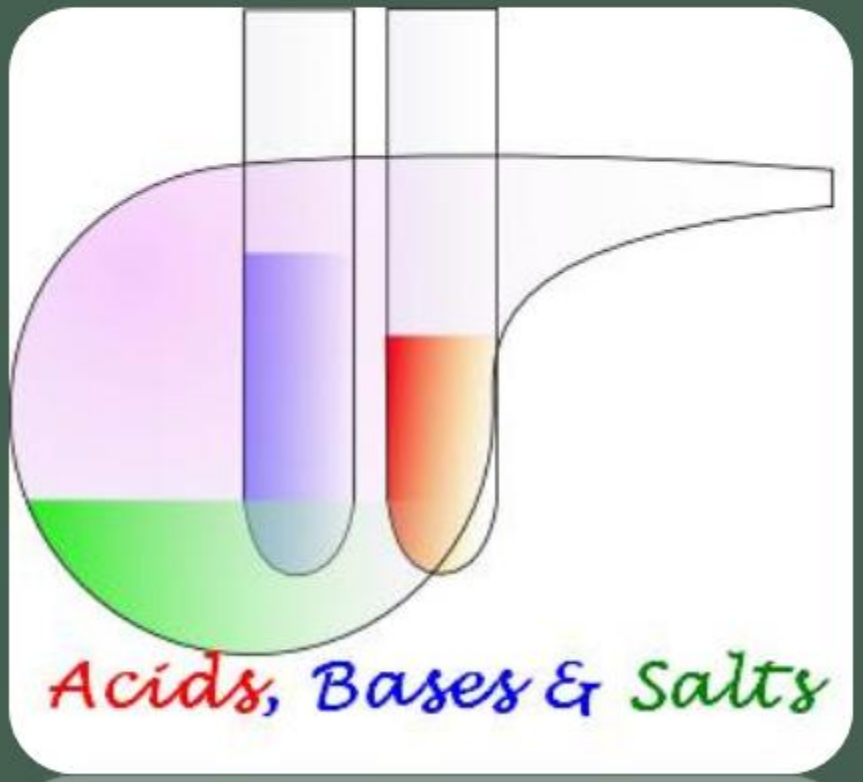
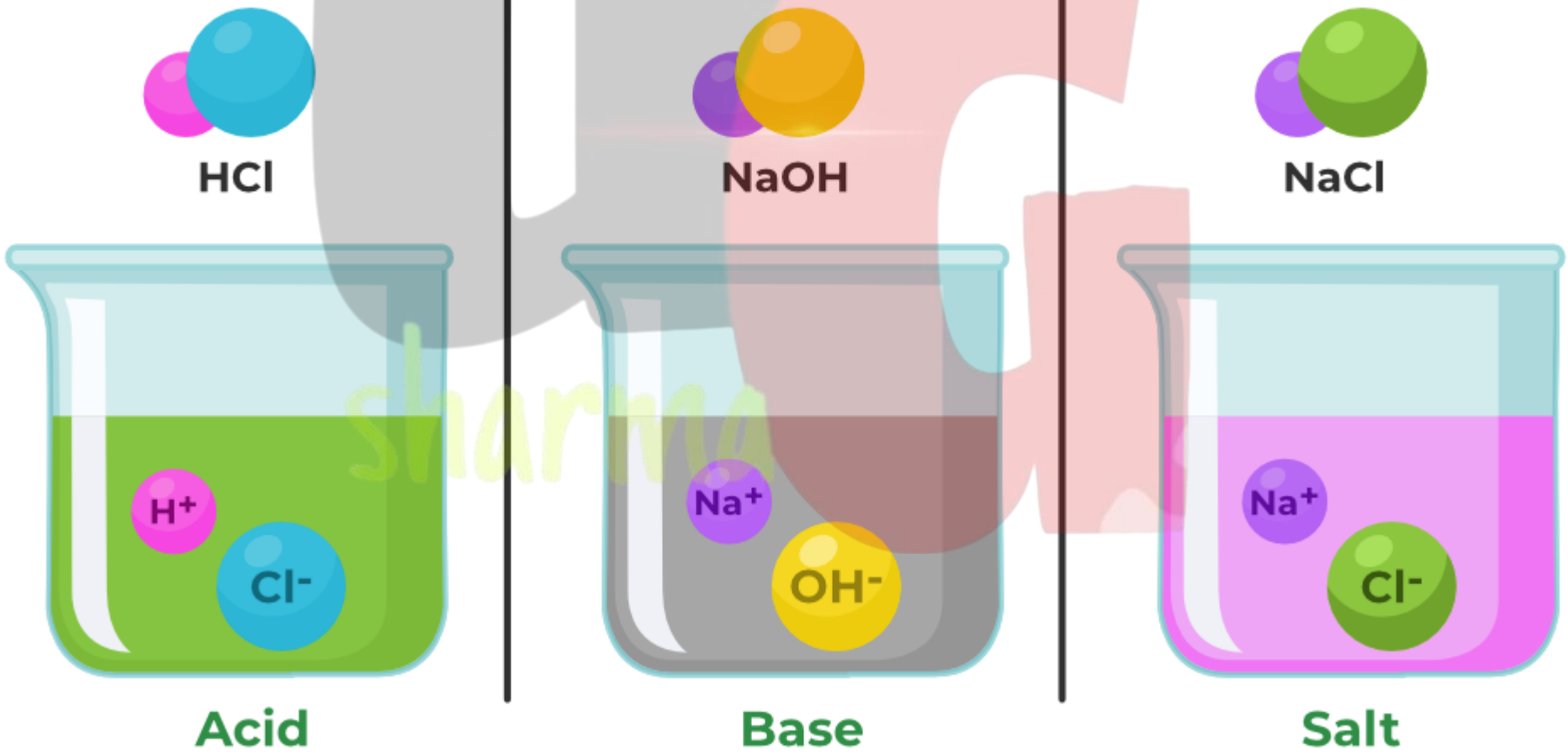
Acids Bases and Salts

