Revision Notes

Class 10 Science

Chapter 2 - Acids, Bases and Salts

Introduction:

- Electrolytes are chemicals that conduct electricity when dissolved in water.
- Chemical compounds are divided into three categories: acids, bases, and salts. Many fruits and vegetables, such as lemon, have a sour flavour due to the presence of different acids. Acids can also be found in the digestive secretions of most animals and humans.
- The term "acid" comes from a Latin word that means "sour." Stronger acids, such as hydrochloric and sulphuric acid, are used in the laboratory. Acids are corrosive and can cause skin burns. Bases, on the other hand, are the polar opposites of acids in terms of chemistry. They have a harsh flavour and feel soapy to the touch.
- Basic ingredients include things like sea water and detergents. Metal oxide or hydroxide complexes make up many bases. Strong bases can also cause skin irritation.
  Organic acids are acids found in plant and animal components.
  Some acids are found in nature.

Vinegar	Acetic acid
Sour milk (curd)	Lactic acid
Oranges	Citric acid
Lemons	Citric acid
Tamarind	Tartaric acid
Ant sting	Formic acid
Apples	Malic acid
Tomatoes	Oxalic acid.

- Mineral acids, often known as inorganic acids, are generated from naturally existing minerals. The following are some of the most frequent acids discovered in laboratories:
  i. Hydrochloric acid (HCl),

ii. Sulphuric acid (H_2SO_4) and
iii. Nitric acid (HNO_3).
iv. Some of the lesser used acids are
v. Acetic acid (CH_3COOH),
vi. Hydrofluoric acid (HF) , Hydrofluoric acid is a highly corrosive acid and is used to etch glass.
vii. Carbonic acid (H_2CO_3).

General properties of Acids:

- Tastes sour
- Reacts with metals such as zinc, magnesium etc. liberating hydrogen gas.
- Changes the colour of litmus from blue to red.
- Conducts electricity.

General properties of Bases:

- Have a soapy feel,
- May also burn the skin
- Common examples are soaps & detergents.
- Commonly found bases in laboratories and in our daily life are: Caustic soda, $NaOH$; Caustic potash, KOH; Milk of magnesia, $Mg(OH)_2$; Liquor ammonia, NH_3; Washing powder, Tooth paste.

ACIDS:

- Concentrated & Dilute acids - A concentrated acid is one that has the least quantity of water in it. By diluting a concentrated acid with water, a dilute acid is created.

- Dissolving Acids or Bases in Water - Dissolving an acid or a base in water is a very exothermic process. Because this reaction generates a lot of heat, caution should be exercised when mixing strong acids with water, particularly nitric or sulphuric acid. Always put acid to water, never the other way around! The acid must be slowly added to the water while swirling constantly.

- When water is added to a concentrated acid, the heat generated causes the mixture to splash out, resulting in burns. Excessive local heating may potentially cause the glass container to break and cause harm! Dilution occurs when an acid or base is mixed with water. It reduces the concentration of ions $\left(H_3O^+/OH^-\right)$ per unit volume, allowing the heat effect to be easily dissipated.

- **What Happens When an Acid Is Dissolved in Water?**
  Acids - Because all acids contain hydrogen ions, the stronger they are the more hydrogen ions they contain. A chemical that creates H^+ ions when dissolved in water is a suitable definition of an acid.
  Hydrogen ions can't exist by themselves; they can only exist when they combine with water molecules. When H^+ ions combine with a water molecule, they generate $H3O^+$ ions, or hydronium ions.
  $$H^+ + H_2O \longrightarrow H_3O^+$$
  When hydrogen chloride gas is dissolved in water, for example, the hydrogen chloride molecules dissociate or split into hydrogen ions and chloride ions almost instantly. The solution turns into hydrochloric acid, which is an extremely strong acid.
  $$HCL(aq) \longrightarrow H^+(aq) + Cl^-(aq)$$
  In the absence of water, the separation of the H^+ ion from the HCl molecules is impossible. As a result, hydrogen ions must always be represented by the letter $H^+(aq)$ or $\left(H_3O^+\right)$.
  The concentration of hydronium ions present in a solution determines the acid's strength. We already know that the bigger the quantity of hydronium ions, $\left(H_3O^+\right)$ present, the stronger the acid. However, other acids, such as carbonic acid, do not dissociate in water to any significant degree. As a result, these acids will have a low hydronium ion concentration.

