Unit 10

Acids, Bases and Salts

Long Answer Questions

Q.1 Define an acid and base according to Arrhenius concept with the help of examples.

Ans. Arrhenius Acid

According to Arrhenius concept (1787)

Acid is a substance which dissociates in aqueous solution to give hydrogen ions (H^+).

Examples:

HCl, HNO_3, CH_3COOH, H_2SO_4, H_3PO_4, HCN etc are acids because they ionize in aqueous solution to provide H^+ ions.

In general the ionization of acids takes place as follows:

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

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

$$HNO_{3(aq)} \xrightleftharpoons{water} H^+_{(aq)} + NO^-_{3(aq)}$$

$$CH_3COOH_{(aq)} \xrightleftharpoons{water} CH_3COO^-_{(aq)} + H^+_{(aq)}$$

Arrhenius Base

Base is a substance which dissociates in aqueous solution to give hydroxide ions (OH^-).

Examples:

The substances such as $NaOH$, KOH, NH_4OH, $Ca(OH)_2$ etc are bases because they provide OH^- ions in aqueous solution.

In general the ionization of bases take place as follows:

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

$$NaOH_{(aq)} \xrightleftharpoons{water} Na^+_{(aq)} + OH^-_{(aq)}$$

$$Ca(OH)_{2(aq)} \xrightleftharpoons{water} Ca^{2+}_{(aq)} + 2OH^-_{(aq)}$$

Neutralization reactions according to Arrhenius concept

Acids give H^+ ions in water, bases give OH^- ions in water.

Q.2 Write down limitations of Arrhenius Concept.

Ans. Limitations of Arrhenius concept

(i) This concept is applicable only in aqueous medium and does not explain nature of acids and bases in non-aqueous medium.

(ii) According to this concept, acids and bases are only those compounds which contain hydrogen (H^+) and hydroxyl (OH^-) ions, respectively. It can not explain the nature of compounds like CO_2, NH_3 etc., which are acid and base, respectively.

Although this concept has limited scope yet, it led to the development of more general theories of acid-base behaviour.

Q.3 Describe Bronsted-Lowry concept about acids and bases with examples.

Ans. In 1923, the Danish chemist Bronsted and the English chemist Lowry independently presented their theories of acids and bases on the basis of proton transfer. According to this concept.

Bronsted-Lowry Acid

An acid is a substance (molecule or ion) that can donate a proton (H^+) to another substance e.g HCl.

Bronsted-Lowry Base

A base is a substance that can accept a proton (H^+) from another substance e.g NH_3.

Explanation

HCl acts as an acid while NH_3 acts as base:

$$\underset{\text{Acid}}{HCl_{(aq)}} + \underset{\text{Base}}{NH_{3(aq)}} \rightleftharpoons NH^+_{4(aq)} + Cl^-_{(aq)}$$

Similarly, when HCl dissolved in water; HCl acts as an acid and H_2O as a base.

$$\underset{\text{Acid}}{HCl_{(aq)}} + \underset{\text{Base}}{H_2O} \rightleftharpoons \underset{\text{Conjugate acid}}{H_3O^+_{(aq)}} + \underset{\text{Conjugate base}}{Cl^-_{(aq)}}$$

It is a reversible reaction. In the forward reaction HCl is an acid as it donates a proton, whereas H_2O is a base as it accepts a proton. In the reverse reaction Cl^- ion is a base as it accepts a proton from acid H_3O^+ ion. Cl^- ion is called a conjugate base of acid HCl and H_3O^+ ion is called a conjugate acid of base H_2O. It means every acid produces a conjugate base and every base produces a conjugate acid such that there is conjugate acid-base pair. Conjugate means joined together as a pair.

Conjugate Acid

A conjugate acid is a specie formed by accepting a proton by a base.

Conjugate Base

A conjugate base is a specie formed by donating a proton by an acid.

Thus, conjugate acid-base pair differs from one another only by a single proton.
Similarly,

$$\underset{\text{Acid}}{CH_3COOH_{(aq)}} + \underset{\text{Base}}{H_2O_{(aq)}} \rightleftharpoons \underset{\text{Conjugate acid}}{CH_3OO^-_{(aq)}} + \underset{\text{Conjugate base}}{H_3O^+_{(aq)}}$$

Limitations of Bronsted-Lowry concept

It has been observed that there are certain substances which behave as acids though they do not have the ability to donate a proton, e.g., SO_3. Similarly, CaO behaves as a base but it cannot accept a proton. These observations prove the limitations of Bronsted-Lowry concept of acids and bases.

Conjugate acid-base pairs of common species.

