hence, it is an Lewis acid.

Substances which can donate proton are Bronsted ~~Base~~ acid.

Ex: HCl.

Though BF_3 is an Lewis acid, it does not have a proton & it cant donate proton. So it is not a Bronsted Base. Hence, all Lewis acids are not Bronsted acids

12) Ice melts slowly at high attitudes. Explain why?

Ans.

Ice has more volume than water. When pressure is increased Ice converts into water. When at low Pressure ice melts slowly. Since, at high attitudes pressure is low, Ice melts slowly

Short Answer Type Questions

1. **Derive the relation between K_p and K_C for the equilibrium reaction.** $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

Ans:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

$$K_C = \frac{[NH_3]^2}{[N_2][H_2]^3}, \quad K_P = \frac{P_{NH_3}^2}{P_{N_2} \times P_{H_2}^3} \text{ --------equation 1}$$

$$PV = nRT \Longrightarrow P = \frac{n}{V}RT$$

$$\Longrightarrow P = cRT \quad (\because {}^{n}/_{v} = con = C)$$

$$\therefore P_{NH_3} = [NH_3]RT$$

$P_{N_2} = [N_2]RT$

$P_{H_2} = [H_2]RT$ substitute these values in equation $--1$

$K_P = \frac{\{[NH_3]RT\}^2}{\{[N_2RT\}\{[H_2]RT\}^3}$ separate the RT values

$K_P = \frac{[NH_3]^2}{[N_2][H_2]^3}(RT)^{2-4} = K_C(RT)^{-2}$

$K_P = K_C(RT)^{-2}$

$K_P = \frac{K_C}{(RT)^2}$

$K_P\,(RT)^2 = K_C$

$\therefore K_C > K_P$ or $K_P < K_C$

2) Explain the Arrhenius concept of acids and bases. Ans.

1. In aqueous solution,

the substances which can give hydrogen ions ($H^+_{(aq)}$) are called acids and the substances which can give hydroxyl ions ($OH^-_{(aq)}$) are called bases.

$HX_{(aq)} \rightleftharpoons H^+_{(aq)} + X^-_{(aq)}$

$MOH_{(aq)} \rightleftharpoons M^+_{(aq)} + OH^-_{(aq)}$

CHEMICAL EQUILIBRIUM AND ACIDS - BASES

2. Acids such as HCl, HNO_3 undergo almost **complete ionization**.

These are **strong acids.**

Acids such as acetic acid (CH_3COOH) undergoes **partial ionization**.

Hence it is a **weak acid.**

In the same manner bases which undergo **complete ionization are**

strong bases

the ones which undergo **partial ionization are weak bases**.

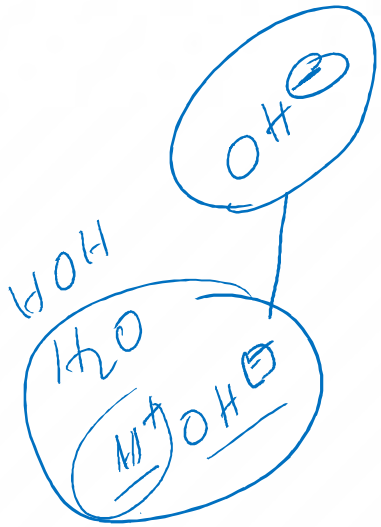
3. According to this theory **neutralization reaction is formation of water** by the combination of H^+, OH^- ions.

$$H^+_{(l)} + OH^-_{(l)} \rightleftharpoons H_2O_{(l)}$$

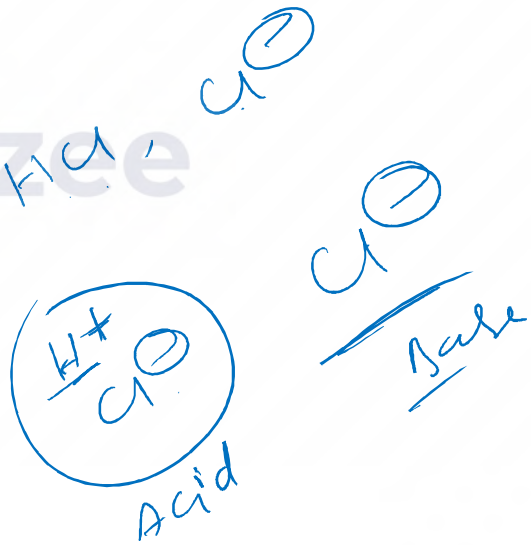
3) What is the conjugate acid base pair? Illustrate with an examples.

Ans.

A pair of substances, that differ by 'a Proton' is called as Conjugate acid base pair.



Ex 1. $HCl \underset{+H^+}{\overset{-H^+}{\rightleftharpoons}} Cl^-$



2. $CH_3 - COOH \underset{+H^+}{\overset{-H^+}{\rightleftharpoons}} CH_3COO^-$

4) The Species H_2O, HCO_3^- , HCO_4^- and HH_2 can act both as Bronsted acids and bases. Give the corresponding conjugate acid and base for each of them.

