Class X – Science (Chemistry)
Acid, Bases and Salts

1. There are 115 elements known to us.
2. These elements are combined in fixe ratio by weight to form various compounds.
3. These compounds are classified on the basis of their chemical properties into Acids, bases and salts.
4. Substances called ***Indicators*** are used to test acids and bases.

Indicators

• *Indicators are of tow types*:-

a) **Colour indicators -** They are used to identify the presence of acids or bases in given Sample by color change.
e.g:- Litmus solution (blue litmus solution and red litmus solution, Methyl orange, Phenolphthalein

b) **Olfactory indicators -** They are used to identify the presence of acids or bases in given Sample by their change in odour (smell).
e.g:-onion, vanilla & clove test.

MOSTLY USED TEST IN LABORATORY

Observation Tables For Both Tests

a) ***Observation Tables For Colour Indicators in Different Solutions*:-**

Indicators	Color in Neutral Solution	Color in Acidic Solution	Color in Basic Solution
LITMUS SOLUTION	PURPLE	RED	BLUE
PHENOLPHTHALEIN	COLORLESS	COLORLESS	PINK
METHY ORANGE	ORANGE	RED	YELLOW

b) ***Observation Tables For Olfactory Indicators in Different Solutions:-***

Indicators	Odour in Neutral Solution	Odour in Acidic Solution	Odour in Basic Solution
ONION	CHARACTERISTIC SMELL	CHARACTERISTIC SMELL	**NO** CHARACTERISTIC SMELL
VANILLA	CHARACTERISTIC SMELL	CHARACTERISTIC SMELL	**NO** CHARACTERISTIC SMELL

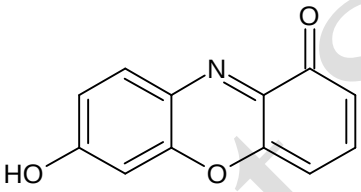
Litmus

- *Information about litmus solution:-*

1. It is a natural indicator
2. It is extracted from a type of plant called '***lichen***'.
3. Neutral litmus is *purple* in colour
4. Litmus can be used as solution or paper
5. It is converted in to red or blue for the sake of convenience in detecting colour change.
6. An acid turns ***blue litmus*** to ***red.***
7. A base turns ***red litmus*** to ***blue.***

Component which impart color

Chemical Structure of 7-hydroxyphenoxazone ('***Chromophore***' of Litmus Solution)



7-hyroxyphenoxazone

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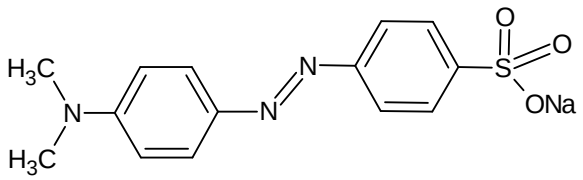
Methyl orange

- *Information about methyl orange indicator:-*

1. It is a synthetic indicator.
2. Neutral methyl orange is *Orange* in colour.
3. Methyl orange has a pK_a of 3.47 in water at 25 °C
4. Methyl orange gives ***red colour*** in acidic solution.
5. It gives ***yellow colour*** in basic solution.

Chemical Structure of '*Methyl Orange*' indicator



Methyl Orange

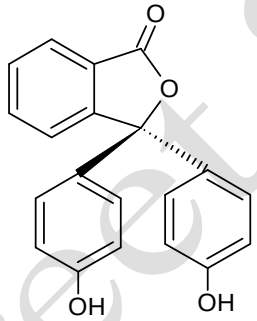
IUPAC NAME = Sodium 4-[(4-dimethylamino)phenyldiazenyl]benzenesulfonate

Phenolphthalein

- *Information about Phenolphthalein indicators:-*

1. It is synthetic indicator.
2. Neutral phenolphthalein is colorless.
3. It is often written as "**HIn**" or "**phph**" in shorthand notation.
4. It gives ***colorless*** solution in ***acidic medium***.
5. It gives ***pink*** color in ***basic solution***.

Chemical structure of '*Phenolphthalein*' indicator



Phenolphthalein

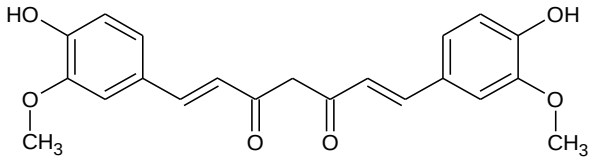
Turmeric (Haldi)

- *Information about Phenolphthalein indicators:-*

1. It is natural indicator.
2. It is yellow in color.
3. It changes its color from yellow to red in basic medium.
4. No color change in acidic medium.

*The best-studied compound is '**Curcumin',** which constitutes 3.14% (on average) of powdered turmeric.*

Chemical Structure of ***'Curcumin'*** (Component of turmeric)



Curcumin

Ques. Why does yellow stain of curry on white clothes turns reddish-brown when soap is scrubbed on it?

Ans. This is due to the fact that soap solution is basic in nature which changes the color of turmeric in the curry stain to red-brown. This stains truns to yellow again when the cloth is rinsed with plenty of water. This is because soap is removed with water.