Chapter 2



On the basis of chemical properties, all the compounds can be classified into three groups :-

1. Acids
2. Bases
3. Salts



Acids

- The term 'acid' has been derived from the latin word 'acidus' which means sour.
- Acids are those substance which are sour in taste and turn blue litmus into red.
  OR,
- Acids are those substance which produce H^+ ion in its aqueous solution
- E.g. :- $H_2SO_4 \xrightarrow{H_2O} 2H^+ \quad (SO_4)^{-2}$

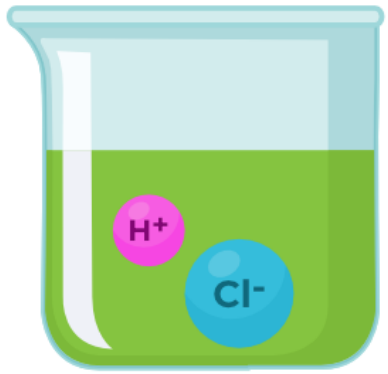
  $HCl \xrightarrow{H_2O} H^+ \quad Cl^-$

On the basis of their source/occurrence, acids are of two types :-

1. Mineral acids
2. Organic acids

Acid

Blue Litmus Turns Red



Acid

Mineral acids

- Acids that are obtained from rocks and minerals are known as mineral acids.
- E.g :- HNO_3 , HCl , H_2SO_4 , H_3PO_4 (Carbonic acid)

Mineral Acids

- Hydrochloric acid (HCl)
- Nitric acid (HNO_3)
- Sulfuric acid (H_2SO_4
- Phosphoric acid (H_3PO_4)
- Boric acid (H_3BO_4)
- Hydrobromic acid (HBr)
- Hydroiodic acid (HI)
- Hydrofluoric acid (HF)
- Perchloric acid ($HClO_4$)

Organic acids

- Acid that present in (or obtain from) animals & plants.
- They are week
- Eg. :- Lactic acid, formic acid, etc.

- Mineral acids are strong acids except carbonic acid.

Some naturally occurring acids :-

Natural source	Acid	Natural source	Acid
Vinegar	Acetic acid	Sour milk (Curd)	Lactic acid
Orange	Citric acid	Lemon	Citric acid
Tamarind	Tartaric acid	Ant sting	Methanoic acid
Tomato	Oxalic acid	Nettle sting	Methanoic acid

Physical properties acid :-

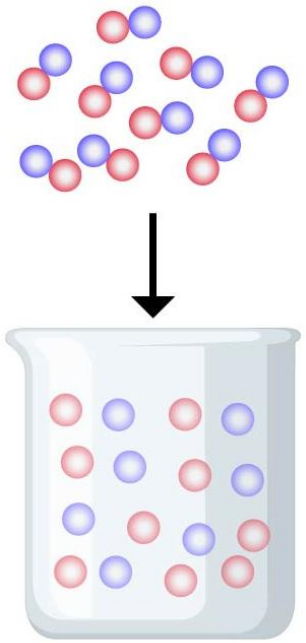
- Acis are sour in taste.
- Change blue litmus into red.
- Acid solution conduct electricity.
- Give H^+ ions in aqueous solution.

Strong Acids: HCl, C , 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 diluting the strength of acid decreases therefore amount of H^+ ions also decrease.
- Acid show their acid properties due to presence of H^+ ions.

