Introduction

- The taste of the food that we eat depends on the presence of acids and bases in them.
- Acids are sour in taste and change the colour of blue litmus to red.
- Bases are bitter in taste and change the colour of red litmus to blue.
- Litmus and turmeric are natural indicators. Some other examples of natural indicators are red cabbage leaves, coloured petals of some flowers like hydrangea, petunia, geranium.

Acids

- Acids are those which produce hydrogen ions in water. Example sulphuric acid, hydrochloric acid etc.
- Acids turn blue litmus to red which is used as the confirmation test for acid.

Reaction with acids

1. **Reaction of acid with metal**

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

$$2HCl + Zn \rightarrow ZnCl_2 + H_2$$

2. **Reaction of acids with metal carbonates and bicarbonates**

$$2HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$$

$$H_2SO_4 + Mg(HCO_3)_2 \rightarrow MgSO_4 + 2H_2O + CO_2$$

Bases do not react with metal carbonates and bicarbonates

3. **Reaction of an acid with a base**
Acids and bases react together to form Salt and water.

$$HCL + NaOH \rightarrow NaCl + H_2O$$

Neutralisation Reaction: Reaction of an acid with a base is called Neutralisation Reaction.

Acid + Base → Salt + Water

4. **Reaction of metallic oxides with Acids**

$$H_2SO_4 + MgO \rightarrow MgSO_4 + H_2O$$

$$2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2H_2O$$

5. **Reaction of non - metallic oxides with Base**

Non-metal oxides are acidic in nature

Base + Nonmetal oxide → salt + water + heat

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

What happens to acid and base in water?

- Acid in water produces H^+ ion, which cannot exist alone therefore it combines with the water molecule to give hydronium ion. Example:

$$HCl + H_2O \rightarrow H_3O + Cl^-$$

- Bases produce OH^- ion in water. Bases which are soluble in water are known as alkalis. Example:

$$NaOH + H_2O \rightarrow Na^+(aq) + OH^-(aq)$$

$$KOH + H_2O \rightarrow K^+(aq) + OH^-(aq)$$

- Now after knowing that all acids give H^+ (aq) and all bases give OH^- (aq), neutralisation reaction can be written as follows:

Acid + Base → Salt + Water
HX + MOH → MX + HOH

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

Caution while adding acid to water

- Mixing an acid or a base with water results in decrease of ions (H_3O/ OH^-) per unit volume. This process is called as dilution.
- The process of dissolving an acid or a base in water is highly exothermic in nature.
- If water is added to concentrated acid, huge amount of heat is generated which may cause the mixture to splash out and cause burns. Therefore, It should be kept in mind that acid should always be added to water slowly with constant stirring.

