ACIDS, BASES AND SALTS

There are 118 elements known at the present time. When these elements combine to form compounds, on the basis of their chemical properties, all the compounds can be classified into three groups.

(i) Acids (ii) Bases (iii) Salts

In order to know whether a substance is an acid or a base, we should know about indicator.

Topic : Indicator

An indicator is a 'dye' (or colour) that changes colour when it is put into an acid or a base. In other words an indicator tells us whether the substance, we are testing is an acid or a base by change in its colour. They are called indicators because they indicates the presence of an acid or a base showing change in colour. There are two types of indicators, (i) natural indicators (ii) synthetic indicators

Indicators

Natural Indicators	Synthetic Indicators
(i) Litmus	(i) Methyl Orange
(ii) Turmeric juice	(ii)Phenolphthalein
(iii) Red Cabbage Juice	
(iv) Coloured petals of some flower (like Hydrangea plant, Petunia plant and Geranium plant etc.	

1 : Natural Indicators

(i) Litmus: The most common indicator used for testing acids and bases is litmus. The natural colour of litmus is **purple** for sake of convenience. It is made into blue litmus and red litmus.

(a) Blue Litmus: (Natural colour paper)

(i) In acidic solution blue litmus turns to red.

(ii) In basic solution, it remains blue.

(iii) In neutral solution, it remains blue.

Note: Acidic solution like binegar, lemon juice, juice of unripe grapes, Juice of unrip mangoes, tamrind is turns blue litmus to red.

(b) Red Litmus: (Natural colour paper)

(i) In basis solution red litmus turns to blue.

(ii) In acidic solution, it remains red.

(iii) In neutral solution, it remains red.

Note: Basic solution as like, baking soda, washing soda, bitter gourd (loki) extract, cucumber extract etc turns red litmus to blue.

Litmus is extracted from **'Lichen'** a plant belonging to variety of **'Thallophyta'**. It is applied on paper in the form of strip and is available as blue and red strip.

(ii) Turmeric Juice (Natural colour is yellow):

(a) In acidic solution it remains yellow

(b) In natural solution it remains yellow

(c) In brown solution it turns reddish brown

Important Discussion: When a yellow stain of curry on a white cloth, turn reddish brown. When soap is scrubbed on it. This is because, the soap solution is a basic in nature which change the colour of turmeric in the curry stain to red brown. This stain turns to yellow again when the cloth is washed with plenty of water. This is because the basic soap gets removed with water.

(iii) Red Cabbage Juice (Natural colour is red):

(a) it remains red in solution

(b) it becomes pink in acidic solution

(c) it becomes green in based solution

Note: The coloured petals of some flowers like rose, petunia, hydrangea and geranium etc which change colour in the presence of acids or bases also act as indicator. For example, the flowers of **Hydrangea plant** are usually **blue** which turn **pink** in the basic solution.

2 : Synthetic Indicators

(i) Phenolphthalein: Phenolphthalein is synthetic indicator. The neutral colour of phenolphthalein is **'colourless'.**

(i) In acidic solution, it remains **colourless**

(ii) In basic solution, the colour of phenolphthalein changes to **pink.**

(iii) It natural solution it remains colours

(ii) Methyl Orange: Methyl Orange is a synthetic indicator. The neutral colour of methyl orange is **'orange'.**

(i) In the acidic medium the colour of indicator becomes **red**

(ii) In the basic solution, it changes to **yellow.**

(iii) It remains orange in natural solution.

Topic: Some Common Indicators with Characteristic Colours

	Name of Indicator	Colour in acidic solution	Colour in neutral solution	Colour in basic solution
Natural Indicator	1. Blue Litmus	Red	Purple	Blue
	2. Red Litmus	Red	Purple	Blue
	3. Flowers of Hydrangea plant.	Blue	Blue	Pink
	4. Turmeric	Yellow	Yellow	Reddis brown
Synthetic indicator	5. Red Cabbage extract	Pink	Red	Green
	6. Phenolphthalein	Colourless	Colourless	Pink
	7. Methyl orange	Red	Orange	Yellow

Activity 2.1

Aim: To test the given sample with the help of red litmus solution, blue litmus solution, phenolphthalein and methyl orange indicators.

Materials Required: hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3), acetic acid (CH_3COOH), sodium hydroxide (NaOH), calcium hydroxide $Ca(OH_2)$, potassium hydroxide (KOH), magnesium hydroxide $Mg(OH)_2$ and ammonium hydroxide (NH_4OH).

Procedure:

Step 1: Take each of the above solutions in separate test tube.

Step 2: Test the nature of these solutions by adding a drop of red litmus solution, blue litmus solution, phenolphthalein and methyl orange indicators.

Step 3: Observe the change in colour and record your observations.

Sample solution	Red litmus solution	Blue litmus solution	Phenolphthalein solution	Methyl orange solution
Hydrochloric acid	Red	Red	Colourless	Red
Sulphuric acid	Red	Red	Colourless	Red
Nitric acid	Red	Red	Colourless	Red
Acetic acid	Red	Red	Colourless	Red
Sodium hydroxide	Blue	Blue	Pink	Yellow
Calcium hydroxide	Blue	Blue	Pink	Yellow
Potassium hydroxide	Blue	Blue	Pink	Yellow
Magnesium hydroxide	Blue	Blue	Pink	Yellow
Ammonium hydroxide	Blue	Blue	Pink	Yellow

Observations: Acidic substances turn blue litmus to red. Basic substances turn red litmus to blue. Phenolphthalein remains colourless in acidic solution, whereas it becomes pink in basic solution, methyl orange becomes red in acidic substances and yellow in basic substances.

Conclusions: Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3) and Acetic acid (CH_3COOH) are acidic in nature, while Sodium Hydroxide (NaOH), Calcium Hydroxide $Ca(OH)_2$, Potassium Hydroxide (KOH), Magnesium Hydroxide $Mg(OH)_2$ and Ammonium Hydroxide (NH_4OH) are basic in nature.

Olfactory Indicators

The term of Olfactory means relating to the sense of smell. Those substances whose smell changes in acidic or basic solution are called olfactory indicators, onion and vanilla extract are the example of olfactory indicators.

Onion Extract: Onion has characteristic smell in basic solution the characteristic smell of onion becomes disappear. In acidic solution, the characteristic smell of onion remains same.

Vanilla Extract: Vanilla extract has a characteristic pleasant smell in basic solution the characteristic pleasant smell of Vanilla Extract becomes disappear in acidic solution the characteristic pleasant smell of vanilla extract remains same.

Activity 2.2(a)

Aim: To test the given sample with the help of onion extract.

Materials Required:

Finally chopped onion in a plastic bag along with two strips of clean cloth, dilute Hydrochloric acid (HCl) solution and dilute Sodium Hydroxide (NaOH) solution.

Procedure:

Step1: Tie up the bag tightly and leave overnight in the fridge.

Step2: Take two of the cloth strips and check their odour.

Step3: Keep the cloth strips on a clean surface and put a few drops of dilute Hydrochloric acid (HCl) solution on one strip and a few drops of dilute Sodium Hydroxide (NaOH) solution on the other strip.

Step 4: Wash both cloth strips with water and again check their odour.

Step 5: Note your observations.

Observations: The characteristic smell of onion get destroyed with sodium hydroxide solution and remains as such with hydrochloric acid solution.

Conclusion: Hydrochloride acid (HCl) is acidic in nature and Sodium Hydrooxide (NaOH) is basic in nature.

Activity 2.2(b)

Aim: To test the given sample with the help of vanilla extract.

Materials Required: Dilute vanilla extract, dilute Hydrochloride acid solution (HCl), Dilute Sodium Hydroxide (NaOH) solution and two test tubes.

Procedure:

Step1: Take some dilute Hydrochloride acidic (HCl) solution in one test tube and dilute Sodium Hydroxide (NaOH) solution in another test tube.

Step 2: Add a few drops of dilute vanilla extract to both the test tubes and shake well.

Step 3: Check the odour and record our observations.

Observations: The characteristic pleasant smell of Vanilla extract is destroyed with Sodium Hydroxide (NaOH) solution and remains as such with hydrochloric acid (HCl) solution.

Conclusion: Dilute Hydrochloric acid (HCl) solution is acidic in nature and dilute Sodium Hydroxide (NaOH) solution is basic in nature.

Topic: Acids & their Properties

Earlier Definition: Acids are those chemical substances which have a sour taste and turns blue litmus to red. Some of the common fruits such as raw mangos, raw grapes, lemon, orange and tamarind etc are sour in taste due to the presence of acids in them.