- **What is the Strength of Acid Solutions?**
  1. Strong Acid –
  A strong acid is an acid that dissociates completely or nearly completely in water. Only ions and water make up an aqueous solution of a strong acid.
  It is important to note that in these acids, all hydrogen ions $\left(H^+\right)$ react with the water molecule to form hydronium ions $\left(H_3O^+\right)$. Strong acids include hydrochloric acid, sulphuric acid, and nitric acid, among others.

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

Hydrochloric acid

$$HNO_3(aq) \longrightarrow H^{+}(aq) + NO_3^{-}(aq)$$

Nitric acid

$$H_2SO_4(aq) \longrightarrow 2H^{+}(aq) + SO_4^{2-}(aq)$$

2. Weak Acid –

A weak acid is an acid that only partially dissociates when dissolved in water. Ions and molecules are present in a weak acid aqueous solution. Acetic acid, formic acid, carbonic acid, and other acids are examples.

$$CH_3COOH(aq) \longrightarrow CH_3COO^{-}(aq) + H^{+}(aq)$$

Acetic acid

$$HCOOH(aq) \longrightarrow HCOO^{-}(aq) + H^{+}(aq)$$

Formic acid

$$H_2CO_3(aq) \longrightarrow H^{+}(aq) + HCO_3^{-}(aq)$$

Carbonic acid

$$H_2CO_3(aq) \longrightarrow 2H^{+}(aq) + CO_3^{2-}(aq)$$

Carbonic acid

- **Reaction of Acids with Metals:**

a. In the metal reactivity series, all metals above hydrogen react with dilute acids to generate their respective salts and liberate hydrogen.

$$\underset{\text{Magnesium}}{Mg(s)} + \underset{\text{Dil. Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Magnesium chloride}}{MgCl_2} + \underset{\text{Hydrogen}}{H_2(g)}$$

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Dil. Hydrochloric Acid}}{2HCl(aq)} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

$$\underset{\text{Iron}}{Fe(s)} + \underset{\text{Dil. Sulphuric acid}}{H_2SO_4(aq)} \longrightarrow \underset{\text{Iron(II) Sulphate}}{Fe_2SO_4(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

b. Very active metals like potassium, sodium and calcium also react similarly, but tend to explode when combining with acids.

$$\underset{\text{Sodium}}{2Na(s)} + \underset{\text{Dil. Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Sodium chloride}}{2NaCl(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

c. Nitric acid (at varied doses) usually has an oxidising rather than an acidic quality. To liberate hydrogen, metals like magnesium react with extremely dilute (1%) nitric acid.

d. How do Acids React with Metal Carbonates and Metal Hydrogen Carbonates? Acids generate salt, water, and carbon dioxide when they react with carbonates and hydrogen carbonates (bicarbonates).

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Sodium Carbonate | Hydrochloric acid | Sodium chloride | Water | Carbon dioxide

$$ZnCO_3(aq) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(l) + CO_2(g)$$

Zinc Carbonate | Sulphuric acid | Zinc Sulphate | Water | Carbon dioxide

$$2NaHCO_3(s) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l) + 2CO_2(g)$$

Sodium Hydrogen Carbonate | Sulphuric acid | Sodium sulphate | Water | Carbon dioxide

- **Neutralization:**

i. Neutralization is the reaction between the hydrogen ions of an acid and the hydroxyl ions of a base. A neutralisation reaction can be written as follows:

Acid + Base $\longrightarrow$ Salt + Water

Examples:

1. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_20(l)$

   Sodium hydroxide | Hydrochloric acid | Sodium chloride | Water

2. $3NH_40H(aq) + H_3PO_4(aq) \rightarrow (NH_4)_3PO_4(aq) + 3H_20(l)$

   Ammonium hydroxide | Phosphoric acid | Ammonium phosphate | Water

3. $PbO(s) + 2HN0_3(aq) \rightarrow (PbNO_3)_2(aq) + H_20(l)$

   Lead oxide | Nitric acid | Lead nitrate | water

The presence of hydrogen ions (H^+) in an acid causes it to be acidic, whereas the presence of hydroxyl ions (OH^-) in a base or alkali causes it to be alkaline. When an acid and a base (alkali) interact, the acid's positively charged hydrogen ion joins the base's negatively charged hydroxyl ion to produce a water molecule. Because the positive and negative charges of the hydrogen ions and hydroxyl ions are neutralised, the water molecule created has no charge.

ii. Neutralization is defined as a reaction in which an acid reacts with a base to neutralise the positively charged hydrogen ion and the negatively charged hydroxyl ion, resulting in the formation of a water molecule and the salt.

- **Acid Reactions of Metallic Oxides:**

  Basic Oxides in Action

  Basic oxides are oxides that react with an acid to generate salt and water. When these oxides react with acids, they get neutralised.

  1. $Na_2O(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l)$

     Sodium Oxide, Hydrochloric acid, Sodium chloride, Water

  2. $PbO(s) + 2HNO_3(aq) \rightarrow Pb(NO_3)_2(aq) + H_2O(l)$

     Lead oxide, Nitric acid, Lead nitrate, Water

  3. $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

     Copper Oxide, Sulphuric acid, Copper sulphate, Water

- **Action with Basic Hydroxides:**

  Acids undergo neutralization reaction with basic hydroxides to form salt and water.

  1. $2KOH(aq) + H_2CO_3(aq) \rightarrow K_2CO_3(aq) + 2H_2O(l)$

     Potassium hydroxide, Carbonic acid, Potassium carbonate, Water

  2. $3NaOH(aq) + H_3PO_4(aq) \rightarrow Na_3PO_4(aq) + 3H_2O(l)$

     Sodium Hydroxide, Phosphoric acid, Tri sodium phosphate, Water

  3. $NH_40H(aq) + H_2S0_4(aq) \rightarrow (NH_4)_2S0_4(aq) + 2H_2O(l)$

     Ammonium Hydroxide, Sulphuric acid, Ammonium sulphate, Water

- **Non-metallic Salts and Base Reaction:**

The base calcium hydroxide reacts with carbon dioxide to create salt and water. We can deduce that nonmetallic oxides are acidic in nature since this reaction is similar to that of a base and an acid.

$$CaOH_2(aq) + CO_2(g) \rightarrow CaCO_3 \downarrow + H_2O(l)$$

Calcium Hydroxide, Carbon dioxide, Calcium carbonate, Water

This reaction occurs during white washing.

Bases:

- Metal oxides and hydroxides are known as bases. Sodium hydroxide, magnesium oxide, calcium oxide, copper oxide, potassium hydroxide, magnesium hydroxide, and other bases are examples. Some bases are water soluble, forming hydroxyl ions (OH^-) when they dissolve in water. An alkali is a base that is soluble in water. When sodium hydroxide is dissolved in water, for example, it readily dissociates into a large number of hydroxide ions.

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

- All alkalis are bases that dissociate in water to produce the lone negative ion, the hydroxyl ion. The most prevalent alkalis are sodium hydroxide, potassium hydroxide, calcium hydroxide, and ammonium hydroxide.

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

  $$KOH(aq) \rightarrow K^+(aq) + OH^-(aq)$$

  $$Ca(OH)_2(aq) \rightarrow Ca^{2+}(aq) + 2OH^-(aq)$$

  $$NH_4OH(aq) \rightarrow NH^{4+}(aq) + OH^-(aq)$$

- **Strong Base/Alkali -** When a base is dissolved in water, the concentration of hydroxyl ions determines its strength. A strong base is one that dissociates completely or nearly completely in water to produce a large concentration of hydroxyl ions. The base's strength is proportional to the quantity of hydroxyl ions it produces. Strong alkalis are represented by the letter $NaOH$, KOH, & $LiOH$.