pH Scale

- The scale developed for measuring hydrogen ion concentration in a solution is known as pH scale, where p stands for *potenz* in German.
- pH scale ranges from 0 (very acidic) to 14 (very alkaline).
- The pH of a neutral solution is 7.
- Values less than 7 on the pH scale refers to an acidic solution. pH value from 7 – 14 refers to an alkaline solution.
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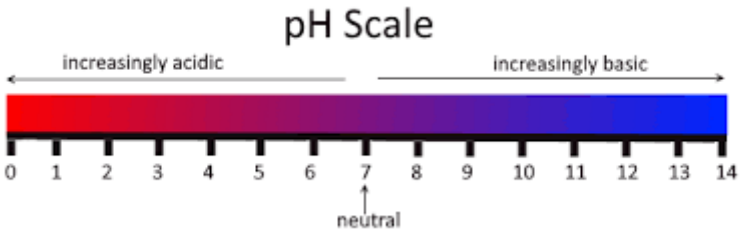
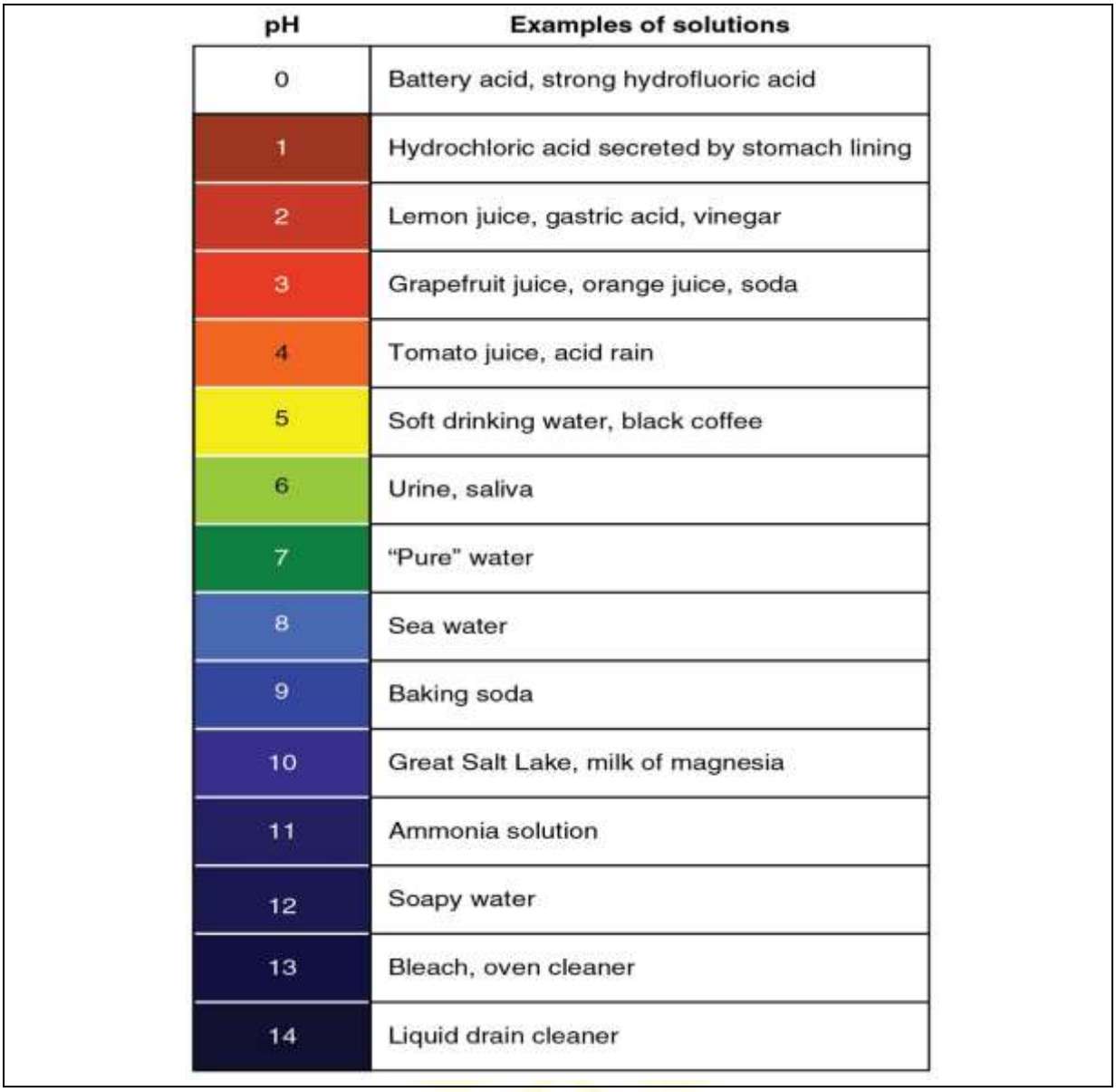


- Acids producing more H^+ ions are strong acids while those producing less H^+ are said to be weak acids.
- Similarly, bases giving more OH^- ions are strong bases and those giving less OH^- ions are called as weak bases.



pH	Examples of solutions
0	Battery acid, strong hydrofluoric acid
1	Hydrochloric acid secreted by stomach lining
2	Lemon juice, gastric acid, vinegar
3	Grapefruit juice, orange juice, soda
4	Tomato juice, acid rain
5	Soft drinking water, black coffee
6	Urine, saliva
7	"Pure" water
8	Sea water
9	Baking soda
10	Great Salt Lake, milk of magnesia
11	Ammonia solution
12	Soapy water
13	Bleach, oven cleaner
14	Liquid drain cleaner

pH in our day-to-day life

- Our body works within the pH range of 7.0 – 7.8. the pH of our saliva is around 6.5 – 7.5.
- When pH of rain water drops below 5.6, it is called acid rain. This lowers the pH of river water, because of which survival of aquatic life becomes difficult.

- Our stomach produces hydrochloric acid during digestion which causes no harm. But during indigestion stomach produces too much acid causing pain and irritation.
- pH of tomato juice ranges from 4.1 to 4.6 whereas the pH of carrot juice is around 6.4.
- Bacteria present in the mouth releases acid by degradation of remaining sugar and food particles. This reduces the pH below 5.5 and corrodes calcium phosphate present in the tooth enamel.
- Bee- sting leaves acid that causes pain and irritation. Nettle leaves inject methanoic acid causing burning pain. Use of a mild base such as baking soda on the stung area gives relief.

