CHAPTER NO.10

ACIDS, BASES AND SALTS

Q.1: What is the origin of Acid? Give examples of acids, bases and salts substances in our daily life?

Ans: Origin of Acid:

The term acid is derived from Latin word "Acidus" which means sour. So acids are those substances having sour taste.

Some important acids in our daily life:

Many important acidic substances which we use in our daily life are as under:

i. **Acetic Acid:** It is found in vinegar.
ii. **Lactic Acid:** It is found in fermented milk.
iii. **Malic Acid:** It is found in apple.
iv. **Citric Acid:** It is found in citrus fruits like lemon, orange, grapes etc.
v. **Hydrochloric Acid:** It is found in our stomach which helps in the digestion of food.
vi. **Formic Acid:** It is in sting of ants and bees.

Some important bases and salts in our daily life:

There are many bases and salts which we use in our daily life. For example:

i. **Washing Soda (Na_2CO_3 $10H_2O$):**
It is a salt and is used for washing purposes.

ii. **Baking Soda ($NaHCO_3$):**
It is also a salt and is used for baking of cakes and other confectionaries.

iii. **Sodium Hydroxide (NaOH):**
It is also called caustic soda which is used for the preparation of soap.

iv. **Magnesium Hydroxide($Mg(OH)_2$):**
It is used as antacid.

Q.2: Compare the physical properties of acids and bases?

Ans: Comparison between physical properties of acids and bases:

It is given in the table given below:

	Acid	Base
(i)	Acid solution has bitter taste.	Base solution has sour taste.
(ii)	Acid solution turns blue litmus paper to red.	Base solution turns red litmus paper to blue.
(iii)	Strong acids are very corrosive and damage skin and other organic substances.	Strong bases are also very corrosive but less corrosive as compared to strong acids.
(iv)	Acid solutions do not have soapy touch.	Base solutions have soapy touch.
(v)	Acids solutions conduct electric current.	Base solutions can also conduct electric current.

Q.3: Describe the different concepts of acids and bases?

Ans: Different concepts about acids and bases:

The different concepts about acids and bases are described below:

1. The Arrhenius concept(The classical concept):

Introduction:

The first concept about acids and bases was presented by a Swedish chemist, Arrhenius in 1884.

Definitions of acids and bases:

According to this concept acids and bases are defined as follows:

Acid:

"The compound which gives H^+ ions in water is called acid."

General Ionization Equation:

The general ionization equation for acid is given below:

$$HA_{(aq)} \longrightarrow H^+_{(aq)} + A^-_{(aq)}$$

Base:

"The compound which gives OH^- ions in water is called base."

General Ionization Equation:

The general ionization equation for a base is given below:

$$BOH_{(aq)} \longrightarrow B^+_{(aq)} + OH^-_{(aq)}$$

Examples of Arrhenius acids:

HCl, H_2SO_4, HNO_3, HBr, HI, CH_3COOH etc. are some of the examples of Arrhenius acids because when these are added to water, they ionize to give H^+ ions which react with water to form hydronium ions H_3O^+. The chemical equations for the ionization of some acids are as follows:

$$HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$$
$$H_2SO_{4\,(aq)} \longrightarrow 2H^+_{(aq)} + SO_4^{-2}{}_{(aq)}$$
$$HNO_{3\,(aq)} \longrightarrow H^+_{(aq)} + NO_3^-{}_{(aq)}$$

Note: That hydronium ion (H_3O^+) is formed by the reaction of H^+ with H_2O i.e.

$$H^+_{(aq)} + H_2O_{(l)} \longrightarrow H_3O^+_{(aq)}$$

Examples of Arrhenius bases:

NaOH, KOH, LiOH, $Ba(OH)_2$, NH_4OH, $Al(OH)_3$ etc. are the examples of Arrhenius bases because they give OH^- ions in water. The chemical equations for the ionization of some of the bases are given below:

$$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$$
$$KOH_{(aq)} \longrightarrow K^+_{(aq)} + OH^-_{(aq)}$$
$$LiOH_{(aq)} \longrightarrow Li^+_{(aq)} + OH^-_{(aq)}$$

Summary:

Acid gives H^+ ion while base gives OH^- ions in water.

Advantage:

- It shows the strength of Acids and bases.

Limitations Of Arrhenius Concept:

The limitations of Arrhenius concept are given below:

i. **Restriction To Aqueous Medium:**

This concept is only limited to aqueous medium and it does not explain the acidity and basicity of substances in non-aqueous medium.

ii. **Restriction To H^+ and OH^- Ions:**

In this concept acids are limited to H^+ while bases to OH^- ions only and it cannot explain the acidic nature of CO_2 and basic nature of NH_3.

2. The Bronsted-Lowry concept(The protonic concept):

Introduction:

This concept was presented by Danish chemist J.N Bronsted and English chemist T.M Lowry in 1923.

Definitions of acids and bases:

According to Bronsted-Lowry concept, **acids** are defined as the substances which donate protons (H^+ ions), while **bases** are defined as the substances which accept protons.

Examples:

i. When ammonia(NH_3) is added to water, the following reaction occurs:

$$\underset{\text{Proton donor}}{HCl_{(aq)}} + \underset{\text{Proton acceptor}}{NH_{3(aq)}} \longrightarrow NH_4^+{}_{(aq)} + Cl^-_{(aq)}$$

In the above example the ammonia accepts a proton from HCl, therefore, it acts as a base while HCl donates a proton and therefore it acts as an acid.

ii.

$$\underset{\text{Acid}}{HCl} + \underset{\text{Base}}{H_2O} \xrightarrow{} H_3O^+ + Cl^-$$

In the above example water accepts proton, therefore it acts as a base.

iii. $\underset{\text{Base}}{NH_{3(aq)}} + \underset{\text{acid}}{H_2O} \longrightarrow NH_4^+ + OH^-$

In the above example water donates proton, therefore here water acts as an acid. Thus water is amphoteric.

Summary:

Acid is proton (H^+) donor while base is proton acceptor.

Limitations Of Bronsted-Lowry Concept:

Some bases like NaOH, KOH etc. cannot be explained on the basis of this concept because these cannot accept protons.

3. The Lewis concept:

Introduction:

G.N Lewis presented his own concept of acids and bases in 1923.

Definitions of acids and bases:

According to this concept an **acid** is a species that can accept or tends to accept a pair of electrons while a **base** is a species which can donate or tends to donate a pair of electrons.

An acid is electrophile (electron loving) while a base is a nucleophile (nucleus loving).