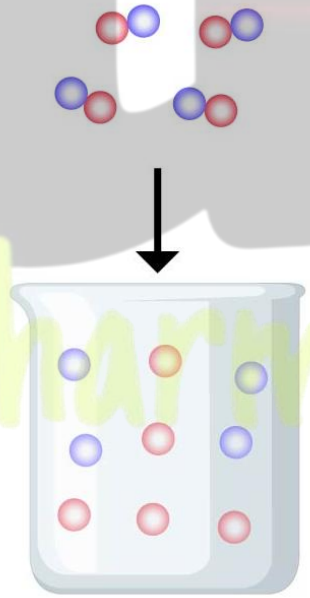
CONCENTRATED AND DILUTED ACIDS

More
Acid Added



Concentrated Acid

Less
Acid Added



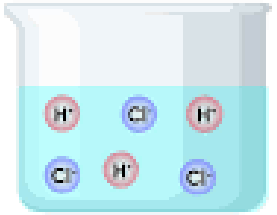
Dilute Acid

Hydrogen ion

Negative ion

STRONG AND WEAK ACID

Strong Acid



HCl Strong Acid

Weak Acid

CH_3COOH Weak Acid

Chemical properties acid :-

1. Reaction with metals to form Salt & Hydrogen gas

Acid + Metal → Salt + Hydrogen gas

E.g. :-

$Zn(s) + H_2SO_4 \rightarrow ZnSO_4(aq) + H_2(g)$

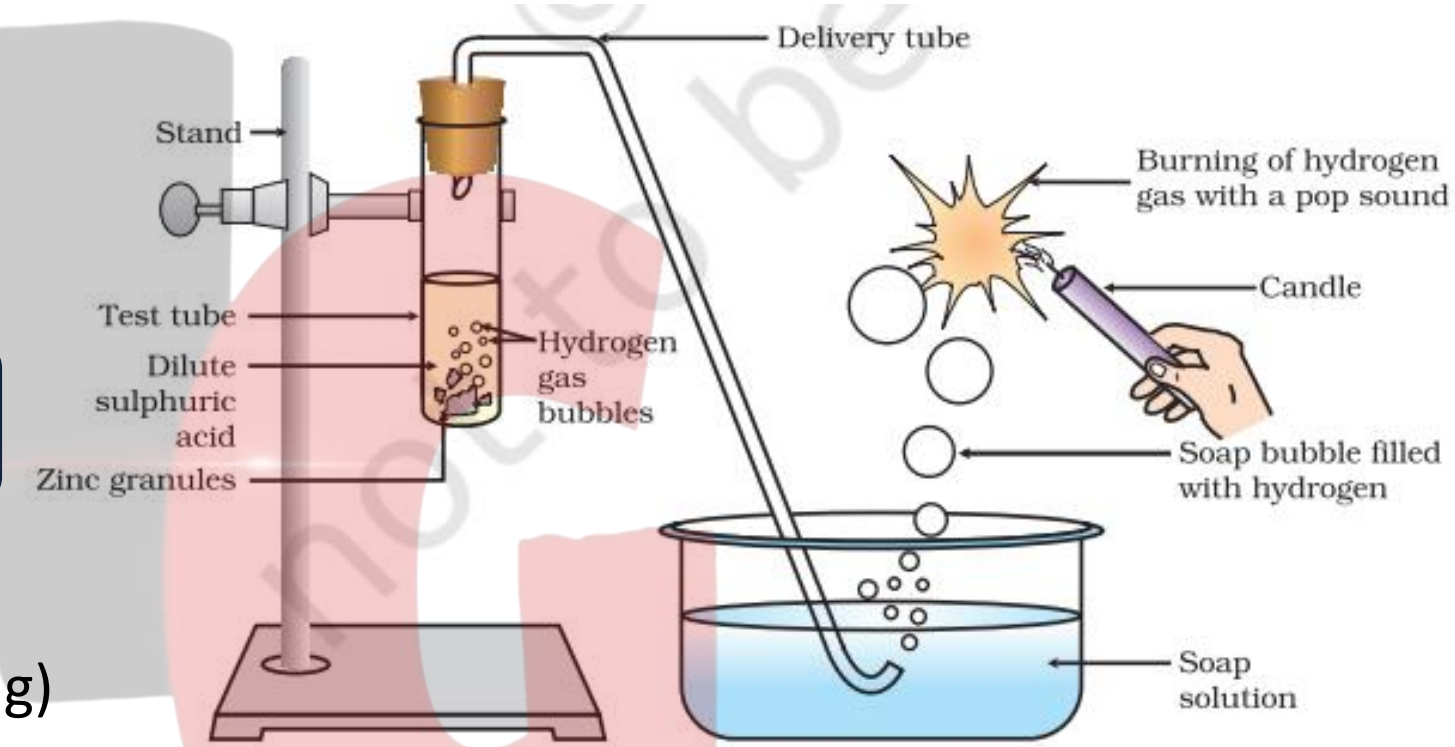


Figure 2.1 *Reaction of zinc granules with dilute sulphuric acid and testing hydrogen gas by burning*

2. Reaction with metal oxide

Activity 2.7

- Take a small amount of copper oxide in a beaker and add dilute hydrochloric acid slowly while stirring.
- Note the colour of the solution. What has happened to the copper oxide?

When dilute hydrochloric acid is added to black copper oxide and stirred, the solution gradually turns blue-green.

The blue-green colour of the solution is due to the formation of copper(II) chloride in the reaction.

Acid + Metal oxide → Salt + Water

$CuO\ (s) + 2HCl\ (aq) \rightarrow CuCl_2\ (aq) + H_2O\ (l)$

$CaO + H_2SO_4 \rightarrow$

$MgO + H_2SO_4 \rightarrow$

Note :-
Metalic Oxides are basic in nature

3. Reaction with metal carbonate & metal hydrogen carbonate

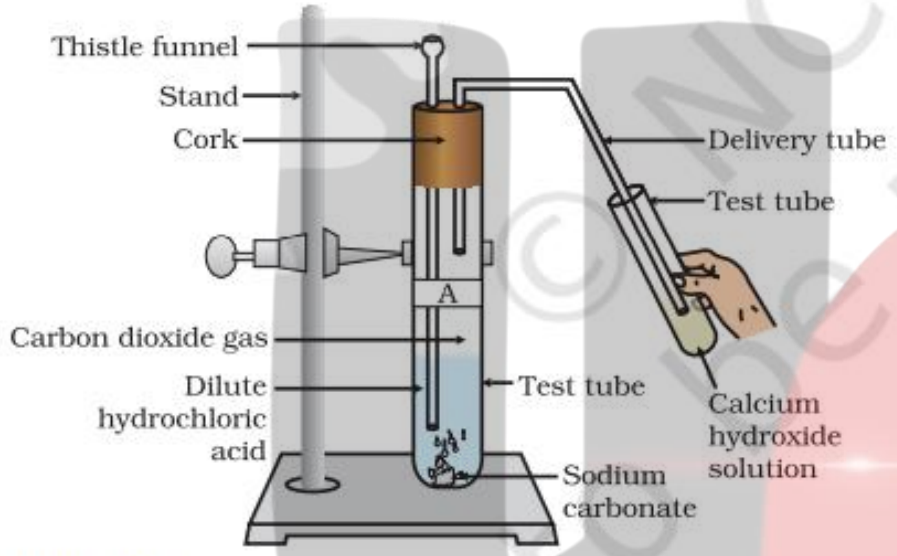


Figure 2.2
Passing carbon dioxide gas through calcium hydroxide solution

Activity 2.5

- Take two test tubes, label them as A and B.
- Take about 0.5 g of sodium carbonate (Na_2CO_3) in test tube A and about 0.5 g of sodium hydrogencarbonate ($NaHCO_3$) in test tube B.
- Add about 2 mL of dilute HCl to both the test tubes.
- What do you observe?
- Pass the gas produced in each case through lime water (calcium hydroxide solution) as shown in Fig. 2.2 and record your observations.