Present Definition: According Arrhenius Theory an acid is a substance which dissociates (or ionise) on dissolving in water to produce hydrogen ions (H^+). For example aqueous solution of hydrochloric acid (HCl) to form hydrogen ions.

$$HCl\ (aq) \longrightarrow H^+\ (aq) + Cl^-\ (aq)$$

Note: Hydrogen ions do not exist as H^+ ions in a solution, they attach themselves to the polar water molecules to form hydronium ions (H_3O^+)

$$H^+ + H_2O \longrightarrow H_3O^+ \text{(Hydronium ion)}$$

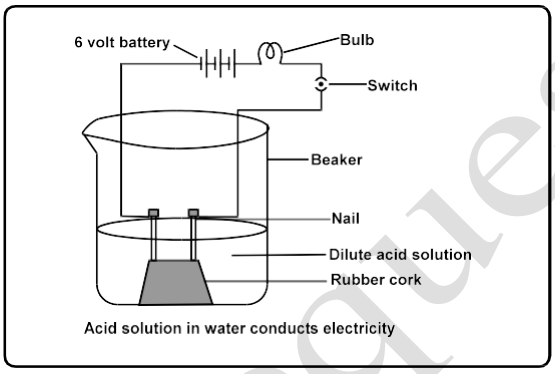
Important discussion: The acids shows acidic

character due to presence of hydrogen ions in aqueous solution. The compounds such as glucose ($C_6H_{12}O_6$) alcohol (C_2H_5OH) and methane (CH_4) etc. also contains hydrogen. But they are not show acidic behaviour because their hydrogen does not separate out as hydrogen ion (H^+) from a aqueiv solution. From above discussion it is clear a common thing in all the acids is that they produce hydrogen ions (H^+), when dissolved in water. **Note:** All the acids shows same behaviour due to the presence of hydrogen ions (H^+).

Activity 2.7

Aim: To show that acid solutions can conduct electricity whereas solutions of glucose and alcohol do not conduct electricity.

Materials Required: A Beaker, two iron nails, a rubber cork, 6 volt battery, switch, glucose, alcohol, hydrochloric acid or sulphuric acid.



Procedure:

Step 1: Fix two iron nails on a rubber cork, and place the cork in 100 mL beaker.

Step 2: Connect the Iron nails to the two terminals of a 6 volt battery through a electric bulbs and a switch, as shown in figure.

Step 3: Now pour dil Hydrochloric acid (HCl) in the beaker and switch on the current.

Step 4: Repeat the experiment with dilute sulphuric acid and observe carefully.

Step 5: Repeat the experiment separately with glucose and alcohol solutions and observe carefully.

Observations:

- The electric bulb glows when acid solutions are taken in the beaker and the bulb does not glow when solutions of glucose and alcohol are taken in the beaker.

Conclusions:

(i) Acids conduct electricity in aqueous solution because they produce hydrogen ions (H^+) in aqueous solution.

(ii) Substances like alcohol and glucose do not conduct electricity because they do not produce hydrogen ion (H^+) in aqueous solution

Activity 2.8

Aim: To show acids do not show acidic behaviour in the absence of water.

Materials Required: 1 gm of solid Sodium chloride (NaCl), the dry test tubes, conical flask, delivery tube, cork, dry and wet blue litmus paper, concentrated sulphuric acid.

Procedure (A):

Step 1: Take about 1g of solid Sodium chloride (NaCl) in a clean and dry test tube.

Step 2: Add some concentrated sulphuric acid to the test tube.

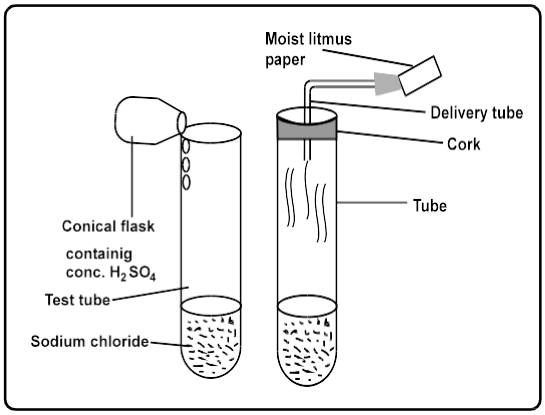
Step 3: Note the observations.

Observations: Con. sulphuric acid reacts with sodium chloride to form hydrogen chloride gas (HCl).

Procedure (B):

Step 1: Test the gas evolved Hydrogen chloride (HCl) successively with dry and wet blue litmus paper.

Observations: There is no change on dry litmus paper but moist blue litmus paper turns red.



Conclusions:

1. Hydrogen chloride gas (HCl) does not behave as an acid in the absence of water.
2. Hydrogen chloride gas (HCl) shows acidic behaviour in the presence of water.

Knowledge Boosters: The aqueous solution of an acid conducts electricity due to the presence of charged particles. Distilled water does not conduct electricity because it does not contain any ionic compound dissolved in it. On the other hand rain water conduct electricity this is because, when rain water falls, on the earth through the atmosphere, dissolve an acidic gas Carbondioxide (CO_2) to form carbonic acid (H_2CO_3). This carbonic acid provides hydrogen ions (H^+). Due to this the rain water conduct electricity.

Classification of Acids

Acids are classified on the basis (i) sources (ii) concentration (iii) strength.

(1) Classification of acids on the bases of sources on the basis of sources all the acids are divided into two categories

(i) Organic Acids

(ii) Mineral Acids

(i) **Organic Acids:** Those acids which are obtained from plants and animals are called organic acids. Some common organic acids and their sources are given below.

S.No.	Name of Acids	Name of Sources
1.	Acetic Acid	Vinegar (Sirka)
2.	Citric Acid	Lemon, orange & raw mangoes or Citrus fruit
3.	Lactic Acid	In sour milk or curd
4.	Tartaric Acid	In tamarind and unripe tomatoes
5.	Oxalic Acid	Tomatoes, spinach
6.	Formic Acid	In ant sting and nettle leaf sting
7.	Melic Acid	In apples
8.	Amino acids	In Proteins

Some Organic Acids and their formulae

Name of Acids	Chemical Formulae
(i) Acetic Acid	CH_3COOH
(ii) Citric Acid	$C_6H_6O_7$
(iii) Lactic Acid	$CH_3CH(OH)COOH$
(iv) Tartaric Acid	$C_4H_6O_6$
(v) Oxalic Acid	$C_2H_2O_4$
(vi) Formic Acid	$HCOOH$

Note: All the organic acids are the weak acids.

(ii) **Mineral Acids:** Those acids which are prepared from the minerals of the earth are called mineral acids. Hydrochloric acid $(HC\ell)$, sulphuric acid (H_2SO_4), nitric acid (HNO_3), Carbonic acid (H_2CO_3), Sulphurous acid (H_2SO_3), Phosphorous acid (H_3PO_4) one the examples mineral acids.

Note: All the mineral acids are strong acids except carbonic acid (H_2CO_3), phosphoric acid (H_3PO_4) and Sulphurous acid (H_2SO_3). Some common acids and their Chemical formulae are given below:

Sl.No.	Name of the acid	Chemical Formula
1.	Hydrochloric acid	HCL
2.	Sulphuric acid	H_2SO_4
3.	Nitric acid	HNO_3
4.	Acetic acid	CH_3COOH
5.	Formic acid	$HCOOH$
6.	Carbonic acid	H_2CO_3
7.	Phosphoric acid	H_3PO_4

(2) Classification of acids on the basis of Concentration: On the basis of concentration all acids are divided into two categories:

(i) Concentrated Acids **(ii)** Dilute Acids

(i) Concentrated Acids: Concentrated acids are those acids which contains less amount of water and large amount of acid. For example: concentrated sulphric acid contains 98% acid and 2% water.

(ii) Dilute Acids: Dilute acids are those acids which contains large amount of water and small amount of acid. For example, dilute sulphuric acid contains 90% water and 10% acid.

Dilution of Acids: The process of diluting acid is highly exothermic reaction so dilution of concentrated acid done by adding concentrated acid to water, gradually not by adding water to concentrated acid. This is because, when concentrated acid is added to water. The heat energy is evolved gradually easily absorbed by the large amount of water. On the other hand if water is added to concentrated sulphuric acid, then a large amount of heat is evolved at once. This heat changes some of the water to steam explosively which can splash out from the test tube and may cause acid burn.

(3) Classification of acids on the basis of upon their Strengths: On the basis of strength the acids are divided into two categories

(i) Strong Acids (ii) Weak Acids

(i) Strong Acids: Those acids which are completely ionised in water and produces a large amount of hydrogen ions(H^+)are called strong acids. Hydrochloric acid (HCl), sulphuric acid (H_2SO_4) and nitric acid HNO_3) are the examples of strong acid.

$$HCl\ (aq) \longrightarrow H^+\ (aq) + Cl^-\ (aq)$$

- The single arrow indicates that hydrochloric acid is completely ionised.

Note: The word 'strong' refer to the 'degree of ionisation' and not to the 'concentration' of the acid. Strong acids have a high electrical conductivity i.e. strong acids are very good electrolytes because of the high concentration of hydrogen ions (H^+).

(ii) Weak Acids: Those acids which are partially ionised in water and produces a small amount of hydrogen ions (H^+) are called weak acids. Acetic acid (CH_3COOH), carbonic acid (H_2CO_3) and sulphurous acid (H_2SO_3) etc. are the examples of weak acids.

$$CH_3COOH \rightleftharpoons CH\ COO_3^-\ (aq) + H^+$$

- The double arrow shows that acetic acid does not ionise completely.

Note: When the concentrated solution of an acid is dilute by mixing water, then the concentration of hydrogen ions per unit volume decreases.