  Example:

  $$NaOH \rightarrow Na^+ + OH^-$$

- **Weak Base / Alkali -** A weak base is one that only partially dissociates

in water, leaving a low concentration of hydroxyl ions. Weak alkalis include calcium hydroxide and ammonium hydroxide.
Example:

$$NH_4OH(aq) \rightarrow NH^{+}{}_4(aq) + OH^{-}(aq)$$

- **Reactions of Bases/alkalis:**
  Neutralization Reaction – Already done
  Action of Alkalis/Base with Ammonium Salts
  Alkalis combine with ammonium salts to liberate ammonia.

$$Ca(OH)_2(aq) + 2NH_4Cl(s) \rightarrow CaCl_2(s) + 2H_2O(l) + 2NH_3(g)$$

Calcium hydroxide	Ammonium chloride	Calcium chloride	Water	Ammonia

$$2NaOH(aq) + (NH_4)_2SO_4aq \rightarrow Na_2SO_4(aq) + 2H_2O + 2NH_3(g)$$

Sodium hydroxide	Ammonium sulphate	Sodium sulphite	Water	Ammonia

The negative logarithm of hydrogen ion concentration in moles per litre is used to calculate the **pH of a solution**.

$$pH = \text{-}\log\left[H + (aq)\right]$$

The pH scale is a continuous scale and the value of pH varies between 0 to 14 .
The pH of pure or neutral water is 7. Solutions having pH less than 7 are acidic in nature and the solutions with pH more than 7 are basic in nature.

Indicators:

- With the use of markers, it is possible to distinguish between acids and bases. Indicators are compounds that change colour when exposed to a different acidic, neutral, or basic media. In laboratories, litmus, a purple dye derived from the lichen plant, is widely employed as an indicator. Litmus solution turns red when it comes into contact with acids, and blue when it comes into contact with bases.
- Another popular home indication is turmeric. When you remove a turmeric-based food stain on a white towel with soap, it turns reddish-brown. Soap is a natural product that alters the colour of the turmeric stain. When the cloth is cleaned in a lot of water, it turns yellow again.

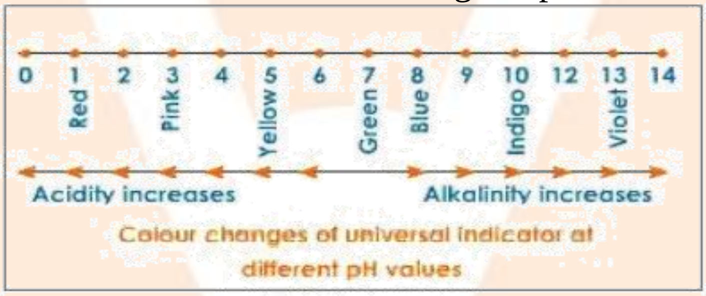
Other factors to consider:

- In acidic solutions, red cabbage extract produces a red colour, while in basic solutions, it produces a yellow tint.
- Onions have a distinct odour. There is no odour in simple solutions like NaOH. Onions, on the other hand, are not affected by acids.
- Vanilla extract has a pleasant odour in acidic solutions but none in basic solutions.

- **The common indicators used and the color changes observed are mentioned below:**

Indicator	**Acid**	**Alkali**
Litmus	Red	Blue
Methyl orange	Pink	Yellow
Phenolphthalein	Colorless	Deep pink
Methyl red	Yellow	Red

Universal Indicator: It is a mixture of indicators which give a gradual change of various colors over a wide range of pH.



Colour changes of universal indicator at different pH values

Approximate pH Values of Some Common Substances

Substance	**pH Value**
Hydrochloric acid	1.0
Sulphuric acid	1.2
Gastric juice	2.0
Rain water	6.2
Lemon	2.3
Milk	6.5
Vinegar (Acetic acid)	2.8
Pure water	7.0
Soft drink	3.0
Apple	3.1
Sea water	8.5

Importance of pH in our daily life:

a. Plants and pH: For healthy plant growth, the pH of the soil must be at a certain level. It shouldn't be acidic or basic in any way.
b. Digestive pH: The human body produces hydrochloric acid, which assists digestion. Hyperacidity is a condition in which the stomach produces too much acid. Anti-acid tablets or suspensions can be used to treat hyperacidity.
c. pH and dental decay: When the pH of the mouth falls below, tooth enamel, the toughest component in our bodies, corrodes. Toothpaste cleaning aids in the prevention of tooth decay. Toothpastes are basic in nature, and as a result, they neutralise excess acid in the mouth, preventing tooth decay.