Metal carbonate / hydrogen carbonate + Acid → Salt + carbon dioxide + Water

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

Test tube B: $NaHCO_3 + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$

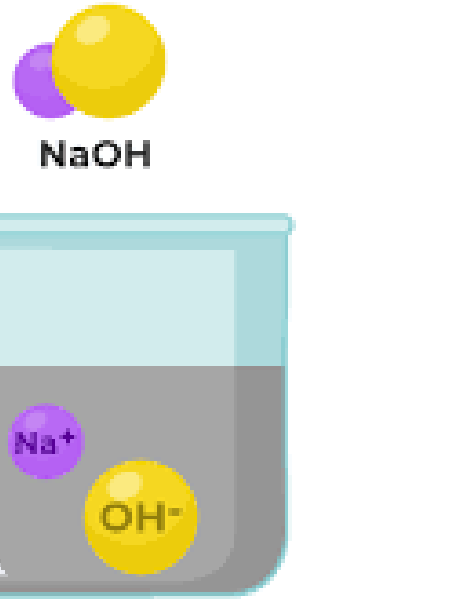
$CaCO_3(s) + 2HCl(aq) \rightarrow$

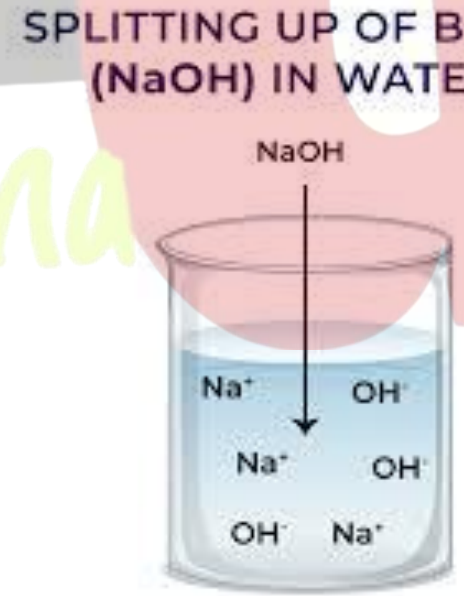
Bases

- Bases are those substances which are bitter in taste and turn red litmus blue

  OR,

- Bases are those substances which produces OH^- ion in their aqueous solution.
- E.g. :- $NaOH \xrightarrow{H_2O} Na^+ \quad OH^-$
- Bases are soapy in touch.





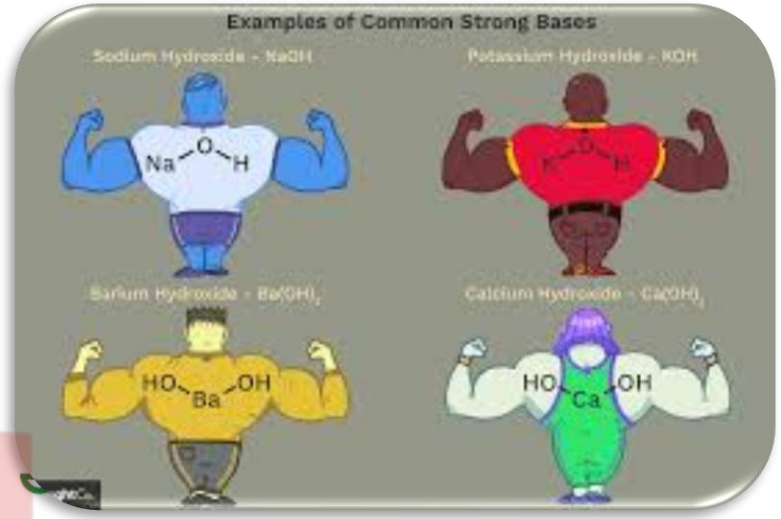
Bases are two types :-

1. <u>Strong Bases</u> :- Which ionise completely to OH^- ions

   E.g. :- KOH, NaOH, etc

2. <u>Weak Bases</u> :- Which ionise only partially

   E.g. :- $Ca(OH)_2$, NH_4OH, etc



Water soluble base is called <u>alkali</u>.

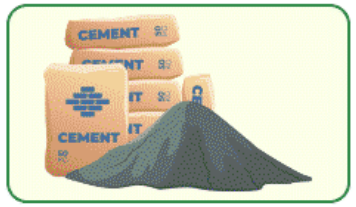
Note :- All alkalies are base, but all bases are not alkalies.