Acid		Base		Conjugate acid		Conjugate base
$HNO_{3(aq)}$	+	$H_2O_{(l)}$	$\rightleftharpoons$	$H_3O^+_{(aq)}$	+	$NO^-_{3(aq)}$
$H_2SO_{4(aq)}$	+	$H_2O_{(l)}$	$\rightleftharpoons$	$H_3O^+_{(aq)}$	+	$HSO^-_{4(aq)}$
$HCN_{(aq)}$	+	$H_2O_{(l)}$	$\rightleftharpoons$	$H_3O^+_{(aq)}$	+	$CN^-_{(aq)}$
$CH_3COOH_{(aq)}$	+	$H_2O_{(l)}$	$\rightleftharpoons$	$H_3O^+_{(aq)}$	+	$CH_3COO^-_{(aq)}$
$H_2O_{(l)}$	+	$NH_{3(aq)}$	$\rightleftharpoons$	$NH^+_{4\,(aq)}$	+	$OH^-_{(aq)}$
$H_2O_{(l)}$	+	CO_3^{2-}	$\rightleftharpoons$	$HCO^-_{3(aq)}$	+	$OH^-_{(aq)}$
$HCl_{(l)}$	+	HCO_3^-	$\rightleftharpoons$	$H_2CO_{3(aq)}$	+	$Cl^-_{(aq)}$

Q.4 Define an acid and a base according to Bronsted-Lowry concept and justify with examples that water is an amphoteric compound.

Ans. In 1923, the Danish chemist Bronsted and the English chemist Lowry independently presented their theories of acids and bases on the basis of proton transfer. According to this concept.

Bronsted-Lowry Acid

An acid is a substance (molecule or ion) that can donate a proton (H^+) to another substance e.g HCl.

Bronsted-Lowry Base

A base is a substance that can accept a proton (H^+) from another substance e.g NH_3.

Water as an amphoteric compound

According to Bronsted-Lowry concept, an acid and a base always work together to transfer a proton. That means, a substance can act as an acid (proton donor) only when another substance simultaneously behaves as a base (proton acceptor). Hence, a substance can act as an acid as well as a base, depending upon the nature of the other substance. For example, H_2O acts as a base when it reacts with HCl and as an acid when it reacts with ammonia such as

Water acting as an acid:

$$\underset{\text{Acid}}{H_2O_{(l)}} + \underset{\text{Base}}{NH_{3(aq)}} \rightleftharpoons NH^+_{4(aq)} + OH^-_{(aq)}$$

Water acting as a base:

$$\underset{\text{Acid}}{HCl_{(aq)}} + \underset{\text{Base}}{H_2O_{(l)}} \rightleftharpoons H_3O^+_{(aq)} + Cl^-_{(aq)}$$

Amphoteric

Such a substance that can behave as an acid, as well as, a base is called **amphoteric.**

Q.5 Explain Lewis Concept of Acids and Bases with example.

Ans. The Arrhenius and Bronsted-Lowry concepts of acids and bases are limited to substances which contain protons. G.N. Lewis (1923) proposed a more general and broader concept of acids and bases. According to this concept.

Lewis Acid

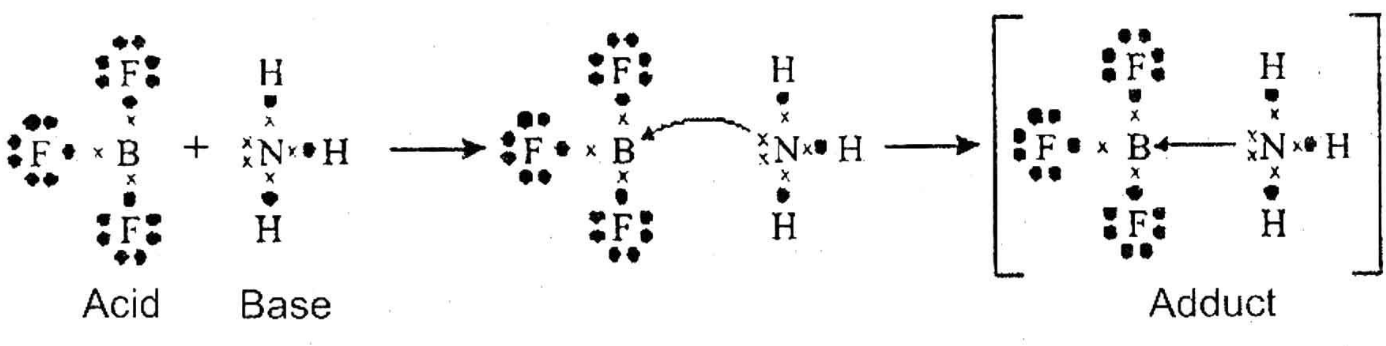
An acid is a substance (molecule or ion) which can accept a pair of electrons.

Lewis Base

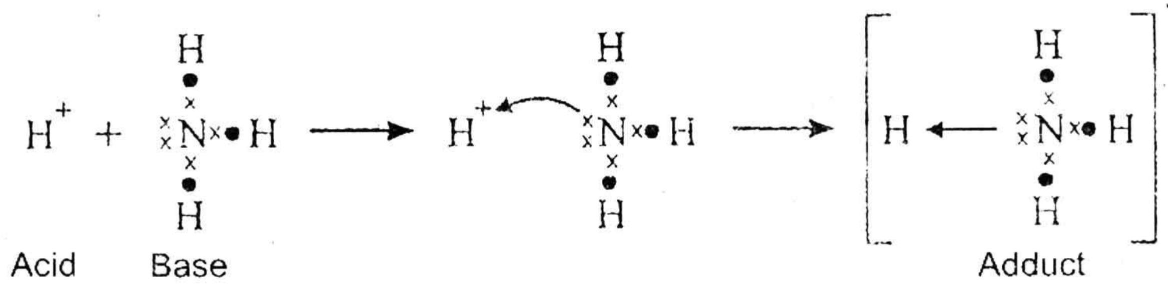
A base is a substance (molecule or ion) which can donate a pair of electrons.

