THE RADIANT EDUCATION POINT
(MRITUNJAY MISHRA)
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Acids

Acids are defined as the one which produces hydrogen ions in water. For Example, Sulphuric Acid, Hydrochloric Acid etc.

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.
•**Strong Acids**: HCl, H_2 SO_4 , HNO_3
•**Weak Acids**: CH_3COOH, Oxalic acid, Lactic acid
•**Concentrated Acids:** More amount of acid + Less amount of water
•**Dilute Acids**: More amount of water + Less amount of acid

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.

Commonly found organic acids	Their natural sources
▪ Citric acid	Orange, lemon
▪ Tartaric acid	Tamarinds, grapes
▪ Lactic acid	Curd/ sour milk
▪ Oxalic acid	Tomatoes
▪ Acetic acid	Ketchup, vinegar (sirka)
▪ Formic acid (Methanoic acid)	Ant sting, nettle leaf sting

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

Note:

• Organic acids are always weak but minerals acids can be strong as well as weak.
• We can take dilute weak acids like organic acid in our body. But strong acids (like strong mineral acids) are very harmful for us.

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).

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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.

Diluting Acids and Bases -

If concentrated acid (or base) is mixed with water, concentration of hydronium ions decreases. So the acid or base becomes dilute.

The phenomena of changing concentrated acid/base into dilute acid/base (respectively) is an exothermic reaction.

Conc. acid + H_2O ⟶ dilute acid + Heat
Conc. base + H_2O ⟶ dilute base + Heat

NOTE : Always add concentrated acid/base to water: not water to concentrated acid/base.

When concentrated acid is added to water, heat is released gradually. This heat is absorbed by large amount of water to increase its temperature.

When water is added to concentrated acid, heat is released suddenly. This heat vaporizes small amount of water to steam. This steam is splits out with drops of concentrated acid which can damage our body. So always add concentrated acid to water, not water to concentrated acid.

Same is true with base also.

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.

Bases

Bases are the one which produces hydroxide ions in aqueous solutions. Bases which are water soluble they are known as **Alkalis**.

Some common bases	Presence
▪ Sodium hydroxide (NaOH)	Soap, detergents, caustic soda
▪ potassium hydroxide(KOH)	Caustic potash
▪ sodium carbonate(Na_2CO_3)	Washing soda
▪ Calcium hydroxide($Ca(OH)_2$)	White wash

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.

Similarity between Acids and Bases

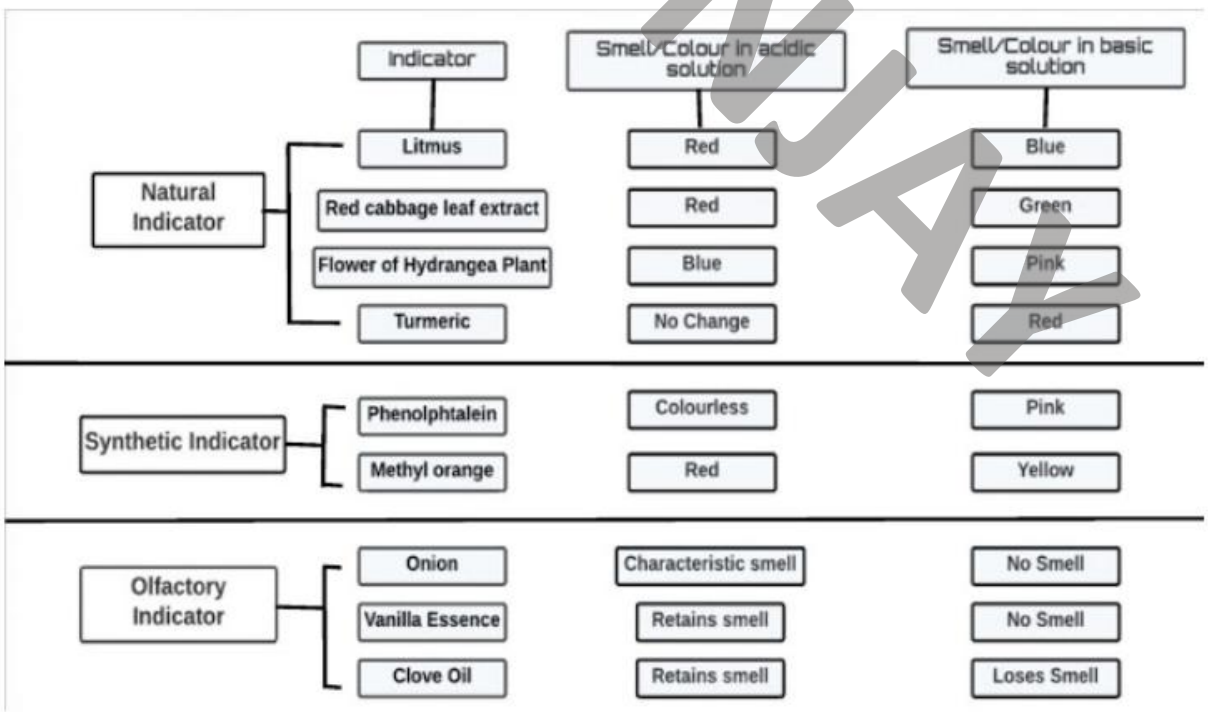
Both acids and base react with water. They produce ions in water