Ans:

(a) H_3O^+ – H_2O – OH^-

Conjugate acid Conjugate base

(b) H_2CO_3 – HCO_3^- – CO_3^{-2}

Conjugate acid Conjugate base

(c) H_2SO_4 – $HSO4^-$ – SO_4^{-2}

Conjugate acid Conjugate base

(d) HCO_4^+ – NH_3 – NH_2^-

Conjugate acid Conjugate acid

5) Write the Conjugate acid and Conjugate base of each of following:

(a) OH^- **(b)** H_2O **(C)** HCO_3^- **(d)** H_2O_2

Ans:

(a) H_2O – OH^- – O_2^-

Conjugate acid conjugate base

(b) H_3O^+ – H_2O – OH^-

Conjugate acid conjugate base

(c) H_2CO_3 – HCO_3^- – CO_3^{-2}

Conjugate acid conjugate base

(d) $H_3O_2^+$ – H_2O_2 – HO_2^-

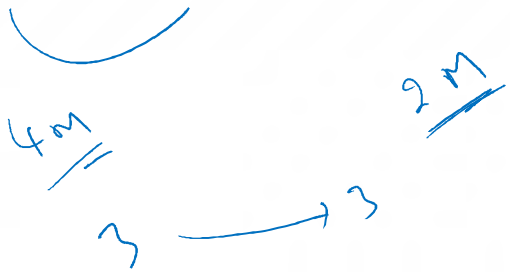
Conjugate acid Conjugate base

6) Discuss the Application of Lechatlier's Principle for the Industrial Synthesis of Ammonia.

Ans.

Lechatlien's Principle: When a system at Equilibrium is subjected to stress (like change in pressure, temperature and concentration) the equilibrium position shifts in the directions where the stress is reduced (or) nullified. Applying Lechatlien's principle to synthesis of NH_3 by Haber's Process:

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH3 \ (\Delta H = -92kJ)$



1) Effect of Concentration: According to Lechatlier's Principle increase in the **concentration of N_2 and H_2 favours** the forward reaction there by increases the formation of NH_3 .

2) Effect of Temperature: Formation of NH_3 is a **Exothermic Reaction**. According to Lechatlier's principle **low temperature favours** the forward reaction. But at low temperature reaction is very slow. Hence **optimum temperature 725k - 775k** is used in Haber's Process.

3) Effect of Pressure: The formation of ammonia is accompanied with decrease in number of moles (4→2). So, **high pressure** is required for the better yield of ammonia. Hence **200 atm pressure** is used in Haber's Process

Optimum Condition:

Pressure : 200 atm

Temperature : 725K – 775K

Catalyst : Iron (Fe)

Promoter : Mo

7) Discuss the application of Lechatlier's principle for the industrial synthesis of sulphur trioxide.

Ans :

Lechatlien's Principle: When a system at equilibrium is subjected to stress (like change of pressure, temperature and concentration) the equilibrium position shifts in the direction where the stress is reduced (or) nullified.

Properties of SO_3

$2\,SO_{2(g)} + O_{2(g)} \rightleftharpoons 2\,SO_{3(g)}$ $(\Delta H = -189kJ)$

CHEMICAL EQUILIBRIUM AND ACIDS - BASES

1) Effect of Concentration: According to Lechatlien's Principle increase in the concentration of reactants favours the forward reaction. Hence **high concentration of SO_2 and O_2** are required for **better yield of SO_3.**

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2) Effect of Temperature: Formation of SO_3 is a Exothermic Reaction. According to Lechatlien's Principle low temperature favours the forward reaction. Hence, **Temperature 673k** is used.

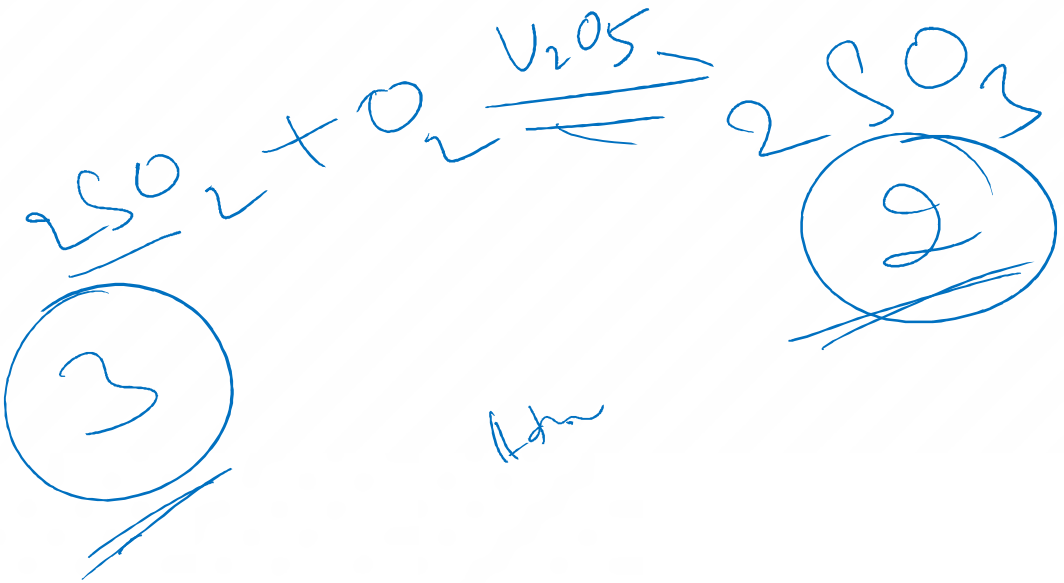
3) Effect of Pressure: The formation of SO_3 is accompanied with decrease in number of moles (3 → 2). So, high pressure is required for the better yield of SO_3 . Hence, to get better yield of SO_3 **2 atm pressure** is used.

Optimum Condition:

Temperature : 675k

Pressure : 2 atm

Catalyst : V_2O_5



THANK YOU