Explanation

A reaction between ammonia and boron trifluoride takes place by forming a coordinate covalent bond between ammonia and boron trifluoride by donating an electron pair of ammonia and accepting that electron pair by boron trifluoride.



The cations (proton itself or metal ions) act as Lewis acids. For example a reaction between H^+ and NH_3, where H^+ acts as an acid and ammonia as a base.



Adduct

The product of any Lewis acid-base reaction is a single specie, called an adduct.

Neutralization

A neutralization reaction according to Lewis concept is donation and acceptance of an electron pair to form a coordinate covalent bond in an adduct.

Conclusion

Acids are electron pair acceptors while bases are electron pair donors. Thus, it is evident that any substance which has an unshared pair of electrons can act as a Lewis base while a substance which has an empty orbital that can accommodate a pair of electrons acts as Lewis acid.

Q.6 Describe characteristics of Lewis Acids and Bases.

Ans. Characteristics of Lewis Acids:-

According to Lewis concept, the following species can act as Lewis acids.

(a) Molecules in which the central atom has incomplete octet. For example, in BF_3, $Fecl_3$, $AlCl_3$, the central atom has only six electrons around it, therefore, these can accept an electron pair.

(b) Simple cations can act as Lewis acids. All cations act as lewis acids since they are deficient in electrons. However, cations such as Na^+, K^+, Ca^{2+} ions, etc., have a very little tendency to accept electrons. While the cations like H^+, Ag^+ ions, etc., have a greater electron accepting tendency therefore, act as Lewis acids.

Characteristics of Lewis Bases

According to Lewis concept, the following species can act as Lewis bases:

(a) Neutral species having at least one lone pair of electrons. For example, ammonia, amines, alcohols etc., act as Lewis bases because they contain a lone pair of electrons:

$$\ddot{N}H_3, \quad R-\ddot{N}H_2 \qquad R-\ddot{\underset{\cdot\cdot}{O}}-H$$

(b) Negatively charged species or anions. For example, chloride, cyanide, hydroxide ions, etc., act as Lewis bases:

CN^-, Cl^-, OH^- etc,

Q.7 Explain the chemical properties of acids.

Ans (i) Reaction with metals

Acids react explosively with metals like sodium, potassium and calcium. However dilute acids (HCl, H_2SO_4) react moderately with reactive metals like:
Mg,Zn,Fe and Al to form their respective salts with the evolution of hydrogen gas.

$$Zn_{(s)} + H_2SO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + H_{2(g)}\uparrow$$

$$2Al_{(s)} + 6HCl_{(aq)} \longrightarrow 2AlCl_{3(aq)} + 3H_{2(g)}\uparrow$$

(ii) Reaction with Carbonates and Bicarbonates

Acids react with carbonates and bicarbonates to form corresponding salts with the evolution of carbon dioxide gas.

$$CaCO_{3(aq)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + CO_{2(g)}\uparrow + H_2O_{(l)}$$

$$2NaHCO_{3(aq)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + 2CO_{2(g)}\uparrow + 2H_2O_{(l)}$$

(iii) Reaction with bases

Acids react with bases (oxides and hydroxides of metal and ammonium hydroxide) to form salts and water. This process is called neutralization.

$$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$$

$$CuO_{(aq)} + H_2SO_{4(aq)} \longrightarrow CuSO_{4(aq)} + H_2O_{(l)}$$

(iv) Reaction with Sulphites and Bisulphites

Acids react with sulphites and bisulphites to form salts with liberation of sulphur dioxide gas.

$$CaSO_{3(aq)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + SO_{2(g)}\uparrow + H_2O_{(l)}$$

$$NaHSO_{3(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + SO_{2(g)}\uparrow + H_2O_{(l)}$$

(v) Reaction with Sulphides

Acids react with metal sulphides to liberate hydrogen sulphide gas.

$$FeS_{(aq)} + H_2SO_{4(aq)} \longrightarrow FeSO_{4(aq)} + H_2S_{(g)}\uparrow$$

Q.8 Write down the uses of Acids

Ans Uses of Acids

(i) **Sulphuric acid** is used for manufacture of fertilizers, ammonium sulphate, calcium superphosphate, explosives, paints, dyes, drugs it is also used as an electrolyte in lead storage batteries, and other chemicals.

(ii) **Nitric acid** is used for manufacturing of fertilizer (Ammonium nitrate), explosives, paints and drugs. Etching designs on copper plates.