Both acids and bases acts as electrolytes, so are good conductors of electricity.

Both of them changes the colour of the litmus paper.

Types of Indicators and its properties

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.



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Types of Indicators:

(i) Natural indicators (ii) Synthetic indicators (iii) Olfactory indicators

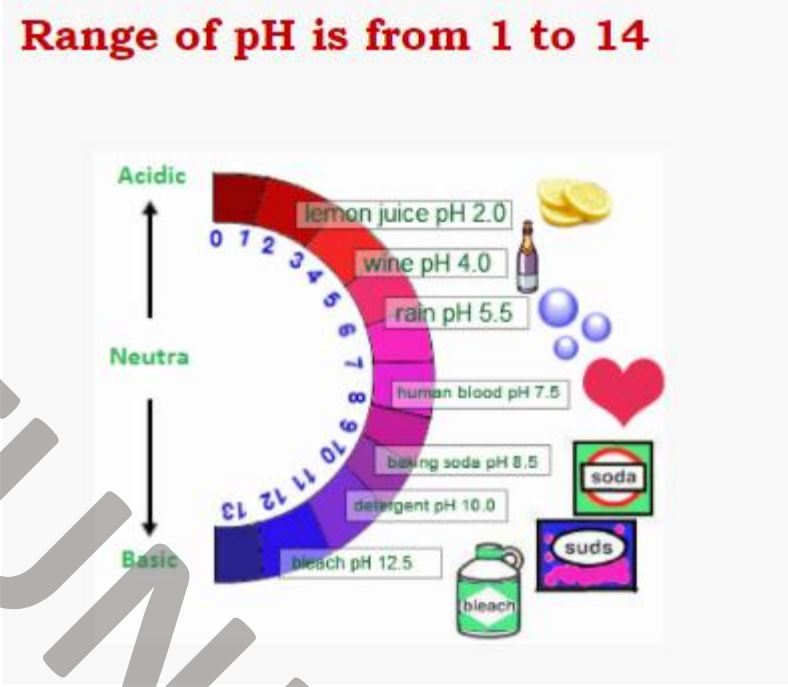
(i) **Natural indicators:** Found in nature in plants. Examples: Litmus, red cabbage leaves extract, flowers of hydrangea plant, turmeric.

(ii) **Synthetic indicators**: These are chemical substances. Examples: Methyl orange, phenolphthalein.

(iii) **Olfactory indicators**: These substances have different odour in acid and bases.

Importance of pH

pH =7	Neutral Solution
pH>7	Basic Solution
pH<7	Acidic Solution



•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.

Importance of pH in Everyday Life

pH in Digestive System.