Characteristics of Acids:

Physical Properties of Acids:

1. Acids have a sour taste
2. Acids turn blue litmus to red
3. Acid are electrolytes.
4. Strong acids have corrosive nature, they produce a burning sensation.

Note: Acids have corrosive nature, so they attack metal structure and stone work, due to this they are stored in containers of glass or ceramics

Electrolytes: Those substances which conduct electricity an aqueous solution or taken in molten state.

Chemical Properties of Acids:

4. Reaction of acids with metals: All metals above hydrogen in the reactivity series of metal react with dilute acid to form metal salt and hydrogen gas.

Concept:

Metal + Dil Acid → Metal Salt + Hydrogen gas

Example: When dilute sulphuric acid reacts with zinc metal, then zinc sulphate and hydrogen gas are formed:

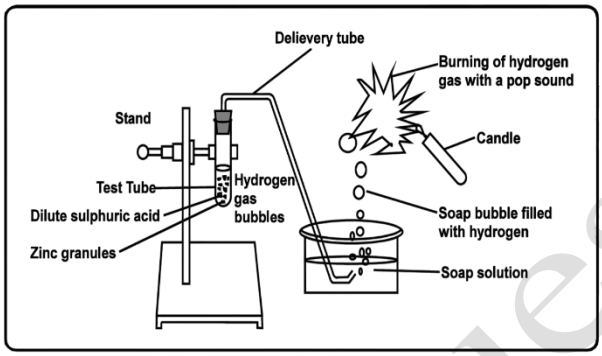
$Zn + H_2SO_4 \longrightarrow ZnSO_4(aq) + H_2(g)$

Note: All the metals above hydrogen in the reactivity series react with dil. Sulphuric acid (H_2SO_4) or Dil. HCl to form metal salt and hydrogen gas.

Activity 2.3

Aim: To show that Dil. acids reacts with metals to liberate hydrogen gas.

Material Required: Zinc granules, dilute sulphuric acid (H_2SO_4) cork, delivery tube, test tube, match box, gas jar, soap solution, stand etc.



Procedure (Case I):

Step 1: Take about 5mL of dilute Hydrochloride acid in a test tube and add a few pieces of zinc granules to it.

Step 2: Note your observations.

Observations: It is observed that a brisk evolution takes place at the surface of zinc granules.

Conclusion: This result shows that reaction is taking place with the evolution of a gas.

Procedure (Case II):

Step 1: Pass the gas through the soap solution.

Step 2: Note your observations.

Observations: The soap bubbles filled with the gas rise up.

Conclusion: This result shows that the gas is lighter than the soap solution.

Procedure (Case III):

Step 1: Take a burning candle near the soap bubbled filled with gas.

Step 2: Note your observations.

Observations: The bubbles bursts and the gas present in it catches fire with pop sound.

Conclusion: This result shows that the gas is hydrogen. Dilute hydrochloric acid reacts with zinc to form zinc chloride and hydrogen gas

$$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$$

Note: The curd and other sour food - stuffs should not be kept in metal vessels (like copper vessels or brass vessels). This is because curd and other sour food - stuffs contains acids which can react with metal of the vessel to form poisonous metal compounds which can cause food poisoning and damage our health.

5. **Reaction of acids with metal carbonate:** Acids react with metal carbonates to form metal salt, carbon dioxide gas and water.

Concept:

Metal carbonate + Dil Acid ⟶
Metal Salt + Carbon dioxide gas + water

Example: When dilute hydrochloric acid reacts with sodium carbonate, then sodium chloride, carbon dioxide gas and water are formed

$Na_2CO_3(s) + 2HCl(aq) \longrightarrow 2NaCl(aq) + CO_2(g) + H_2O$

6. **Reactions of acids with metal Bi carbonate:** Acids reacts with metal carbonate to form metal salt, carbon dioxide gas and water. **Concept:**

Metal Bicarbonate + Dil Acid ⟶
Metal Salt + carbon dioxide gas + water

Example: When dilute hydrochlric acid reacts with sodium Bi carbonate, then sodium chloride, carbon dioxide gas and water are formed

$NaHCO_3(s) + HCl(aq) \longrightarrow NaCl(aq) + CO_2(g) + H_2O(l)$

Note: Limestone, marble, egg shells and chalk are the different forms of the same chemical compound i.e. 'calcium carbonate' $(CaCO_3)$.

Activity 2.4

Aim: To show that acids reacts with metal carbonate to liberate carbon dioxide gas.

Materials Required: Two test tubes, label them as A and B, 0.5 gm sodium Bi carbonate ($NaHCO_3$), dil, Hydrochloric acid (HCl) lime water ($Ca(OH)_2$) and 0.5 g sodium carbonate (Na_2CO_3).

Procedure:

Step 1: Take about 0.5 gm of sodium carbonate (Na_2CO_3) in test tube A and about 0.5 gm of sodium Bi carbonate ($NaHCO_3$) in test tube B.

Step 2: Add about 2mL of dilute HCl to both the test tube A and B.

Step 3: Note your observations.

Observations: Acid reacts with metal carbonate and metal Bi carbonate to give metal salt, carbon dioxide gas and water.

Chemical Reactions in Test Tube A:

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

Chemical Reactions in Test Tube B:

$$NaHCO_3(s) + HCl(aq) \rightarrow NaCl + H_2O + CO_2$$

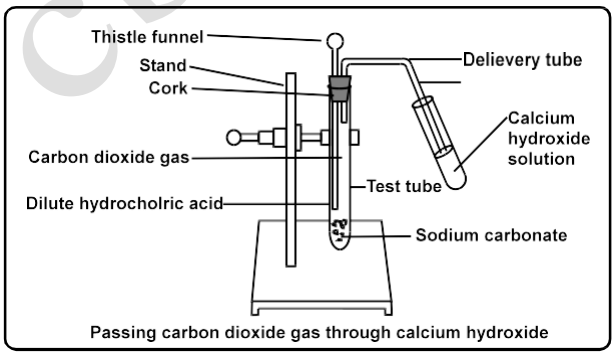
Conclusion: All metal carbonates and metal Bi carbonates react with acids to give a corresponding metal salt, carbon dioxide gas and water.

On passing the carbondioxide gas (CO_2) through lime water, the lime water turns milky due to the formation of a white precipitate of calcium carbonate.

$$\underset{\text{(Lime water)}}{Ca(OH)_2(aq)} + CO_2(aq) \rightarrow \underset{\text{(White ppt.)}}{CaCO_3(s)} + H_2O(\ell)$$

If excess amount of carbon dioxide is passed through lime water, then milkiness of solution becomes colourless due to formation of calcium Bi carbonate.

$$\underset{\text{(Whiteppt)}}{CaCO_3(s)} + CO_2(g) + H_2O(\ell) \rightarrow \underset{\text{Calcium hydrogen Carbonate}}{Ca(HCO_3)_2(aq)}$$



Passing carbon dioxide gas through calcium hydroxide

Note: If someone is suffering from the problem of acidity after overeating, we can suggest taking baking soda solution as remedy. This is because baking soda is sodium Bi carbonate reacts with excess hydrochloric acid in the stomach and neutralises it. This gives relief to the person suffering from acidity.

6. Reaction of acids with bases:

When an acid reacts with a base, then a metal salt and water are formed.

Concept:

Acid + Base ⟶ Metal Salt + Water

For example: When sodium hydroxide (NaoH) react with hydrochloric acid (HCl) to form sodium chloride salt and water.

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

Neutralization Reaction: The reaction in which an acid react with a base to form salt and water is called neutralisation reaction.

Note: The antacid called 'Milk of Magnesia' which is used to remove indigestion is a metal hydroxide called 'magnesium hydroxide' $Mg(COH)_2$ it is basic in nature. It reacts with the excess hydrochloric acid present in the stomach and neutralises it.

Activity 2.5

Aim: To demonstrate neutralization reaction between acid and base.

Materials Required: 2 mL of dilute Sodium Hydroxide (NaOH) solution test tube, two drops of phenolphthalein solution and dilute hydrochloric acid (HCl).

Procedure:

Step 1: Take about 2 mL of dilute Sodium Hydroxide (NaOH) solution in a test tube.

Step 2: Add 2 or 3 drops of phenolphthalein solution to the test tube and observe the colour of the solution.

Step 3: We observe that the colour of the solution will turns pink.

Step 4: Add dilute Hydrochloric acid (HCl) solution to the above solution drop by drop solution.

Step 5: Observe the colour change for the reaction mixture.

Observations: The pink Colour of solution in the test-tube disappears and the solution becomes colourless.

Chemical Reation:

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(\ell)$$

Conclusion: All the sodium hydroxide solution taken in the test tube has been completely neutralized by hydrochloric acid.

7. **Reaction of acids with metal oxides:** Acids reacts with metal oxide to form metal salt and water.

Concept:

Metal oxide + Dil. Acid ⟶ Metal Salt + Water

Example: copper oxide reacts with dilute hydrochloric acid to form copper chloride and water.

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

Important Discussion: The reaction of metal oxides, metal carbonate, metal Bi carbonate and base with acids are the examples of neutralisation reaction. But main Neutralization reaction between Acids and Base

Activity 2.6

Aim: To study the neutralization reaction of copper oxide with dil. sulphuric acid (H_2SO_4)

Materials Required: Copper oxide (CuO), dil. sulphuric acid (H_2SO_4) and glass rod etc.

