Class – 10th

Chapter -2nd

ACIDS, BASES AND SALTS

On the basis of their chemical properties, all the compounds can be classified into three groups :

1. **Acids,**
2. **Bases,**
3. **Salts**

An indicator is a 'dye' that changes colour when it is put into an acid or a base.

The three most common indicators to test for acids and bases are : Litmus, Methyl orange and Phenolphthalein.

Litmus can be used in the form of litmus solution or in the form of litmus paper. It is of two types : Blue litmus and Red litmus

(i) An acid turns blue litmus to red.
(ii) (ii) A base (or alkali) turns red litmus to blue

(i) Methyl orange indicator gives red colour in acid solution.

(ii) Methyl orange indicator gives yellow colour in basic solution.

(i) Phenolphthalein indicator is colourless in acid solution.
(ii) Phenolphthalein indicator gives pink colour in basic solution.

There are some substances whose odour changes in acidic or basic media. These are called olfactory indicators.

Hoe Do Acids & Bases React with Metals

Example

Take about 5 mL of dilute sulphuric acid in a test tube and add a few pieces of zinc granules to it.

What do you observe on the surface of zinc granules?

Pass the gas being evolved through the soap solution.

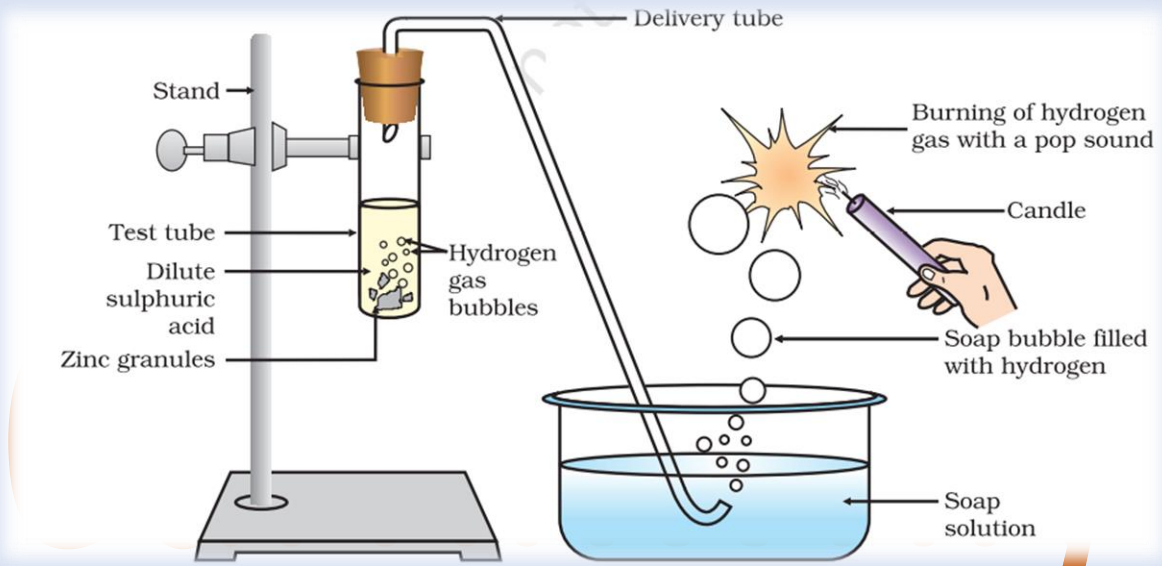
Why are bubbles formed in the soap solution?

Take a burning candle near a gas filled bubble.

The gas present in soap bubble burns with a 'pop' sound. Only hydrogen gas burns making a 'pop' sound. This shows that hydrogen gas is evolved in the reaction of dilute sulphuric acid with zinc metal

the metal in the above reactions displaces hydrogen atoms from the acids as hydrogen gas and forms a compound called a salt.

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



<u>How do Metal Carbonates & Metal Hydrogencarbonates Reacts with Acids</u>

When an acid reacts with a metal carbonate (or metal hydrogencarbonate), then a salt, carbon dioxide gas and water are formed :

Metal carbonate + Acid $\longrightarrow$ Salt + Carbon dioxide + Water

Metal hydrogencarbonate + Acid $\longrightarrow$ Salt + Carbon dioxide + Water

Example

Take two test tubes, label them as A and B.

Take about 0.5 g of sodium carbonate (Na_2CO_3) in test tube A and about 0.5 g of sodium hydrogencarbonate ($NaHCO_3$) in test tube B.