(iii) **Hydrochloric acid** is used for cleaning metals, tanning and in printing industries.

(iv) **Benzoic acid** is used for food preservation.

(v) **Acetic acid** is used for flavouring food and food preservation. It is also used to cure the sting of wasps.

Q.9 Explain chemical properties of bases.

Ans. **Chemical Properties of Bases**

(i) Reaction with acids

Bases react with acids to form salt and water. It is a neutralization reaction.

$$2KOH_{(aq)} + H_2SO_{4(aq)} \longrightarrow K_2SO_{4(aq)} + H_2O_{(l)}$$

(ii) Reaction with Ammonium Salts

Alkalis react with ammonium salts to liberate ammonia gas

$$NH_4Cl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + NH_{3(g)}\uparrow + H_2O_{(l)}$$

$$(NH_4)_2SO_{4(aq)} + Ca(OH)_{2(aq)} \longrightarrow CaSO_{4(aq)} + 2NH_{3(g)}\uparrow + 2H_2O_{(l)}$$

(iii) Precipitation of Hydroxides

Alkalis precipitate insoluble hydroxides when added to solutions of salts of heavy metals such as copper, iron, zinc, lead and calcium.

$$CuSO_{4(aq)} + 2NaOH_{(aq)} \longrightarrow Cu(OH)_{2(aq)} + Na_2SO_{4(aq)}$$

Blue ppt.

$$ZnCl_{2(aq)} + 2NaOH_{(aq)} \longrightarrow Zn(OH)_{2(aq)} + 2NaCl_{(aq)}$$

White ppt.

$$FeCl_{3(aq)} + 3NaOH_{(aq)} \longrightarrow Fe(OH)_{3(s)} + 3NaCl_{(aq)}$$

Brown ppt.

$$Pb(NO_3)_{2(aq)} + 2NaOH_{(aq)} \longrightarrow Pb(OH)_{2(s)} + 2NaCl_{(aq)}$$

White ppt.

$$CaCl_2 + 2NaOH \longrightarrow Ca(OH)_{2(s)} + 2NaNO_{3(aq)}$$

White ppt.

$$FeSO_{4(aq)} + 2NaOH_{(aq)} \longrightarrow Fe(OH)_{2(s)} + Na_2SO_{4(aq)}$$

Dirty Green.

Q.10 Write down the uses of bases.

Ans. Uses of Bases

(i) **Sodium hydroxide** is used for manufacturing of soap, artificial silk, in textile and paper industries and as a laboratory reagent.

(ii) **Calcium hydroxide** is used for manufacturing of bleaching powder, softening of hard water and neutralizing acidic soil and lakes due to the acid rain.

(iii) **Potassium hydroxide** is used in alkaline batteries and shaving cream.

(iv) **Magnesium hydroxide** is used as a base to neutralize acidity in the stomach. It is also used for the treatment of bee's stings.

(v) **Aluminium hydroxide** is used as foaming agent in fire extinguishers.

(vi) **Ammonium hydroxide** is used to remove grease stains from clothes.

Q.11 What is auto-ionization of water? How it is used to establish the pH of water.

Ans. Concentration of hydrogen ion $[H^+]$ in pure water is the basis for the pH scale. Water is a weak electrolyte because it ionizes very slightly into ions in a process called auto ionization or self ionization;

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

The equilibrium expression of this reaction may be written as

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

As concentration of water (H_2O) is almost constant. The above equation may be written as

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

A new equilibrium constant known as ionic product constant of water 'K_w' is used instead of product of equilibrium constant and $[H_2O]$. Therefore,

$$K_w = [H^+][OH^-] = 1.0 \times 10^{-14} \text{ at } 25^\circ C$$

As we know, one molecule of water produces one H^+ ion and one OH^- ion on dissociation. So

$$[H^+] = [OH^-] \quad \text{or} \quad [H^+]^2 = 1.0 \times 10^{-14}$$

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

Therefore, $$[H^+] = 1.0 \times 10^{-7} \text{ M at } 25^\circ C$$

As it is difficult to deal with such small figures having negative exponents, so it is convenient to convert these figures into a positive figure using a numerical system. It is taking the common (base-10) logarithm of the figure and multiplying it with -1. 'p' before the symbol H means' negative logarithm of H^+. On this scale pH is the negative logarithm of molar concentration of the hydrogen ions. That is,

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

So, according to this scale, pH of water is:

$$pH = -\log (1.0 \times 10^{-7}) = 7$$

Similarly $pOH = -\log (1.0 \times 10^{-7}) = 7$

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

pH value normally varies from 0 to 14. therefore;

$$pH + pOH = 14$$

So, the sum of the pH and pOH of the solution is always 14 at 25°C.

Identification of acids and bases by pH scale

			Highly acid			Slightly acid		Neutral			Slightly basic				Highly basic
pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
pOH	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

A solution or compound of pH 7 or pOH 7 is considered a neutral solution. Solutions of pH less than 7 are acidic and more than 7 are basic as are also shown in fig.