Example of Bases

Sodium Hydroxide
Soaps

Sodium Carbonate
Detergents

Bases used in
Labs



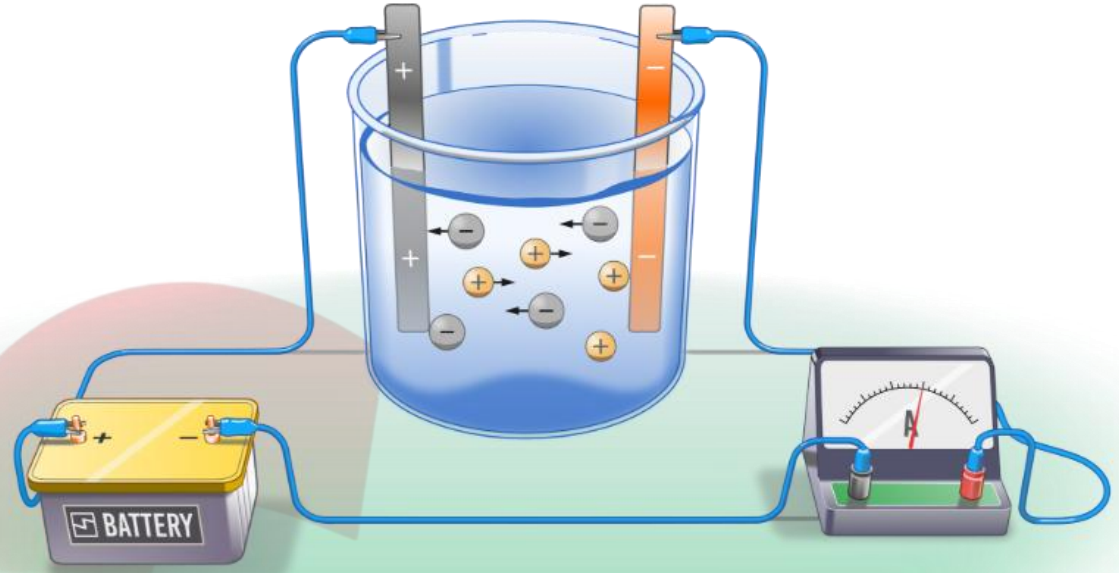
Calcium Hydroxide
Cement

Sodium Fluoride
Toothpaste

Ammonia
Fertilizers

Physical properties of Bases :-

- Bitter in taste
- Turn red litmus blue
- Soapy / slippery in touch
- Give OH^- ions
- Good conductor of electricity

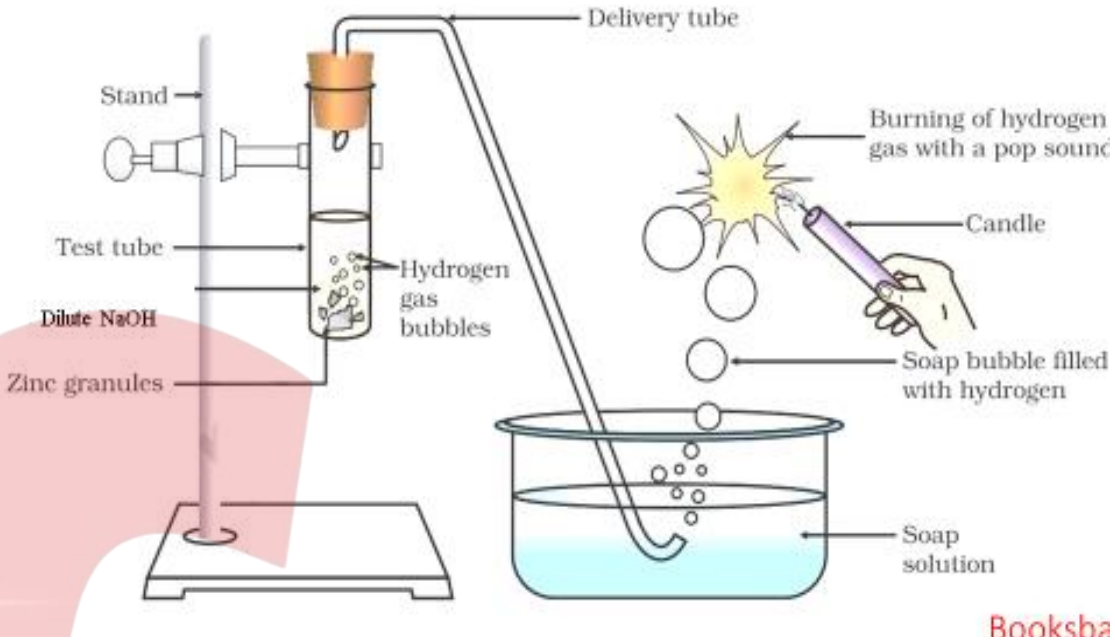


Chemical properties of Bases :-

1. Reaction with active metals

Activity 2.4

- Place a few pieces of granulated zinc metal in a test tube.
- Add 2 mL of sodium hydroxide solution and warm the contents of the test tube.
- Repeat the rest of the steps as in Activity 2.3 and record your observations.



Base + Metal → Salt + Hydrogen gas

$2NaOH(aq) + Zn(s) \rightarrow Na_2ZnO_2(s) + H_2$

1) $Zn + 2\ NaOH \longrightarrow \underset{\text{Sodium Zincate}}{Na_2ZnO_2} + H_2$

$Zn + 2\ KOH \longrightarrow \underset{\text{Potassium Zincate}}{K_2ZnO_2} + H_2$

2) $Pb + 2\ NaOH \longrightarrow \underset{\text{Sodium plumbate}}{Na_2PbO_2} + H_2$

$Pb + 2\ KOH \longrightarrow \underset{\text{Potassium plumbate}}{K_2PbO_2} + H_2$

3) $2\ Al + 2\ NaOH + 2H_2O \longrightarrow \underset{\text{Sodium aluminate}}{2\ NaAlO_2} + 3\ H_2$

$2\ Al + 2\ KOH + 2\ H_2O \longrightarrow \underset{\text{Potassium aluminate}}{2\ KAlO_2} + 3\ H_2$