Procedure:

Step 1: Take small amount of copper oxide in a conical flask.

Step 2: Observe its colour. The colour of Copper Oxide (CuO) is black.

Step 3: Add dilute sulphuric acid (H_2SO_4) to conical flask.

Step 4: Warm a little conical flask.

Step 5: Observe the change in colour.

Observations: The black colour of copper oxide changes to blue coloured due to formation of copper sulphate solution ($CuSO_4$).

Chemical Reaction:

$$\underset{\text{Black}}{CuO} + \text{dil.}H_2SO_4 \longrightarrow \underset{\text{(Blue)}}{CuSO_4} + H_2O$$

Copper oxide

Conclusion: Metal oxides (Basic oxides) or bases react with acids to form salts and water.

Uses of Acids:

1. Sulphuric acid is used in the manufacture of fertilizers, paints, dyes, synthetic fibres, detergents, explosives and car batteries.
2. Nitric acid is used for manufacture of fertilizers, explosives (like TNT - Tri - Nitro toulene), dyes and plastics.
3. Hydrochloric acid (HCl) is used for removing oxide film from steel objects and for removing scale deposits from inside the boilers.

Advantages of Acids:

1. Hydrochloric acid (HCl) is released into stomach coagulate of proteins and helps in their digestion..
2. Hydrochloric acid (HCl) kills bacteria coming to the stomach with the food.
3. Acetic acid (Vinegar) is used as preservative in pickles and in chinese food. It gives sour taste to food.
4. Lemon contains citric acid which is used in case of indigestion.
5. Oranges and amla contains ascorbic acid (vitamin C) which prevent scurvy.

Activity 2.7

Aim: To show mixing of acid in water is an exotherimic reaction.

Materials Required: One beaker, 10 mL water and few drops of concentrated Sulphuric acid (H_2SO_4)

Procedure:

Step 1: Take 10 mL of water in a beaker.

Step 2: Add few drops of concentrated Sulphuric acid (H_2SO_4) to beaker.

Step 3: Swirl the beaker slowly.

Step 4: Touch the base of the beaker.

Step 5: Note the observation.

Observations: There is a rise in temperature.

Conclusions: Dissolution of acid in water is an exo-thermic reaction.

Topic : Bases & their Properties

Earlier Definition: Bases are those chemical substances which have a bitter taste and turns red litmus to blue. Sodium Hydroxide (NaOH), Potassium Hydroxide (KOH), Magnesium Hydroxide $(MgOH)_2$ etc. are the examples of bases.

Note: All the metal oxide, metals hydroxides , (except Ammonium Hydroxide) Metal carbonates and metal Bi carbonates are bases because they react with acids and neutralises the effect of acids.

Present Definition of bases: According Arrhenius Theory, a base is a substance which dissolove in water to produce hydroxide ions (OH^-) in a solution.

Example: When sodium hydroxide is dissolved in water to give hydroxide ions (OH^-).

$$NaOH\ (aq) \longrightarrow Na^+\ (aq) + OH^-\ (aq)$$

Base Sodium ions Hydroxide ion

Note: All the bases shows basic character due to the presence of hydroxide ions (OH^-) in aqueous solution.

Note: When the solution of base is diluted by mixing more water, then the concentration of hydroxide ions (OH^-) per unit volume decreases.

Alkalies: Water soluble bases are called alkalies. Sodium hydorxide (NaOH), Potassium Hydroxide (KOH), Calcium Hydroxide ($Ca(OH)_2$), Ammonium Hydroxide (NH_4OH) and magnesium hydroxide ($Mg(OH)_2$) are the examples of alkalies. All the bases are metal Hydroxide except Ammonium Hydroxide (NH_4OH)

Note: All the alkalies are bases but all the bases are not alkalies.

Classifaction of bases:

1. **Classification of bases on the Based upon Strength:** On the basis of strength bases are divided into two categories:
   (i) Strong Bases (ii) Weak Bases

(i) **Strong Bases:** Those bases which are completely ionised in water and produces a large amount of hydroxide ions (OH^-) are called strong bases, sodium hydroxide (NaOH), potassium hydroxide (KOH) and barium hydoxide $Ba(OH)_2$ are the examples of strong bases.

(ii) **Weak Bases:** Those bases which are partially ionised in water and produces small amount of hydroxide ions(OH^-) are called weak- bases. Ammonium hydroxide (NH_4OH), calcium hydroxide $Ca(OH)_2$ and magnesium hyroxide $Mg(OH)_2$ are the examples of weak bases.

1. **Physical properties of Bases:**
   1. Bases have bitter taste.
   2. Bases are slippery to touch.
   3. Bases turns red litmus to blue.
   4. Bases are electrolytes.
   5. Strong bases like potassium hydroxide (KOH) and sodium hydroxide NaOH have corrosive nature.

2. **Chemical properties of Bases:**

1. **Reaction of bases with acids:** Bases react with acids to form salt and water.

Concept:

Base + Dil. Acid $\longrightarrow$ salt + water

Example when sodium hydroxide react with sulphuric acid to form sodium sulphate and water.

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

Note: When an acid and base combine then the real neutralisation reaction occurs due to combination of hydrogen ions and hydroxide ions present an acid and base.

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

2. **Reaction of bases with non metal oxide:** Bases react with non metal oxides to form salt and water.

Concept:

Base + Non metal oxide ⟶ salt + water

Example: calcium hydroxide $Ca(OH)_2$ react with CO_2 gas to form calcium carbonate salt and water.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

Activity 2.8

Aim: To study the reaction of carbon dioxide (non-metallic oxide) with calcium hydroxide (Base).

MaterialS Required: Carbon dioxide gas (CO_2), calcium hydroxide Solution $Ca(OH)_2$ and test tube.

Procedure:

Step 1: Take a small amount of calcium hydroxide solution (Lime water) and a test tube.

Step 2: Pass carbon dioxide gas through calcium hydroxide solution.

Observations: During reaction a white precipitate of Calcium carbonate $CaCO_3$ is formed

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(\ell)$$

Conclusion: Calcium hydroxide $(CaOH)_2$, reacts with carbon dioxide to produce a salt and water.

3. **Reaction of bases with metals:** Like acid certain metals like zinc and aluminium react with bases to form hydrogen gas.

Concept:

Base + metal ⟶ metal salt + hydrogen gas

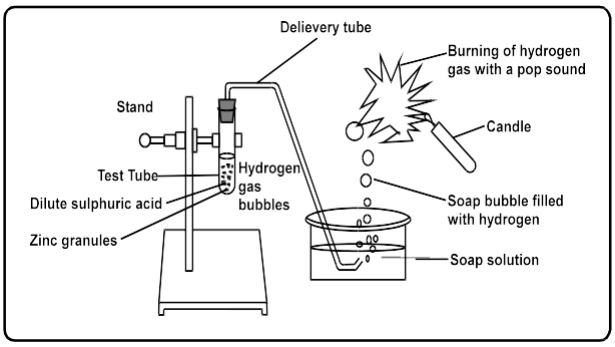
Example 1: Zinc metal react with sodium hydroxide solution (NaOH) to form sodium zincate (Na_2ZnO_2) and hydrogen gas.

$$2NaOH + Zn \longrightarrow Na_2ZnO_2 + H_2$$

Activity 2.9

Aim: To show that base reacts with metals to liberate hydrogen gas.

MaterialS required: Zinc granules, sodium hydroxide solution (NaOH), cork, delivery tube, test tube, match box, gas jar, stand, soap solution etc.



Procedure: (Case I)

Step1: Place a few pieces of granulated zinc metal in a test tube.

Step 2: Add 2 ml of sodium hydroxide solution (NaOH)and warm the contents of the test tube.

Step 3: Record your observations.

Observations: It is observed that a brisk evolution takes place at the surface of zinc granules.

Conclusion: This result shows that reaction is taking place with the evolution of a gas.

Procedure (Case II):

Step 1: Pass the gas through the soap solution.

Step 2: Note your observations.

Observations: The soap bubbles filled with the gas rise up.

Conclusion: This result shows that the gas is lighter than the soap solution.

Procedure (Case III):

Step 1: Take a burning candle near the bubbled with gas.

Step 2: Note your observations.

Observations: The bubbles bursts and the gas present in it catches fire with pop sound.

Conclusion: This shows that the gas is hydrogen.

$$2NaOH + Zn \longrightarrow \underset{\text{(Sodium Zincate)}}{Na_2ZnO_2} + H_2$$

Activity 2.10

Aim: To show mixing of base in water is an exothermic reaction.

Materials Required: One beaker, 10 mL water, few pellets of NaOH.

Procedure:

Step 1: Take 10 mL water in beaker.

Step 2: Add 2-3 pellets of NaOH to it.

Step 3: Swirl the beaker slowly.

Step 4: Touch the base of the beaker.

Step 5: Note the observations.

Observation: There is a rise in temperature.

Conclusion: Dissolution of base in water is an exothermic reaction.

Knowledge Booster:

A sweedish chemist has given a very important theory for acids and bases known as Arrhenius theory.

