Chapter 2 Acids, Bases and Salts

Properties of Acids:

– Produce hydrogen ions [H^+] in H_2O.

– Sour taste.

– Turn blue litmus red.

– Act as electrolytes in Solution.

– Neutralize solutions carrying hydroxide ions.

– React with several metals releasing Hydrogen gas.

– React with carbonates releasing CO_2 (g)

– Destroy body tissues.

– corrode metal surface quickly.

On the basis of origin, acids are classified as :

a. Organic acids: Acids derived from living organisms like plants and animals . For example: citric acid is present in fruits, acetic acid present in vinegar, oxalic acid present in tomato, tartaric acid present in tamarind, lactic acid present in sour milk and curd.

b. Mineral acids: They are also called inorganic acids. They are dangerous Example sulphuric acid (H_2SO_4), hydrochloric acid (HCl) etc.

➢ **On the basis of their strength, acids are classified as :**

a. Strong acids: Completely dissociate into its ions in aqueous solutions.
Example: Nitric acid (HNO_3), sulphuric acid (H_2SO_4), hydrochloric acid (HCl).

b. Weak acids: Weak acids are those acids which do not completely dissociate into its ions in aqueous solutions. For example: carbonic acid (H_2CO), acetic acid (CH_3COOH).

➢ **On the basis of their concentration, acids are classified as :**

a. Dilute acids: Have a low concentration of acids in aqueous solutions.
b. Concentrated acids: Have a high concentration of acids in aqueous solutions.

➢ **On the basis of number of hydrogen ion, acids can be classified as :**

Monoprotic acid – Such type of acid produces one mole of H^+ ions per mole of acid, e.g., HCl , HNO_3

Diprotic acid – They can produce two moles of H^+ ions per mole of acid, e.g., H_2SO_4.

Triprotic acid – They produce three moles of H^+ ions per mole of acid, e.g., H_3PO_4.

Polyprotic – They can produce more than three H+ ions per mole of acid.

➢ **Properties of Base:**

– Produce hydroxide ions [OH –] in H_2O.
– Water soluble bases are called alkalies.
– Bitter Taste
– Turn Red Litmus blue.
– Act as electrolytes in Solution.
– Neutralize solutions containing H^+ ions.
– Have a slippery, 'soapy' feel.
– Dissolve fatty material.

➢ **On the basis of their strength, bases are classified as:**

a. Strong bases: Strong bases are those bases which completely dissociate into its ions in aqueous solutions. Example: sodium hydroxide (NaOH), potassium hydroxide (KOH).

b. Weak bases: Weak bases are those bases which do not completely dissociate into its ions in aqueous solutions. For example: ammonium hydroxide (NH_4OH).

➢ **On the basis of their concentration, bases are classified as:**

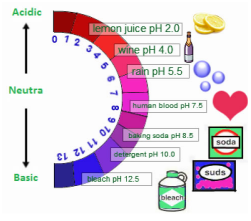
a. Dilute bases: Have a low concentration of alkali in aqueous solutions.
b. Concentrated bases: Have a high concentration of alkali in aqueous solutions.

➢ **Strength Of Acid Or Base Solutions:**

A scale for measuring hydrogen ion concentration in a solution, called pH scale has been developed. The p in pH stands for 'potenz' in German, meaning power.
p= potential or Power H = Hydrogen

pH =7	Neutral Solution	$H_3O^+ = OH^-$
pH>7	Basic Solution	$H_3O^+ < OH^-$
pH<7	Acidic Solution	$H_3O^+ > OH^-$

Range of pH is from 1 to 14



➢ **pH Sensitivity of Plants & Animals:**

• Human body works in a narrow range of pH 7 to 7.8. Acidity can be lethal for plants and animals.
• pH of Digestive System: Stomach secretes HCl to kill bacteria in the food. The inner lining of stomach protects vital cells from this acidic pH.
• pH and tooth decay: Lower pH because of sour food and sweet food can cause tooth decay. The pH of mouth should always be more than 5.5.
• pH as self defense mechanism in plants & animals: Certain animals like bee and plants like nettle secrete highly acidic substance for self defense.

➢ **Properties of salts:**

• Salts form by the combination of acid and base through neutralization reaction.

