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# Acids, Bases and Salts

The taste of the food is due to presence of acids and bases in them.

## Acids

- Acids is defined as the one which produces hydrogen ions in water. **For Example**, Sulphuric Acid, Hydrochloric Acid etc.
- They give sour taste.
- Acids turn blue litmus to red. This is used as confirmation test for the presence of acid.
- When acids react with metals, gases are evolved.

## Reactions with Acids

**1. Reaction of Acid with Metal**

$$\text{Acid} + \text{Metal} \rightarrow \text{Salt} + \text{Hydrogen gas}$$

$$Mg + H_2SO_4 \rightarrow H_2 + MgSO_4$$

**2. Reaction of Acid with Carbonates**

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

**3. Reaction of Acid with Bicarbonates**

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

## Similarity between Acids and Bases

- Both acids and base react with water. They produce ions in water
- Both acids and bases acts as electrolytes, so are good conductors of electricity.
- Both of them changes the colour of the litmus paper.

## Classification of Acids

Acids are classified as **Organic Acids and Mineral Acids**. Acids which are derived from plants and animals, they are known as **Organic Acids**. **For Example**, Citric Acid from fruit. Mineral acids are inorganic acids such as **Sulphuric Acid**. They are dangerous to be used, so need more precautions.

Acids are also classified as **Strong Acids or Weak Acids**. Strong acid is an acid, that completely dissociates into ions in aqueous solutions. **For Example**, Sulphuric Acid, Hydrochloric Acid.

$$\underset{\text{acid}}{HCl} + H_2O = H_3O^+ + Cl^-$$

Weak acid is the one which does not dissociate completely into ions in aqueous solutions. **For Example**, **Acetic Acid**.

$$CH_3COOH + H_2O \rightleftarrows CH_3COO^- + H^+$$

Acids can also be as **Dilute Acid and Concentrated Acids**. The one which has low concentration of acids in aqueous solution, they are known as **Dilute Acids** whereas the one which has high concentration of acids in aqueous solution, are known as **Concentrated Acids**.

It is advisable to add acid to water and not vice versa because large amount of heat is released if water is added to acid. This released heat is large enough to cause harm.

Acids can also be classified based on **number of hydrogen ions**. **Monoprotic acid** is the one which gives one mole of hydrogen ions per mole of acid, such as HCl. **Diprotic Acid** is the one which produces two mole of hydrogen ions per mole of acid. **For Example**, $H_2SO_4$.

## Bases

- Bases are the one which produces hydroxide ions in aqueous solutions. Bases which are water soluble they are known as **Alkalis**.
- They turn red litmus to blue.
- They have a bitter taste.
- They also produced carbon-dioxide when reacted with carbonates.
- They also evolved hydrogen gas when bases react with metals.

## Reactions of Bases

**1. Reaction with Metals**

Base reacts with metals and produce hydrogen gas.

$$\mathbf{2NaOH + Zn \rightarrow Na_2 \rightarrow Na_2ZnO_2 + H_2}$$

**2. Reaction with Acids**

Base reacts with acids to form salts. **For Example**,

$$\mathbf{KOH + HCl \rightarrow KCl + H_2O}$$

**3. Reaction with Non-metallic Oxides**

Base reacts with non-metallic oxides to form salt and water.

$$\mathbf{2NaOH + CO_2 \rightarrow CO_2 \rightarrow Na_2CO_3 + H_2O}$$

## Classification of Bases

Bases are classified as **Strong Base** and **Weak Base**. Strong base is the one which dissociates completely into its ions in aqueous solution. **For Example**, **NaOH**.

Weak base is the one which does not dissociate completely into its ions in aqueous solutions. **For Example**, **Ammonium Hydroxide**, **$NH_4OH$**

Bases are also classified as **Dilute Base** and **Concentrated Base**. The solution which has low concentration of base in aqueous solution is defined as **Dilute Base** whereas the one which has high concentration of base in aqueous solution is known as **Concentrated Base**.

## Strength of Acid or Base Solutions

The dissociation constant of weak acid or weak base can be represented as-

$$CH_3COOH + H_2O \rightleftharpoons CH_2COO^- + H_3O^+$$

$$NH_3 + H_2O \rightleftharpoons NH_4 + (aq) + OH^-(aq)$$

Suppose HA is weak acid, then dissociation constant is represented as-

$$HA + H_2O \rightleftharpoons A^-(aq) + H_3O + (aq)$$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

Strength of an acid or base can be determined using a pH scale. It is a scale to measure the hydrogen ion concentration in a solution. The p stands for ‘potenz’, it is a German word which means power.

- If pH is equal to 7, means the solution is neutral.
- If pH is greater then 7 means alkaline solution.
- If pH is less then 7 means the solution is acidic.