Species which acts as Lewis acids:

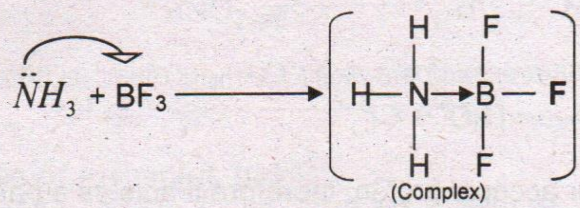
- ❖ Those compounds in which central atom has less than eight electrons in valance shell and positive ions act as Lewis acids i.e. they accept electron pair e.g. BF_3, $AlCl_3$, etc.
- ❖ All cations are act as lewis acids e.g. H^+, Ag^+

Species which acts as Lewis Bases:

- ❖ Those compounds which have lone pair of electrons in valance shell and negative ions, act as Lewis bases i.e. they donate electron pair e.g. NH_3, H_2O, etc.
- ❖ All anions act as lewis bases. e.g, CN^-, Cl^- etc.

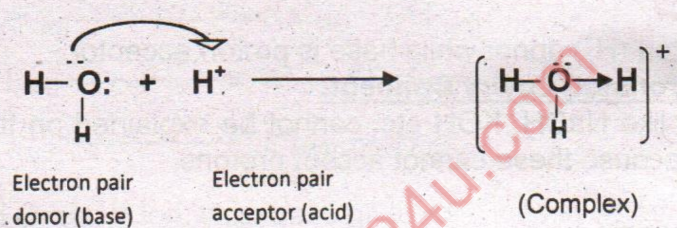
Examples:

i. Consider the following reaction:



In the above example NH_3 acts as a base (electron pair donor) while BF_3 acts as an lewis acid (electron pair acceptor).

ii.



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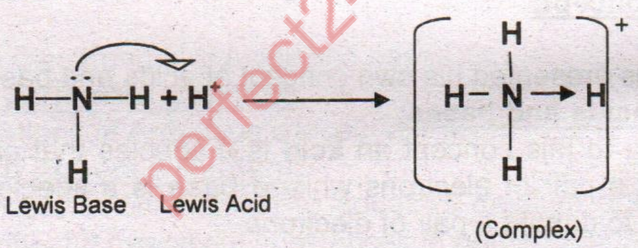

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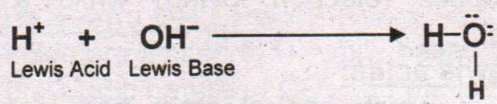

Q.4: Compare the definitions of acids-bases.

Ans: Comparison between acids-bases definitions:

It is given in the table given below:

Type Of Concept	Acid	Base
Arhenius	H^+ producer in water.	OH^- producer in water.
Bronsted-Lowry	Proton(H^+) donor	Proton(H^+) acceptor
Lewis	Electron pair acceptor	Electron pair donor

Q. What is meant by conjugate acid and base? Explain with examples.

Ans: **Conjugate acids:**

"The positively charged species formed by a base after taking a proton is called conjugate acid of the corresponding base because it can give a proton."

Examples:

i. $NH_{3(aq)} + H_2O \longrightarrow NH_4^+ + OH^-$

Base acid conjugate acid

In the above example NH_4^+ is the conjugate acid of NH_3.

It may be noted that a base and its conjugate acid differ from each other by one proton (H^+) e.g. NH_3 and NH_4^+, H_2O and H_3O^+ etc.

ii. $H_2O + HCl \longrightarrow H_3O^+ + Cl^-$

Base acid conjugate acid

Conjugate bases:

"The negatively charged species left after an acid donates proton is called conjugate base of that acid because it can accept a proton."

Examples:

i. When acetic acid gives a proton it forms acetate ion (CH_3COO^-). Acetate ion is the conjugate base of acetic acid because it can accept a proton.

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

Acid base conjugate base

ii. $HCl + H_2O \longrightarrow Cl^- + H_3O^+$

Acid base conjugate base

It may be noted that acid and its conjugate base differ by one proton e.g. HCl and Cl^-, HBr and Br^- etc.

Q.5: Describe the types of Acids?

Ans: **Types Of Acids:**

On the basis of number of protons that can be given by an acid per molecule in water, there are the following types of acids:

i. Mono-protic acids

ii. Poly-protic acids

i. Mono-protic acids:

"Those acids which give one proton per molecule are called mono-protic acids or mono-basic acids."

Examples:

HCl, HNO_3, CH_3COOH, HBr, HCN etc are some of the examples of mono-protic acids because they give only one proton per molecule. Their dissociation in water is as follows:

$$HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$$
$$HNO_{3\,(aq)} \longrightarrow H^+_{(aq)} + NO_3^-{}_{(aq)}$$
$$CH_3COOH_{(aq)} \longrightarrow H^+_{(aq)} + CH_3COO^-_{(aq)}$$
$$HBr_{(aq)} \longrightarrow H^+_{(aq)} + Br^-_{(aq)}$$
$$HCN_{(aq)} \longrightarrow H^+_{(aq)} + CN^-_{(aq)}$$

ii. Poly-protic acids:

"Those acids which give more than one protons per molecule are called poly-protic acids or poly-basic acids."

These are further divided into the following sub-groups:

i. Di-protic acids:

"Those acids which give two protons per molecule are called di-protic acids or di-basic acids."

Examples:

H_2SO_4, H_2CO_3 etc. are the examples of di-protic acids because they give two protons per molecule.

$$H_2SO_{4(aq)} \longrightarrow 2H^+_{(aq)} + SO_4^{-2}{}_{(aq)}$$
$$H_2CO_{3\,(aq)} \longrightarrow 2H^+_{(aq)} + CO_3^{-2}{}_{(aq)}$$

ii. Tri-protic acids:

"Those acids that give three protons per molecule are called tri-protic acids or tri-basic acids."

Example:

Phosphoric acid is an example of tri-protic acid as clear from the following chemical equation:

$$H_3PO_{4\,(aq)} \longrightarrow 3H^+_{(aq)} + PO_4^{-3}{}_{(aq)}$$

Q.6: Describe the types of Bases?

Ans: Types Of Bases:

On the basis of number of OH^- ions that can be given by an acid per molecule in water, there are the following types of bases:

i. Mono-acid bases

ii. Poly-acid bases

i. Mono-acid bases:

"Those bases which give one OH^- ion per molecule are called **mono-acid bases.**

Examples:

NaOH, KOH, LiOH, CsOH etc are some of the examples of mono-acid bases because they give only one OH^- ion per molecule. Their dissociation in water is as follows:

$$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$$
$$KOH_{(aq)} \longrightarrow K^+_{(aq)} + OH^-_{(aq)}$$
$$LiOH_{(aq)} \longrightarrow Li^+_{(aq)} + OH^-_{(aq)}$$

ii. Poly-acid Bases:

"Those bases which give more than one OH^- ions per molecule are called poly-acid bases".