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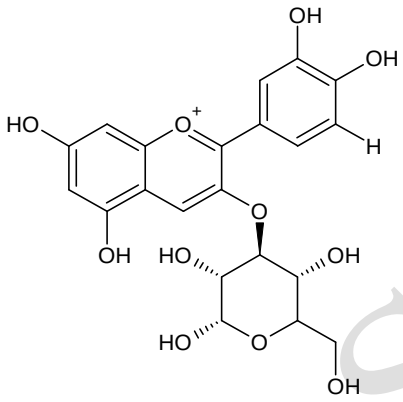
Red cabbage extract

- *Information about Phenolphthalein indicators*

1. It is a natural indicator
2. Obtained from **red cabbage** leaves
3. It is red in color.
4. It remains **red** in **acidic medium**.
5. It gives **green** color in **basic medium.**

Red cabbage contains pigments called *anthocyanins*. There are many types of *anthocyanins*. The *anthocyanin* present in red cabbage is '***Cyaniclin***'.

Chemical structure of **'*Cyaniclin*'** (Component of red cabbage)



Cyaniclin

Onion & Vanilla

- *Information about Phenolphthalein indicators*:-

1. They are olfactory indicator and have ***peculiar*** smells.
2. Onion and Vanilla ***lose*** their characteristic smells in basic solutions.
3. But they ***retains*** their characteristic odours in acidic solutions.

INTRODUCTION:- ACIDS

An acid (from the Latin language '*acidus'* meaning *sour*) is a chemical substance whose aqueous solution are characterized by a sour taste, the ability to turn blue litmus red, and the ability to react with bases and certain metalst to form salts.

Classification of Acids:- Acids are classified into two categories

(i) On the basis of source
(ii) On the basis of strength of solution

(i) ***On the basis of source:-*** Acids are of two type on the basis of source (i) mineral acids (ii) Organic acids.

The acids prepare from the mineral of the earth are called mineral acids, also called as 'man-made' acids. For e.g. Sulphuric acid, Hydrochloric acid and Nitric acid are mineral acids. They are very dangerous and can burn our hand and clothes.

The acids presents in plants and animals are called organic acids. For e.g. Acetic acid, citric acid and Lactic acid etc. It is not harmful to eat or drink substances containing naturally occurring acids in them.

Some Organic Acid Present in Plants/Animals:- There is a information about some organic acids present in plants (fruits) and animals.

SOURCE	ORGANIC ACID
VINEGAR(SIRKA)	ACETIC ACID
LEMONS AND ORANGES	CITRIC ACID
MILK (OR CURD)	LACTIC ACID
TAMARIND AND UNRIPE GRAPES	TARTARIC ACID
TOMATOES	OXALIC ACID
ANT STING AND NETTLE LEAF STING	FORMIC ACID
APPLES	MALIC ACID

(ii) ***On the basis of strength of solution:-*** Acids are of two type on the basis of strength (i) Concentrated acids (ii) Dilute acids.

C***oncentrated acids*** are those which contain the minimum possible amount of water in it. The concentration of an acid is dcreased by adding more water in to it. When water is added to a concentrated acid, then dilute acid is formed. Therefore, ***Dilute acids*** are one which contains much more of water in it.

Ques. How to dilute concentrated acids?

Ans. The dilution of a concentrated acid should always be done by adding concentrated acids to water with constant stirring and not by adding water to concentrated acids. This is because of:-

1. When we add concentrated acids to water for dilution, then a large amount of heat is evolved, and easily absorbed by large amount of water present in container.(safe method)
2. But when we add water to container having concentrated acid for dilution then heat is released. This heat changes some of the water to steam explosively, which can splash the acid on our face or clothes and cause burns.

Classification of Acids on the basis of ionization strength in water:-

On the basis of ionization strength of acids in water, they are of two types (i) Strong acids (ii) Weak acids

Strong acids

The acids which get completely ionized in water to produce large amount of hydrogen ions are called strong acids. All mineral acids are strong acids **except carbonic acid.** Strong Acids show high electrical conductivity due to high concentration of hydrogen ions.(They are strong electrolytes). The Strong word refers to degree of ionization and not to the Concentration of the acid. Example- Hydrochloric acid, Sulphuric acid and Nitric acid.

Weak acids

The acids which get partially ionized in water to produce small amount of hydrogen ions are called weak acids. All organic acids and carbonic acid are weak acids.Weak acids are safe for consumption. Acetic acid (vinegar), citric acid and tartaric acids are used as food Preservatives. Tartaric acid is used in making baking powder. Carbonic acid is used in fizzy soft drinks and soda water.

Ques1. Dry HCl gas does not change the color of litmus Blue. Give reason?

Ans. H^+ ion from HCl cannot ionize to give H^+ ions in the absence of water. Acidic property like change in color of litmus depends on production of H^+ ion, hence there is no change in color.

Ques2. Though the compounds such as glucose and alcohol have hydrogen atoms in their molecules yet they are not categorized as acids. Why?

Ans. Glucose and alcohol do not produce H^+ ions, when dissolve in water. Those substances which contain hydrogen are considered to be acids. Acids when dissolved in water produce H^+ ion. But glucose and alcohol in water do not produce H^+ ions.

Properties of Acids

- *The chemical and physical characteristics of acids are given below:-*

1. Acids have sour taste.
2. They turn blue litmus to red.
3. Acid solutions conduct electricity. (Therefore, can be used as electrolytes)
4. **Acids react with metals to produce hydrogen gas**
   When acids are reacted with metal, then salt and hydrogen gas are formed. Some reactions are given below:

ACIDS + METALS ⟶ SALT + HYDROGEN GAS

For e.g. (a)

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

Zinc — Sulphuric acid (Dilute) — Zinc sulphate — Hydrogen

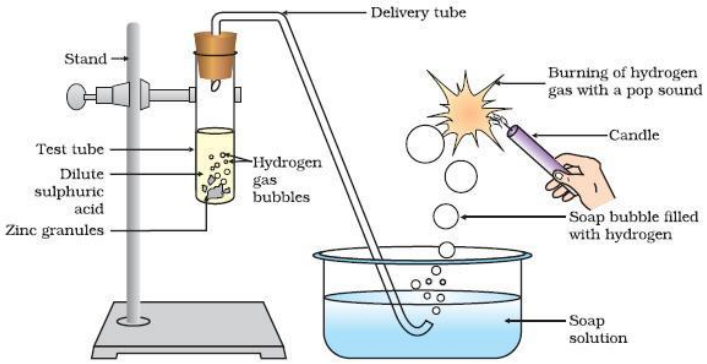


Figure1- Experiment to show reaction between Zinc and Sulphuric acid

Hydrogen gas can be easily detected as it burns with ***'pop'*** sound.