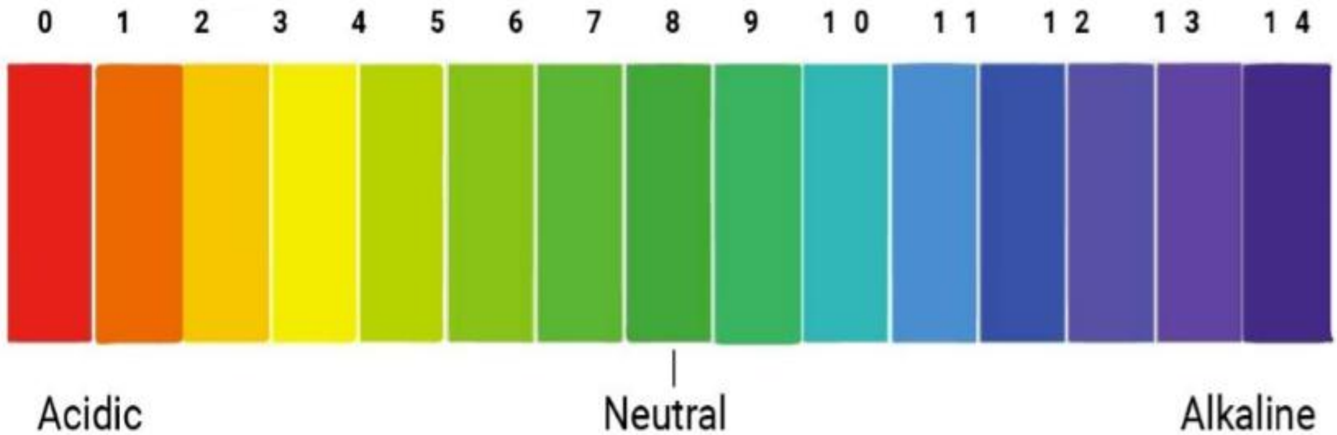


**Fig.1. pH scale**

# Importance of pH

- Human body works at a pH of about 7.4.
- Stomach has a pH of about 2 due to presence of hydrochloric acid in it. It is needed for the activation of pepsin protein required for protein digestion.
- When we eat food containing sugar, then the bacteria present in our mouth break down the sugar to form acids. This acid lowers the pH in the mouth. Tooth decay starts when the pH of acid formed in the mouth falls below 5.5. This is because then the acid becomes strong enough to attack the enamel of our teeth and corrode it. This sets in tooth decay. The best way to prevent tooth decay is to clean the mouth thoroughly after eating food.
- Many animals and plants protect themselves from enemies by injecting painful and irritating acids and bases into their skin.
  - When honey bee stings a person, it injects an acidic liquid into the skin. Rubbing with mild base like baking soda solution on the stung area of the skin gives relief.
  - When a wasp stings, it injects an alkaline liquid into the skin. Then rubbing with a mild acid like vinegar on the stung area of the skin gives relief.

- Soil pH and plant growth: Most of the plants grow best when the pH of the soil is close to 7. If the soil is too acidic or basic, the plants grow badly or do not grow at all. The soil pH is also affected by the use of chemical fertilisers in the field. Chemicals can be added to soil to adjust its pH and make it suitable for growing plants. If the soil is too acidic then it is treated with materials like quicklime or slaked lime. If the soil is too alkaline then alkalinity can be reduced by adding decaying organic matter.

## Salts

When acid and base neutralize, salts are formed. Strong acid and strong base combines to form neutral salt.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

**Eq.1. Formation of Neutral Salt**

Strong acid and weak base combine to form acidic salt. **For Example**, Hydrochloric Acid and ammonium hydroxide combine to form ammonium chloride. Other examples, sodium hydrogen carbonate, sodium hydrogen sulphate etc.

$$HCl + NH_4OH \rightarrow NH_4Cl + H_2O$$

**Eq.2. Formation of Acidic Salt**

Similarly, weak acid and strong base combine to form basic salt. **For Example**, Acetic Acid and sodium hydroxide combine to form sodium acetate. Other examples are calcium carbonate, potassium cyanide etc.

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

**Eq.3. Formation of Basic Salt**

The most common salt is table salt or sodium chloride (NaCl).

### Indicators

They are the substances that which indicate acidic or basic nature of the solution using colour change. **For Example**, litmus solution, methyl orange, phenolphthalein, methyl red etc. Acids convert blue litmus paper red in colour. Bases turn red litmus blue. Phenolphthalein remains colourless in presence of acids but turn pink in presence of bases.

## Some Important Chemical Compounds and their uses

| | Preparation | Uses |
|---|---|---|
| **Common Salt (NaCl)**<br>**(Sodium Chloride)** | 1. $NaOH + HCl \rightarrow NaCl + H_2O$<br>2. From sea water by evaporation<br>3. From underground deposit<br>{Large crystals of common salt found in underground deposit which is brown due to presence of impurities in it. It is mined from underground deposit like coal.} | 1. Raw material for making large number of useful chemicals in industry. Eg: NaOH (caustic soda), $Na_2CO_3$ (washing soda), $NaHCO_3$ (baking soda).<br>2. Preservative in pickle and curing meat and fish.<br>3. To melt ice and clear roads in winters in cold countries.<br>4. Used in manufacturing of soap. |
| **Caustic Soda (NaOH)**<br>**(Sodium Hydroxide)** | Passing electricity through concentrated solution of NaCl (called '**brine**')<br>$2NaCl\ (Brine) + 2H_2O \xrightarrow[\text{(electrolysis)}]{\text{electricity}}$<br>2NaCl (Brine) + $2H_2O2NaOH$ (Caustic Soda) + $Cl_2$ + $H_2$<br><u>At anode</u> (+ve electrode): $Cl_2$ is produced<br><u>At cathode</u> (-ve electrode): $H_2$ is produced | <u>**Uses of $H_2$**</u><br>1. Hydrogenation of oil to get vegetable ghee (margarine)<br>2. To make ammonia for fertilizers<br>3. In fuel for rockets.<br><u>**Uses of $Cl_2$**</u> |