These are further divided into the following sub-groups:

iii. Di-acid Bases:

"Those Bases which give two OH^- ions per molecule are called di-acid bases"

Examples:

$Mg(OH)_2$, $Be(OH)_2$ etc. are the examples of di-acid bases because they give two OH^- ions per molecule:

$$Mg(OH)_{2(aq)} \longrightarrow Mg^{+2}_{(aq)} + 2OH^-_{(aq)}$$
$$Be(OH)_{2\,(aq)} \longrightarrow Be^{+2}_{(aq)} + 2OH^-_{(aq)}$$

iv. Tri-acid bases:

"Those bases that give three OH^- ions per molecule are called tri-acid bases."

Example:

$Al(OH)_3$, $Fe(OH)_3$etc are the examples of tri-acid bases as clear from the following chemical equations:

$$Al(OH)_{3\,(aq)} \longrightarrow Al^{+3}_{(aq)} + 3OH^-_{(aq)}$$
$$Fe(OH)_{3\,(aq)} \longrightarrow Fe^{+3}_{(aq)} + 3OH^-_{(aq)}$$

***Q. What are amphoteric substances?**

Ans: Amphoteric substances:

"Those substances which can act both as an acids and a base are called amphoteric substances."

Examples:

i. Water is amphoteric because it acts as a base with an acid while it acts as an acid with a base

$$\underset{\text{Acid}}{HCl} + \underset{\text{Base}}{H{-}OH} \longrightarrow \underset{\text{Conjugate Acid}}{H_3O^+} + \underset{\text{Conjugate base}}{Cl^-}$$

$$\underset{\text{Base}}{NH_3} + \underset{\text{Acid}}{H_2O} \longrightarrow \underset{\text{Conjugate Acid}}{NH_4^+} + \underset{\text{Conjugate base}}{OH^-}$$

ii. During self-ionization of water some water molecules acts as an acid while some acts as a base:

$$\underset{\text{Acid}}{H_2O} + \underset{\text{Base}}{H_2O} \longrightarrow \underset{\text{Conjugate acid}}{H_3O^+} + \underset{\text{Conjugate base}}{OH^-}$$

Q.7: What are strong and weak acids? OR
Describe the strength of Acids?

Ans: Strong acids:

"Those acids which almost completely ionize in aqueous solutions and give higher concentration of H^+ ions are called **strong acids**."

The solutions of strong acids contain ions and almost no unionized molecules are left.

Examples:

Hydrochloric acid is a strong acid because it almost completely ionize in water.

$$HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$$

Some other strong acids are given below:

	Strong Acid	Chemical Formula
(i)	Perchloric acid	$HClO_4$
(ii)	Nitric Acid	HNO_3
(iii)	Sulphuric Acid	H_2SO_4
(iv)	Hydroiodic acid	HI

Weak acids:

"Those acids which partially ionize in water are called **weak acids**." The solutions of weak acids, in addition to ions, also contain unionized molecules.

Examples:

When acetic acid is added to water, very few molecules are ionized, therefore acetic acid is a weak acid.

$$CH_3COOH(aq) \rightleftharpoons H^+_{(aq)} + CH_3COO^-_{(aq)}$$

Some other weak acids are given below:

	Weak Acid	Chemical Formula
(i)	Phosphoric acid	H_3PO_4
(ii)	Nitrous Acid	HNO_2
(iii)	Sulphurous Acid	H_2SO_3
(iv)	Carbonic acid	H_2CO_3
(v)	Propanoic acid	C_2H_5COOH

Q.8: What are strong and weak bases? OR
Describe the strength of bases?

Ans: Strong bases:

"Those bases which dissociate almost completely in water are called **strong bases**."

Strong bases completely ionize in water and almost no unionized molecule is left behind.

Examples:

Examples of some of the strong bases are given below:

	Strong Base	Chemical Formula
(i)	Sodium Hydroxide	$NaOH$
(ii)	Potassium Hydroxide	KOH
(iii)	Lithium Hydroxide	$LiOH$
(iv)	Cesium Hydroxide	$CsOH$

Weak bases:

"Those bases which do not dissociate completely in water are called **weak bases**."

Weak bases partially ionize in water and their solutions in addition to ions also contain unionized molecules.

Examples:

Some bases weak bases are given below:

	Weak Base	Chemical Formula
(i)	Ammonium Hydroxide	NH_4OH
(ii)	Aluminium Hydroxide	$Al(OH)_3$
(iii)	Ferric Hydroxide	$Fe(OH)_3$
(iv)	Zinc hydroxide	$Zn(OH)_2$

Q.9 : Explain self-ionization of water.

Ans:Self-ionization of water:

"The reaction in which two water molecules produce ions is called self-ionization or auto-ionization of water.

Explanation:

It is experimentally proved that water ionizes into hydronium ion(H_3O^+)and hydroxide ions (OH^-) to a very small extent.

During self-ionization of water two molecules of water react to produce hydronium ion (H_3O^+) and hydroxide ion (OH^-)

$$H_2O_{(l)} + H_2O_{(l)} \longrightarrow H_3O^+_{(aq)} + OH^-_{(aq)}$$

In order to understand the concept of ionization of water, we take one molecule of water and its ionization at 25°C.

The equation for ionization of water is:

$$H_2O \rightleftharpoons H^+ + OH^-$$

Equilibrium constant expression for this reaction is:

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

$$\Rightarrow \quad K_c[H_2O] = [H^+][OH^-]$$

Since the dissociation of water into ions is very small, the concentration of H_2O remains constant and the above equation can be written as:

$K_W = [H^+][OH^-]$ where $K_W = K_c[H_2O]$

Dissociation constant of water(K_w):

K_W is called dissociation constant or ionization constant of water. It is defined as "the product of molar concentration of $H^+(H_3O^+)$ and OH^- ions is called dissociation constant of water." The value of K_W of water at 25^{0}C is $1.0\times10^{-14}M^2$ i.e.

$K_W = [H^+][OH^-] = 1.0\times10^{-14}M^2$----- eq.1

As $[H^+] = [OH^-]$

Putting $[OH^-] = [H^+]$ in eq.1 we get

$[H^+][H^+] = 1.0\times10^{-14}M^2$

$[H^+]^2 = 1.0\times10^{-14}M^2$

$\sqrt{[H^+]} = \sqrt{1.0\times10^{-14}M^2}$

Therefore $[H^+] = 1.0\times10^{-7}$ M

and $[OH^-] = 1.0\times10^{-7}$ M

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

$\Rightarrow K_W = [1.0\times10^{-7}M][1.0\times10^{-7}M] = 1.0\times10^{-14}M^2$

Q.10: What is meant by P^H? Explain.