- **Salts and their pH:**
  Salts are made by combining an acid and a base. Positive ions, also known as 'cations,' and negative ions, sometimes known as 'anions,' make up salts. The cations are known as basic radicals and are derived primarily from metallic ions (with the exception of the ammonium ion), whereas the anions are known as acidic radicals and are derived from acids.

$$\underset{\substack{\text{Sodium hydroxide}\\ \text{(Base)}}}{Na^{+}OH^{-}(aq)} + \underset{\substack{\text{Hydrochloric acid}\\ \text{(acid)}}}{H^{+}Cl^{-}(aq)} \rightarrow \underset{\substack{\text{Sodium chloride}\\ \text{(Salt)}}}{NaCl(aq)} + \underset{\text{Water}}{H_2O(l)}$$

  Salt is a compound that, when dissociated in water, produces positive ions other than hydrogen and hydronium ions, as well as a negative ion other than the hydroxyl ion.

- **Family of salts:** The following are the several types of salts:
  Normal or Neutral Salts - A normal salt is generated when the replaceable hydrogen ions of an acid are completely replaced by a metal ion or an ammonium ion. Examples : $NaCl$, Na_2SO_4, Na_3PO_4, NH_4Cl, K_2CO_3 and so on. The neutralisation reaction produces a neutral salt. Strong acid and strong base salts combine to generate such compounds with a neutral pH of 7.

- **Sodium Chloride:**
  Common salt is sodium chloride, which is the most widely available salt. The main source of sodium chloride is seawater. The most

common soluble salt in seawater is sodium chloride $(2.7 \text{ to } 2.9\%)$, which makes up roughly 3.5% of the total. Inland lakes' saline water is another good source of this salt. Rock salt is a form of sodium chloride. Evaporation of seawater is the most common method of obtaining common salt. Crude sodium chloride is made by crystallising 'brine,' which contains impurities such as sodium sulphate, calcium sulphate, calcium chloride, and magnesium chloride. By dissolving the crude salt in a small amount of water and filtering it to eliminate insoluble contaminants, pure sodium chloride can be obtained. When pure sodium chloride crystals break from the solution, it is saturated with hydrogen chloride gas. Calcium and magnesium chlorides remain in solution because they are more soluble than sodium chloride.

- **Properties:**
  - Sodium chloride is a white crystalline solid having a density of 2.17 g/ml.
  - It melts at $1080 \text{ K } (807°\text{C})$ and boils at $1713 \text{ K } (1440°\text{C})$.
  - It is soluble in water and its solubility is $36 \text{ g per } 100 \text{ g of water at } 273 \text{ K. } (0^{\circ}\text{C})$. The solubility in water remains constant with temperature.
  - Pure sodium chloride is non-hygroscopic, but behaves as hygroscopic due to the impurities of $CaCl_2$ and $MgCl_2$ in it.
  - Solid Sodium chloride does not conduct electricity at room temperature but molten sodium chloride is a very good ionic conductor.

- **Uses:**
  - As table salt, an essential constituent of our food.
  - In the manufacture of Na_2CO_3, NaOH, Cl_2, etc.
  - For salting out soap, and organic dyes.
  - In freezing mixtures.
  - In tanning and textile industries.
  - As a preservative for fish, meat, butter etc.

- **Sodium Carbonate** (Na_2CO_3):

  Sodium carbonate (Na_2CO_3) is available as both an anhydrous and hydrated salt. Washing soda is the name for the dehydrated salt $(Na_2CO_3.10H_2O)$, while soda ash is the name for the anhydrous salt.