2. Reaction with non – metallic oxide

Base + Non Metal oxide → Salt + Water

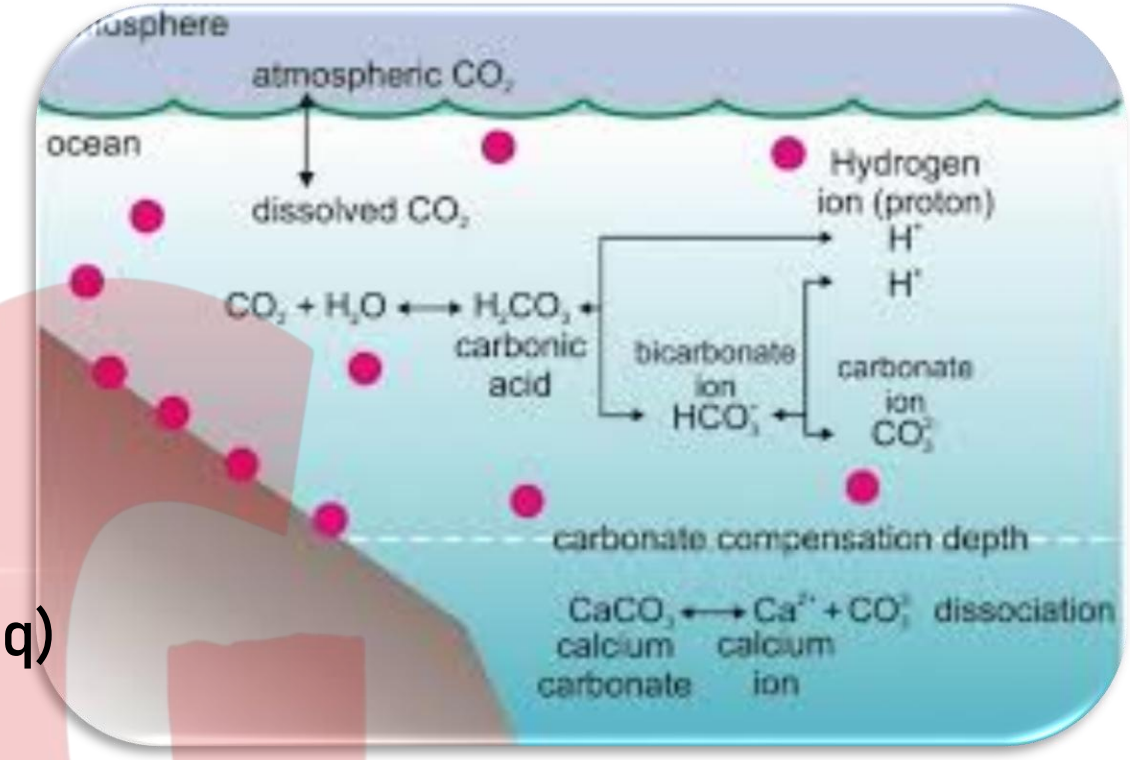
$$CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l)$$

white ppt.

On passing excess carbon dioxide

$$CaCO_3(s) + H_2O(l) + CO_2 \rightarrow Ca(HCO_3)_2\,(aq)$$

soluble in water



The product of this reaction is calcium bicarbonate, a compound that is soluble in water.

Non – metallic oxide are basic in nature.

$$CO_{2\,(g)} + 2\,NaOH_{(aq)} \longrightarrow Na_2CO_{3\,(aq)} + H_2O_{(l)}$$

$$\underline{CO_{2\,(g)}} + 2\,KOH_{(aq)} \longrightarrow K_2CO_{3\,(aq)} + H_2O_{(l)}$$

$$SO_{3\,(g)} + \underline{2\,NaOH_{(aq)}} \longrightarrow Na_2SO_{4\,(aq)} + H_2O_{(l)}$$

- Bases do not react with metal carbonates or metal hydrogen carbonates.
- Both metal carbonates and metal hydrogen carbonates are themselves considered bases, and therefore do not react with other bases.

AMPHOTERIC OXIDE REACTION WITH ACID AND BASE

Amphoteric Oxide :- Amphoteric oxides are metal oxides that exhibit both acidic and basic properties

Aluminium oxide

$Al_2O_3 + HCl \rightarrow AlCl_3 + H_2O$

$Al_2O_3 + NaOH \rightarrow NaAlO_2 + H_2O$

} Salt + Water

$$ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$$

$$\underset{\text{Zinc oxide}}{ZnO} + \underset{\text{Sodium hydroxide}}{2NaOH} \rightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + H_2O$$

Note :- Non-metallic oxides generally do not react with acids.

In shorts

Reaction Of Base

(i) Base + Metal $\rightarrow$ Salt + H_2
(ii) Base + Metal Carbonate $\rightarrow$ No Reaction
(iii) Base + Metal Hydrogen Carbonate $\rightarrow$ No Reaction
(iv) Base + Acid $\rightarrow$ Salt + H_2O
(v) Base + Non Metallic oxide $\rightarrow$ Salt + H_2O

Reaction b/w Acids & Bases

Acids reacts with bases to produces salt and water. This reaction is known as neutralisation reaction (Because they neutralise each other).