Ques. Why curd and other sour foodstuff are not kept in a vessel made up of metal?

Ans. It is advised that not to store curd and other sour foodstuff in a vessel made up of metal because curd and sour food stuff contain acids which can react with the metal of the vessel to form poisonous metal compounds which can cause food poisoning and damage our health.

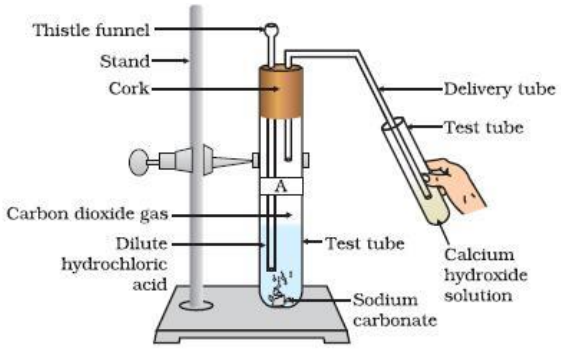
5. **Acids react with metal carbonates to produce carbon dioxide**.
When acids react with metal carbonate, then a salt and carbon dioxide gas are formed as a product.

METAL CARBONATE + ACIDS ⟶ SALT + CARBON DIOXIDE + WATER

For e.g. (a)

$$\underset{\text{Sodium carbonate}}{Na_2CO_3} + \underset{\text{Hydrochloric acid}}{HCl} \longrightarrow \underset{\text{Sodium Chloride}}{NaCl} + \underset{\text{Carbon Dioxide}}{CO_2} + \underset{\text{Water}}{H_2O}$$

The evolve CO_2 react with lime water as following ways.



(a) When CO_2 gas is passed through lime water, the lime water turn milky, due to the formation of a white precipitate of $CaCO_3$:-

$$\underset{\text{Calcium hydroxide}}{Ca(OH)_2\,(aq)} + \underset{\text{Carbon Dioxide}}{CO_2(g)} \longrightarrow \underset{\text{Calcium Carbonate}}{CaCO_3\,(s)} + \underset{\text{Water}}{H_2O\,(l)}$$

(b) If *Excess* of CO_2 is passes through lime water, then white precipitate formed dissolve due to the formation of *soluble calcium bicarbonate*.

The reaction is given below:

$$\underset{\text{Calcium Carbonate}}{CaCO_3\,(s)} + \underset{\text{Carbon Dioxide}}{CO_2(g)} \longrightarrow \underset{\text{Calcium Bicarbonate}}{Ca(HCO_3)_2\,(aq)} + \underset{\text{Water}}{H_2O\,(l)}$$

If someone is suffering from the problem of acidity, then baking soda is used as remedy. This is because baking soda is sodium hydrogen carbonate which reacts with excess hydrochloric acid in the stomach and neutralizes it. This gives relief to the person suffering from acidity.

6. **Acids react with base to form salt and water**.
When an acid is treated with a base, the neutralize the acid and destroy its acidity**.** This reaction is known as *Neutralization Reaction.*

ACID + BASE ⟶ SALT + WATER

For e.g.

$$\underset{\text{Sodium Hydroxide}}{NaOH} + \underset{\text{Hydrochloric acid}}{HCl} \longrightarrow \underset{\text{Sodium Chloride}}{NaCl} + \underset{\text{Water}}{H_2O}$$

Bases like magnesium hydroxide $Mg(OH)_2$, Baking soda can be used to neutralize the acid which is produced in our stomach.

7. **Acids react with metal oxides to form salt and water.**

METAL OXIDE + ACID ⟶ SALT + WATER

For e.g.

$$\underset{\text{Copper oxide}}{CuO} + \underset{\text{Hydrochloric acid}}{2HCl} \longrightarrow \underset{\text{Copper chloride}}{CuCl_2} + \underset{\text{water}}{H_2O}$$

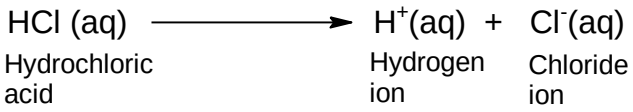
The antacid called '*Milk of Magnesia*' which is used to remove indigestion (caused by too much of hydrochloric acid in stomach) is a metal hydroxide called 'magnesium hydroxide'. Magnesium hydroxide is a basic in nature. It reacts with excess of HCl present in the stomach and neutralize.

8. **Acids have corrosive nature**.

Mineral acids cause severe burns on skin and attack or eat up materials like metals, wood, cloth, stones etc so are said to be corrosive in order to warn people about dangerous corrosive nature of mineral acids strong bases, a hazard warning sign is usually printed on their containers. we can see such a hazard warning signs on the cans of concentrated sulphuric acid and bottles of sodium hydroxide.

9. **What do all acids have in Common.**

All acids on ionization produce Hydrogen (Hydronium ion) ions in aqueous solution. For e.g.