		$[H_3O^+]$	pH	$[OH^-]$	pOH
More basic ↑		1×10^{-14}	14.0	1×10^{-0}	0.0
		1×10^{-13}	13.0	1×10^{-1}	1.0
		1×10^{-12}	12.0	1×10^{-2}	2.0
	BASIC	1×10^{-11}	11.0	1×10^{-3}	3.0
		1×10^{-10}	10.0	1×10^{-4}	4.0
		1×10^{-9}	9.0	1×10^{-5}	5.0
		1×10^{-8}	8.0	1×10^{-6}	6.0
	NEUTRAL	1×10^{-7}	7.0	1×10^{-7}	7.0
More acidic ↓		1×10^{-6}	6.0	1×10^{-8}	8.0
		1×10^{-5}	5.0	1×10^{-9}	9.0
		1×10^{-4}	4.0	1×10^{-10}	10.0
	ACIDIC	1×10^{-3}	3.0	1×10^{-11}	11.0
		1×10^{-2}	2.0	1×10^{-12}	12.0
		1×10^{-1}	1.0	1×10^{-13}	13.0
		1×10^{-0}	0.0	1×10^{-14}	14.0

Since the pH scale is logarithmic, a solution of pH 1 has 10 times higher concentration of $[H^+]$ than that of a solution of pH 2, 100 times than that of a solution of pH 3 and so on.

Hence, low pH value means strong acid while high pH value means a strong base and vice versa.

Conclusion

(i) pH of a neutral solution is always 7.

(ii) Acidic solution has pH less than 7

(iii) Basic solution has pH value greater than 7

(iv) pH and pOH values range from 0 to 14.

Q.12 Write an note on the followings
(i) Indicators (ii) Universal indicators (iii) pH meter

Ans. Indicators

Indicators are the organic compounds. they have different colours in acidic and alkaline solutions. Litmus is a common indicator. It is red in acidic solutions and blue in alkaline solutions.

- Each indicator has a specific colour in acidic medium which changes at a specific pH to another colour in basic medium. For example, phenolphthalein is colourless in strongly acidic solution and red in strongly alkaline solution. It changes colour at a pH of about 9. This means phenolphthalein is colourless in a solution with pH less than 9. If the pH is above 9, phenolphthalein is red as is shown in figure.

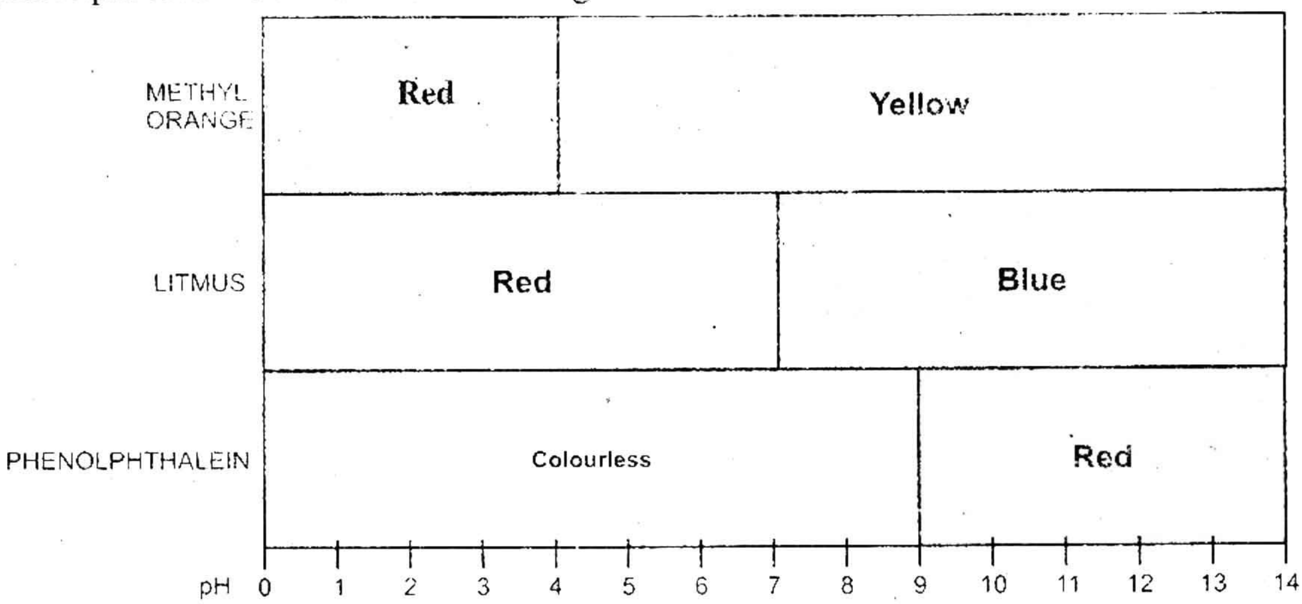


Fig: Colours of indicators at different pH solutions

A few commonly used indicators in titrations are given in Table:

Table : Few important indicators

Indicator	Colour in strongly acidic solution	pH at which colour changes	Colour in strongly alkaline solution
Methyl orange	red	4	yellow
Litmus	red	7	blue
Phenolphthalein	colourless	9	red

(i) Universal Indicator

Some indicators are used as mixtures. The mixture indicators give different colours at different pH values. Hence, it is used to measure the pH of a solution. Such a mixed indicator is called Universal Indicator or simply pH indicator. The pH of solution can be measured by dipping a piece of Universal Indicator paper in the solution. The pH is then found by comparing the colour obtained with a colour chart as shown in figure.