When we start eating, our body produces strong dilute hydrochloric acid (HCI) to begin the process of digestion. Normally, your body produces just the amount of HCI and other chemicals it needs for digestion. But, under certain conditions, our stomach starts producing more HCI acid. Too much stomach acid can cause pain and irritation. This problem is called acidity. At that point, we may have to take medicines called antacids

that decrease the amount of active HCI in your stomach.
Antacids are actually anti acids or we can say basic in nature which neutralize Acids in stomach and we feels good.

Tooth Decay.
Our mouth is full of bacteria. Some bacteria are helpful. But some can be harmful such as those that play a role in the tooth decay process.
Tooth decay is the result of an infection with certain types of bacteria. These bacteria use sugars in food to make acids. Over time, these acids can make a cavity in the tooth.
Toothpaste is used to protect our teeth from those acids. Toothpaste is basic in nature which neutralizes the acids and thus protects our teeth.

pH of Soil -
• Take soil and dissolve it in water.
• You will get a muddy solution.
• Now filter this solution and do a test either using universal indicator or using litmus paper or using any other acid base indicator.
• If soil is more acidic, you can use basic substance such as chalk, quick lime, and slacked lime to neutralize it.
• If soil is more basic in nature, you can use manure and compost (organic matters obtained by the decomposition of dead plants and animals) etc. to neutralize it.

Effects of pH on Animals and Plants -
pH of acid rain is around 5— 6. This is highly acidic. Due to acid rain, acid reaches into oceans, lakes and affects the lire of aquatic animals and plants. Some aquatic animals and plants are died due to acid rain and some plants lose lots of their leaves.
To neutralize this acidic behaviour of lakes and oceans, calcium carbonate (CaCO3) is added into it.

Acids and Bases in absence of Water -
A dry acid does not dissociate in hydrogen ions. When we dissolve it with water, then it shows the acidic behaviour.
For example, dry hydrochloric acid (gas) does not change the colour of blue litmus paper to red because a dry acid does not dissociate hydrogen ion This is the cause that a moist litmus paper is used to check the acidic or basic character of a gas.
Similarly at room temperature, sodium hydroxide is in the form of solid. So as a solid, NaOH does not dissociate into hydroxide ion. When we dissolve it with water, then it shows its basic behaviour.

Salt -

Salts are the ionic compounds which are produced after the neutralization reaction between acid and base.
Family of Salt -
Salts having common acidic or basic radicals are said to belong to same family.
Example:
Sodium chloride (NaCI) and Calcium chloride ($CaCl_2$) belong to chloride family.
Sodium sulphate (Na_2SO_4), Potassium sulphate (K_2S0_4) and Aluminium sulphate ($A1_2(S0_4)_3$) belong to sulphate family.

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Calcium chloride ($CaCl_2$) and calcium sulphate ($CaSO_4$) belong to calcium family.
Zinc chloride ($ZnCI_2$) and Zinc sulphate ($ZnSO_4$) belong to zinc family.

Conduction of Electricity
As we saw that acid and base solution can conduct electricity due to formation of mobile ions.
Similarly when salt is dissolved in water, it ionizes to form ions. And these ions are responsible to conduct electricity same as in the case of acids and bases.

Common Salt (Sodium Chloride) -
Sodium chloride (NaCl) is also known as common salt or table salt. It is formed after the reaction between sodium hydroxide and hydrochloric acid.

$$NaOH + HCI \longrightarrow NaCI$$

• It is a neutral salt.
• The pH value of sodium chloride is about 7.
• Sodium chloride is used in cooking as well as to prepare many other Important chemicals such as chemicals used in manufacturing industries.
• It is used as a preservatives in pickles
• It is used in the manufacture of soap

Methods of obtaining Sodium Chloride .
I From sea water by evaporation: Spread sea water in open. In summer season, water of seawater evaporates in atmosphere and we get sodium chloride.
2. From, rocks salts found In mines: Sodium chloride is mined from deposits which form underground. Deposits of rock salt are usually the remains of inland seas which evaporated thousands or millions of years ago.