Add about 2 mL of dilute HCl to both the test tubes.

Pass the gas produced in each case through lime water (calcium hydroxide solution)

The reactions occurring in the above Activity are written as –

Test tube A: $Na_2CO_3(s) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

Test tube B: $NaHCO_3 + HCl(aq) \longrightarrow NaCl(aq)\ H_2O(l) + CO_2(g)$

On passing the carbon dioxide gas evolved through lime water,

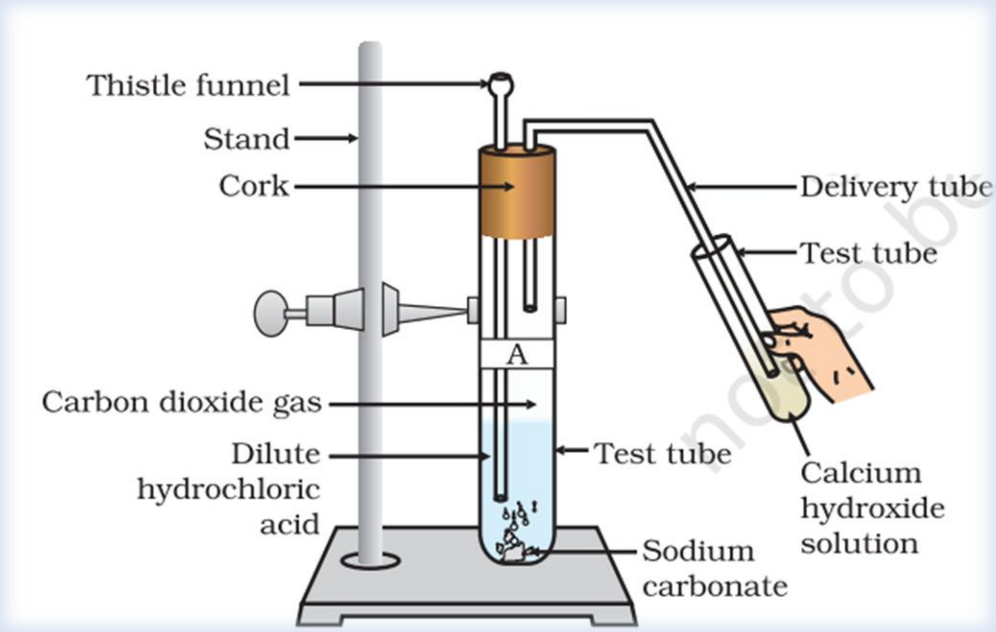
$Ca(OH)_2\ (aq) + Co_2\ (g) \longrightarrow CaCo_3\ (s) + H_2O\ (l)$

(Lime water) (White PPT)

On passing excess carbon dioxide the following reaction takes place:

$CaCO_3(s) + H_2O\ (l) + Co_2(g) \longrightarrow Ca(HCo_3)_2\ (aq)$

(Soluble in water)



How do Acids & Bases reacts with each other

When an acid reacts with a base, then a salt and water are formed. That is :

Acid + Base $\longrightarrow$ Salt + Water

when an acid is treated with a base, the base neutralises the acid and destroys its acidity. Since an acid and a base neutralise each other's effect, so the reaction between an acid and a base to form salt and water is called a neutralisation reaction.

Example

Take about 5 mL of dilute sodium hydroxide solution in a test-tube. Add 2 or 3 drops of phenolphthalein indicator. The solution will turn pink.

Add dilute hydrochloric acid dropwise, we will find that the pink colour of solution in the test-tube just disappears. The solution becomes colourless

Now add a few drops of sodium hydroxide solution to the above colourless mixture. The mixture becomes pink in colour again.

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

Reaction Of Metallic Oxides with Acids

Acids react with metal oxides to form salt and water :

Metal oxide + Acid $\longrightarrow$ Salt + Water

Example

Take a small amount of copper oxide in a beaker and add dilute hydrochloric acid slowly while stirring.

the colour of the solution becomes blue-green and the copper oxide dissolves. The blue-green colour of the solution is due to the formation of copper(II) chloride in the reaction.

$$CuO\ (s) + 2HCl\ (aq) \longrightarrow CuCl_2\ (aq) + H_2O\ (l)$$

Copper (II) oxide Hydrochloric acid Copper (II) chloride Water

(Black) (Blue-green)

WHAT DO ALL ACIDS & BASES HAVE IN COMMON?

Example

Take solutions of glucose, alcohol, hydrochloric acid, sulphuric acid, etc.