- **Manufacture of Sodium Carbonate:**

- The Ammonia-soda or Solvay processes are commonly used to produce sodium carbonate. Common salt, ammonia, and limestone are used as raw ingredients in this procedure (for supplying CO_2 and quicklime).
- Ammonium bicarbonate is formed when carbon dioxide is added to a concentrated solution of brine saturated with ammonia. The sodium bicarbonate is formed when ammonium bicarbonate combines with common salt.

$$\underset{}{NH_4OH} + H_2CO_3 \rightarrow \underset{\text{Ammonium bicarbonate}}{NH_4HCO_3} + H_2O$$

$$NH_4HCO_3 + NaCl \rightarrow \underset{\text{Sodium bicarbonate}}{NaHCO_3} + NH_4Cl$$

Sodium bicarbonate being slightly soluble (in presence of sodium ions) gets precipitated. Precipitated sodium bicarbonate is removed by filtration and changed into sodium carbonate by heating.

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$$

- **Steps in the Solvay process:**

1. Ammoniacal brine reacts with carbon dioxide to produce sodium hydrogen carbonate.
   $NaCl + NH_3 + H_2O + CO_2 \rightarrow NH_4Cl + NaHCO_3$
2. Sodium hydrogen carbonate is heated to get sodium carbonate.
   $2NaHCO_3 + NaCO_3 \rightarrow H_2O + CO_2$
3. Sodium carbonate is recrystallized by dissolving in water to get washing soda.
   $Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3.10H_2O$

Limestone is heated to obtain CO_2. $CaCO_3 \rightarrow CaO + CO_2$.

The quicklime is dissolved in water to obtain slaked lime which is made to react with ammonium chloride to obtain ammonia which is used in step 1.

$CaO + H_2O \rightarrow Ca(OH)_2$

$Ca(OH)_2 + NH_4Cl \rightarrow CaCl_2 + 2NH_3 + 2H_2O$

- **Properties:**

Sodium carbonate is a white crystalline solid, which can exist as anhydrous salt (Na_2CO_3), monohydrate salt $(Na_2CO_3.H_2O)$, heptahydrate salt $(Na_2CO_3.7H_2O)$ and decahydrate $(Na_2CO_3.10H_2O\text{ - washing soda})$. Sodium carbonate is readily soluble in water. On heating, the decahydrate salt gradually loses water to, finally give anhydrous salt $(Na_2CO_3\text{ - soda ash})$.

$$\underset{\text{(washing soda)}}{Na_2CO_3.10H_2O} \xrightarrow[-9H_2O]{373K} Na_2CO_3.H_2O \xrightarrow[-H_2O]{\text{above }373K} \underset{\text{(soda ash)}}{Na_2CO_3}$$

- **Uses:**
- For the manufacture of glass.
- For washing purposes in laundries.
- For the manufacture of other sodium compounds like sodium silicates, sodium hydroxide, borax, hypo etc.
- As a household cleansing agent.
- In paper and soap/detergent industries.
- For the softening of water.
- A mixture of $NaCO_3$ and KCO_3 is used as a fusion mixture.
- In textile industry and petroleum refining

- **Sodium Hydrogen Carbonate,** (Na_2CO_3):

Sodium Hydrogen Carbonate, often known as sodium bicarbonate or baking soda, is a substance that decomposes when heated, releasing carbon dioxide bubbles (leaving pores in cakes or pastries and making them light and fluffy).

Saturating a sodium carbonate solution with carbon dioxide produces $(NaHCO_3)$. The less soluble white crystalline powder of sodium hydrogen carbonate separates.

$$Na_2CO_3 + H_2O + CO_3 \rightarrow NaHCO_3$$

Sodium hydrogen carbonate $(NaHCO_3)$ is produced as an intermediate product in the Solvay process for the production of sodium carbonate on a large scale.

- **Properties:**

Sodium hydrogen carbonate is a white crystalline solid with a density of approximately $2.2\ g/ml$. It has an alkaline flavour and is water soluble only sparingly. As the temperature rises, so does the solubility of sodium hydrogen carbonate.