P^H:

The acidity or basicity of a solution is expressed in term of P^H.

Introduction:

Soren Peter Lauritz Sorenson in 1909 suggested a simple number scale based on H^+ ion concentration to express the acidic or basic nature of the solution which is called P^H scale. The values on this scale range from 0 to 14.

Definition:

"The logarithm of reciprocal of molar concentration of H^+ ions is called P^H.

Mathematically:

$$P^H = \log\frac{1}{[H^+]}$$

$\Rightarrow P^H = \log 1 - \log[H^+]$ $\quad \because \log\frac{m}{n} = \log m - \log n$

$\Rightarrow P^H = 0 - \log[H^+]$ $\quad \because \log 1 = 0$

$\Rightarrow P^H = -\log[H^+]$

Therefore P^H can also be defined as:

"The negative logarithm of molar concentration of H^+ ions is called P^H."

Meaning of p in P^H:

p stands for potenz (potential to be). Thus, P^H means potential of H^+ ions while it denotes negative log i.e. P = –log.

Comparison of P^H values:

A solution having P^H value of 7 is neutral, less than 7 is acidic while a solution having P^H value more than 7 is basic.

Whole number value of P^H below 7 is ten times more acidic than the next higher value.

For example:

A P^H of 2 is ten times more acidic than P^H of 3 and 100times more acidic than a P^H value of 4.

Experimental determination of P^H:

Experimentally P^H is determined by two methods:

i. By P^H paper:

A rough value of P^H is determined by using P^H paper.

ii. By P^H meter:

P^H meter is an instrument which determines accurate value of P^H.

Q.11: Differentiate between P^H and P^{OH} scales.

Ans: Difference between P^H and P^{OH}:

	P^H	P^{OH}
1	"The logarithm of reciprocal of molar concentration of H^+ ions is called P^H.	"The logarithm of reciprocal of molar concentration of OH^- ions is called P^{OH}.
2	$P^H = \log\frac{1}{[H^+]}$ $\Rightarrow P^H = \log 1 - \log[H^+]$ $\because \log\frac{m}{n} = \log m - \log n$ $\Rightarrow P^H = 0 - \log[H^+]$ $\because \log 1 = 0$ $\Rightarrow P^H = -\log[H^+]$	$P^{OH} = \log\frac{1}{[OH^-]}$ $\Rightarrow P^{OH} = \log 1 - \log[OH^-]$ $\because \log\frac{m}{n} = \log m - \log n$ $\Rightarrow P^{OH} = 0 - \log[OH^-]$ $\because \log 1 = 0$ $\Rightarrow P^{OH} = -\log[OH^-]$
3	P^H can also be defined as: "The negative logarithm of molar concentration of H^+ ions is called P^H."	P^{OH} can also be defined as: "The negative logarithm of molar concentration of OH^- ions is called P^{OH}."

Q.12: Prove that $P^H + P^{OH} = 14$

Ans: As we know that:

$$K_W = [H^+][OH^-] = 1.0\times10^{-14} \text{ or } 10^{-14}$$

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

Taking –log on both sides:

$$-\log[H^+][OH^-] = -\log10^{-14}$$

$$\Rightarrow [-\log[H^+]] + [-\log[OH^-]] = -\log10^{-14} \quad \because -\log[H^+] = pH \text{ and } -\log[OH^-] = pOH$$

Therefore $P^H + P^{OH} = -\log10^{-14}$

$\Rightarrow \quad P^H + P^{OH} = -(-14)\log10 \qquad \because \log m^n = n\log m$

$\Rightarrow \quad P^H + P^{OH} = 14\log10 \qquad \because \log 10 = 1$

$\Rightarrow \quad P^H + P^{OH} = 14\times1 = 14$

Hence proved that $P^H + P^{OH} = 14$

Table. P^H and P^{OH} values

Concentration of H^+ ions	P^H	P^{OH}	
1 or 10^0	0	14	Strong acids
10^{-1}	1	13	
10^{-2}	2	12	
10^{-3}	3	11	
10^{-4}	4	10	Weak acids
10^{-5}	5	9	
10^{-6}	6	8	
10^{-7}	7	7	→ Neutral
10^{-8}	8	6	Weak bases
10^{-9}	9	5	
10^{-10}	10	4	
10^{-11}	11	3	
10^{-12}	12	2	Strong bases
10^{-13}	13	1	
10^{-14}	14	0	

Example 10.2:

Calculate the P^H and P^{OH} of 0.001M solution of nitric acid?

Given:

Molarity of nitric acid solution = 0.001M

Required:

To calculate the P^H and P^{OH}

Solution:

Chemical equation for ionization of nitric acid is:

$$HNO_3 \longrightarrow H^+ + NO_3^-$$

0.001M   0.001M

Hydrogen ion concentration $[H^+]$: 0.001M = $\frac{1}{1000}$ = 10^{-3}M

Determination of P^{OH}:

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

Putting the value of $[H^+]$ we get:

$P^H = -\log 10^{-3}$

$\Rightarrow P^H = -(-3)\log 10$ $\because \log m^n = n\log m$

$\Rightarrow P^H = 3\log 10$

$\Rightarrow P^H = 3\times 1$ $\because \log 10 = 1$

$\Rightarrow P^H = 3$

Determination of P^{OH}:

We know that:

$P^H + P^{OH} = 14$

$P^{OH} = 14 - pH$

Putting the value of pH we get:

$P^H = 14 - 3$

$\Rightarrow P^{OH} = 11$

Result:

$P^H = 3$, $P^{OH} = 11$

Example 10.3:

Calculate the P^H and P^{OH} of 0.01M potassium hydroxide (KOH) solution?