Fix two nails on a cork, and place the cork in a 100 mL beaker.

Connect the nails to the two terminals of a 6 volt battery through a bulb and a switch.

Now pour some dilute HCl in the beaker and switch on the current.

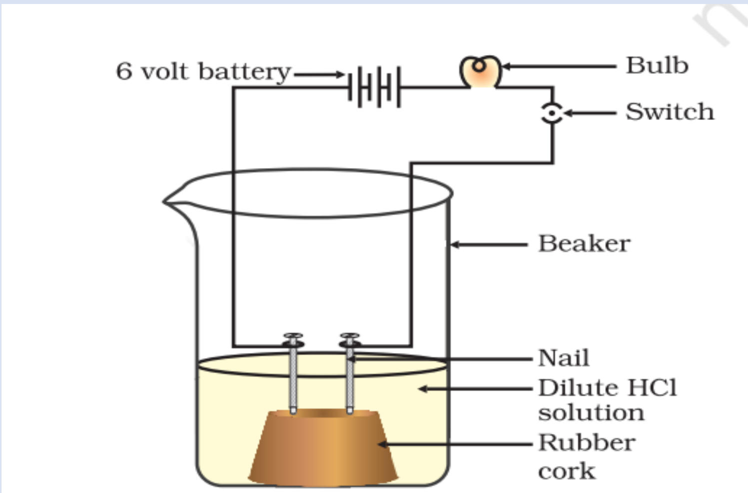
Repeat with dilute sulphuric acid. Repeat the experiment separately with glucose and alcohol solutions.

The bulb will start glowing in the case of acids. But in glucose and alcohol solutions do not conduct electricity.

Glowing of the bulb indicates that there is a flow of electric current through the solution. The electric current is carried through the acidic solution by ions.

Acids contain $\mathrm{H^+}$ ion as cation and anion such as $\mathrm{Cl^-}$ in HCl, $\mathrm{No_3^-}$ in HNO3, so_4^{2-} in H2SO4, CH3$\mathrm{COO^-}$ in CH3 COOH.

Since the cation present in acids is $\mathrm{H^+}$, this suggests that acids produce hydrogen ions, $\mathrm{H^+}$(aq), in solution, which are responsible for their acidic properties.



What Happen to an Acids or a Bases in a Water Solutions?

Example

Take about 1g solid NaCl in a clean and dry test tube and set up the apparatus as shown in .

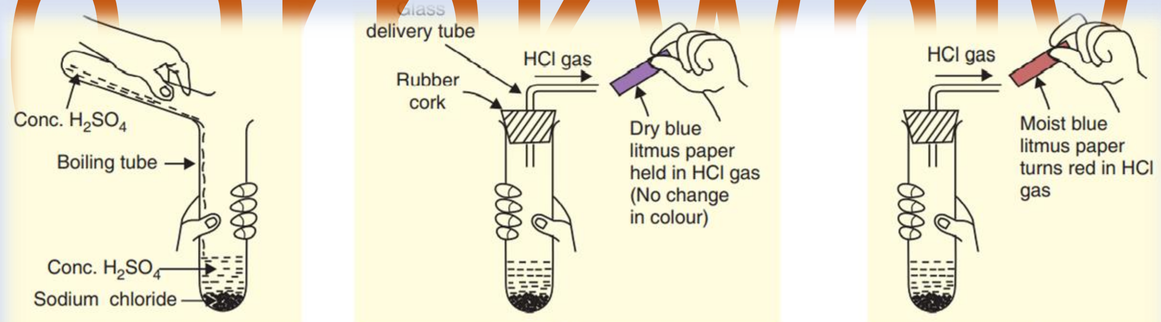
Add some concentrated sulphuric acid to the test tube.

Is there a gas coming out of the delivery tube?

Test the gas evolved successively with dry and wet blue litmus paper.

In which case does the litmus paper change colour?

The HCl gas turns 'wet' blue litmus paper red because it dissolves in the water present in wet litmus paper to form hydrogen ions, H+(aq) ions, which can turn blue litmus paper to red.



(a) Preparation of HCl gas (b) Testing HCl gas with dry litmus paper (c) Testing HCl gas with moist (wet) litmus paper

hydrogen ions in HCl are produced in the presence of water. The separation of H+ ion from HCl molecules cannot occur in the absence of water.

HCl + H2O $\longrightarrow$ H_3O^+ **+** Cl^-

Hydrogen ions cannot exist alone, but they exist after combining with water molecules.