- **Uses:**
- As an ingredient in baking powder.
- In fire extinguishers.
- As a mild antiseptic for skin illnesses and to reduce stomach acidity in medicines.
- As a laboratory reagent.

- **Sodium Hydroxide** $\left(NaOH\right)$:

Because of its corrosive effect on animal and vegetable tissues, sodium hydroxide is usually referred to as caustic soda. The electrolytic process known as the 'Chlor-alkali process' is used to produce large amounts of sodium hydroxide. The anode emits chlorine gas, while the cathode emits hydrogen gas. Near the cathode, a sodium hydroxide solution forms.

- **Properties:**
- Sodium hydroxide is a white deliquescent solid having melting point at $591\ K\ \left(318^{\circ}C\right)$.
- It is stable towards heat.
- It is highly soluble in water and considerable amount of heat is evolved due to the formation of a number of hydrates e.g., $NaOH.H_2O,\ NaOH.2H_2O$. It is also soluble in alcohol.
- Aqueous solution of sodium hydroxide is strongly alkaline due to its complete dissociation into Na^+ and OH^-.
  $NaOH + H_2O \rightarrow Na^+\left(aq\right) + OH^-\left(aq\right)$
- When you touch a sodium hydroxide solution, it feels soapy. It has a sour taste to it. When skin is exposed to a concentrated solution of sodium hydroxide, the skin and flesh are broken down into a pasty substance.

- **Uses:**
- Soap, paper, viscose rayon (fake silk), organic dyestuffs, and a variety of other compounds are made with it.
- In the petroleum and vegetable oil refining industries.
- In the purification of bauxite for aluminium extraction.
- As a cleaning agent and in machine, metal sheet, and other laundry powders It's too corrosive to use on your clothes or your hands.
- Used to mercerize cotton.
- In the laboratory, as a reagent.

- In rubber reclamation.
- In the manufacture of soda lime.

- **Plaster of Paris $\left[CaSO_4 . 1/2\ H_2O\right]$:**
  Plaster of Paris is calcium sulphate with half a molecule of water per molecule of salt (hemi-hydrate) (plaster of paris).

- **Crystallization Water:**
  When crystals of certain salts form, they do so using a specific quantity of water molecules combined chemically in a specific proportion. The number of water molecules chemically associated in a specific molecular proportion with the salt in its crystalline state is known as water of crystallisation. The geometric shape and colour of the crystals are due to this water.

- **Remember**
  A hydrous substance, also known as a hydrate, is a compound that contains water of crystallisation. This water can be ejected from the salt by heating it, and the salt is then considered to be anhydrous.

  - **Preparation:**
    Plaster of Paris is prepared by heating gypsum $\left(CaSO_4.2H_2O\right)$ at $120^{\circ}C$ in rotary kilns, where it gets partially dehydrated.
    $$2\left(CaSO_4.2H_2O\right)\xrightarrow{120^{\circ}C}\left(CaSO\right)_4.H_2O+2H_2O$$
    The temperature should be kept below $140^{\circ}C$ otherwise further dehydration will take place and the setting property of the plaster will be partially reduced.

  - **Properties:**
    It's a powder that's white in colour. When combined with water $\left(1/3 \text{ of its mass}\right)$, it generates heat and hardens into a porous mass within $5 \text{ to } 15 \text{ minutes}$. During the setting process, the volume expands slightly $\left(\text{about } 1\%\right)$ so that it entirely fills the mould and leaves a clear impression. The following is how the setting procedure works:

$$CaSO_4 / 2H_2O \xrightarrow[\text{setting}]{H_2O} CaSO_4.2H_2O \xrightarrow[\text{hardening}]{} CaSO_4.2H_2O$$

plaster of paris	gypsum orthorhombic dihydrate	gypsum monoclinic dihydrate

The setting stage is the first, and the hardening stage is the second. Sodium chloride catalyses the setting of plaster of Paris, while borax or alum reduces it.

- **Uses:**

- For manufacturing casts for sculptures, in dentistry, for surgical instruments, for toys, etc.
- In surgery for setting broken or shattered bones.
- In the creation of blackboard chalks and statues
- In the construction field