ACID-BASE NEUTRALISATION-SALTS

When aqueous solutions of hydrochloric acid and sodium hydroxide are mixed in the proper proportion, a reaction takes place to form sodium chloride and water.

$HCl(aq) + NaOH(aqr) \leftrightarrow NaCl(aq) + H_2O(l)$

Sodium chloride

Such a reaction is termed neutralisation because both acidic (H^+) and basic (OH^-) properties are eliminated during the reaction. The hydrogen ion, which is responsible for the acidic properties, has reacted with the hydroxyl ion which is responsible for the basic properties, producing neutral water. The Na^+ and CI^- ions have undergone no chemical change and appear in the form of crystalline sodium chloride upon evaporation of the solution. Sodium chloride is an example of the class of compounds called salts.

HCl(aq) + $Cl^-(aq) + Na^+(aq) \leftrightarrow H_2O(l) + Na^+(aq) + Cl^-(aq)$

or $H^+(aq) + OH^-(aq)$ $H_2O(l)$

Thus, the neutralisation of a base with an acid involves the interaction between $OH^-$and H^+ ions.

or

The reaction between an acid and a base to form salt and water is termed neutralisation.

The process of neutralization does not produce the resulting solution always neutral; no doubt it involves the interaction of H^+ and OH^- ions. The nature of the resulting solution depends on the particular acid and a particular base involved in the reaction. The following examples illustrate this point when equivalent amounts of acids and bases are reacted in aqueous solution.

(i) A strong acid plus a strong base gives a neutral solution because both are completely ionised and the reaction goes to completion.

$H^+ + CI^- + Na^+ + OH^- \leftrightarrow H_2O + Na^+ + CI-$

(ii) A strong acid plus a weak base gives an acidic solution as the weak base is not completely ionised. The reaction does not go to completion and there is an excess of hydrogen ions in solution.

$$H^+ + CI^- + NH_4OH \leftrightarrow H_2O + NH_4^+ + Cl^-$$

(iii) A weak acid plus a strong base gives a basic solution as the weak acid is not completely ionised. The reaction does not go to completion and there is an excess of hydroxyl ions in solution.

$$CH_3COOH + Na^+ + OH^- \leftrightarrow H_2O + CH_3COO^- + Na^+$$

(iv) A weak acid plus a weak base gives an acidic or a basic or a neutral solution depending on the relative strength of acid and base. In case both have equal strength, the resulting solution is neutral in nature.

$$CH_3COOH + NH_4OH \;\; H_2O + NH_4^+ + CH_3COO^-$$

Salts:

Salts are regarded as compounds made up of positive and negative ions. The positive part comes from a base while negative part from an acid. Salts are ionic compounds. Salts may taste salty, sour, bitter, astringent or sweet or tasteless. Solutions of salts may be acidic, basic or neutral. Fused salts and aqueous solutions of salts conduct electricity and undergo electrolysis. The properties of salts in aqueous solutions are the properties of ions. The salts are generally crystalline solids.

The salts are classified into the following classes:

(i) Simple salts:

The salt formed by the neutralization process, i.e., interaction between acid and base, is termed as simple salt. These are of three types:

(a) Normal salts: The salts formed by the loss of all possible protons (replaceable hydrogen atoms as H^+) are called normal salts. Such a salt does not contain either a replaceable hydrogen or a hydroxyl group.

Examples are: NaCl, $NaNO_3$, K_2SO_4, $Ca_3(PO_4)_2$, Na_3BO_3, Na_2HPO_3 (one H atom is not replaceable as H_3PO_3 is a dibasic acid), NaH_2PO_2 (both H atoms are not replaceable as H_3PO_2 is a monobasic acid), etc.

(b) Acid salts: Salts formed by incomplete neutralization of poly-basic acids are called acid salts. Such salts still contain one or more replaceable hydrogen atoms. These salts when neutralised by bases form normal salts.