H^+ **+ H2O** $\longrightarrow$ H_3O^+

When a base is dissolved in water, it always produces hydroxide ions (OH^- ions).

$$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$$

$$KOH(s) \xrightarrow{H_2O} K^+(aq) + OH^-(aq)$$

a base which is soluble in water is called an alkali. Some of the common water soluble bases (or alkalis) are : Sodium hydroxide (NaOH), Potassium hydroxide (KOH), Calcium hydroxide [Ca(OH)2], Ammonium hydroxide (NH4OH), and Magnesium hydroxide [Mg(OH)2].

How Strong Are Acids Or Bases Solutions?

The universal indicator shows different colours at different concentrations of hydrogen ions in a solution.

A scale for measuring hydrogen ion concentration in a solution, called pH scale has been developed.

On the pH scale we can measure pH generally from 0 (very acidic) to 14 (very alkaline). pH should be thought of simply as a number which indicates the acidic or basic nature of a solution.

Higher the hydronium ion concentration, lower is the pH value. The pH of a neutral solution is 7. Values less than 7 on the pH scale represent an acidic solution.

As the pH value increases from 7 to 14, it represents an increase in OH– ion concentration in the solution, that is, increase in the strength of alkali.

The strength of acids and bases depends on the number of H+ ions and OH– ions produced, respectively.

Acids that give rise to more H+ ions are said to be strong acids, and acids that give less H+ ions are said to be weak acids.

IMPORTANCE OF pH IN EVERYDAY LIFE

Are plants and animals' pH sensitive?

Our body works within the pH range of 7.0 to 7.8. Living organisms can survive only in a narrow range of pH change. When pH of rain water is less than 5.6, it is called acid rain. When acid rain flows into the rivers, it lowers the pH of the river water. The survival of aquatic life in such rivers becomes difficult.

Most of the plants grow best when the pH of the soil is close to 7. If the soil is too acidic or too basic (too alkaline), the plants grow badly or do not grow at all. The soil may be acidic or basic naturally. The soil pH is also affected by the use of chemical fertilisers in the fields. The pH of acidic soil can reach as low as 4 and that of the basic soil can go up to 8.3.

pH in our digestive system

our stomach produces hydrochloric acid. It helps in the digestion of food without harming the stomach. During indigestion the stomach produces too much acid and this causes pain and irritation. To get rid of this pain, people use bases called antacids. These antacids neutralise the excess acid. Magnesium hydroxide (Milk of magnesia), a mild base, is often used for this purpose.

pH change as the cause of tooth decay

Tooth decay starts when the pH of the mouth is lower than 5.5. Tooth enamel, made up of calcium hydroxyapatite is the hardest substance in the body. It does not dissolve in water, but is corroded when the pH in the mouth is below 5.5. Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth after eating.

Salts

A salt is a compound formed from an acid by the replacement of the hydrogen in the acid by a metal

Salts are formed when acids react with bases.

Just like acids and bases, solutions of salts in water conduct electricity. That is, salts are electrolytes. Salt solutions conduct electricity due to the presence of ions in them. Salts are ionic compounds.

Family of Salts

The salts having the same positive ions (or same negative ions) are said to belong to a family of salts.

sodium chloride (NaCl) and sodium sulphate (Na_2SO_4) belong to the same family of salts called 'sodium salts'.

sodium chloride (NaCl) and potassium chloride (KCl) belong to the same family of salts called 'chloride salts'.

The pH of Salt Solutions

Salts of a strong acid and a strong base are neutral with pH value of 7.

On the other hand, salts of a strong acid and weak base are acidic with pH value less than 7.

And those of a strong base and weak acid are basic in nature, with pH value more than 7.

Chemicals from Common Salts

The salt formed by the combination of hydrochloric acid and sodium hydroxide solution is called sodium chloride.

$$NaOH\,(aq) + HCl\,(aq) \longrightarrow NaCl\,(aq) + H_2O\,(l)$$

Seawater contains many salts dissolved in it. Sodium chloride is separated from these salts. Deposits of solid salt are also found in several parts of the world. These large crystals are often brown due to impurities. This is called rock salt. Beds of rock salt were formed when seas of bygone ages dried up. Rock salt is mined like coal.