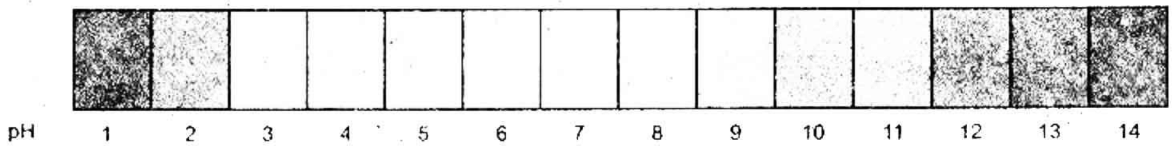
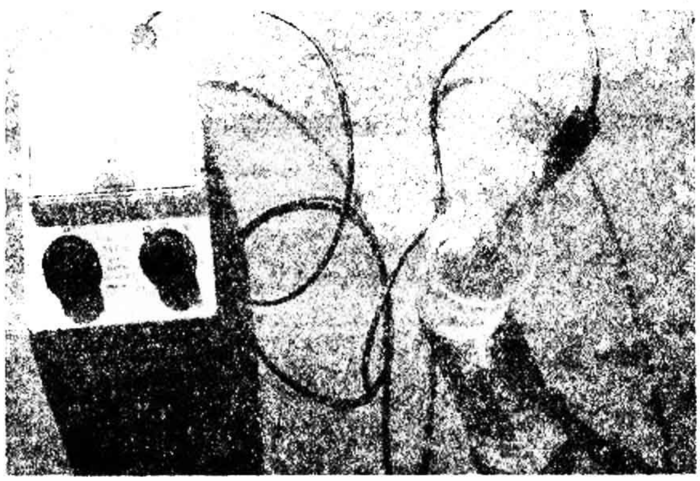


Fig: Colours of universal indicator

(ii) The pH Meter

The pH of a solution can be measured with a pH meter. It consists of a pH electrode connected to a meter. The electrode is dipped into the solution and the meter shows the pH either on a scale or digitally. It is much more reliable and accurate method of measuring pH than Universal Indicator paper, though the latter is often more convenient.

Figure



pH meter

Q.13 What are salts? Write down the characteristic properties of salts.

Ans: Salts are ionic compounds generally formed by the neutralization of an acid with a base.

Acidic and Basic radicals

Salts are made up of positive ions (cations) and negative ions (anions). A cation is metallic and derived from a base, therefore, it is called basic radical. While anion is derived from acids therefore it is called acid radical.

Salt Names

A salt gets its name from the names of the metal and the acid as shown in table

Metal	Acid	Salt Name
Sodium (Na)	Hydrochloric acid (HCl)	Sodium chloride (NaCl)
Potassium (K)	Nitric acid (HNO_3)	Potassium nitrate (KNO_3)
Zinc (Zn)	Sulphuric acid (H_2SO_4)	Zinc sulphate ($ZnSO_4$)
Calcium (Ca)	Phosphoric acid (H_3PO_4)	Calcium phosphate $Ca_3(PO_4)_2$
Silver (Ag)	Acetic acid (CH_3COOH)	Silver acetate ($CH_3COO\ Ag$)

Characteristic properties of salts:

(i) Salts are ionic compounds found in crystalline form.

(ii) They have high melting and boiling points.

(iii) Most of the salts contain water of crystallization which is responsible for the shape of the crystals. Number of molecules of water are specific for each salt and they are written with the chemical formula of a salt. For example,

Copper sulphate $CuSO_4.5H_2O$; Calcium sulphate $CaSO_4.2H_2O$

(iv) Salts are neutral compounds. Although, they do not compose of equal number of positive and negative ions, but have equal number of positive and negative charges.

Q.14 Explain with examples that how soluble salts are prepared?

Ans: Salts may be water soluble or insoluble. The methods used for the preparation of salts are based on their solubility in water.

General Methods for the preparation of Salts

There are five general methods for the preparation of salts. Four methods, make soluble salts but one prepares insoluble salts.

(i) Preparation of soluble salts

Soluble salts are often prepared in water. Therefore, they are recovered by evaporation or crystallization.

(a) By the reaction of an acid and a metal: (direct displacement method)

This is direct displacement method in which hydrogen ion of acid is replaced by a reactive metal. Such as, calcium, magnesium, zinc and iron, e.g,

$$\text{Acid} + \text{Metal} \longrightarrow \text{Salt} + \text{Hydrogen gas}$$

$$2HCl_{(aq)} + Mg_{(s)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$$

(b) By th reaction of an acid and a base: (Neutralization method)

It is a neutralization reaction in which acid and base react to produce a salt and water.