Hydrogen ion does not exist as H^+ ions in solution. They attach themselves to polar water molecules to form hydronium (H_3O^+) ions. For e.g.

10. **All acids contain hydrogen but all hydrogen containing substances are not acids.**

1. Glucose and alcohol are hydrogen containing substances but are not acids because they do not ionize (dissociate) in water to give Hydronium ions. This can be found out by a simple experiment whether they conduct electricity or not. Acids conduct electricity as they ionize but glucose does not.
2. Distilled water does not conduct electricity as it does contain ionic compounds.on the other hand rain water conduct electricity. This can be explained as rain falls to the earth surface through atmosphere, dissolve an acidic gas carbon dioxide from air and form carbonic acids (H_2CO_3). Carbonic acid provides hydrogen ions and carbonate ions to rain water. Due to this rain water can conduct electricity.
3. Acids do not show acidic behaviour in absence of water.(Acidic behaviour is due to Hydronium ions which are produced only in water)
4. Dry HCl (gas) does not turn blue litmus red because dry HCl not dissociate to give free H^+ ion which turns blue litmus paper red, but if we take wet blue litmus then it will turns red because it contains H_2O which helps to dissociate HCl into H^+ ions.

11. **Uses of mineral acids in Industries**

1. *Sulphuric acid* - Used in the manufacture of Fertilizer (like Ammonium Sulphate), Paints, Dyes, Plastics, Synthetic Fibres, Detergents, Explosives, Car batteries.

2. *Nitric acid* - Used for making Fertilizers (like Ammonium Nitrate), Explosives (TNT- Trinitro toluene), Dyes, Plastics.
3. *Hydrochloric acid* - Used for removing 'scale' deposits from the Boilers. Also used in leather industries

INTRODUCTION:- BASES

Bases are substances that, in aqueous solution are slippery to the touch, taste bitter, change the color of indicators (e.g. turns red litmus paper blue), react with acids to form salts, and promote certain chemical reactions.

IMPORTANT INFORMATIONS ABOUT BASES:-

1. They turn red litmus blue.
2. Their chemical behavior is totally different from acids and can used to neutralize them.
3. All metal oxides and metal hydroxides are bases. Example – Na_2O (Sodium oxide), NaOH (Sodium hydroxide), NH_4OH (Ammonium hydroxide).
4. Metal carbonates and hydrogen carbonates are considered bases because they also neutralize the acids. Na_2CO_3 (Sodium carbonate), $NaHCO_3$ (Sodium hydrogen carbonate)
5. Water soluble bases are called Alkalis (Normally base term is used for soluble bases or Alkalis)
6. All bases when dissolved in water produce hydroxide ions (OH^-).The basic behaviour is due to OH^- ions produced. For e.g.

$$\underset{\text{Sodium Hydroxide}}{NaOH\ (s)} \xrightarrow{\text{Water}} \underset{\text{Sodium Ion}}{Na^+\ (aq)} + \underset{\text{Hydroxide Ion}}{OH^-\ (aq)}$$

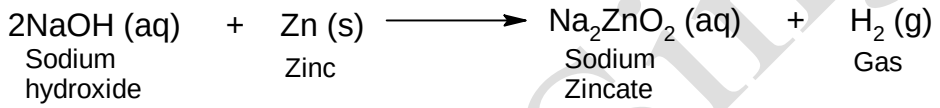
Strong and Weak Bases

1. *Strong bases* - The bases which completely ionize in water and produce large amount of hydroxide ions are called strong bases or strong alkalis. Examples - NaOH, KOH etc.
2. *Weak bases* - The bases which partially ionize in water to produce small amount of hydroxide ions are weak bases or weak alkalis.Examples - NH_4OH (Ammonium hydroxide) etc.

Properties of Bases.

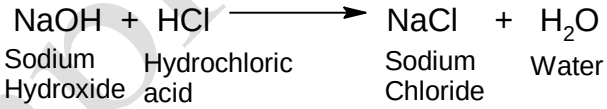
There are some important features of bases, which are given below:-

1. They have bitter taste.
2. They are soapy in touch.
3. They turn red litmus blue
4. Bases conduct electricity as they ionize in water.(so can be used as electrolytes)
5. **Bases react with some metals to form hydrogen gas.**
   For e.g. when sodium hydroxide solution is heated with zinc, then sodium zincate and hydrogen gas are formed. Hydrogen gas can be detected easily as it burns with a 'pop' sound.



All the metals do not react with bases to form salts and hydrogen gas

6. **Bases react with Acids to form salts and water**.
   When a base reacts with an acid, then a salt and water are formed. For e.g when sodium hydroxide reacts with Hydrochloric acid, then sodium chloride and water are formed. This reaction is known as *Neutralization Reaction***.**



   When an acid and a base combine then the real neutralization reaction occurs due the Combination of hydrogen ions (produced by the acid) and hydroxide ion (produced by the Base) to form water.
7. **Bases react with non-metal oxides to form salt and water.**

Non-Metal Oxide + Base → Salt + Water

   For e.g. Calcium hydroxide is a base and carbon dioide is a non-metal oxide. So, Calcium hydroxide reacts with carbon dioxide to produce calcium carbonate and water.

$$Ca(OH)_2\ (aq) + CO_2\ (g) \longrightarrow CaCO_3\ (s) + H_2O\ (l)$$

Calcium Hydroxide	Carbon dioxide	Calcium Carbonate	Water
(Base)	(Non-Metal Oxide)	(Salt)	

This reaction shows that non-metal oxides are acidic in nature as they form salt and Water with base.