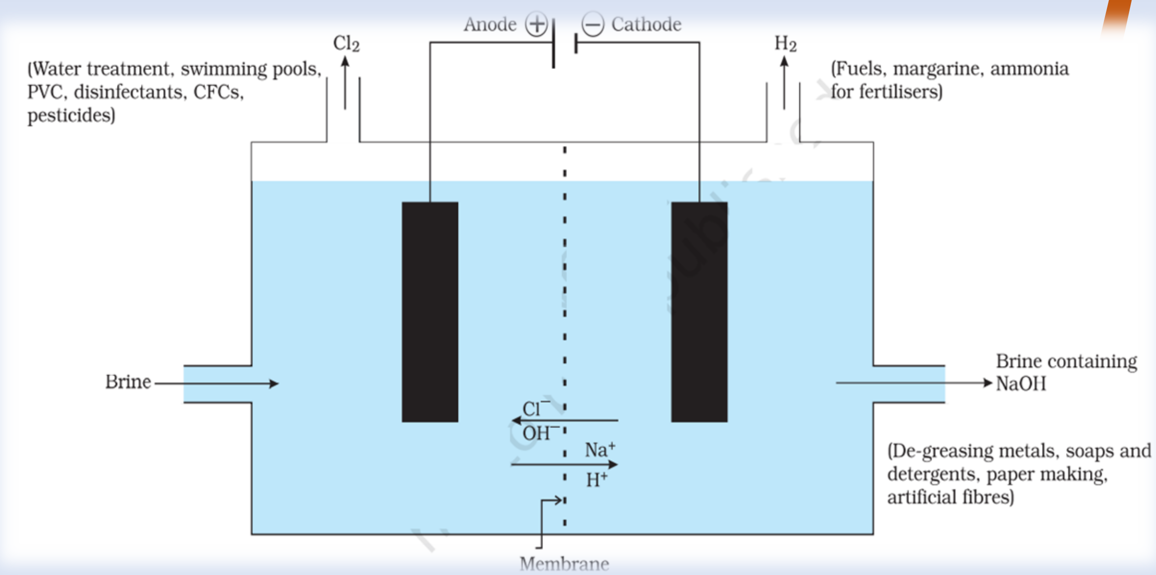
CHEMICALS FROM COMMON SALT

Sodium hydroxide

When electricity is passed through an aqueous solution of sodium chloride (called brine), it decomposes to form sodium hydroxide. The process is called the chlor-alkali process because of the products formed– chlor for chlorine and alkali for sodium hydroxide.

$$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$$

Chlorine gas is given off at the anode, and hydrogen gas at the cathode. Sodium hydroxide solution is formed near the cathode. The three products produced in this process are all useful.



Bleaching powder

Bleaching powder is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$]. Bleaching powder is represented as $CaOCl_2$, though the actual composition is quite complex.

$$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$$

Bleaching powder is used –

(i) **for bleaching cotton and linen in the textile industry, for bleaching wood pulp in paper factories and for bleaching washed clothes in laundry;**

(ii) **as an oxidising agent in many chemical industries;**

(iii) **to make drinking water free from germs.**

Baking soda

The chemical name of the compound is sodium hydrogencarbonate ($NaHCO_3$). It is produced using sodium chloride as one of the raw materials.

$$NaCl + H_2O + CO_2 + NH_3 \longrightarrow NH_4Cl + NaHCO_3$$

(Ammonium chloride) (Sodium hydrogencarbonate)

Uses of Baking soda

(i) **For making baking powder, which is a mixture of baking soda (sodium hydrogencarbonate) and a mild edible acid such as tartaric acid. When baking powder is heated or mixed in water, the following reaction takes place –**

$$NaHCO_3 + H^+ \rightarrow CO_2 + H_2O + \text{Sodium salt of acid}$$

(ii) **Sodium hydrogencarbonate is also an ingredient in antacids. Being alkaline, it neutralises excess acid in the stomach and provides relief.**

(iii) **It is also used in soda-acid fire extinguishers**

Washing soda

sodium carbonate can be obtained by heating baking soda; recrystallisation of sodium carbonate gives washing soda. It is also a basic salt

Na_2CO_3 + $10H_2O$ ⟶ $Na_2CO_3.10H_2O$

Uses of washing soda

(i) Sodium carbonate (washing soda) is used in glass, soap and paper industries.

(ii) It is used in the manufacture of sodium compounds such as borax.

(iii) Sodium carbonate can be used as a cleaning agent for domestic purposes.

(iv) It is used for removing permanent hardness of water.

PLASTER OF PARIS

On heating gypsum at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate $CaSO_4.\frac{1}{2}H_2O$

This is called Plaster of Paris, Plaster of Paris is a white powder and on mixing with water, it changes to gypsum once again giving a hard solid mass.

$$CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O \longrightarrow CuSO_4.2H_2O$$