Given:

Concentration of KOH solution = 0.01M

Required:

To calculate the P^H and P^{OH}

Solution:

Chemical equation for ionization of potassium hydroxide is:

$$KOH \longrightarrow K^+ + OH^-$$

0.01M   0.01M

Hydroxide ion concentration $[OH^-]$ = 0.01M = 10^{-2}M

Determination of P^{OH}:

$P^{OH} = -\log[OH^-]$

Putting the value of $[OH^-]$ we get:

$P^{OH} = -\log 10^{-2}$

$\Rightarrow P^{OH} = -(-2)\log 10$ $\because \log m^n = n\log m$

$\Rightarrow P^{OH} = 2 \log 10$

$\Rightarrow P^{OH} = 2 \times 1 \qquad \because \log 10 = 1$

$\Rightarrow P^{OH} = 2$

Determination of P^H:

We know that:

$P^H + P^{OH} = 14$

$\Rightarrow P^H = 14 - P^{OH}$

Putting the value of P^{OH} we get:

$P^H = 14 - 2$

$\Rightarrow P^H = 12$

Result:

$P^{OH} = 2$ and $P^H = 12$

Q.13: Explain acidic, basic and neutral solutions?

Ans: Neutral Solution:

A solution having P^H value of 7 is neutral solution. Neutral solution has equal concentration of H^+ ions and OH^- ions which is 1×10^{-7}M at 25^0C.

Acidic Solution:

A solution having P^H value less than 7 is acidic solution. Acids increase the concentration of H^+ ions thus its P^H is decreased. Thus; in acidic solution the concentration of H^+ ions will be more than 1×10^{-7}M.

Example:

A solution having concentration of H^+ ions 1×10^{-4}M is acidic because this concentration is greater than the concentration of H^+ ions in a neutral solution.

Basic Solution:

The solution having P^H value greater than 7 is basic solution. Bases increase the concentration of OH^- ions in aqueous solutions. Thus, its pH is increased.

Example:

A solution containing concentration of OH^- ions 1×10^{-4}M is basic because this concentration is greater than the concentration of H^+ ions in a neutral solution.

Q.14: Explain the process of neutralization?

Ans: Neutralization:

"The reaction of an acid with a base to form salt and water is called neutralization reaction."

Explanation with example:

For example, when HCl reacts with NaOH, NaCl and water are formed.

$$\underset{\text{Acid}}{HCl_{(aq)}} + \underset{\text{base}}{NaOH_{(aq)}} \longrightarrow \underset{\text{salt}}{NaCl_{(aq)}} + \underset{\text{water}}{H_2O_{(l)}}$$

In order to understand the process of neutralization, we need to write the acid, base and salt in their ionic forms.

$$H^+ + Cl^- + Na^+ + OH^- \longrightarrow Na^+ + Cl^- + H_2O$$

In solution HCl exists as H^+ and Cl^-, and NaOH exists as Na^+ and OH^-. In neutralization H^+ reacts with OH^- to form water, leaving Na^+ and Cl^- ions in the solution.

In the above equation Na^+ and Cl^- ions are present on both sides of the equation and they have not reacted. They are called **spectator ions**. So the net reaction of neutralization is the reaction of H^+ with OH^- to form water as given below:

$$H^+ + OH^- \longrightarrow H_2O$$

There are equal number of H^+ and OH^- ions in equal molar solutions of HCl and NaOH both of which are fully converted to H_2O.

Q.15: What are salts explain with examples?

Ans. <u>Salt:</u>

"The substance obtained (in addition to water) as a result of acid base reaction is called **salt**." **OR**

"A class of solid crystalline ionic substances consisting of positive and negative ions, generally good conductors in aqueous solution or in molten states are called salts."

Composition of salt:

A salt consists of positive ions combined with negative ions. Positive ions come from a base while negative ions come from an acid i.e. In NaCl Na^+ is from NaOH while Cl^- is from HCl. The detail of combination of positive and negative ions is given below:

Monoatomic positive ion + monoatomic negative ions:

Examples of such salts are given NaCl, AgCl, and KCl, LiF, NaF etc

Polyatomic positive ions + polyatomic negative ions:

Examples of such salts are $(NH_4)_2CO_3$, NH_4NO_3, NH_4HCO_3 etc.

Monoatomic positive ions + polyatomic negative ions:

Examples of such salts are Na_2SO_4, $CaSO_4$, $MgCO_3$ etc.

Polyatomic positive ions + monoatomic negative ions:

Examples of such salts are NH_4Cl, NH_4F, NH_4Br, $(NH_4)_2S$ etc.

Examples of some salts:

Some examples of salts are given below:

i. Sodium chloride (NaCl)
ii. Sodium bicarbonate ($NaHCO_3$)
iii. Calcium oxide (CaO)
iv. Ammonium nitrate (NH_4NO_3) etc.

Q.16: How salts can be prepared?

Ans: Preparation of salts:

There are two types of salts

1. Soluble salts
2. Insoluble salts

Their preparations are given below:

1. Preparation of soluble salts:

They are prepared by the following methods:

i. By neutralization reaction:

One of the most important and common method of preparation of soluble salts is neutralization reaction, in which an acid reacted with a base to form salt and water:

$$NaOH + HCl \longrightarrow NaCl + H_2O$$
$$\underset{\text{Base}}{KOH} + \underset{\text{Acid}}{HNO_3} \longrightarrow \underset{\text{salt}}{KNO_3} + \underset{\text{water}}{H_2O}$$

ii. By the reaction of metal and acid (Direct displacement method):

In this method hydrogen ion of an acid is replaced by an active metal like zinc, calcium, magnesium etc to produce salt and hydrogen gas.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$
$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

iii. By The Reaction Of Acid And Metal Oxide:

Metallic oxide like calcium oxide, copper oxide etc react with dilute acids to form salt and water.

$$CaO + H_2SO_4 \longrightarrow CaSO_4 + H_2O$$
$$CuO + H_2SO_4 \longrightarrow CaSO_4 + H_2O$$

iv. By the reaction of acids with carbonates and bicarbonates:

When an acid reacts with carbonate or bicarbonate it produces salts e.g.

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2 + H_2O$$
$$NaHCO_3 + HCl \longrightarrow NaCl + CO_2 + H_2O$$

2. Preparation Of Insoluble Salts:

Insoluble salts are prepared by mixing the solutions of two soluble salts. In this reaction the two salts exchange their ions and form two new salts. One is the insoluble salt which is precipitated while the other salt remains dissolved in the solution.

$$AgNO_{3\,(aq)} + NaCl_{(aq)} \longrightarrow AgCl_{(ppt)} + NaNO_{3\,(aq)}$$
$$Na_2CO_{3\,(aq)} + CuSO_{4\,(aq)} \longrightarrow CuCO_{3\,(ppt)} + Na_2SO_{4\,(aq)}$$

Q.17: Describe the different types of salts in detail.

Ans: Types of salts:

There are three types of salts i.e. normal, acidic and basic salts their detail is given below:

i. Normal salts or neutral salts:

"The salts formed when hydrogen atom of an acid is completely replaced by a metal ion or group of atoms behaving like metal ion are called normal salts." **OR**

The salt which is formed by strong acid and strong bases is called neutral salt.