Uses of Bases

1. *Sodium Hydroxide*- Used in the manufacture of soap, paper and synthetic fibres like Rayon .
2. *Calcium Hydroxide*-Uused in the manufacture of bleaching powder. (*Slaked lime*)
3. *Magnesium hydroxide* -Used as antacid to neutralize the acid in the stomach.
4. *Sodium carbonate* - Used as washing soda and for softening hard water.
5. *Sodium hydrogencarbonate* - Used as baking soda (baking powder), antacid and in soda fire extinguishers.

INTRODUCTION:- pH SCALE

Acids produce hydrogen ions in water. Therefore acidic solution is those which contain excess of hydrogen ions in solution. Similarly, Base produce hydroxide ions in water, basic solution are those which contain excess of hydroxide ions in solution form.

From the above discussion, we conclude that both acidic solution as well as basic solution contains hydrogen ions. *In 1909 Sorenson devised a scale for the measurement of acidic and basic strength of compound in the term of hydrogen ion concentration, that scale is known as* ***pH scale.*** According to this scale, **the pH of a solution is inversely proportional to the concentration of hydrogen ion in it**.

USEFUL INFORMATION ABOUT pH SCALE

1. 'p' in the term pH stands for 'potenz' (a German word which means 'power')
2. 'H' in the term pH stands for Hydrogen ion concentration.
3. Neutral solution pH value of 7.
4. All acidic solution have pH range from 0-7.
5. Bases have a pH range of 7-14.

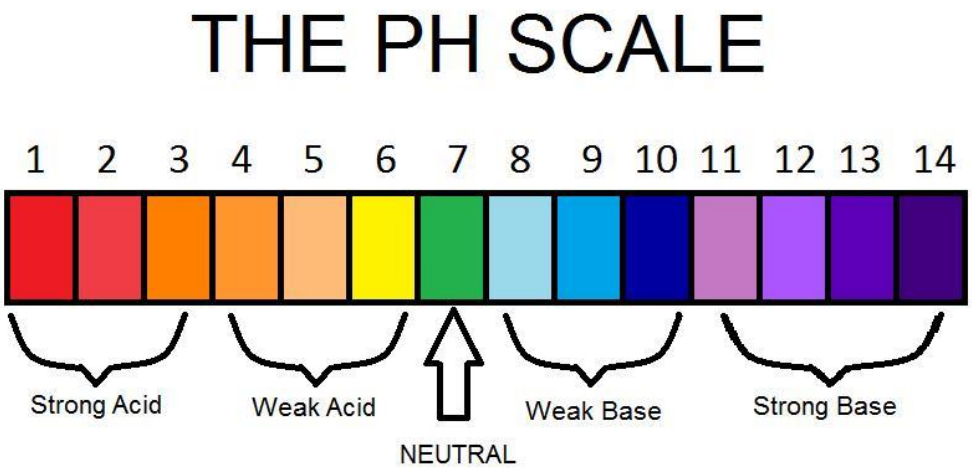


TABLE FOR pH VALUES OF SOME OF THE COMMON SUBSTANCES:-

SOLUTION	pH	SOLUTION	pH
Con. HCl	0	Saliva	5.8-7.4
Dil. HCl	1.0	Blood	7.4
Lemon juice	2.5	Toothpaste	8.0
Vinegar	4.0	Baking Soda	8.5
Tomato juice	4.1	Washing Soda	9.0
Soft drink	6.0	Milk of Magnesia	10.5
Milk	6.5	Dil. NaOH	13.0
Pure water	**7.0**	Conc. NaOH	**14.0**

Importance of pH in Everyday Life.

1. ***In Biochemical Systems:-***

1. pH plays a very significant role in biochemical reactions. For example, the blood in our bodies is maintained at a pH value of 7.36 - 7.42 due to bicarbonate ions.A change of 0.2 pH units can cause death.
2. Certain enzymes in the body get activated only at certain definite pH values (Pepsin at pH 1.2).
3. The stomach produces hydrochloric acid that helps in the digestion of food. Under normal conditions this acid does not harm the stomach. During indigestion the stomach produces too much acid causing pain and irritation. The pain due to excess acid can be got over by

neutralizing it with a base. A base like magnesium hydroxide (Milk of magnesia), a mild base, is often used for this purpose. These are also called antacids - substances neutralizing the excess acid.

4. Similarly bee-sting or ant sting and the stinging hair of nettle leaves produce an acid called Methanoic acid which causes burning sensation, pain and irritation. Use of a mild base like baking soda on the stung area gives relief.
5. Tooth enamel is the hardest substance in the body, it begins to corrode when the pH in the mouth falls below 5.6.
6. The bacteria present in the mouth act on sugar and food particles that remain stuck in teeth. These bacteria release acid which causes damage to teeth.The best way to prevent this is to clean the mouth after eating food or use toothpastes, which are slightly basic
7. The stinging hair of nettle leaves inject Methnoic acid which cases burning and pain. The effect of nettle sting can be neutralized by rubbing "Dock plant" which contains chemicals which are basic in nature.

2. ***In Agriculture:-***

1. The pH of the soil is very important for a proper crop yield. Salts such as carbonates, bicarbonates, phosphates, and organic acids make the soils acidic or basic.
2. Most vegetables like carrot and cabbage grow better in a neutral soil (pH 7.0).

3. ***In Industries:-***

1. Most of the industries use acids or bases in the variety of processes. Acids and bases are used in paper industry, in making Dyes, Ink, Paints and Drugs industries.