| | | |
|---|---|---|
| | It is called chloro-alkali process because products formed are chlorine (Chloro) and NaOH (alkali). | 1. In water treatment<br>2. To clean water in swimming pools<br>3. To make plastic, e.g. PVC<br>4. To make CFCs, chloroform, dyes etc.<br>**Uses of NaOH**<br>1. Used in making soap and detergent.<br>2. Used in manufacturing of paper<br>3. De-greasing metals<br>4. Refining oil<br>5. Making dyes and bleaches<br>**Uses of HCl**<br>1. Cleaning steel<br>2. Preparation of chloride, e.g. $NH_4Cl$<br>3. In making medicines and cosmetics<br>4. In making plastics, PVC etc. |
| **Baking Soda ($NaHCO_3$) (Sodium Hydrogencarbonate)** | $NaCl + NH_3 + H_2O + CO_2 \rightarrow NaHCO_3 + NH_4Cl$<br>**Properties**<br>Action of Heat:<br>$2NaHCO_3 \xrightarrow{heat} Na_2CO_3 + CO_2 + H_2O$ | 1. Used as antacid in medicine to remove acidity of the stomach<br>2. Used in making baking powder (Basic soda + tartaric acid)<br>$NaHCO_3 + H^{\oplus}$ (from mild acid) $\rightarrow$<br>$Na^{\oplus}$ (sodium salt of acid) $+ CO_2 + H_2O$<br>The $CO_2$ produced during the process gets trapped in wet dough and bubbles out slowly to make cake 'rise' so that it becomes soft and spongy.<br>Tartaric acid neutralizes it, and so it has pleasant taste.<br>3. Used in soda-acid fire extinguisher |
| **Washing Soda ($Na_2CO_3.10H_2O$) (Sodium Carbonate)** | $\mathbf{Na_2CO_3} + 10\ H_2O \rightarrow Na_2CO_3.10H_2O$<br>Preparation of $\mathbf{Na_2CO_3}$<br>{$NaCl + NH_3 + H_2O + CO_2 \quad NaHCO_3 + NH_4Cl$<br>$NaHCO_3 \rightarrow \mathbf{Na_2CO_3} + CO_2 + H_2O$} | 1. Used in glass, soap and paper industries<br>2. Used in manufacturing of sodium compounds such as Borax<br>3. Cleaning agent for domestic purpose<br>4. Remove permanent hardness of water |
| **Bleaching Powder ($CaOCl_2$)** | $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$<br>Slaked Lime Calcium Oxychloride | 1. For bleaching cotton and linen in textile industry, for bleaching wood pulp in paper |

| | | |
|---|---|---|
| **Calcium Oxychloride** | Properties<br>$CaOCl_2 + H_2SO_4 \rightarrow CaSO_4 + Cl_2 + H_2O$<br>The $Cl_2$ produced by action of dilute acid acts as bleaching agent. | factories, for bleaching washed clothes in laundry<br>2. Oxidizing agent in chemical industries<br>3. Disinfecting drinking water |
| **Plaster of Paris (P.O.P) ($CaSO_4$.1/2 $H_2O$) (Calcium Sulphate Hemihydrate)** | $CaSO_4.2H_2O(\text{Gypsum}) \xrightarrow{\text{Heat to } 100°C}$<br>$CaSO_4.H_2O$ (Plaster of Paris) +3/2 $H_2O$<br>* Heating of gypsum should not be done above 100°C as above that temperature, water of crystallization will eliminate and anhydrous $CaSO_4$ will be obtained. This anhydrous $CaSO_4$ is known as **Dead Burnt Plaster**.<br>* $CaSO_4$.1/2 $H_2O$ means that two molecules of $CaSO_4$ share one molecule of water.<br>Properties<br>Has remarkable property of setting into a hard mass on wetting with water, as gypsum is formed.<br>$CaSO_4$.1/2 $H_2O$ (P.O.P) + 1/2 $H_2O \rightarrow CaSO_4.2H_2O$ (Gypsum set as hard mass)<br>Hence, P.O.P should be stored in moisture-proof container as moisture can cause slow setting of P.O.P by hydrating it. | 1. Used in hospital for setting fractured bones in the right position to ensure correct healing.<br>2. Making toys, decorative materials, cheap ornaments, and casts of statues.<br>3. Used as fire-proofing material<br>4. Used in chemistry labs for setting air gaps in apparatus.<br>5. Making smooth surfaces, such as For making ornamental designs on ceilings of houses and other buildings |

# Thank You

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