Acids, Bases& Salts
Salts & its Types

❖ Salts

A salt is a compound formed by the reaction of an acid with a base in which the hydrogen of the acid is replaced by the metal.

In polybasic acids, more than one hydrogen atoms are present in a molecule. The hydrogen atoms can be replaced partially or completely. So, two kinds of salts are possible.

Here, partial replacement of hydrogen atoms from H_2SO_4 has resulted in the formation of sodium hydrogen sulphate.

Here, complete replacement of hydrogen atoms from H_2SO_4 has resulted in the formation of sodium sulphate. $NaHSO_4$ and Na_2SO_4 represent two kinds of salts.

Types of Salts:

The different types of salts are: normal salt, acid salt, basic salt and double salt.

1.Normal salt: A salt that does not contain any replaceable hydrogen atoms or hydroxyl groups is called a normal salt.

Examples:

Na_2SO_4 obtained in the reaction between H_2SO_4 and NaOH is a normal salt because it is formed by the complete replacement of both the H atoms of H_2SO_4.

Similarly, calcium sulphate ($CaSO_4$), sodium phosphate (Na_3PO_4) and potassium phosphate (K_3PO_4) are also normal salts.

2.Acid salt: When a polybasic acid is not completely neutralized by a base, the salt produced will contain replaceable hydrogen atoms. Hence, it may further take part in the reaction with the base as an acid. Such a salt is called an **acid salt.**

For example, the salt $NaHSO_4$ produced in the reaction between NaOH and H_2SO_4 is an acid salt because it is capable of further reaction with the base NaOH to produce the normal salt Na_2SO_4.

Thus, "A salt that contains replaceable hydrogen atoms is called an acid salt".

Examples:

$NaHSO_4$, NaH_2PO_4 and Na_2HPO_4

3.Basic salt: When a polyacidic base reacts with lesser amount of acid than is necessary for complete neutralization, the salt produced contain hydroxyl group(s) (OH) also. Such a salt is called a basic salt.

Examples:

1 mole of Pb $(OH)_2$ requires 2 moles of HCl for complete neutralization. But when 1 mole of $Pb(OH)_2$ is made to react with 1 mole of HCl, some $Pb(OH)_2$ is left unreacted. The salt produced is not $PbCl_2$, but Pb(OH)Cl.

$$Pb(OH)_2 + HCl \rightarrow \underset{\text{lead hydroxy chloride}}{Pb(OH)Cl} + H_2O$$

Similarly, when one mole of $Bi(OH)_2$ is reacted with 1 mole of HNO_3, the salt $Bi(OH)_2NO_3$ is formed.

$$Bi(OH)_3 + HNO_3 \rightarrow Bi(OH)_2NO_3 + H_2O$$

Salts like Pb(OH)Cl and $Bi(OH)_2NO_3$ contain the OH group. These salts are called basic salts, because they can further react with the acids to form H_2O and the corresponding normal salts.

$$Pb(OH)Cl + HCl \rightarrow PbCl_2 + H_2O$$

$$Bi(OH)_2NO_3 + HNO_3 \rightarrow Bi(OH)(NO_3)_2 + H_2O$$

$$Bi(OH)(NO_3)_2 + HNO_3 \rightarrow Bi(NO_3)_3 + H_2O$$

Thus, a basic salt is formed when a polyacidic base reacts with a lesser amount of an acid than is necessary for the formation of a normal salt.

4.Double salt: In a double salt, there are two different negative ions and / or positive ions. For example, the mineral dolomite, $CaCO_3.MgCO_3$, contain both Ca^{2+} and Mg^{2+} ions. Hence, it is a double salt. Potash alum, $K_2SO_4.Al_2(SO_4)_3.\ 24H_2O$, also is a double salt.

Double salts exist only in the solid state. When dissolved in water, they break up into a mixture of two separate salts. For example, when potash alum is dissolved in water, it breaks up as follows.

$$K_2SO_4 \rightleftharpoons 2K^+ + SO_4^{2-}$$

$$Al_2(SO_4)_3 \rightleftharpoons 2Al^{3+} + 3SO_4^{2-}$$

Preparation of Salts:

1.By the reaction between metal and acid:

Certain metals (for example, Zn and Mg) react with HCl or H_2SO_4 to form salt and water.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2\uparrow$$

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2\uparrow$$

2.By the reaction between an acid and a base:

All acid-base reactions (neutralization reactions) produce salts.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

3.By direct union of a metal and a nonmetal:

Sodium and chlorine combine directly to form sodium chloride.

$$2Na + Cl_2 \rightarrow 2NaCl$$

Similarly, when sulphur is heated with iron filings, ferrous sulphide (FeS) is formed.

$$Fe + S \rightarrow FeS$$

4.By the union between an acidic oxide and a basic oxide:

$$\underset{\text{carbon dioxide}}{CO_2} + \underset{\text{calcium oxide}}{CaO} \rightarrow \underset{\text{calcium carbonate}}{CaCO_3}$$

$$\underset{\text{sulphur trioxide}}{SO_3} + \underset{\text{sodium oxide}}{Na_2O} \rightarrow \underset{\text{sodium sulphate}}{Na_2SO_4}$$

5.By the reaction between a metal and a base:

When zinc is heated with an aqueous solution of NaOH, sodium zincate (salt) is formed with the evolution of hydrogen gas.

$$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2\uparrow$$

General Properties of Salts:

1.Reaction with an acid:

When a salt reacts with an acid, another salt and acid are formed. For example, when sodium chloride is heated with sulphuric acid, sodium hydrogen sulphate (at low temperature) and then sodium sulphate (at high temperature) are produced and hydrogen chloride gas is evolved.

$$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl \quad \text{(at low temperature)}$$

$$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl \quad \text{(at high temperature)}$$

2.Reaction with a base:

A salt reacts with a base to produce another salt and base.

$$(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2NH_4OH$$

3.Reaction with a metal:

Sometimes, a salt solution may react with a metal. For example, when an iron nail is dipped into an aqueous solution of copper sulphate, copper gets deposited on the surface of the nail and the ferrous sulphate formed remains in the solution.

$$CuSO_4 + Fe \rightarrow FeSO_4 + Cu\downarrow$$

This reaction shows that iron is more reactive than copper.

Thus, a more reactive metal can displace a less reactive metal from a solution of its salt.

Uses of Salts:

The following table gives uses of some salts.

Salts	Uses
Sodium chloride	1. An essential requirement of our food 2. In the preservation of food 3. In curing fish and meat 4. In making a freezing mixture which is used by icecream vendors 5. In the manufacture of soaps
Sodium carbonate	1. As washing soda for cleaning clothes 2. Used in the manufacture of glass, paper, textiles, caustic soda, etc. 3. In the refining of petroleum 4. In fire extinguishers
Sodium bicarbonate	1. Used as baking soda 2. In fire extinguishers 3. As an antacid in medicine
Potassium nitrate	1. To make gunpowder, fireworks and glass 2. As a fertilizer in agriculture
Copper sulphate	1. Commonly called 'blue vitriol', used as a fungicide to kill certain germs 2. In electroplating 3. In dying
Potash alum	1. Used to purify water; makes suspended particles in water settle down 2. As an antiseptic 3. In dying