4. ***In Environment:-***

1. Rain water reacts with chemicals such as oxides of sulphur (SO_2), oxides of nitrogen (NO_2), released from automobile exhausts industrial plants, electric power plants etc. and forms acids.This leads to acid rain (pH ranges between 5.6 -3.5.).
   Harmful Effects of Acid Rain:-

   1. **Damage to Plants** -Acidic water is dangerous for plants.

      1. Sulphuric and nitric acid containing rain damages the bark and leaves of trees and harms the fine root hairs of many plants which are needed to absorb water.
      2. It washes nutrients out of the soil.
      3. Leaf pigments are decolorized because acid affects green pigment (chlorophyll) of plants.

   2. **Damage to Animals** - Most of the aquatic animals cannot survive when the pH is less than 4.

3. **Material Damage** -Metallic surfaces exposed to acid rain get corroded.

    1. Textile fabrics, paper and leather products lose their material strength
    2. Building materials such as limestone, marble ($CaCO_3$) are weakened on reaction with acid rains because of the formation of soluble compounds.

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2$$

    3. Historical monuments are particularly prone to damage caused due to acid rain (example Taj Mahal).

INTRODUCTION:- SALTS

A salt is a compound formed from an acid by the replacement of the hydrogen in the acid by a metal. For e.g. Hydrochloric acid is HCl. Now, if we replace the hydrogen of this acid by a metal atom, say asodium atom (Na), then we will get a salt of NaCl. This is called *Sodium chloride*.

1. Salts are formed as a result of the reaction between an acid and a base.Salts are placed in to various families.**Salt Families** named **on the basis of the acid** taking part in the reaction
    1. Hydrochloric acid (HCl) - salts are called chloride family salts
    2. Sulphuric acid (H_2SO_4) - salts are called sulphate family salts
    3. Nitric acid (HNO_3) - salts are called nitrate salts
2. **Salt Families** named **on the basis of the base** taking part in the reaction.
    1. Sodium Hydroxide (NaOH) – salts are called Sodium family salts.
    2. Potassium hydroxide (KOH) – salts are called Potassium family salts.
    3. Ammonium hydroxide (NH_4OH) – salts are called Ammonium family salts

pH of Salts

A salt is formed by the reaction between acid and a base, so we should expect that the solution of a salt in water will be neutral towards litmus. Though the aqueous solution of many salt are neutral, some salts produce acidic or basic solution when dissolved in water.

The acidic nature and basic nature of some salt solutions can be explained on the basis of hydrolysis of salts. There are three classifications on the basis of hydrolysis:-

1. **The salts of strong acid and strong base give neutral solution(Neutral Salts)**:-

    There are many salts which formed from the strong acids and strong base. For e.g. NaCl. On hydrolysis of NaCl, it give HCl (Hydrochloric acid) and NaOH (Sodium Hydroxide). Both HCl and NaOH are the strong acid and base.

2. The salt of strong acid and weak bases give acidic solution:-

There are many salts which formed from the strong acids and weak base. For e.g. Ammonium chloride (NH_4Cl) is a salt of a strong acid HCl and a weak base NH_4OH, so on hydrolysis solution of ammonium chloride is acidic in nature.

$$\underset{\text{Ammonium chloride}}{NH_4Cl\ (s)} + \underset{\text{Water}}{H_2O\ (l)} \rightleftharpoons \underset{\text{Ammonium Hydroxide}}{NH_4OH\ (aq)} + \underset{\text{Hydrochloric acid}}{HCl\ (aq)}$$

3. **The salt of weak acid and strong base give basic solution**:-

There are many salts which formed from the strong acids and weak base. For e.g. Sodium Carbonate (Na_2CO_3) is a salt of weak acid carbonic acid (H_2CO_3) and a strong base sodium hydroxide (NaOH), so on hydrolysis solution of sodium carbonate is basic in nature.

$$\underset{\text{Sodium Carbonate}}{Na_2CO_3\ (s)} + \underset{\text{Water}}{2H_2O\ (l)} \rightleftharpoons \underset{\text{Sodium Hydroxide}}{2NaOH\ (aq)} + \underset{\text{Carbonic acid}}{H_2CO_3(aq)}$$

SODIUM CHLORIDE **(NaCl)**

1. Sodium chloride is the most commonly available salt and so is called common salt.
2. Sea water is the main source of sodium chloride.
3. Seawater contains about 3.5% of soluble salts, the most common of which is sodium chloride (2.7 to 2.9%).
4. Saline water of inland lakes is also a good source of this salt.
5. Sodium chloride is also found as rock salt.

Extraction of salt

There are two extraction methods by which salt is obtained:-

1. From sea water:-

1. Common salt is generally obtained by evaporation of seawater.
2. In India the coastal line of Gujarat is one of the important areas producing salt by solar evaporation.
3. Crude sodium chloride is obtained by crystallization of 'brine'(concentrated solution of sodium chloride), that contains sodium sulphate, calcium sulphate, calcium chloride and magnesium chloride as impurities.

2. From rock salt:-

1. Pure sodium chloride is obtained from the rock salt by dissolving it in minimum amount of water and filtering it to remove insoluble impurities.

2. The solution is then saturated with hydrogen chloride gas, when crystals of pure sodium chloride separate out.
3. Calcium and magnesium chlorides, being more soluble than sodium chloride, remain in solution.

