Acids, Bases and Salts

- **Acids:**

  Acids are the chemical compounds that are sour in taste and changes the color of the blue litmus to red. Ex: sulfuric, nitric, hydrochloric, phosphoric acids, etc.

- **Bases:**

  Bases are the substances in water solution that is slippery to touch. They are also bitter in taste and there is no change in color of the blue litmus. Ex: hydroxide, calcium carbonate, potassium oxide, etc.

- **Indicators:**

  The materials that indicate the presence of the acid or the base in any substance are called the indicators.

  - Litmus and turmeric are some natural indicators.
  - Methyl orange and phenolphthalein are some synthetic indicators.
  - Some substances whose odor changes in acidic or basic medium they are known as olfactory indicators.

- **Chemical Properties of Acids and Bases:**

  1. Acids and Bases in the Laboratory:

  - While reacting with base color of red litmus would change to blue whereas it won't show any change in the reaction with acid.
  - When a base reacts with blue litmus the color shows no change whereas in acid it changes the color to red.

- In reaction of phenolphthalein with the base the solution results in the purple color whereas with acid it shows the pink color.
- Reaction of methyl orange with base results in the yellow color whereas in acid it results in red color.

2. Reactions of Acids and Bases with Metals:

- While reacting with the metal the hydrogen atoms are displaced from the acids/bases and the hydrogen gas is evolved along with the formation of a compound called a salt.

Acids/Bases + Metals → Salt + Hydrogen gas

Ex:

(i) $2NaOH\ (aq) + Zn\ (s) \rightarrow Na_2ZnO_2\ (s) + H_2\ (g)$

(ii) $Mg\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (s) + H_2\ (g)$

3. Reactions of Acids with Metal Carbonates and Metal Hydrogencarbonates:

- When metal carbonates and hydrogencarbonates react with acids they result in the formation of salt, water and carbon dioxide. Both metal carbonates and metal hydrogencarbonates are considered as the base itself.

Metal carbonate/Metal hydrogencarbonate + Acid → Salt + Carbon dioxide + Water

Ex:

(i) $Metalcarbonate + Acid \rightarrow Salt + Water + CO_2$

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

(ii) $Metalhydrogencarbonate + Acid \rightarrow Salt + Water + CO_2$

$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

4. Reactions of Acids with Bases:

- When a base reacts with an acid then it neutralize the charge of overall reaction resulting in the formation of salt and water such a reaction in known as neutralization reaction.

Acid + Base → Salt + Water

Ex: NaOH (aq) + HCl (aq) → NaCl (aq) + H_2O (l)

5. Reactions of Acids with Metallic Oxides:

- The reaction of an acid with a metallic oxide would result in the formation of salt and water.

Metal Oxide+ Acid → Salt + Water

Ex: H_2SO_4 (aq) + CuO (s) → $CuSO_4$ (aq) + H_2O (l)

6. Reactions of Base with Non- Metallic Oxides:

- The reaction between a base and a non-metallic oxide results similar to that of the reaction which is taken place between an acid and a base.

Non-Metal Oxide+ Base → Salt + Water

Ex: $Ca(OH)_2 + CO_2 \Rightarrow CaCO_3 + H_2O$

➢ Similarities between Acids and Bases:

1) Activity performed to find out whether all compounds contain hydrogen are acidic:

- Two nails are fixed on a cork and the cork is placed in a beaker.
- The nails are connected with the two terminals of a 6 volt battery through a bulb and a switch.

- The beaker is then filled with a little amount of dilute HCl.
- Then the switch is turned on to check whether the blub glows or not?
- The same thing is repeated again but this time with dilute Sulphuric acid.
- Again the switch is turned on to check whether the blub glows or not this time?

On observing the above experiment it is concluded that the bulb would glow in any acidic solution, as the electric current is carried through these solution by ions.

Acids contain H^+ ion as cation and anion such as Cl^- in HCl.