Chemicals from common salt

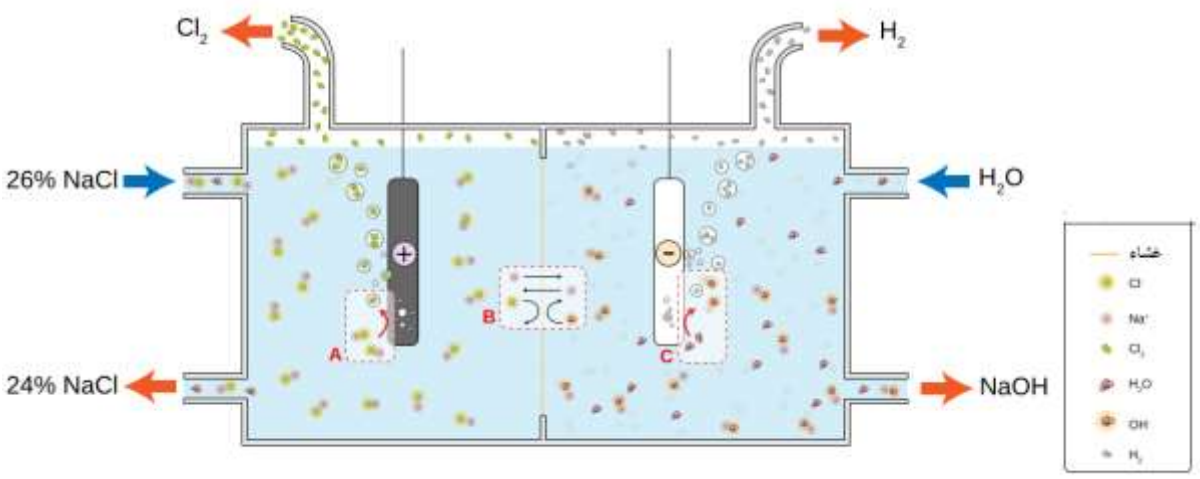
- Salt formed by the reaction of hydrochloric acid and sodium hydroxide is called sodium chloride. (common salt) hence it is a neutral salt.
- Sea water contains many dissolved salts. Sodium chloride is separated from these salts.
- Common salt is the main raw material for many materials of daily use such as sodium hydroxide, washing soda, baking soda, bleaching powder and many more.

Sodium Hydroxide

- When electricity is passed through an aqueous solution of sodium chloride also called brine solution, it breaks into sodium hydroxide and chlorine.
- The process is known as chlor-alkali process. Chlor for chlorine and alkali for sodium hydroxide.

  $2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$

- Chlorine gas is given off at anode and hydrogen is released at cathode.



Bleaching Powder

- Chlorine produced during electrolysis of brine solution is used for manufacture of bleaching powder.
- The reaction of chlorine gas on dry slaked lime [Ca $(OH)_2$] produces bleaching powder.

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

Uses of bleaching powder

- It is used as a bleaching agent for cotton and linen in textile industry.
- To bleach wood pulp in paper industries.
- To bleach washed clothes in laundry.
- It is used as disinfectant for drinking water.
- It is used as an oxidising agent in chemical industries.

Baking Soda

- It is prepared by passing CO_2 gas through a concentrated solution of sodium chloride and ammonia.

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

- Its chemical name is Sodium Hydrogen Carbonate
- It is a mild non- corrosive basic salt.
- When heated during cooking following reaction takes place:

$$2\underset{\text{(Sodium hydrogen carbonate)}}{NaHCO_3} \xrightarrow{\text{Heat}} \underset{\text{(Sodium carbonate)}}{Na_2CO_3} + H_2O + CO_2$$

Uses of Baking Soda

- For making baking powder which is produced by reaction of mild edible oil like tartaric acid with baking soda.
- When baking powder is mixed with water or heated, following reaction occurs:

$$NaHCO_3 + H^+ \rightarrow CO_2 + H_2O + \text{Sodium salt of acid}$$

- This CO_2 produced makes bread and cake rise making them soft and spongy.
- Being alkaline it is an active ingredient of antacids which acts by neutralising excess acid in the stomach.
- It is also used in soda-acid fire extinguishers.

Washing Soda

- This is another derivative of sodium chloride. The heating baking soda produces sodium carbonate.

$$\underset{\text{Sodium hydrogen carbonate}}{2NaHCO_3} \rightarrow \underset{\text{sodium carbonate}}{NaCO_3} + H_2O + CO_2$$

- Recrystallization of sodium carbonate yields washing soda.

$$\underset{\text{sodium carbonate}}{Na_2CO_3} + 10\ H_2O \rightarrow Na_2CO_3\ .10H_2O$$

Uses of washing soda

- Washing soda is used in glass, paper and soap industries.
- It is used in manufacturing of sodium compounds like borax.
- It is also used as a cleaning agent for domestic purposes.
- It is also used for removing permanent hardness of water.

Water of Crystallization

- The fixed number of water molecules present in one formula unit of a salt is known as water of crystallization.
- For example, there are 5 water molecules in one formula unit of copper sulphate. Therefore, chemical formula of hydrated copper sulphate is written as $CuSO_4 .5H_2O$.
- Gypsum has two molecules of water as water of crystallization and hence its chemical formula is written as $CuSO_4 .2H_2O$.
- Gypsum on heating loses water molecules and becomes calcium sulphate hemihydrate. This is known as plaster of paris.

Uses of plaster of Paris:

- It is used by doctors for supporting fractured bones in the right position.
- When mixed with water, it changes again to gypsum giving a hard solid mass.

$$CaSO_4 .0.5\ H_2O + 1.5\ H_2O \rightarrow CaSO_4 .2H_2O$$

Plaster of paris — Gypsum

- It is used for making toys, materials for decoration and for making surfaces smooth.