Examples are: $NaHCO_3$, $NaHSO_4$, NaH_2PO_4, Na_2HPO_4, etc.,

(c) Basic salts: Salts formed by incomplete neutralization of poly acidic bases are called basic salts. Such salts still contain one or more hydroxyl groups. These salts when neutralised by acids form normal salts.

Examples are: $Zn(OH)Cl$, $Mg(OH)Cl$, $Fe(OH)_2Cl$, $Bi(OH)_2Cl$, etc.

(ii) Double salts:

The addition compounds formed by the combination of two simple salts are termed double salts. Such salts are stable in solid state only.

Examples are: Ferrous ammonium sulphate, $FeS0_4\text{-}(NH_4)_2SO_4.6H_2O$, Potash alum, $K_2SO_4Al_2(SO_4)_3.24H_2O$, and other alums.

Properties:

(a) When dissolved in water, it furnishes all the ions present in the simple salts from which it has been constituted.

(b) The solution of double salt shows the properties of the simple salts from which it has been constituted.

(iii) Complex salts:

These are formed by combination of simple salts or molecular compounds. These are stable in solid state as well as in solutions.

$$\underbrace{FeSO_4 + 6KCN} \rightarrow K_4Fe(CN)_6 + K_2SO_4$$

Simple salt Complex salt

$$CoSO_4 + 6NH_3 \rightarrow Co(NH_3)_6SO_4$$

Simple salt Molecular compound Complex salt

Properties:

(a) On dissolving in water it furnishes a complex ion.

$K_4F_2(CN)_6 \leftrightarrow 4K^+ + [Fe(CN)_6]^{4-}$

$Cu(NH_3)_4SO_4 \leftrightarrow [Cu(NH_3)_4]^{2+} + SO_4^{-2}$

Complex ion

(b) The properties of the solution are different from the properties of the substances from which it has been constituted.

(iv) Mixed salts:

The salt which furnishes more than one cation or more than one anion when dissolved in water is called a mixed salt.

Examples are:

Acidic, Basic and Amphoteric oxides

(i) Non-metal oxides are acidic, they dissolve in water to form acid. These oxides form salt with bases.

$$\text{e.g.}\quad \left.\begin{array}{l} SO_2, SO_3, P_4O_{10}, CO_2, NO_2, N_2O_5 \\ SiO_2, B_2O_3 \end{array}\right\} \text{Non-metal oxides}$$

Some Transition metal oxides are also acidic

e.g., CrO_3, MoO_3, WO_3, Mn_2O_7

$CO_2 + H_2O \rightarrow H_2CO_3$ Carbonic acid

$2N0_2 + H_2O \rightarrow HNO_2 + HN0_3$ (nitrous and nitric acid)

$P_2O_5 + 3H_3O \rightarrow 2H_3PO_4$

(Phosphoric acid)

$NaOH + SO_3 \rightarrow NaHSO_4$

Salt

$2KOH + CO_2 \rightarrow K_2CO_3 + H_2O$

Salt

(ii) Usually, oxides of highly electropositive metals are basic. These oxides dissolve in water to form base and they form salt with acids.

e.g., Na_2O, K_2O, MgO, CaO, Sc_2O_3, TiO_2, ZrO_2

$Na_2O + H_2O \rightarrow 2NaOH$

(Sodium hydroxide, a base)

$CaO + 2HC1 \rightarrow CaCl_2 + H_2O$

Salt

$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2O$

Salt

(iii) Oxides of metalloids and less electropositive metals are amphoteric. These oxides form salt with both acids and bases.

e.g., BeO, Al_2O_3, GeO, SnO, Sb_2O_3, PbO

ZnO, Cr_2O_3

$Al_2O_3 + 6HC1 \rightarrow 2AlCl_3 + 3H_2O$

$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

Source : http://ciseche10.files.wordpress.com/2013/12/ionic-equilibrium.pdf