According to this theory:

(i) An acid or base when dissolved in water splits into ions. This is known as inonisation.

(ii) Upon dilution the ions gets separated from each other. This is known as dissociation of ions.

Uses of Bases:

(i) Sodium Hydroxide (NaOH) is used in the manufacture of soap, paper and synthetic fibre.

(ii) Calcium Hydroxide ($CaOH_2$) is used in the manufacturing of bleaching powder.

(iii) Magnesium hydroxide $Mg(OH)_2$ is used as an antacid.

Notes:

Topic : Strength of Acids and Bases Solution (pH Scale)

Water (H_2O) is slightly ionised into hydrogen ions (H^+ ions) and hydroxide ions (OH^-). In pure water, the concentration of hydrogen ions and hydroxide ions are equal. Due to this, pure water is neither acidic nor basic, it is a neutral substance.

(i) We know Acids produce hydrogen ions (H^+) in water. So, when an acid is added to water, then the concentration of hydrogen ions in water increases and the solution becomes acidic in nature.

(ii) We know bases produce hydroxide ions(OH^-) in water. So, when a base is added to water, then the concentration of hydroxide ions in water increases and the solution becomes basic in nature. It means both acidic solutions as well as basic solutions contains hydrogen ions.

In 1909 Sorenson devised a scale (known as pH scale) on which the strength of acidic solutions as well as basic solutions could be represented by making use of the concentration of hydrogen ions. Sorenson linked the hydrogen ions concentrations of acid and base solutions to the simple numbers 0 to 14 on his pH scale.

Note: The pH of a solution is inversely proportional to the concentration of hydrogen ions present in solution. That is, a solution having a high concentration of hydrogen ions has a low pH value and vice versa.

✦ pH Means Power of concentrain of Hydrogen ions in a solution.

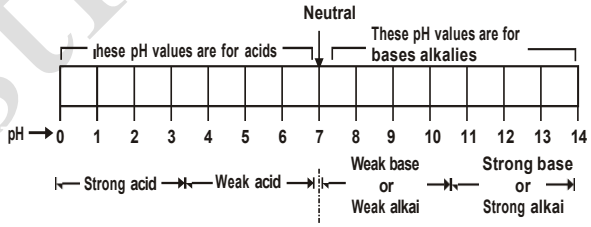
pH scale: The presentation of hydrogen ions concentration in a solution in simple whole number on a scale is called pH scale. On the basis of pH value all the substances are divided into three groups.

1. Neutral substances 2. Acidic substances
3. Basic substances

1. Neutral Substances: Neutral substances have a pH of exactly 7: A substance having pH 7 will have no effect on any type of litmus paper, methyl orange and phenophthalein.

2. Acidic Substances: Acidic substance have a pH of less than 7: All the substances having pH less than 7 are acidic in, so they turns blue litmus to red. Methyl orange to red and phenophthalein remains colourless.

3. Basic Substances: Basic substances have a pH of more than 7: All the substances having pH more than 7 are basic in nature (or alkaline in nature) hence they turn red litmus to blue, phenolphthalin to pink and methyl orange to yellow.



The pH values of some common substances is given below :

No.	Name of Solution	pH Values	No.	Name of Solution	pH Values
1.	Conc. hydrochloric acid	0.1	2.	Dil. hydrochloric acid	1.0
3.	Gastric juices	1.0 – 3.0	4.	Lemon juice	2.2 – 2.5
5.	Vinegar	2.4 – 3.4	6.	Tomato juice	4.0 – 4.4
7.	Coffe	4.5 – 5.5	8.	Soft drinks	3.0
9.	Milk	6.8	10.	Pure water	7.0
11.	Saliva (before meals)	7.4	12.	Saliva (after meals)	5.8
13.	Human blood and Tears	7.4	14.	Egg and sea water	7.8
15.	Toothpaste	8.0	16.	Baking soda solution ($NaHCO_3$)	8.5
17.	Washing soda solution	9.0	18.	Milk of magnesia $Mg(OH)_2$	10
19.	Household ammonia	11.6	20.	Dil. sodium hydroxide 0.1 ml (NaOH)	13.0
20.	Battery acid	10.5			
21.	Wine	2.8-3.8	21.	Conantrated sodium Hydroxide (NaOH)	14
22.	Bear	4.0-5.0		1MNaOH	

Topic : Universal Indiactor

Universal indiactor is a mixture of many different colours (or dyes) which give different colours at different pH values of the entire pH scale.

Note: The common indicators (like litmus) can tell us whether the given substance is an acid or a base. They cannot tell us the relative strength of acids or bases. The relative strength of acids or bases can be identified by using universal indicators. The colours produced by universal indiactor at various pH values are given below.

pH	Colours	pH	Colours
0	Dark red	8	Greenish Blue
1	Red	9	Blue
2	Light Red	10	Navy Blue
3	Orage Red	11	Purple
4	Orange	12	Dark Purple
5	Orange Yellow	13	Light voilet
6	Greenish Yellow	14	Dark Violet
7	Green		

Activity 2.13

Aim: To determine the pH values of various substances with the help of pH paper.

Materials Required: Saliva (before meal), Saliva (after meal), lemon juice, colourless aerated drink, carrot juice, coffee, tomato juice, tap water, 1mL NaOH, 1 mL HCl

Procedure

Step1 Take pH paper.

Step2 Add 2- 3 drops of various susbstances on pH paper.

Step3 Observe the change in colour and write approx pH and nature of susbstance in observation table.

Note : _____

Observation : (Activity 2.12)

S.No.	Solution	Colour of pH paper	Arroximate pH value	Nature of substance
1.	Saliva (before meal)	Green	7.4	Basic
2.	Saliva (after meal)	Greenish yellow	5.8	Acidic
3.	Lemon juice	Orange	2.4	Acidic
4.	Colourless aerated drink	Greenish yellow	6	Acidic
5.	Carrot juice	Green	6.4	Acidic
6.	Coffee	Orange	5.00 – 6.5	Acidic
7.	Tomato juice	Yellow	4.00	Acidic
8.	Tap water	Green-Blue	6.5 – 8.00	Acidic-Basic
9.	IML NaOH	Blue	14.00	Basic
10.	IML HCl	Red	0.1	Acidic

Topic : Importance of pH in everyday life

1. pH in our digestive system: Our stomach produces hydrochloric acid of pH about 1.4: This dilute hydrochloric acid helps in digestion of our food. Somtimes, Excesses of Acid is produced in the stomach due to various reason. Which produces pain and irritation. In this case we take antacids like milk of meganesia ($Mg(OH)_2$ and baking soda ($NaHCO_3$) which reacts with excess acid in the stomach and neutralise it. This gives relief to the person concerned.

2. pH change as the cause of tooth decay:

When we eat food containing sugar, then the bacteria present in our mouth break down the sugar molecules to form lactic acid. This lactic acid lowers the pH in our mouth upto 5.5. Due to this the acid becomes strong enough and attack the enamel of our teeth and corrode it. The best way to prevent tooth decay is to clean the mouth by using toothpaste because its nature is basic.

Note: Tooth Enamel is made of calcium phosphate $Ca_3 (PO_4)_2$ (which is the hardest substance in our body but it starts getting corrode, when the pH in our mouth becomes less than 5.5.

3. **Soil pH and Plant Growth:** Most of the plants grow perfectly and develop when the pH of the soil is close to 7. If the soil is too acidic or too basic, the plants do not grow properly. If the soil is to acidic, then it is treated with basic materials like quick lime (CaO), Slaked lime $Ca(OH)_2$ or chalk ($CaCO_3$). If the soil is to basic then, it is treated with acidic materials like manure.

Note: The soil may be acidic or basic naturally. The soil pH is also affected by the using of fertilisers, insecticides and pesticides etc.

Activity 2.14

Aim: To determine pH of various types of soils using pH paper.

Materials Required: 3 gm soil, test tube, filter paper, pH paper and distilled water

Procedure:

Step 1: Take 3 g of soil in a test tube.

Step 2: Add distilled water to tes tube.

Step 3: Filter the content

Step 4: Add few drops of filterate on pH paper.

Step 5: Repeat the process with other samples of soils and record your observation.

Observations: The pH paper shows different colours in different types of soils.

Conclusion: If pH of soil is less than 7, then soil is acidic, if pH is equal to 7, then soil is neutral and if pH is more than 7, then soil is basic.

4. **pH change and survival of animals:** Our body works well within a narrow pH range of 7.0 to 7.8. If due to some reason, this pH range gets disturbed , then many ailment occur in our body. The aquatic animals and plants can survive in water bodies within a narrow pH range of 7 to 7.8. When acid rain having pH less than 5.6 flows into the water bodies it can lower the pH of water bodies due to this the survival of aquatic animals and plants in such water bodies becomes difficult even kill the aquatic animals and plants.

5. **Self defense of animals and plants through chemical welfare:** Many animals and plants protect themselves from their enemies by injecting painful and irritating acids and bases into their skin.

Example1: When we are stung by a honey bee, red ant or yellow ant etc., we feel pain and irritation due to the formic acid (methanoic acid) injected into our skin. To get the relief we apply the solution of mild base like baking soda or Sodium Bi carbonate ($NaHCO_3$).