Examples:

$$NaOH + HCl \longrightarrow NaCl + H_2O$$
$$KOH + HNO_3 \longrightarrow KNO_3 + H_2O$$

Base Acid Normal salt

Some other examples of normal salts are given below:

i. Potassium sulphate (K_2SO_4)
ii. Sodium phosphate (Na_3PO_4)
iii. Ammonium sulphate [$(NH_4)_2SO_4$]
iv. Sodium carbonate(Na_2CO_3)

ii. Acidic salts:

"The salts formed when hydrogen atom of a polyprotic acid is partially replaced by a metal ion or group of atoms behaving like metal ion are called acidic salts." **OR**

"The salt which is formed by strong acid and weak base is called acidic salt."

Acids which form acidic salts:

Acidic salts are formed by polyprotic or polybasic acids only e.g. H_2SO_4, H_2CO_3, H_3PO_4etc

Examples:

$$H_2SO_4 + KOH \longrightarrow KHSO_4 + H_2O$$
$$H_2CO_3 + NaOH \longrightarrow NaHCO_3 + H_2O$$

Polyprotic acid baseacidic salt

Some other examples of acidic salts are given below:

i. Ammonium bi phosphate [$(NH_4)H_2PO_4$]
ii. Potassium bicarbonate ($KHCO_3$)
iii. Lithium bisulphate ($LiHSO_4$)
iv. Calcium bicarbonate [$(Ca(HCO_3)_2$] etc.

iii. Basic salts:

"The salts formed when hydroxide ion of a poly acid base is partially replaced by negative ions of acids are called basic salts." **OR**

"The salt which is formed by weak acid and strong base is called basic salt."

Bases which form basic salts:

Basic salts are formed by poly acid bases only e.g. $Ca(OH)_2$, $Mg(OH)_2$, $Al(OH)_3$ etc.

Examples:

$$Ca(OH)_2 + HCl \longrightarrow Ca(OH)Cl + H_2O$$

$$Mg(OH)_2 + HCl \longrightarrow Mg(OH)Cl + H_2O$$

Some other examples of basic salts are:

i. Lead monohydroxy chloride [$Pb(OH)Cl$]
ii. Copper monohydroxy chloride [$Cu(OH)Cl$]
iii. Aluminum dihydroxy fluoride [$Al(OH)_2F$]
iv. Barium monohydroxy fluoride [$Ba(OH)F$]

Q.18: Describe the uses of salts?

Ans: Uses of salts:

Salts have many different uses, ranging from household to big industries. Some important uses of different salts are given below:

1. Sodium chloride($NaCl$):

i. It is daily used in our food to give it taste.
ii. In industry it is used as raw material for the preparation of caustic soda, washing soda etc.
iii. It is also used in de-icing if road ways.
iv. It is also used for preserving food.

2. Calcium sulphatedihydrate ($CaSO_4.2H_2O$):

i. It is also called gypsum and is used in the manufacture of plaster of paris and cement.
ii. It is also used as fertilizer.

3. Sodium Sulphate (Na_2SO_4):

It is used in the manufacture paper, glass and detergents etc.

4. Sodium carbonate(Na_2CO_3):

i. Anhydrous sodium carbonate (Na_2CO_3) is called soda ash while hydrated sodium carbonate ($Na_2CO_3.10H_2O$) is called washing soda.
ii. It is used as cleaning agent in laundries and as water softner.
iii. It is also used as raw material in the manufacture of glass.
iv. It is also used in paper industry, leather industry and petroleum refining industry.

5. Sodium bicarbonate($NaHCO_3$):

i. It is also called as baking soda because it is used in baking of cakes and other confectionaries.
ii. It is also used as antacids in medicines and in toothpastes.

6. Copper sulphate($CuSO_4.5H_2O$)(Blue vitriol):

i. It is used as electrolyte in copper electroplating process.
ii. It is also used to kill algae in water reservoirs and in agriculture spray.

7. Magnesium sulphate($MgSO_4.7H_2O$) (Epsom salt):

i. It is used as antacid and laxative in medicines.
ii. It is also used in dye industries.

8. **Potash alum($K_2SO_4 . Al_2(SO_4)_3 . 24H_2O$):**
   i. It is used for water purification to remove suspended impurities by a process called flocculation or coagulation.
   ii. It is also used in textile industry since it causes dyes to adhere to the fabric.
   iii. It is also used as blood coagulant in small injuries.
9. **Calcium Carbonate($CaCO_3$):**
   It is used in preparation of cement and ceramics industry.
10. **Potassium Nitrate (KNO_3):**
   It is used as a fertilizer and in the manufacture of flint glass.

EXERCISE

Q.1: Select the suitable option:

i. According to Arrhenius concept, which of the following is not an acid:
A) HCl B) H_2SO_4 **C) CO_2** D) HNO_3

ii. $AlCl_3$ is an acid according to ____
A) Arhenius B) Lowry and Bronsted **C) Lewis** D) All

iii. Which one of the following is a Lewis base?
A) HCl B) $AlCl_3$ C) BF_3 **D) F^-**

iv. Neutral solution has a pH value of ______
A) 3 B) 5 **C) 7** D) 14

v. The pOH of 0.001M solution of nitric acid is ____
A) 0.001 B) 10.0 **C) 11** D) 14

vi. When a strong base and weak acid reacts, the only products are:
A) Neutral salt and water **B) Basic salt and water**
C) Acidic salt and water D) Acidic, Basic salt and water

vii. NH_3 is a base according to _____
A) Arhenius B) Lowry and Bronsted **C) Lewis** D) Both B&C

viii. Which one of the following is a basic salt?
A) KCl B) NaCl **C) Pb(OH)Cl** D) $KHSO_4$

ix. The bases which are soluble in water are called
A) Acids **B) Alkalis** C) Salts D) Amphoteric

x. The example of weak acid is _____
A) HNO_3 **B) CH_3COOH** C) HCl D) H_2SO_4

SHORT QUESTIONS

Q.1: When a clear liquid is placed in a beaker. How can you identify it as an acid, base or neutral (water)?

Ans: Identification of a liquid to be acid, base or neutral:

A clear liquid in a beaker can be determined to be an acid, base or neutral by finding its P^H value. P^H value is find by the following ways;

i. By Using P^H paper:

A strip of pH paper will be dipped in the liquid. Its colour will change. This colour will be matched with colour bands having pH values from 0 to 14.

ii. By Using P^H meter:

It is a digital instrument which is dipped in the liquid. pH value is directly read from its LCD screen.