Properties

1. Sodium chloride is a white crystalline solid.
2. It melts at 1080 K (807°C) and boils at 1713 K (1440°C).
3. It is soluble in water and its solubility is 36 g per 100 g of water at 273 K (0°C).
4. The solubility in water remains constant with temperature.
5. Pure sodium chloride is non-hygroscopic (does not absorbs water) but behaves as hygroscopic due to the impurities of $CaCl_2$ and $MgCl_2$.
6. Solid Sodium chloride does not conduct electricity at room temperature but molten sodium chloride is a very good ionic conductor

Uses

1. As table salt, an essential constituent of our food as it provides Na^+ and Cl^-.
2. Na^+ ions help in nerve impulse conduction.
3. In the manufacture of Na_2CO_3, NaOH, Cl_2, etc.
4. For salting out soap, and organic dyes.
5. In freezing mixtures.
6. In tanning and textile industries.
7. As a preservative for fish, meat, butter etc

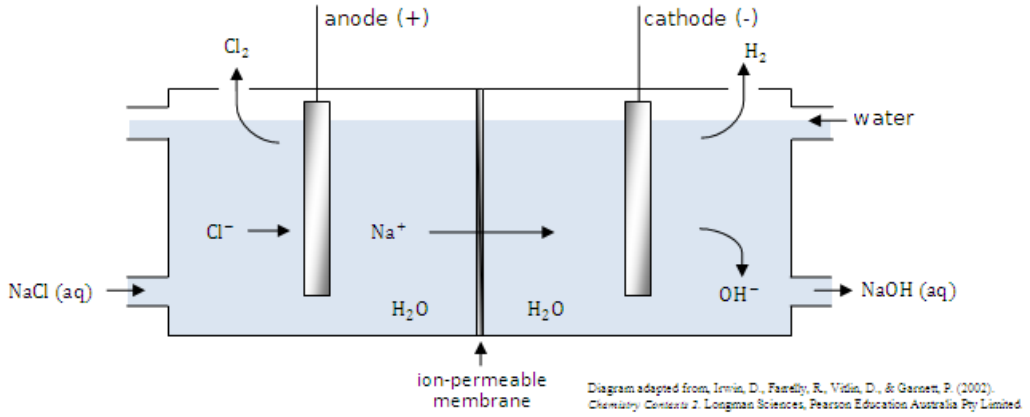
SODIUM HYDROXIDE **(NaOH)**

Sodium hydroxide is commonly called **caustic soda** because of its corrosive action on animal and vegetable tissues.

Preparation

1. Large quantity of sodium hydroxide is prepared by electrolytic process called the '**Chlor-alkali process'.**
2. Electricity is passed through cold Brine (Concentrated aqueous solution of sodium chloride).
3. Chlorine gas is given of at the anode and hydrogen gas at the cathode.
4. Sodium hydroxide solution is formed near the cathode.

$$\underset{\text{Brine solution}}{NaCl\,(aq)} + \underset{\text{Water}}{2H_2O\,(l)} \longrightarrow \underset{\text{Sodium Hydroxide}}{2NaOH\,(aq)} + \underset{\text{Chlorine Gas}}{Cl_2\,(g)} + \underset{\text{Hydrogen gas}}{H_2\,(g)}$$



Properties

1. Sodium hydroxide is a white deliquescent solid.
2. Melting point is 591 K (318°C).
3. It is highly soluble in water (reaction is exothermic).
4. It is also soluble in alcohol.
5. Aqueous solution of sodium hydroxide is strongly alkaline due to its complete dissociation into Na^+ and OH^-.
6. Solution of sodium hydroxide is soapy to touch.
7. It has a bitter taste.
8. When a concentrated solution of sodium hydroxide comes in contact with skin, it breaks down the skin and flesh to a pasty mass.

Uses of NaOH

1. In the manufacture of soap, paper, viscose rayon (artificial silk), organic dyestuffs, and many other chemicals.
2. In the refining of petroleum and vegetable oils.
3. As a cleansing agent and in washing powder for machines, metal sheets etc.
4. It is too caustic to be used in washing clothes or hands.
5. For mercerizing cotton (making it wrinkle free).
6. As a reagent in the laboratory.
7. In making rubber.
8. In the preparation of soda lime

Uses of Chlorine (Cl_2)

1. As bleaching agent.
2. Disinfectant in Drinking water.
3. In swimming pools.
4. In making, CFC used as coolant (now banned as it causes depletion of ozone layer).

5. PVC (poly vinyl Chloride) used in making pipes.
6. In making HCl, Chloroform etc.

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Uses of Hydrogen

1. As fuel in rockets.
2. In making Ammonia.
3. In making Vanaspati Ghee by hydrogenation of oil.

***Washing Soda* (*Sodium Carbonate Decahydrate*) ($Na_2CO_3.10\ H_2O$)**

Sodium carbonate exists as anhydrous (Na_2CO_3) and also as hydrated salt.The decahydrate salt ($Na_2CO_3.10H_2O$) is known as **washing soda** while the anhydrous salt is called **soda ash.**

Manufacture of Sodium Carbonate

It is produced from common salt in the following three steps

1. Cold brine (Concentrated solution of common salt) is treated with Ammonia and Carbon dioxide to obtain Sodium hydrogen carbonate

$$\underset{\text{Brine}}{NaCl} + H_2O + \underset{\text{Ammonia}}{NH_3} + CO_2 \longrightarrow \underset{\text{Sodium hydrogen carbonate}}{NaHCO_3} + \underset{\text{Ammonium chloride}}{NH_4Cl}$$

2. Sodium hydrogen carbonate is separated by filtration, dried and heated-

$$\underset{\text{Sodium hydrogen carbonate}}{NaHCO_3} \longrightarrow \underset{\text{Sodium Carbonate}}{Na_2CO_3} + H_2O + CO_2$$

3. Anhydrous Sodium carbonate (soda ash) is dissolved in water and re-crystallized to get Sodium hydrogen carbonate (Washing soda)

$$\underset{\text{Blue Vitriol}}{CuSO_4.5H_2O} \xrightarrow{\text{Heating}} \underset{\text{Copper Sulphate (Colorless)}}{CuSO_4} + 5H_2O$$

Properties of Washing Soda

1. It is a transparent crystalline solid.
2. It is one of the few metal carbonates which are soluble in water.

3. Solution of washing soda is alkaline.
4. It has detergent properties (it removes dirt and grease from dirty clothes).

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Uses of Washing Soda

1. It is used as a cleansing agent.
2. It is used for removing hardness of water.
3. Also used in the manufacture of glass. Soap and paper.
4. Used in the manufacture of compounds like Borax.