Example 2: When we are stung by a wasp, we feel pain and irritation due to alkaline liquid injected into our skin by the wasp . To get the relief we apply mild acid like vinegar (acetic acid).

Example 3: The nettle plants have leaves with stinging hairs. When a person touch the leaves of a nettle plant, the stinging hairs of nettle leaves inject methanoic acid into the skin of the person causing burning pain. To get the relief we apply mild base like baking soda ($NaHCO_3$). Even nature itself, has provided remedy for the nettle sting in the form of a 'dock' plant. So, leaves of dock plant are rubbed around string area of the skin of the person and relief the person.

Notes: _____

Topic : Preparation of Salt, their Properties and uses

Definition 1: A compound which is formed by replacing Hydrogen (Except Ammonium ion) from an acid by a metal is called salt. For example, if hydrogen is replaced from hydrochloric acid (HCl) by say sodium metal then we will get a salt called Sodium Chloride (NaCl). In some cases hydrogen in the acid replaced by ammonium ion (NH_4^+) to form salt for example if Hydrogen replaced from sulphuric acid by Ammonium ion (NH_4^+) then Ammonium sulphate $(NH_4)_2SO_4$ salt is form.

Definition 2: A salt is a compound formed by the reaction of an acid with base. For example, when hydrochloric acid (HCl) react with sodium hydroxide (NaOH), then sodium chloride salt is formed.

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

Note: A Salt has two parents, an acid and a base. So the name of salt consist of two parts: the first part of the name of the salt is derived from the name of base, and the second part of the name of the salt derived from the name of acid. For example, the name of a salt sodium chloride is derived from base sodium hydroxide (NaOH) and an acid from hydrochloric acid (HCl).

Types of Salts

There are six types of salt, these are (1) chlorides salts (2) sulphate salts (3) nitrate salts (4) carbonate salts (5) acetates salts (6) Phosphate Salts.

1. Chloride Salts: Those salts which are obtained from hydrochloric acid (HCl) are called chloride salts. Sodium Chloride(NaCl), Potassium Chloride (KCl), Calcium Chloride ($CaCl_2$), Magnesium Chloride ($MgCl_2$) etc are the examples of Chloride salts.

2. Sulphate Salts: Those salts which are obtained from sulphuric acid (H_2SO_4) are called sulphate salts. Magnesium sulphate ($MgSO_4$), Calcium sulphate ($CaSO_4$), Zinc sulphate ($ZnSO_4$), sodium sulphate (Na_2SO_4), Potassium sulphate (K_2SO_4) etc are the examples of sulphate salts.

3. Nitrate Salts: Those salts which are obtained from nitric acid are called nitrates salts. Sodium nitrate ($NaNO_3$), potassium nitrate (KNO_3), magnesium nitrate $Mg(NO_3)_2$, calcium nitrate $Ca(NO_3)_2$ etc are the examples of nitrate salts.

4. Carbonate Salts: Those salts which are obtained from carbonic acid are called carbonate salts. Sodium carbonate (Na_2CO_3), Zinc Carbonate ($ZnCO_3$), Calcuium Carbonate ($CaCO_3$) etc are the examples of carbonate salts.

5. Acetate Salts: Those salts which are obtained from acetic acid (CH_3COOH) are called acetate salts. Sodium Acetate (CH_3COONa), Potassium Acetate (CH_3COOK) and calcium Acetate $(CH_3COOH)_2Ca$ etc are the examples of acetate salts.

6. Phosphate Salts: Those salts which are obtained from phosphoric acid (H_3PO_4) are called phosphate salts calcium phosphate $Ca_3(PO_4)_2$, Zinc Posphate $Zn_3(PO_4)_2$, and sodium phosphate $Na_3(PO_4)$ etc are example of phosphate salts.

Note: Mostly salts are solids. They have high melting points and boiling points. Salts are usually soluble in water. The salts are electrolytes due to presence of ions. For example, sodium chloride salt solution (NaCl) conducts electricity because it consists of sodium ion (Na^+) chloride ion (Cl^-).

Family of salts

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

Ex.1: Sodium chloride (NaCl), sodium sulphate (Na_2SO_4) and Sodium Nitrate ($NaNO_3$) consists of some type of positive sodium ion (Na^+) so they belong to the same family of salts called 'sodium salt'.

Ex.2: Sodium chloride (NaCl), potassium chloride (KCl) and magnesium chloride ($MgCl_2$) salt consists of some type of negative chloride ion (Cl^+)so they belong to the same family of salts called 'chloride salts.

Note: Salts are made up of cations and anions and they release the same ions when dissolved in water.

For example Sodium chloride consist of sodium ion (Na^+) and chloride ion (Cl^-). When sodium chloride dissolved water, then it release sodium ion and chloride ion $NaCl(aq) \longrightarrow Na^+(aq) + Cl^-(aq)$

Activity 2.15

AIM: (i) Write the formulae of the salts given below: Potassium sulphate, Sodium sulphate, Calcium sulphate, Magnesium sulphate, Copper sulphate, Sodium Chloride, Sodium nitrate, Sodium carbonate and Ammonium Chloride.

(ii) Identify the acids and bases from which the above salts may be obtained

Name of Salt	Formulae	Acids used to get salt	Bases used to get salt
Potassium sulphate	(K_2SO_4)	Sulphuric acid (H_2SO_4)	Potassium hydroxide (KOH)
Sodium sulphate	(Na_2SO_4)	Sulphuric acid (H_2SO_4)	Sodium hydroxide $(NaOH)$
Calcium sulphate	$(CaSO_4)$	Sulphuric acid (H_2SO_4)	Calcium hydroxide $Ca(OH)_2$
Magnesium sulphate	$(MgSO_4)$	Sulphuric acid (H_2SO_4)	Magnesium hydroxide $Mg(OH)_2$
Copper sulphate	$(CuSO_4)$	Sulphuric acid (H_2SO_4)	Copper hydroxide $Cu(OH)_2$
Sodium chloride	$(NaCl)$	Hydrochloric acid (HCl)	Sodium hydroxide $(NaOH)$
Sodium nitrate	$(NaNO_3)$	Nitric acid (HNO_3)	Sodium hydroxide $(NaOH)$
Sodium carbonate	(Na_2CO_3)	Carbonic acid (H_2CO_3)	Sodium hydroxide $(NaOH)$
Ammonium chloride	(NH_4Cl)	Hydrochoric acid (HCl)	Ammonium hydroxide (NH_4OH)

Activity 2.16

AIM: To identify the family of salts from the following compounds of the salts given below: Potassium sulphate, Sodium sulphate, Calcium sulphate, Magnesium sulphate, Copper sulphate, Sodium chloride, Sodium nitrate, Sodium carbonate and Ammonium chloride.

Ans.

S.No	Name of Salts	Family of Salts
1.	Sodium Sulphate Sodium Chloride Sodium Nitrate Sodium Carbonate	Family of Sodium
2.	Potassium sulphate Magnesium sulphate Sodium sulphate Copper sulphate Calcium sulphate	Family of sulphate
3.	Ammonium Chloride Sodium chloride	Family of Chloride
4.	Sodium carbonate	Family of Carbonate
5.	Sodium Nitrate	Family of Nitrate
6.	Potassium sulphate	Family of Potassium
7.	Magnesium sulphate	Family of Magnesium
8.	Copper Suplhate metal	Family of Copper
9.	Calcium sulphate	Family of Calcium
10.	Ammonium Chloride	Family of Ammonium

Topic : The pH of salt solutions

The pH of salt solution depends upon the strength of acids and bases used to make salts on the basis of four pH value all the salts divided into groups.

(1) Salts of Strong acid and Strong Base: The salts of strong acid and strong base give neutral solution. For example the aqueous solution of sodium chloride (NaCl) is neutral because it consists of strong base called sodium hydroxide (NaOH) and strong acid called hydrochloric acid (HCl). The pH value of such salt solution will be 7 and such salt solutions have no effect on any type of common indicator.

(2) Salts of Strong acid and Weak Base: The salts of strong acid and weak base give acidic solution. For example aqueous solution of Magnesium Chloride ($MgCl_2$) is acidic in nature, because it consist of weak base called Magnesium Hydroxide $Mg(OH)_2$ and strong acid called Hydrochloric Acid (HCl). The pH value of such salt solution will be less than 7 and such salt solutions turns blue litmus to red, methyl orange to red and phenolphathalein remians colourless.

(3) Salts of Weak acid and Strong Base: The salts of weak acid and strong base give basic solution. For example aqueous solution of Sodium Carbondioxide (Na_2CO_3) is basic in nature, because it consist of strong base called sodium hydroxide (NaOH) and weak acid called carbonic acid (H_2CO_3).The pH value of such salt solution will be greater than 7 and such salt solutions turns red litmus to blue, methyl orange to yellow and phenolphathalein to pink.

(4) Salts of Weak acid and Weak Base: The salts of weak acid and weak base give Neutral solution for example aqueous solutoin of Ammonium acetate (CH_3COONH_4) is Neutral because it consist of weak acid called acetic acid (CH_3COOH) and weak base called Ammonium Hydroxide (NH_4OH). The pH value of salt solution will be 7 and such salts solutions have no effect of any type of common indicator.