➢ Acids and Bases in Water:

- Acids give H_3O^+ or H^+ (aq) ion in water.

  Ex: **$HCl + H_2O \rightarrow H_3O^+ + Cl^-$**
- Bases generate hydroxide (OH^-) ions in water. Bases which are soluble in water are called alkalis.

  Ex: **$KOH(s) \xrightarrow{water} K^+(aq) + OH^-(aq)$**

All the acids generate H^+(aq) whereas all bases generate OH^-(aq). So the neutralization reaction could be stated as:

- **Acid + Base → Salt + Water**
- **H [X + M] OH → MX + HOH**
- **H^+ (aq) + OH^- (aq) → H_2O(l)**

➢ How strong are Acid and Base Solution:

All acid and base solutions contain hydrogen ions. Acid contains ***H^+*** ions whereas base contains ***OH^-*** ions.

❖ **pH scale**- is a scale developed to measure the presence of Hydrogen ions in a solution. The stands for *'potenz'* that means power so the meaning of **pH is 'power of hydrogen'.**

- ❖ The pH scale ranges from 0(highly acidic) to 14(highly basic.) The pH of a neutral solution in 7.
- ❖ The pH value less than 7 indicates acidic solution whereas more than 7 indicate alkali.
- ❖ Paper impregnated is used for measuring pH.
- ❖ The acids that contain more amounts of H^+ ions are said to be strong acids.
- ❖ The bases that contain more amounts of OH^- ions are said to be strong bases.

➢ Importance of pH in Everyday Life:

- Human body works within the pH range of 7.0 – 7.8.
- The rain water including the pH value less than 5.6 is the acid rain.

1) pH in our digestive System:

- HCl is produced in our stomach for digestion of the food.
- While the ingestion of food the HCl is produced in a large amount and leads to cause of pain.
- To cure the pain we use bases called antacids.
- Magnesium hydroxide (Milk of magnesia) is used as a antacid to neutralize the excess of acid.

2) pH change as the tooth decay:

- Tooth enamel the hardest substance in the body is made up of calcium hydroxyapatite (a crystalline form of calcium phosphate).
- It does not dissolve in water, but is corroded when the pH in the mouth is below 5.5 that decays the tooth.
- The degradation of sugar and food particles remaining in the mouth causes the bacteria to produce acids.
- Brushing the teeth after the meal neutralize the excess acid and prevents the tooth decay.

3) **Self defense by animals and plants through chemical warfare:**
   - Bee-sting leaves an acid which causes pain and irritation.
   - Stinging hair of nettle leaves inject methanoic acid causing burning pain.

➢ Salts:

- **Family of Salts**
  Salts having the same positive or negative radicals are said to belong to a family. For example, NaCl and Na_2SO_4 belong to the family of sodium salts.
- **pH of Salts**
  Salts of a strong acid and a strong base are neutral with pH value of 7.
- **Chemicals from Common Salt**
  There are many salts dissolved in the seawater. Some of them are:
  1) **Common salt** is used as the raw materials for various materials like sodium hydroxide, baking soda, washing soda, etc.
  2) Chlor-alkali the process in which electricity is passed through an aqueous solution of sodium chloride (called brine) it decomposes to form **sodium hydroxide**.
     $2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$
  3) **Bleaching powder** is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$].
     $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$
  4) **Baking soda** is produced using sodium chloride as one of the raw materials. It is used in the kitchen.
     $NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$
  5) **Washing soda** can be obtained by heating baking soda. It is also known as basic salt.
     $Na_2CO_3 + 10\ H_2O \rightarrow Na_2CO_3.10\ H_2O$

6) When gypsum is heated at 373 K, it loses water molecule and becomes calcium sulphate hemihydrate to form **Plaster of Paris.**

$CaSO_4 .1/2\ H_2O + 3/2\ H_2O \rightarrow CaSO_4 .2H_2O$