Q.2: Justify H^+ ion as a Lewis acid?

Ans: H^+ ion As Lewis Acid:

According to Lewis concept:

Acid is a species which accept a pair of electrons. Since H^+ has shortage of two electrons. Therefore, it accepts a pair of electron when reacts with a species having lone pair of electrons or a species having negative charge like OH^-.

Reactions:

i. $\underset{Acid}{H^+} + \underset{Base}{OH^-} \longrightarrow H_2O$

In the above reaction H^+ ion accept a pair of electron from OH^- ion, thus it is a Lewis acid.

ii. $NH_3 + H^+ \longrightarrow NH_4^+$

In the above reaction H^+ ion accept a pair of electron from NH_3, thus it is a Lewis acid

Q.3: Distinguish strong acids from weak acids? Give two examples of each.

Ans: Differences between strong and weak acids:

Some differences between strong and weak acids are given in the table below:

	Strong Acid	Weak Acid
(i)	"Those acids which almost completely ionize in aqueous solutions and give higher concentration of H^+ ions are called **strong acids**."	"Those acids which partially ionize in water are called **weak acids**."
(ii)	The solutions of strong acids contain ions and	The solutions of weak acids in addition to ions also

	almost no unionized molecules are left.	contain unionized molecules.
(iii)	Strong acids are strong electrolytes.	Weak acids are weak electrolytes.
(iv)	**Examples:** a. Hydrochloric acid(HCl) b. Nitric acid(HNO_3)	**Examples:** a. Carbonic acid(H_2CO_3) b. Acetic acid(CH_3COOH)

Q.4: Compare the physical properties of acids and bases.

Ans: For answer see Question no.2

Q.5: A carbonated drink has $[H^+]$=3.2×10⁻³M, classify the drink as neutral, acidic or basic with reason?

Ans: Classification of a substance as acidic, basic or neutral:

The acidic, basic or neutral nature of a substance depends upon it pH value.

i. If the pH value is 7 it neutral.
ii. If the pH value is more than 7 it is basic.
iii. If the pH value is less than 7 it is acidic.

So first we will find the pH value of given substance.

As we know that;

Hydrogen ion concentration $[H^+] = 3.2\times10^{-3}M$

Determination of pH:

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

Putting the value of $[H^+]$ we get:

$P^H = -\log 3.2\times10^{-3}$

$\Rightarrow P^H = -(\log 3.2 + \log 10^{-3})$ $\quad \because \log m\times n = \log m + \log n$

$\Rightarrow P^H = -(\log 3.2 + (-3\log 10))$ $\quad \because \log m^n = n\log m$

$\Rightarrow P^H = -(0.5051+(-3\times1))$ $\quad \because \log 10 = 1$

$\Rightarrow P^H = -(0.5051-3)$

$\Rightarrow P^H = -(-2.4949)$

$\Rightarrow P^H = 2.4949$

Conclusion:

As the pH value is less than 7, therefore the given carbonated drink is acidic due to higher concentration of H^+ ions.

Q.6: Write the chemical name of an acid present in the following:

(a) Apple **(b)Grape Juice**
(c) Lemon Juice **(d) Sour milk**

Ans:

	Substance Name	Acid Present
(a)	Apple	Malic Acid
(b)	Grape Juice	Tartaric Acid
(c)	Lemon Juice	Citric Acid
(d)	Sour Milk	Lactic Acid

Q.7: What determines the strength of a base? Give one example of each solution that are strongly and weakly basic.

Ans: Determination of strength of a base:

The extent to which a base ionizes in aqueous solution determines the strength of a base. If the base ionize completely then it is called strong base and if the base ionizes partially it is called weak base.

One example of strongly basic solution"

The solution of sodium hydroxide (NaOH) is strongly basic.

One example of weakly basic solution"

The solution of ammonium hydroxide (NH_4OH) is weakly basic.

Q.8: Calculate the P^H and P^{OH} of 0.5M solution of HCl. (P^H= 0.301, P^{OH}= 13.69)

Given:

Molarity of hydrochloric acid (HCl) solution = 0.5M

Required:

To calculate the P^H and P^{OH}

Solution:

Chemical equation for ionization of nitric acid is:

$$\underset{0.5M}{HCl} \longrightarrow \underset{0.5\,M}{H^+} + Cl^-$$

Hydrogen ion concentration $[H^+] = 0.5M = 5\times10^{-1}$ M

Determination of P^H:

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

Putting the value of $[H^+]$ we get:

$P^H = -\log [5\times10^{-1}]$

$\Rightarrow P^H = -(\log5+\log10^{-1})$ $\quad \because \log mn = \log m + \log n$

$\Rightarrow P^H = -\log5 - \log10^{-1}$

$\Rightarrow P^H = -(0.6989) - (-1)\log10$ $\quad \because \log m^n = n \log m$

$\Rightarrow P^H = -0.6989+1\log10$

$\Rightarrow P^H = -0.6989+1\times1$ $\quad \because \log 10 = 1$

$\Rightarrow P^H = -0.6989+1$

$\Rightarrow P^H = 0.3011$

Determination of pOH:

We know that:

$P^H + P^{OH} = 14$

$\Rightarrow P^{OH} = 14 - pH$

Putting the value of pH we get:

$P^{OH} = 14 - 0.3011$

$\Rightarrow P^{OH} = 13.6989$

Result:

P^{OH} = 13.6989and P^H= 0.3011

Q.9: Calculate the P^{OH} of 0.005 M H_2SO_4. (P^{OH} = 11.699)

Given:

Molarity of sulphuric acid (H_2SO_4) solution = 0.005M

Required:

To calculate the P^{OH}

Solution:

Chemical equation for ionization of sulphuric acid is:

$$H_2SO_{4(aq)} \longrightarrow 2H^+ + SO_4^{-2}$$

0.005M 2 × 0.005M

Hydrogen ion concentration $[H^+] = 2\times0.005M$
$= 0.010M$
$= 1\times10^{-2}$ M or 10^{-2} M

For finding P^{OH} first we will find P^H as we are given the concentration of H^+ ions.