Activity 2.17

Aim: Collect the following salt samples – sodium chloride, potassium nitrate, aluminium chloride, zinc suplhate, copper sulphate, sodium acetate, sodium carbonate and sodium hydrogen carbonate.

(i) Check their soluability in water.

(ii) Check the action of these solutions on litmus paper and find pH using a pH paper.

(iii) Which of the salts are acidic, basic or neutral?

(iv) Identify the acid or base used to form the salt.

Ans. (i) Salts souble in water: Sodium chloride, Aluminium chloride, Sodium carbonate, Potassium nitrate, zinc sulphate, Copper sulphate, Sodium acetate.Sodium hyrogen carbonate is sparingly soluble in water.

Ans:

(ii)

Name of Salt	Chemical Formula	Effect on litmus Paper	pH Value
(1) Sodium chloride	$NaC\ell$	No effect	7
(2) Potassium nitrate	KNO_3	No effect	7
(3) Aluminium chloride	$A\ell C\ell_3$	Blue litmus turn red	< 7
(4) Zinc sulphate	$ZnSO_4$	Blue litmus turn red	4.0 – 5.2
(5) Copper sulphate	$CuSO_4$	Blue litmus turn red	3.4
(6) Sodium acetate	CH_3COONa	Red litmus turn blue	9.25
(7) Sodium carbonate	Na_2CO_3	Red litmus turn blue	> 7
(8) Sodium bicarbonate	$NaHCO_3$	Red litmus turn blue	8.3

(iii)

Acidic salts	Basic salts	Neutral
Copper sulphate $(CuSO_4)$	Sodium hydrocarbonate $(NaHCO_3)$	Sodium chloride $(NaC\ell)$
Zinc sulphate $(ZnSO_4)$	Sodium carbonate (Na_2CO_3)	Potassium nitrate (KNO_3)
Aluminium chloride $(A\ell C\ell_3)$	Sodium acetate (CH_3COONa)	

(iv)

Name of Salt	Acids used to make salt	Bases used to make salt
(a) Sodium chloride (NaCl)	Hydrochloric acid (HCl)	Sodium hydroxide (NaOH)
(b) Potassium nitrate (KNO_3)	Nitric acid (HNO_3)	Potassium hydroxide (KOH)
(c) Aluminium chloride ($AlCl_3$)	Hydrochloric acid (HCl)	Aluminium hydroxide $Al(OH)_3$
(d) Zinc sulphate ($ZnSO_4$)	Sulphuric acid (H_2SO_4)	Zinc hydroxide $Zn(OH)_2$
(e) Copper sulphate ($CuSO_4$)	Sulphuric acid (H_2SO_4)	Copper hydroxide $Cu(OH)_2$
(f) Sodium acetate ($CH_3COOHNa$)	Acetic acid (CH_3COOH)	Sodium hydroxide (NaOH)
(g) Sodium carbonate (Na_2CO_3)	Carbonic acid (H_2CO_3)	Sodium hydroxide (NaOH)
(h) Sodium Bi carbonate ($NaHCO_3$)	Carbonic acid (H_2CO_3)	Sodium hydroxide (NaOH)

Topic : Preparation of Salt, their Properties and uses

Salt of Sodium Metal

Sodium Chloride (NaCl): The common name of sodium chloride is common salt. The chemical name of common salt is sodium chloride (NaCl). The chemical formula of sodium chloride is (NaCl). It is a neutral salt.

Preparation of common salt:

a. Laboratory Preparation of common salt: Common salt is prepared by the reaction between sodium hydroxide (NaOH) and hydrochloric acid (HCl).

b. $NaOH + HCl \longrightarrow \underset{\text{Common Salt}}{NaCl} + H_2O$

Commercial Preparation of common salt: Common salt is prepared by following methods:

(i) From Sea Water.

(ii) From Underground Deposits.

(i) Common Salt From Sea Water: Common salt is obtained from sea water by the process of evaporation. Sea water is trapped in lagoons. The Sun's heat evaporates the water slowly from lagoons and common salt is left behind in the lagoons. The salt obtained by the evaporation is **brown** in colour due to impurities present in it.

(ii) Common Salt from Underground Deposits: The large crystals of common salt found in underground deposit are called rock salt. Rock salt is brown in colour due to the presence of impurities in it. Rock salt is obtained from the underground deposits by mining like coal.

Note: The rock salt was formed when the ancient seas and lakes dried up by evaporation, millions of year ago.

Uses of Common Salt (NaCl):

1. Common salt is used to make sodium hydroxide (caustic soda), sodium carbonate (washing soda), sodium bicarbonate (baking soda), hydrochoric acid, hydrogen gas, chlorine gas and sodium metal.
2. Common salt is used in cooking food.
3. Common salt is used as a preservative in pickles and in curing meat and fish.
4. Common salt is used to melt ice.

Note: Sodium chloride is required by our body for the working of nervous system. The movement of muscles and the production hydrochloric acid in the stomach for the digestion of food.

Sodium Hydroxide (NaOH)

The common name of Sodium Hydroxide is **caustic soda.** The chemical formula of sodium hydroxide is NaOH.

(i) Preparation of Sodium Hydroxide: Sodium Hydroxide is prepared from concentrated solution of sodium chloride (called Brine) When electricity is passed through a concentrated solution of sodium chloride ($NaCl + H_2O$), it decomposes to form sodium hydroxide, chlorine gas and hydrogen gas.

$$2NaCl(aq) + 2H_2O \xrightarrow{\text{Electricity}} 2NaOH + Cl_2 + H_2$$

Note: Above process is also called Chlor–alkalie process because during chemical reaction we obtain chlorine gas and alkalie called sodium hydroxide (NaOH).

Note: During electrolysis, chlorine gas is produced at the anode, hydrogen gas is produced at the cathode sodium hydroxide solution is formed near the cathode.

Uses of sodium hydroxide (NaOH):

(i) It is used for making soaps and detergents.

(ii) It is used for making textile fibres.

(iii) It is used in the manufacture of paper.

(iv) It is used in oil refining and making dyes.

Washing Soda ($Na_2CO_3 \cdot 10\ H_2O$)

Washing soda is decahydrated sodium carbonate chemical. The formula of washing soda is $Na_2CO_3 \cdot 10\ H_2O$. An hydrous sodium carbonate (Na_2CO_3) is called as 'soda ash'

Raw Material: Sodium chloride $(NaCl)$, Water (H_2O), Carbon di oxide (CO_2) and ammonia(NH_3)

Preparation of Washing Soda:

Procedure:

Step 1: A cold and concentrated solution of sodium chloride (brine solution) react with ammonia and carbon dioxide gas to form sodium bicarbonate and Ammonium chloride.

$$NaCl(aq) + H_2O + CO_2 + NH_3 \longrightarrow \underset{\text{(ppt)}}{NaHCO_3} + NH_4Cl$$

Step 2: Sodium bicarbonate is seperated by filteration, dried and heated. On heating

sodium bicarbonate ($NaHCO_3$) decomposes to form sodium carbonate, (soda ash) CO_2 gas and water.

$$2NaHCO_3 \rightarrow \underset{\text{(Soda ash)}}{Na_2CO_3} + CO_2 + H_2O$$

Step 3: An hydrous sodium carbonate is dissolved in water and recrystallised to get washing soda.

$$Na_2CO_3 + 10H_2O \rightarrow \underset{\text{Washing Soda}}{Na_2CO_3.10H_2O}$$

Properties of Washing soda:

(i) Washing soda is a transperent crystalline solid.

(ii) Washing soda is soluble in water.

(iii) The aqueous solution of washing soda is alkaline in nature due to this washing soda turns red litmus to blue. $Na_2CO_3 + 2H_2O \rightarrow 2NaOH + H_2CO_3$

(iv) Washing soda has cleaning properties.

(v) On heating washing soda loses 10 molecules of water of crystalization and become an hydrous. $NaCO_3.10H_2O \rightarrow NaCO_3 + 10H_2O$

(vi) Washing soda react with water to give out CO_2 gas with brisik effervescence.

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

(vii) Washing soda react with hard water to form precipitate of magnesium carbonate and calcium carbonate which can be filttered off. Hence water become soft.

$$CaCl_2 + Na_2CO_3 \rightarrow \underset{\text{ppt}}{CaCO_3} + 2NaCl$$

Uses of washing soda

(i) Washing soda is used as cleaning agent.

(ii) Washing soda is used for removing permanent hardness of water.

(iii) Washing soda is used in the manufacture of glass, soap and paper.

(iv) Washing soda is used in the manufacture of borax.

Baking soda ($NaHCO_3$)

The chemical name of washing soda is sodium hydrogen carbonate ($NaHCO_3$). It is also called sodium bicarbonate. The chemical formula of baking soda is $(NaHCO_3)$

Preparation of Baking soda: A cold and concentrated solution of sodium chloride saturated with ammonia and passe through carbon di oxide gas to form sodium hydrogen carbonate ($NaHCO_3$)

$$NaCl(aq) + NH_3 + H_2O + CO_2 \longrightarrow \underset{\text{ppt}}{NaHCO_3} + NH_4Cl$$

In the above reaction sodium bicarbonate (baking soda) is seperated by filteration and dried it.