Acid + Base → Salt + water

$HCl + NaOH \longrightarrow NaCl + H_2O$

$H_2SO_4 + Ca(OH)_2 \longrightarrow CaSO_4 + 2H_2O$

$HX + MOH \rightarrow MX + HOH$

$2HNO_{3\,(aq)} + Ca(OH)_{2\,(aq)} \rightarrow Ca(NO_3)_2 + 2H_2O$

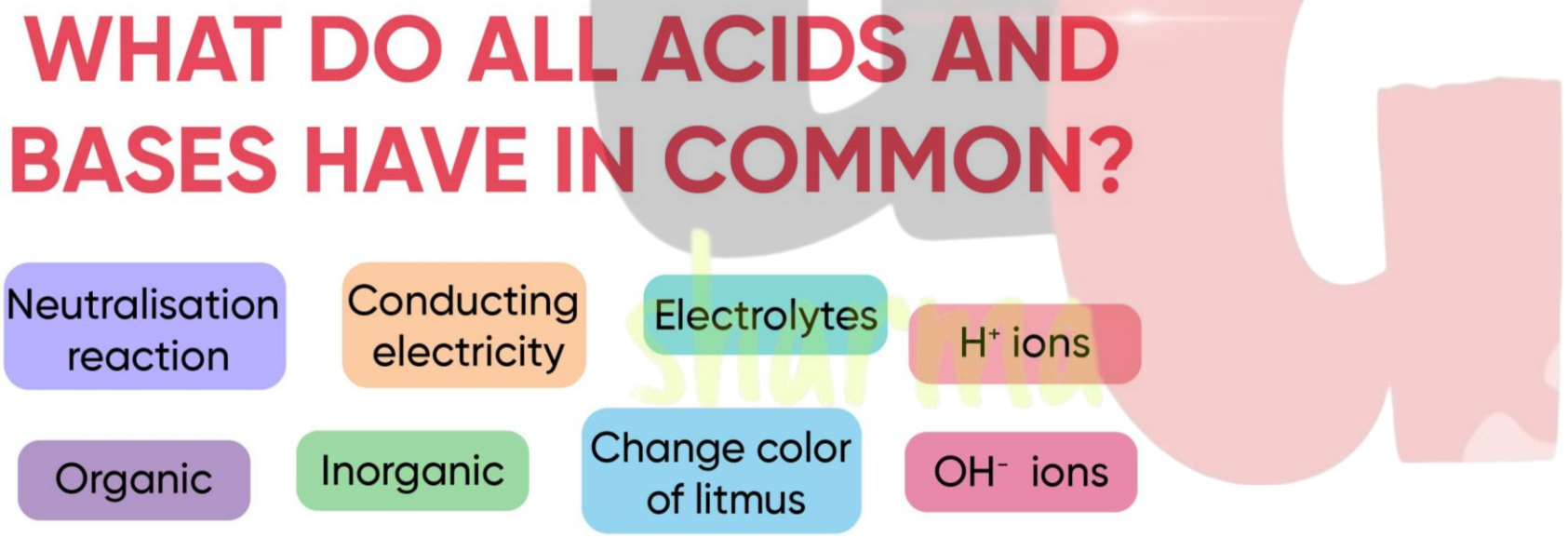
$H_2SO_{4\,(aq)} + 2KOH_{\,(aq)} \rightarrow K_2SO_4 + 2H_2O$

$HNO_{3\,(aq)} + KOH_{\,(aq)} \rightarrow$ _____ + _____

$HCl_{\,(aq)} + Ca(OH)_{2\,(aq)} \rightarrow$ _____ + _____

Similarities between all Acids and all Bases

→ All acids have H^+ ions in common. All acids produce H^+ ions
→ Acids produce H^+ ions in solution which are responsible for their acidic properties.
→ All bases have OH^- (hydroxyl ions) in common. All bases produce OH^- ions
→ Bases produce OH^- ions in solution which are responsible for their basic properties



What Happens to an Acid or a Base in a Water Solution?

The process of dissolving an acid or base water is highly exothermic. This is known as dilution. Which result in decrease in concentration of ions(H_3O^+ or H^+ / OH^-) per unit volume

→ Acids produce H^+ ions in presence of water.

→ H^+ ions cannot exist alone, they exist as H_3O^+ (hydronium ions).

$H^+ + H_2O \rightarrow H_3O^+$

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

→ Bases when dissolved in water gives OH − ions.

$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$

→ Bases soluble in water are called alkali.

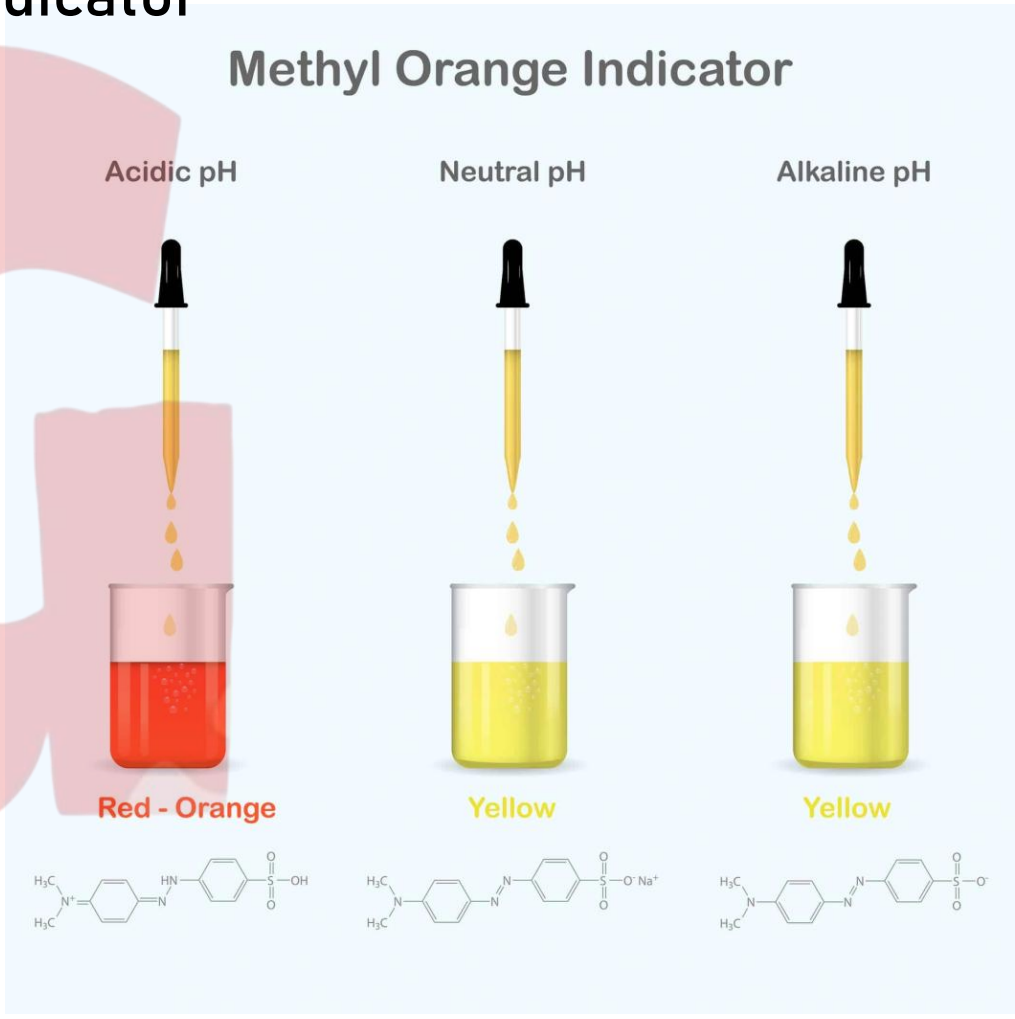
→ While diluting acids, it is recommended that the acid should be added to water and not water to acid because the process of dissolving a acid or a base in water is highly exothermic.