Determination of P^H:

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

Putting the value of $[H^+]$ we get:

$$P^H = -\log[10^{-2}]$$
$$\Rightarrow P^H = -(-2\log10) \qquad \because \log mn = \log m + \log n$$
$$\Rightarrow P^H = -(-2)(1) \qquad \because \log 10 = 1$$
$$\Rightarrow P^H = 2$$

Determination of pOH:

We know that:

$$P^H + P^{OH} = 14$$
$$\Rightarrow P^{OH} = 14 - P^H$$

Putting the value of P^H we get:

$$P^{OH} = 14 - 2$$
$$\Rightarrow P^{OH} = 12$$

Result:

$P^{OH} = 12$

Q.10: Calculate the P^H of 0.2M solution of NaOH. (P^H=13.30)

Given:

Molarity of NaOH solution = 0.2M

Required:

To calculate the P^H

Solution:

Chemical equation for ionization of NaOH is;

$$NaOH \longrightarrow Na^+ + OH^-$$

0.2M 0.2M

Hydroxyl ion concentration $[OH^-]$ = 0.2M
$= 2\times10^{-1}$ M

For finding P^H first we will find P^{OH} as we are given concentration of OH^- ions.

Determination of P^{OH}:

$$P^{OH} = -\log[OH^-]$$

Putting the value of $[OH^-]$ we get:

$$P^{OH} = -\log[2\times10^{-1}]$$

$\Rightarrow P^{OH} = -(\log 2 + \log 10^{-1})$ $\quad \because \log mn = \log m + \log n$

$\Rightarrow P^{OH} = -(\log 2 + (-1)\log 10)$ $\quad \because \log m^n = n\log m$

$\Rightarrow P^{OH} = -(\log 2 + (-1)(1))$ $\quad \because \log 10 = 1$

$\Rightarrow P^{OH} = -(0.3010 - 1)$

$\Rightarrow P^{OH} = -(-0.699)$

$\Rightarrow P^{OH} = 0.699$

Determination of P^H:

We know that:

$$P^H + P^{OH} = 14$$

$\Rightarrow P^H = 14 - P^{OH}$

Putting the value of P^{OH} we get:

$$P^H = 14 - 0.699$$

$\Rightarrow P^H = 13.301$

Result:

$$P^H = 13.301$$

LONG QUESTIONS

Q 1.(a). What is salt?

Ans: For answer see Question no.15

(b).Write down the different types of salts with examples?

Ans: For answer see Question no.17

Q 2.(a) Define the auto- ionization of water. How can you find the P^H of water?

Ans: For auto-ionization see Question no.9

Finding the P^H of water:

The pH value of water can be found by two ways:

i. Mathematically

ii. Experimentally

i. Mathematically:

Mathematically the P^H of water can be found by the following formula;

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

For example the concentration of H^+ ions in pure water is 10^{-7}M therefore its P^H value will be:

$$P^H = -\log 10^{-7}$$

$\Rightarrow P^H = -(-7)\log 10$

$\Rightarrow P^H = 7(1)$

$\Rightarrow P^H = 7$

ii. Experimentally:

Experimentally P^H is determined by two methods:

a. By P^H paper:

A rough value of P^H is determined by using P^H paper.

b. By P^H meter:

P^H meter is an instrument which determines accurate value of P^H.

(b).Why some acids are called monoprotic, diprotic and polyprotic acids. Explain your answer with suitable examples.

Ans: For answer see Question no.5

Q 3.(a) Discuss the concept of Lewis acids and bases with examples.

Ans: For answer see Question no.3

(b) Give the Bronsted – Lowery definition of acids and bases. Write equations that explain the definition.

Ans: For answer see Question no.3

Q 4.Below are two equations showing how two alkalis react with water.

$$NaOH_{(aq)} + H_2O_{(l)} \rightleftharpoons Na^+{}_{(aq)} + OH^-{}_{(aq)}$$

$$NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_{4(aq)} + OH^-{}_{(aq)}$$

(a). Name both the alkalis.

Ans(a)

Alkali Formula	Name
NaOH	Sodium Hydroxide
NH_3	Ammonia

(b). Which is classified as weak alkali and why?

Ans: Weak Alkali In The Given Examples:

NH_3 is a weak alkali.

Reason:

Weak alkali is that alkali which partially ionizes in water. Since, NH_3 partially ionize in water. Therefore, it is a weak alkali.

(c). What is the likely P^H of each alkali?

Ans: P^H Of The Given Alkalis:

The P^H of NaOH is almost 14 while that of NH_3 is about 9.

Q 5. (a) Write the balanced neutralization reaction of ,

(i) Strong acid and strong base

(ii) Strong acid and weak base

(iii) Weak acid and strong base

(iv) Weak acid and weak base

Ans: i. Strong Acid And Strong Base Reaction:

$$\underset{\text{Strong base}}{NaOH} + \underset{\text{strong acid}}{HCl} \longrightarrow NaCl + H_2O$$

ii. Strong Acid And Weak Base Reaction:

$$\underset{\text{Weak base}}{Al(OH)_3} + \underset{\text{strong acid}}{3HCl} \longrightarrow AlCl_3 + 3H_2O$$

iii. Weak Acid And Strong Base Reaction:

$$\underset{\text{Weak acid}}{H_2CO_3} + \underset{\text{strong base}}{NaOH} \longrightarrow NaHCO_3 + H_2O$$

iv. Weak Acid And Weak Base Reaction:

$$\underset{\text{Weak acid}}{3H_2CO_3} + \underset{\text{weak base}}{2\,Al(OH)_3} \longrightarrow Al_2(CO_3)_3 + 6H_2O$$

(b): Define P^H and P^{OH}?

Ans: See answer of Q No. 11.

Q 6. (a) According to your understanding which one of the three acid definitions is the broadest? Explain.

Ans: Three Definitions Of Acid:

	Type Of Concept	Acid
1	Arhenius	H^+ion producer in water.
2	Bronsted-Lowry	Proton(H^+) donor
3	Lewis	Electron pair acceptor

Broadest definition of acid:

Among the three definitions of acid, the broadest is the Lewis concept.

Explanation:

The Arrhenius concept limits the acids to aqueous medium which cannot explain the acidic behavior of acids in non-aqueous medium.

Similarly, the Bronsted-Lowry concept restricts acids to protons which cannot explain the behavior of acids having no protons like $AlCl_3$, BF_3 etc.

The Lewis concept is a broadest of all the above mentioned concepts because it completely explains the acids definitions of Arrhenius and Bronsted-Lowry concepts. But they don't explain the Acid definition of Lewis concept.

Example:

For example BF_3 is a Lewis acid; it cannot be explained to be an acid on the basis of Arrhenius concept because it does not produce hydrogen ion in aqueous solution. Similarly, BF_3 cannot be explained, to be an acid, on the basis of Bronsted - Lowry concept because it does not donate proton. However, it can be explained, to be an acid, on the basis of Lewis concept, to be an acid as it accepts electron pair.

(b). Write the uses of any three salts.

Ans: For answer see Question no.18