Acid	+	Base	⟶	Salt	+	Water
$HCl_{(aq)}$	+	$NaOH_{(s)}$	⟶	$NaCl_{(aq)}$	+	$H_2O_{(l)}$

(c) By the reaction of an acid and metallic oxide:

Mostly the insoluble metallic oxides react with dilute acids to form salt and water.

Acid	+	Metallic oxide	⟶	Salt	+	Water
$H_2SO_{4(aq)}$	+	$CuO_{(aq)}$	⟶	$CuSO_{4(aq)}$	+	$H_2O_{(aq)}$

(d) By the reaction of an acid and carbonate:

Dilute acids react with metallic carbonates to produce salts, water and carbon dioxide gas.

$$2HNO_{3(aq)} + Na_2CO_{3(s)} \longrightarrow 2NaNO_{3(aq)} + CO_{2(g)} + H_2O_{(l)}$$

Q.15 Write note on types of salts.

Ans: Following are the main classes of salts

(i) Normal salts **(ii)** Acidic salts

(iv) Basic salts **(v)** Double salts

(v) Mixed salts **(vi)** Complex salts

(i) Normal or Neutral salts:

A salt formed by the total replacement of ionizable H^+ ions of an acid by a positive metal ion or $NH^+{}_4$ ion is called normal or neutral salt. These salts are neutral to litmus, that is,

$HCl_{(aq)}$	+	$KOH_{(aq)}$	⟶	$KCl_{(aq)}$	+	$H_2O_{(l)}$
$H_2SO_{4(aq)}$	+	$ZnO_{(aq)}$	⟶	$ZnSO_{4(aq)}$	+	$H_2O_{(l)}$
$H_3PO_{4(aq)}$	+	$3NaOH_{(aq)}$	⟶	$Na_3PO_{4(aq)}$	+	$3H_2O_{(l)}$
$HNO_{3(aq)}$	+	$NH_4OH_{(aq)}$	⟶	$NH_4NO_{3(aq)}$	+	$H_2O_{(l)}$

(ii) Acidic Salts

These salts are formed by partial replacement of a replaceable H^+ ions of an acid by a positive metal ion.

$H_2SO_{4(aq)}$	+	$KOH_{(aq)}$	⟶	$KHSO_{4(aq)}$	+	$H_2O_{(l)}$
$H_3PO_{4(aq)}$	+	$NaOH_{(aq)}$	⟶	$NaH_2PO_{4(aq)}$	+	$H_2O_{(l)}$

These salts turn blue litmus red.

Acidic salts react with bases to form normal salts.

$KHSO_{4(aq)}$	+	$KOH_{(aq)}$	⟶	$K_2SO_{4(aq)}$	+	$H_2O_{(l)}$
$NaH_2PO_{4(aq)}$	+	$2NaOH_{(aq)}$	⟶	$Na_3PO_{4(aq)}$	+	$H_2O_{(l)}$

(iii) Basic Salts

Basic salts are formed by the incomplete neutralization of a polyhydroxy base by an acid

$$Al(OH)_{3(aq)} + HCl_{(aq)} \longrightarrow Al(OH)_2Cl_{(aq)} + H_2O_{(l)}$$
$$Pb(OH)_{2(aq)} + CH_3COOH_{(aq)} \longrightarrow Pb(OH)CH_3COO_{(aq)} + H_2O_{(l)}$$
$$Zn(OH)_{2(aq)} + HNO_{3(aq)} \longrightarrow Zn(OH)\,NO_{3(aq)} + H_2O_{(l)}$$

These salts further react with acids to form normal salts.

$$Al(OH)_2Cl_{(aq)} + HCl_{(aq)} \longrightarrow Al(OH)Cl_{2(aq)} + H_2O_{(l)}$$
$$Al(OH)Cl_{2(aq)} + HCl_{(aq)} \longrightarrow AlCl_{3(aq)} + H_2O_{(l)}$$
$$Pb(OH)\,CH_3COO + CH_3COOH_{(aq)} \longrightarrow Pb(CH_3COO)_{2(aq)} + H_2O_{(l)}$$
$$Zn(OH)NO_{3(aq)} + HNO_{3(aq)} \longrightarrow Zn(NO_3)_{2(aq)} + H_2O_{(l)}$$

(iv) Double Salts

Double salts are formed by two normal salts when they are crystallized from a mixture of equimolar saturated solutions. The individual salt components retain their properties. The anions and cations give their respective tests. Mohr's salt $FeSO_4.(NH_4)_2\,SO_4.6H_2O$; Potash Alum $K_2SO_4.Al_2(SO_4)_3\,.\,24H_2O$; Ferric alum $K_2SO_4.\,Fe_2(SO_4)_3\,.\,24H_2O$, are examples of double salts.