• The acidic and basic nature of salts depends on the acid and base combined in neutralization reaction.

Acid	Base	Salt	Example
Strong	Strong	Neutral	$NaOH + HCl \rightarrow NaCl + H_2O$
Strong	Weak	Acidic	$HCl + NH_4OH \rightarrow NH_4Cl + H_2O$
Weak	Strong	Basic	$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$
Weak	Weak	Neutral	$CH_3COOH + NH_4OH \rightarrow CH_3COONH_4 + H_2O$

• The most common salt is sodium chloride or table salt which forms by the combination of sodium hydroxide (base) and hydrochloric acid.

• Other examples include Epsom salts ($MgSO_4$) used in bath salts, ammonium nitrate (NH_4NO_3) used as fertilizer, and baking soda ($NaHCO_3$) used in cooking.

• The pH of salts solution depends on the strength of acids and base combined in neutralization reaction.

• Indicators – Indicators are substances which indicate the acidic or basic nature of the solution by their colour change.

The colour of some acid – base indicators in acidic and basic medium are given below :

S. No.	Indicators	Colour in acidic medium	Colour in basic medium
1	Litmus solution	Red	Blue
2	Methyl Orange	Pink	Orange
3	Phenolphthalein	Colourless	Pink
4	Methyl red	Yellow	Red

Chemical properties of acids:

i) Acids react with active metals to give hydrogen gas.
$Zn + H_2SO_3 \rightarrow ZnSO_4 + H_2$

ii) Acids react with metal carbonate and metal hydrogen carbonate to give carbon dioxide.
$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

iii) Acids react with bases to give salt and water. This reaction is called as neutralization reaction.$NaOH + HCl \rightarrow NaCl + H_2O$

iv) Acids react with metals oxides to give salt and water.
$CuO + H2SO4 \rightarrow CuSO_4 + H_2O$

Addition of Acids or Bases to Water

The process of dissolving an acid, specially nitric acid or sulfuric acid or a base in water is a highly exothermic one. As a rule: Always add acid to water and never the other way! The acid must be added slowly to water with constant stirring. If one mixes the other way by adding water to a concentrated acid, the heat generated causes the mixture to splash out and cause burns.

➢ **Chemical properties of Bases:**

i) Reaction with Metals - Certain reactive metals such as Zinc, Aluminium, and Tin react with alkali solutions on heating and hydrogen gas is evolved. $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$

ii) Reaction with acids -Bases react with acids to form salt and water. $KOH + HCl \rightarrow KCl + H_2O$

iii) Reaction with Non -metallic oxides – These oxides are generally acidic in nature. They react with bases to form salt and water. $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

➢ **Some Important Chemical Compounds:•**

• Common Salt (NaCl)

Sodium chloride is known as common salt. Its main source is sea water. It is also exists in the form of rocks and is called rock salt.
Common salt is an important component of our food. It is also used for preparing sodium hydroxide, baking soda, washing soda etc.

- **Sodium hydroxide (NaOH)**

Prepared by Chlor Alkali process :Electricity is passed through an aqueous solution of Sodium chloride (called brine). Sodium chloride decomposes to form sodium hydroxide. Chlorine gas is formed at the anode, and hydrogen gas at the cathode. Sodium hydroxide solution is formed near the cathode. $2NaCl(aq) + 2\ H_2O\ (l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$

- **Bleaching powder**:

Bleaching powder is represented as $CaOCl_2$, though the actual composition is quite complex. Bleaching powder is produced by the action of chlorine on dry slaked lime. $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

- **Baking soda:**

Sodium hydrogen carbonate ($NaHCO_3$) Preparation: $NaCl + H_2O + CO_2 + NH3 \rightarrow NH_4Cl + NaHCO_3$

•**Washing soda:** Sodium carbonate $N_2CO_3.10H_2$ In the first step, sodium carbonate is obtained by heating baking soda. $2\ NaHCO_3(heat) \rightarrow Na_2CO_3 + H_2O + CO_2$

Then washing sod a is produced by recrystallisation of sodium carbonate $Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3\ .10H_2O$

- **Plaster of Paris:**

Calcium sulphate hemihydrate $CaSO_4$. ½ H_2O Prepared by heating Gypsum at 373K. $CaSO_4.2H_2O$(Heat at 373K) → $CaSO_4$. ½ H_2O + 1½ H_2O