Properties of Baking Soda:

(i) Baking Soda consists of white crystals.

(ii) Baking Soda sparingley soluble in water.

(iii) The aqueous solution of baking soda is alkaline in nature due to salt hydrolysis.

$$NaHCO_3 + H_2O \rightarrow NaOH + H_2CO_3$$

(iv) On heating it decomposes to form sodium carbonate (soda ash), carbon dioxide gas and water.

$$2\ NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$$

(v) Baking soda react soda ash with acid to give out CO_2 with brisic eflervesences

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

Uses of sodium hydrogen carbonate or baking soda:

(i) Baking soda is used as antacid in medicine to remove acidity of the stomach.

(ii) Baking soda is used in making baking powder. Baking powder is mixture of baking soda and tartaric acid which is used in making cakes and breads. This is because on heating, $NaHCO_3$ decomposes to give out CO_2 which causes the bread or cake to rise and makes them highly porous. The function of tartaric acid or citric acid is to neutralize sodium carbonate formed during heating, as otherwise the cake or bread will taste bitter.

(iii) Baking soda used in soda - acid fire extinguishers.

Explaination: Soda acid fire extinguisher contains a solution of baking soda and sulphuric acid in seperate containers. When the knob of fire extinguisher is pressed, then sulhuric acid get mixed with baking soda solution to produce a lot of carbon di oxide gas. The pressure of carbon di oxide gas forces a stream of liquid to fall on the burning susbstance. The carbon di oxide gas forms a blanket around the

burning substance and cuts of the supply of air to burning substance. The stream of liquid falling on the burning susbstance increases its ignition temperature.

(iv) It is used as a laboratory reagent and in laundaries.

Salts of Calcium Metal

(1) Bleaching Powder ($CaOCl_2$):

The chemical name of bleaching powder is calcium oxy chloride. Its chemical formula is $CaOCl_2$

Preparation of bleaching powder: Bleaching powder is prepared by passing chlorine gas over dry slaked lime.

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

Dry slaked lime (Bleaching powder)

Properties of Bleacing Powder:

(i) Bleacing powder is a yellowish, white powder which gives a strong smell of chlorine. This is because carbondioxide present in the air reacts with the bleaching powder, liberating chloring gas (Cl_2)

$$CaOCl_2 + CO_2 \rightarrow CaCO_3 + Cl_2$$

The chlorine gas produced in above reaction act as a bleaching agent. The real bleaching agent present in bleaching powder is chlorine gas. The bleaching action of chlorine is due to its oxidising property.

(ii) Bleaching powder is soluble in cold water. The milkiness in the solution is due to the fact that bleaching powder contains same unreacted lime.

(iii) Bleacing powder reacts with dilute acid to produce chlorine gas.

$$CaOCl_2 + H_2SO_4 \longrightarrow CaSO_4 + Cl_2 + H_2O$$

Note: A when bleaching powder react with oil Dil. H_2SO_4 then chlorine gas is produce with excess of the acid, all the chlorine is liberated. The amount of chlorine thus liberated is called "available chlorine". As the bleaching action by a given samle of bleaching powder depends upon the available chlorine. The greater is the available chlorine, better is the quality a good sample of bleaching. Powder contains 35-38% of available chlorine.

Bleaching Agent: A substance which removes colour from a coloured substances and makes them colourless is called a bleaching agent.

Disinfectant: A substance which is used to kill germs or bacteria is called disinfectant.

Uses of bleacing powder

(i) Bleaching powder is used for bleaching cotton, and wood pulp.

(ii) Bleaching powder is used for bleaching washed cloth in laundry

(iii) Bleacing powder is used for disinfecting drinking water supply.

(iv) Bleacing powder is used for manufacture of chloroform ($CHCl_3$)

(v) Bleaching powder is used for making wool unshrinkable.

(vi) Bleacing powder is used as an oxidising agent in chemical industry.

Plaster of Paris ($CaSO_4 \cdot 1/2\ H_2O$)

Chemical name of plaster of paris is calcium sulphate hemihydrate. Its chemical formula is $CaSO_4 \cdot 1/2\ H_2O$ or $(CaSO_4)_2 \cdot H_2O$

Preparation of Plaster of Paris: Plaster of paris is prepared by heating gypsum ($CaSO_4.2H_2O$) to a temperature of 100°C (373 K). When gypsum is heated at 373 K then it losses $1\frac{1}{2}$ molecules of water of crystallisation and form plaster of paris.

$$CaSO_4 \cdot 2H_2O \xrightarrow{\Delta(1000^\circ C)} CaSO_4 \cdot 1/2H_2O + 3/2\ H_2O$$

Above reaction can also be written as

$$2CaSO_4 \cdot 2H_2O \longrightarrow 2CaSO_4 \cdot H_2O + 3H_2O$$

Properties of Plaster of Paris:

(i) Plaster of paris is a white powder.

(ii) Plaster of paris setting into hard mass when treated with water.

$$CaSO_4 \cdot \tfrac{1}{2}H_2O + 1\tfrac{1}{2}H_2O \rightarrow CuSO_4 \cdot 2H_2O$$

Note: Plaster of Paris should be stored in a moisture proof container. This is because the presence of mositure can cause slow setting of plaster of paris by bringing about its hydration.

Uses of Plaster of Paris:

(i) Plaster of paris is used for setting fractured bones.

(ii) Plaster of Paris used in making toys, decorative materials, cheap ornaments, cosmetic, black board chalk and casts for statues.

(iii) Plaster of Paris is used as a fire - proofing materials.

(iv) Plaster of Paris used in chemistry laboratory for sealing air gap in apparatus.

(v) Plaster of Paris is used for making surfaces smooth before painting.

Topic : Hydrated Salts

Those salts which contains few crystals of water are called hydrated salts. For example copper sulphate salt contains five molecules of water ($CaSO_4 \bullet 5H_2O$). Hydrated copper sulphate is called blue vitroil.

Water of crystalisation: The water molecules which form part of the structure of a crystal are called water of crystalisation. The salt which contain water of crystallisation are called hydrated salts.

Note: The water of crystalisation gives the crystals of the salts their shape and in some cases, impart them colours. For example, $CuSO_4.5H_2O$ is blue in colour due to the presence of 5 molecules of water. $FeSO_4.7H_2O$ is green in colour due to the presence of 7 molecules of water. Sodium carbonate $(Na_2CO_3.10H_2O)$ and Calcium sulphate $(CuSO_4.2H_2O)$ are white in colour.

Examples of hydrated salts:

(i) Copper sulphate crystals contains 5 molecules of water of crystallisation. $CuSO_4.\ 5H_2O$ (copper sulphate pentahydrate)

(ii) Sodium carbonate crystals contains 10 molecules of water of crystallisation $Na_2CO_3\ .\ 10H_2O$ (sodium carbonate decahydrate)

(iii) Iron sulphate crystals contains 7 molecules of water of crystallisation $F_2SO_4\ .\ 7H_2O$ (iron sulphate heptahydrate)

(iv) Gypsum crystals contains 2 molecules of water crystallisation $(CaSO_4.2H_2O)$ Calcium sulphate di oxide.

Action of heat on hydrated salts: When hydrated salts are heated strongle, they lose their water of crystallisation. The salt which have lost their water of crystallisation are called anhydrous salts. **For example**, when copper sulphate crystals are heated strongly then it loses water of crystallisation and form anyhydrous copper sulphate $(CuSO_4)$

$$CuSO_4\ .\ 5H_2O \longrightarrow CuSO_4 + 5H_2O$$

If anhydrous copper sulphate is exposed to atmosphere, it gets hydrated and turns blue.

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4\ .\ 5H_2O$$

Activity 2.18

Aim: To show crystalline salts contain water of crystallization

Materials Required: Crystals of copper sulphate $(CuSO_4.5H_2O)$, dry boiling tube, test tube holder and burner etc.

Procedure (A):

Step 1: Take 2 gm of $CuSO_4.5H_2O$ in a dry boiling test tube.

Step 2: Heat the crystals of copper sulphate.

Step 3: Observe the colour of copper sulphate.

Observation: When copper sulphate crystal is heated, the water of crystallisation of copper sulphate is removed and the salt turns white.

$$CuSO_4 \bullet 5H_2O \longrightarrow CuSO_4 + 5H_2O$$

Procedure (B):

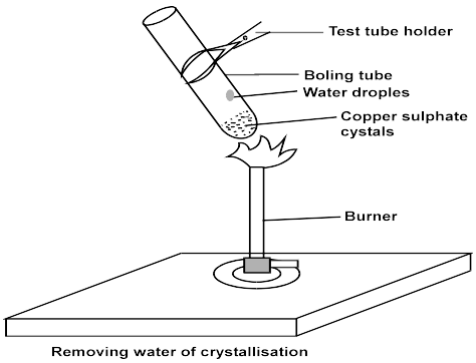
Step 1: Add 2 -3 drops of water on the sample of copper sulphate obtained after heating.

Step 2: Observe the colour of copper sulphate.

Observation: We observe that the blue colour of crystals reappears.

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4.5H_2O$$

Conclusion: Crystalline substances have water of crystallization which are lost on heating.



Removing water of crystallisation