(v) Mixed Salts

Mixed salts contain more than one basic or acid radicals. Bleaching powder Ca(OCl) Cl, is an example of mixed salts.

(vi) Complex Salts

Complex salts on dissociation form a simple cation and a complex anion or vice versa. Only the simple ion yields the characteristics test for cation or anion. Examples are as follow:

Potassium ferrocyanide $K_4\,[Fe(CN)_6]$ gives on ionization, a simple cation K^+ and complex anion $[Fe(CN)_6]^{-4}$

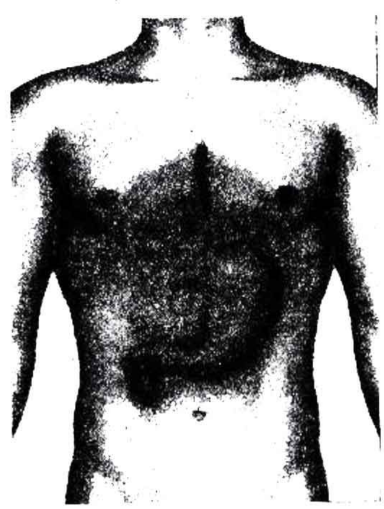
Q.16 Write down uses of salts.

Ans. Salts have vast applications in industries and in our daily life. Some common salts and their uses are given in Table

Name of salts	Common and industrial Uses
Sodium Chloride (NaCl)	It is commonly used as a table salt and for cooking purposes. It is also used for de-icing roads in winter and for the manufacture of sodium metal, caustic soda, washing soda.

Sodium carbonate (Na_2CO_3) soda ash	It is used for the manufacture of glass, detergents, pulp and paper and other chemicals.
Sodium carbonate ($Na_2CO_3.10H_2O$) Washing soda	It is used as cleaning agent for domestic and commercial purposes, for softening of water, in manufacture of chemicals like caustic soda (NaOH), borax, glass, soap and paper.
Sodium sulphate (Na_2SO_4)	It is used for the manufacture of glass, paper and detergents.
Sodium silicate (Na_2SiO_3)	It is used for the manufacture of detergents, cleaning agents and adhesives.
Sodium chlorate (Na_2ClO_3)	It is used for manufacture of explosives, plastics and other chemicals.
Sodium tetraborate ($Na_2B_4O_7.10H_2O$)	It is used for manufacture of heat resistance glass (pyrex), glazes and enamels, in leather industry for soaking and cleaning hides.
Calcium Chloride ($CaCl_2$)	It is used for de-icing roads in winter, as a drying agent of chemical reagents and as a freezing agent.
Calcium oxide (CaO) quick lime	It is used as drying agent for gases and alcohol and in steel making, water treatment and other chemicals like slaked lime, bleaching powder, calcium carbide. For purification of sugar, a mixture of CaO and NaOH called soda lime is used to remove carbon dioxide and water vapours from atmosphere.
Calcium sulphate ($CaSO_42H_2O$)	Gypsum is used as fertilizer, to prepare plaster of paris which is used for making statues, casts etc.
Potassium Nitrate (KNO_3)	It is used as fertilizer and for the manufacture of flint glass.

Q.17 Explain the Stomach acidity.



Ans. Stomach secretes chemicals in a regular way to digest food. These chemicals mainly consist of hydrochloric acids along with other salts. Although hydrochloric acid is highly corrosive, but stomach is protected from its effects because it is lined with cells that produce a base. The base neutralizes stomach acid. The important function of this acid is to break down chemical bonds of foods in the digestion process. Thus, big molecules of food are converted into small ones. It also kills the harmful bacteria of certain foods and drinks.

However, sometimes stomach produces too much acid. It causes stomach acidity also called **hyperacidity**. **Symptoms** of this disease are feeling burning sensation throughout the gastro intestinal track. These feelings sometimes extend towards the chest, that is called **heart burning**.

Prevention from Hyperacidity

- **(i)** Avoiding over-eating and staying away from fatty acids and spicy foods.
- **(ii)** Simple and regular eating, remaining in an upright position for about 45 minutes after taking a meal.
- **(iii)** Keeping the head elevated while sleeping.

Q.18 Explain the Process of Etching in Art and Industry.

Ans. The process of etching on glass is carried out by using a wax stencil. Stencil is placed on areas of glass or mirror that are to be saved from acid. The glass or mirror is dipped into hydrofluoric acid. The acid dissolves the exposed part of the glass thus etching it. This process has been very dangerous because the acid would damage the skin and tissue of artist's body. Although it is dangerous to deal with acid, yet etching done with acid is very attractive as compared to using other chemicals.

Q.19 Describe Preservatives in food.

Ans. Chemicals used to prevent food spoilage are called preservatives. Food spoiling may be due to microbial actions or chemical reactions. So preservatives serve as either anti-microbial or anti-oxidants or both.

Manufactures add preservatives mostly to prevent spoiling during transportation and storage of foods for a period of time.

Natural food preservatives are salts, sugar, alcohol, vinegar, etc. they efficiently control the growth of bacteria in food. They are used to preserve meat, fish, etc.