➢ **[KEY POINTS]**

- Acid is a compound which yields hydrogen ion (H^+), when dissolved in water.
- Acid is sour to the taste and corrosive in nature. The pH value for acids is less than 7.
- Generally, all acids readily react with metal to release hydrogen gas. For example, metal zinc reacts with hydrochloric acid to form zinc chloride and hydrogen gas.
- Acid react with limestone ($CaCO_3$) to produce carbon dioxide. For example, hydrochloric acid reacts with limestone to produce carbonic acid and calcium chloride.
- Acid can be classified in organic and inorganic acids. Acetic acid (CH_3COOH) is the best example of organic acid, while acid produced from minerals are termed as inorganic acids like sulfuric acid (H_2SO_4), hydrochloric acid (HCl).
- Acid converts blue litmus paper to red in color.
- Acids have tendency to corrode metal surface quickly.
- Acids and bases conduct electricity because they produce ions in water. There is a flow of electric current through the solution by ions.
- Indicators are those chemical substances which behave differently in acidic and basic medium and help in determining the chemical nature of the substance.
- Acid base indicators indicate the presence of an acid or a base by a change in their colour or smell.
- Indicators can be natural or synthetic.

•**Olfactory indicators:** These are those indicators whose odour changes in acidic or basic medium.
Onion : Smell of onion diminishes in a base and remains as it is in an acid.
Vanilla: The odour of vanilla essence disappears when it is added to a base. The odour of vanilla essence persists when it is added to an acid.

- **Turmeric:** In acids, yellow colour of turmeric remains yellow. In bases, yellow colour of turmeric turns red.
- **Litmus:** Litmus is a natural indicator. Litmus solution is a purple dye which is extracted from lichen. Acids turn blue litmus red. Bases turn red litmus blue.
- Water is essential for acids and bases to change the colour of litmus paper.
- Remember that litmus paper will act as an indicator only if either the litmus paper is moist or the

acid or base is in the form of aqueous solution. This is because acids and bases release H_+ and OH_- ions respectively in aqueous solutions.

• **Phenolphthalein:** Phenolphthalein remains colourless in acids but turn pink in bases.

• **Methyl orange:** Methyl orange turns pink in acids and becomes yellow in bases.

• Living organisms are pH sensitive. Human body works within a pH range of 7.0 to 7.8.
• Rain water with a pH less than 5.6 is called acid rain. This acid rain if it flows into river water makes the survival of aquatic life difficult.
• Plants also require a specific pH range of soil for their healthy growth.
• pH is also significant as it is used in self defence by animals and plants. Bees use acids in their sting. To neutralise the effect a mild base like baking soda can be used.
• Water of crystallisation: It is the fixed number of water molecules present in one formula unit of a salt.
• Phenolphthalein solution is colorless in acidic solution and turns methyl orange solution to red. Red cabbage juice which is purple in color changes to red in acidic medium.
• Bases are compound which yields hydroxide ion (OH^-), when dissolved in water.
• Bases are bitter to taste and corrosive in nature. They feel slippery and soapy.
• Bases are good conductor of electricity and show pH value more than 7.
• Bases react with oils and grease to form soap molecules.
• Bases convert red litmus paper to blue in color.
• Bases also have the tendency to corrode metal surface.
• A reaction between a base and a metal is similar as for acid to form salt and release hydrogen gas. But this reaction can only occur when a metal is strong enough to displace another metal from its parent constituent. $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$
• Phenolphthalein solution turns pink in color in basic solution. Bases turn methyl orange to yellow. Red cabbage juice which is purple in color changes to yellow in basic medium.

• **Strong bases:** They are completely ionized in water to produce hydroxide ions, e.g,

• **Weak bases:** Partially ionize and equilibrium lies mostly towards reactants side, e.g, ammonia in water: NH3(aq) + H2O(l) NH4 (aq) + OH (aq)

• A salt is defined as a compound formed by the complete or incomplete replacement of the hydrogen ion of an acid by a basic radical.
• A normal salt is formed by the **complete** replacement of the hydrogen ion of an acid by a basic radical whereas an **acid** salt is formed by the **incomplete** replacement of the hydrogen ion of an acid by a basic radical.
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