Sodium hydroxide
• Sodium hydroxide is a strong base. It is also known as caustic soda or lye.
• It is obtained by the electrolytic decomposition of solution of sodium chloride (brine).
• In the process of electrolytic decomposition of brine (aqueous solution of sodium chloride), brine decomposes to form sodium hydroxide.
• In this process, chlorine is obtained at anode and hydrogen gas is obtained at cathode as byproducts. This whole process is known as Chlor-Alkai process.

$$\underset{\text{Sodium chloride}}{2NaCl} + \underset{\text{water}}{2H_2O} \longrightarrow \underset{\text{sodium hydroxide}}{2NaOH} + \underset{\text{chlorine}}{Cl_2} + \underset{\text{water}}{H_2}$$

USES:
•Hydrogen gas is used as fuel, margarine, en making of ammonia for fertilizer, etc.
• Chlorine gas is used in water treatment, manufacturing of PVC, disinfectants, CFC, pesticides. It is also used in manufacturing of bleaching powder and hydrochloric add.
•Sodium hydroxide is used in de-greasing of metals, manufacturing of paper, soap, detergents, artificial fibres, bleach, etc.

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Plaster of Paris (CaSO$_4$.1/2 H2O) Calcium Sulphate Hemihydrate

Plaster of Paris is prepared from gypsum. Gypsum is calcium sulphate dehydrate ($CaSO_4 . 2H_2O$)

$$\underset{\text{Gypsum}}{CaSO_4 . 2H_2O} \longrightarrow \underset{\text{P.O.P}}{(CaSO_4 . 1/2\ H_2O)} + \underset{\text{Water}}{3/2\ H_2O}$$

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**.

$CaSO_4$.1/2 H_2O means that two molecules of **$CaSO_4$** share one molecule of water.

Properties

Has remarkable property of setting into a hard mass on wetting with water, as gypsum is formed.

$$\underset{\text{P.O.P}}{CaSO_4.1/2\ H_2O} + \underset{\text{water}}{½\ H2O} \longrightarrow \underset{\text{Gypsum}}{CaSO_4 . 2H_2O}$$

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.
2. Making toys, decorative materials, cheap ornaments, and casts of statues.
3. Used as fire-proofing material
4. Used in chemistry labs for setting air gaps in apparatus.
5. Making smooth surfaces, such as for making ornamental designs on ceilings of houses and other buildings

Bleaching Powder (CaOCI$_2$) Calcium Oxychloride

Bleaching powder is also known as chloride of lime. It is a solid and yellowish white in colour. Bleaching powder can be easily identified by the strong smell of chlorine.

When calcium hydroxide (slaked lime) reacts with chlorine, it gives calcium oxychloride (bleaching powder) and water is formed.

$$\underset{\text{Slaked Lime}}{Ca(OH)_2} + \underset{\text{chlorine}}{Cl_2} \rightarrow \underset{\text{Calcium Oxychloride}}{CaOCl_2} + \underset{\text{water}}{H_2O}$$

When bleaching powder reacts with excess of dilute acid, all the chlorine present in it is liberated.

$$\underset{\text{Calcium Oxychloride}}{CaOCl_2} + \underset{\text{sulphuric acid}}{H_2SO_4} \rightarrow \underset{\text{calcium sulphate}}{CaSO_4} + \underset{\text{chlorine}}{Cl_2} + \underset{\text{water}}{H_2O}$$

The Cl_2 produced by action of dilute acid acts as bleaching agent.

Water solution of bleaching powder is basic in nature.

The term bleach means removal of colour. Bleaching powder is often used as bleaching agent. It works because of oxidation. Chlorine in the bleaching powder is responsible for bleaching effect.

- Bleaching powder is used as disinfectant to dean water, moss remover, weed killers, etc.
- Bleaching powder is used for bleaching of cotton in textile Industry, bleaching of wood pulp in paper industry.
- Bleaching powder is used as oxidizing agent in many industries, such as textiles industry, paper industry, etc.

Baking Soda (NaHCO$_3$) -

The chemical name of baking soda is sodium hydrogen carbonate ($NaHCO_3$) or sodium bicarbonate. Bread soda, cooking soda, bicarbonate of soda, etc. are some other names of baking soda.