Baking Soda (Sodium Hydrogen Carbonate) $NaHCO_3$

Sodium hydrogen carbonate is also known as sodium bicarbonate or baking soda because it decomposes on heating to generate bubbles of carbon dioxide (leaving pores in cakes or pastries and making them light and fluffy).

Preparation

Baking soda is prepared by two methods, which are given below**:-**

1. $NaHCO_3$ is made by saturating a solution of sodium carbonate with carbon dioxide. The white crystalline powder of sodium hydrogen carbonate being less soluble gets separated.
2. On an industrial scale, sodium hydrogen carbonate ($NaHCO_3$) is obtained as an intermediate product in process for the manufacture of sodium carbonate Cold brine (Concentrated solution of common salt) is treated with Ammonia and Carbon dioxide to obtain Sodium hydrogen carbonate

$$\underset{\text{Brine}}{NaCl} + H_2O + \underset{\text{Ammonia}}{NH_3} + CO_2 \longrightarrow \underset{\text{Sodium hydrogen carbonate}}{NaHCO_3} + \underset{\text{Ammonium chloride}}{NH_4Cl}$$

Properties

1. Sodium hydrogen carbonate is a white crystalline solid.
2. It has alkaline taste.
3. It is slightly soluble in water.
4. The solubility of sodium hydrogen carbonate increases with the rise of temperature,
5. On heating it decomposes in to sodium carbonate , water and carbon dioxide

$$\underset{\text{Sodium hydrogen carbonate}}{NaHCO_3} \longrightarrow \underset{\text{Sodium Carbonate}}{Na_2CO_3} + H_2O + CO_2$$

Uses

1. As a component of baking powder .- Baking powder is a mixture of Baking soda and a mild , edible acid (eg tartaric acid)
   Reason – When baking soda is heated it decomposes to form **sodium carbonate** which is a **bitter tasting compound** and so will spoil the taste of the food.Baking powder (baking soda + edible acid) when heated does not produce bitter tasting Sodium carbonate.
2. In making fire extinguishers
3. In medicines as a mild antiseptic for skin diseases
4. Also used to neutralize the acidity of stomach (Antacid)
5. As a reagent in laboratory.

Plaster of Paris **[$CaSO_4.\frac{1}{2}H_2O$]**

Calcium sulphate with half a molecule of water per molecule of the salt (hemihydrate) is called plaster of Paris (plaster of Paris).

Preparation

1. Plaster of Paris is prepared by heating gypsum ($CaSO_4.2H_2O$) at 100°C (373 K), where it gets partially dehydrated.
2. The temperature should be kept below 120°C otherwise further dehydration will take place and the setting property of the plaster will be partially reduced.

Properties

1. It is a white powder. When mixed with water (1/3 of its mass), it evolves heat and quickly sets to a hard porous mass within 5 to 15 minutes.
2. During setting, a slight expansion (about 1%) in volume occurs so that it fills the mould completely and takes a sharp impression.
3. The process of setting occurs in two steps.
4. The first step is called the setting stage, and the second, the hardening stage.
5. The setting of plaster of Paris is catalyzed by sodium chloride

Uses

1. In surgery for setting broken or fractured bones.
2. For making casts for statues, in dentistry, for surgical instruments, and toys etc.
3. In making black board chalks, and statues.
4. In construction industry (in making Fall sealing).

Water of Crystallization

1. When crystals of certain salts are formed, they do so with a definite number of molecules of water, chemically combined in a definite proportion.
2. Water of crystallization is the number of water molecules, chemically combined in a definite molecular proportion, with the salt in its crystalline state.
3. This water is responsible for the geometric shape and colour of the crystals.
4. A substance containing water of crystallization is called a hydrous substance or a hydrate.
5. This water can be expelled, by heating, and then the salt is said to have become anhydrous.

TABLE FOR SOME HYDROUS COMPOUNDS

NAME	CHEMICAL FORMULA	COMMON NAME
Zinc Sulphate	$ZnSO_4.7H2O$	White vitriol
Sodium carbonate deca hydrate	$Na_2CO_3.10H_2O$	Washing soda(crystal)
Calcium sulphate	$CaSO_4.2H_2O$	Gypsum
Ferrous Sulphate	$FeSO_4.7H_2O$	Green vitriol
Calcium sulphate semi hydrate	$(CaSO_4).1/2H_2O$	Plaster of Paris
Copper sulphate	$CuSO_4.5H_2O$	Blue vitriol

Effect of Heat on Hydrous Salt

1. On heating, hydrous crystals lose their water of crystallization and turn into a powder.
2. They are then said to be anhydrous.
3. Sometimes they may also lose their colour.

$$\underset{\text{Blue Vitriol}}{CuSO_4.5H_2O} \xrightarrow{\text{Heating}} \underset{\text{Copper Sulphate (Colorless)}}{CuSO_4} + 5H_2O$$

4. Certain substances like Sodium Chloride do not require the help of water to form their crystalline shape

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