Baking soda is obtained by the reaction of (sodium chloride) brine with carbon dioxide and ammonia. This is known as Solvay process.

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$NaCl + NH_3 + H_2O + CO_2 \rightarrow NaHCO_3 + NH_4Cl$

Sodium chloride | ammonia | water | carbon dioxide | sodium hydrogen carbonate (Baking soda) | ammonium chloride

Properties

Properties of sodium bicarbonate

- Sodium bicarbonate is white crystalline solid, but it appears as fine powder
- Sodium hydrogen carbonate is amphoteric in nature
- Sodium hydrogen carbonate is sparingly soluble in water

Action of Heat:

- Thermal decomposition of sodium hydrogen carbonate (baking soda)
- When baking soda is heated, it decomposes into sodium carbonate, carbon dioxide and water

$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$

sodium hydrogen carbonate | sodium carbonate | carbon dioxide | water

Uses of baking soda

- Baking soda is used in making of baking powder, which is used in cooking as it produces carbon dioxide which makes the batter soft and spongy.
- Baking soda is used as antacid.
- Baking soda is used in toothpaste which makes the teeth white and plaque free.
- Baking soda is used in cleansing of ornaments made of sliver.
- Since, sodium hydrogen carbonate gives carbon dioxide and sodium oxide on strong heating, thus it is used as fire extinguisher.

Baking powder-

Baking powder produces carbon dioxide on heating, so it is used in cooking to make the batter spongy. Although baking soda also produces carbon dioxide on heating, but it is not used in cooking because on heating: baking soda produces sodium carbonate along with carbon dioxide. The sodium carbonate thus produced: makes the taste bitter.

$NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_20$

Sodium bicarbonate | *Sodium carbonate* | *Carbon dioxide* | *Water*

Baking powder is the mixture of baking soda and a mild edible acid. Generally, tartaric acid is mixed with baking soda to make baking powder.

When baking powder (mixture of baking soda and an edible acid) is heated, the sodium carbonate formed because of heating of baking soda neutralizes after reacting with tartaric acid and sodium tartarate salt is formed. The smell of sodium tartarate is pleasant and taste is good. This makes the cake or any other food tasty.

Washing Soda (Sodium carbonate) -

Sodium carbonate is manufactured by the thermal decomposition of sodium hydrogen carbonate obtained by Solvay process.

$NaCl + CO_2 + NH_3 + H_20 \longrightarrow NH_4CI + NaHCO_3$

Sodium chloride | Carbon dioxide | Ammonia | Water | Ammonium chloride | Sodium bicarbonate

$NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$

Sodium bicarbonate — Sodium carbonate — Carbon dioxide — Water

The sodium carbonate obtained in this process is dry. It is called soda ash or anhydrous sodium carbonate. Washing soda is obtained by rehydration of anhydrous sodium carbonate.

$Na_2CO_3 + H_2O \longrightarrow Na_2CO_3 .10\,H_2O$

Sodium carbonate — Water — Washing soda (Sodium bicarbonate decahydrate)

Since there are 10 water molecules in washing soda, hence it is known as Sodium bicarbonate decahydrate. Sodium carbonate is a crystalline solid and it is soluble in water when most of the carbonates are insoluble in water.

Use of sodium carbonate

- It is used in cleaning of cloths; especially in rural areas.
- In making of detergent cake and powder.
- In removing permanent hardness of water,
- It is used in glass and paper industries.

Base & Alkali - Alkali are water soluble bases.

Bases in which complete dissociation of hydroxide ion takes place are called strong base. In alkali, complete dissociation of hydroxide ions takes place so they are considered as strong base.

But it is not perfectly well defined that which substance is considered in categorize of Alkali and which is not.

Water of crystallization:

There are some salts which contain a few water molecules as an essential part of their crystal structure. The water molecules which form part of the structure of a crystal are called water of crystallisation. The salts which contain water of crystallisation are called hydrated salts.