Indicator

The substances which is used to indicate the presence of acid or base in a solution are called acid-base indicator or simply indicator

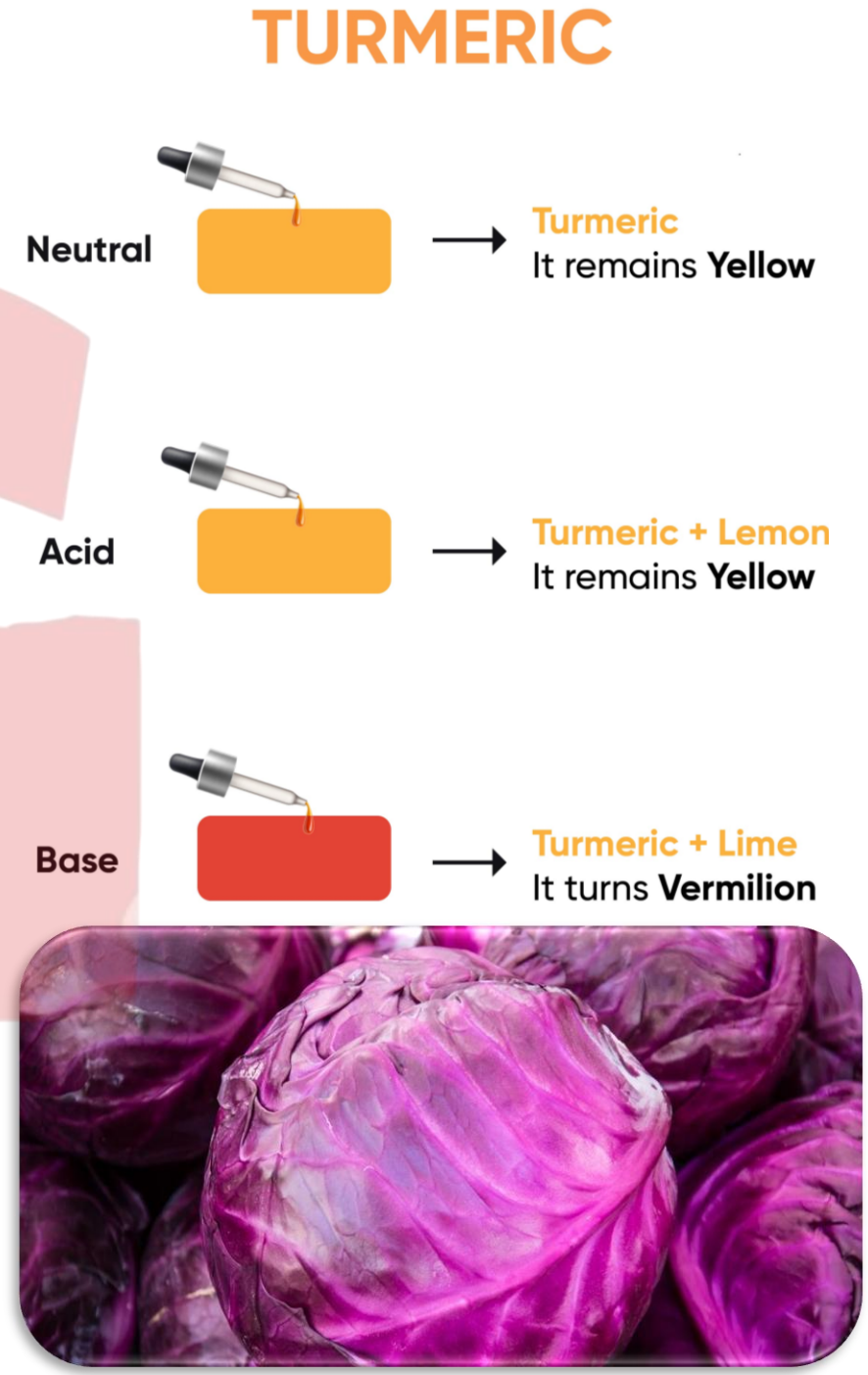
Classification of indicator :-

1. Natural indicator
2. Synthetic indicator
3. Olfactory indicator
4. Universal indicator



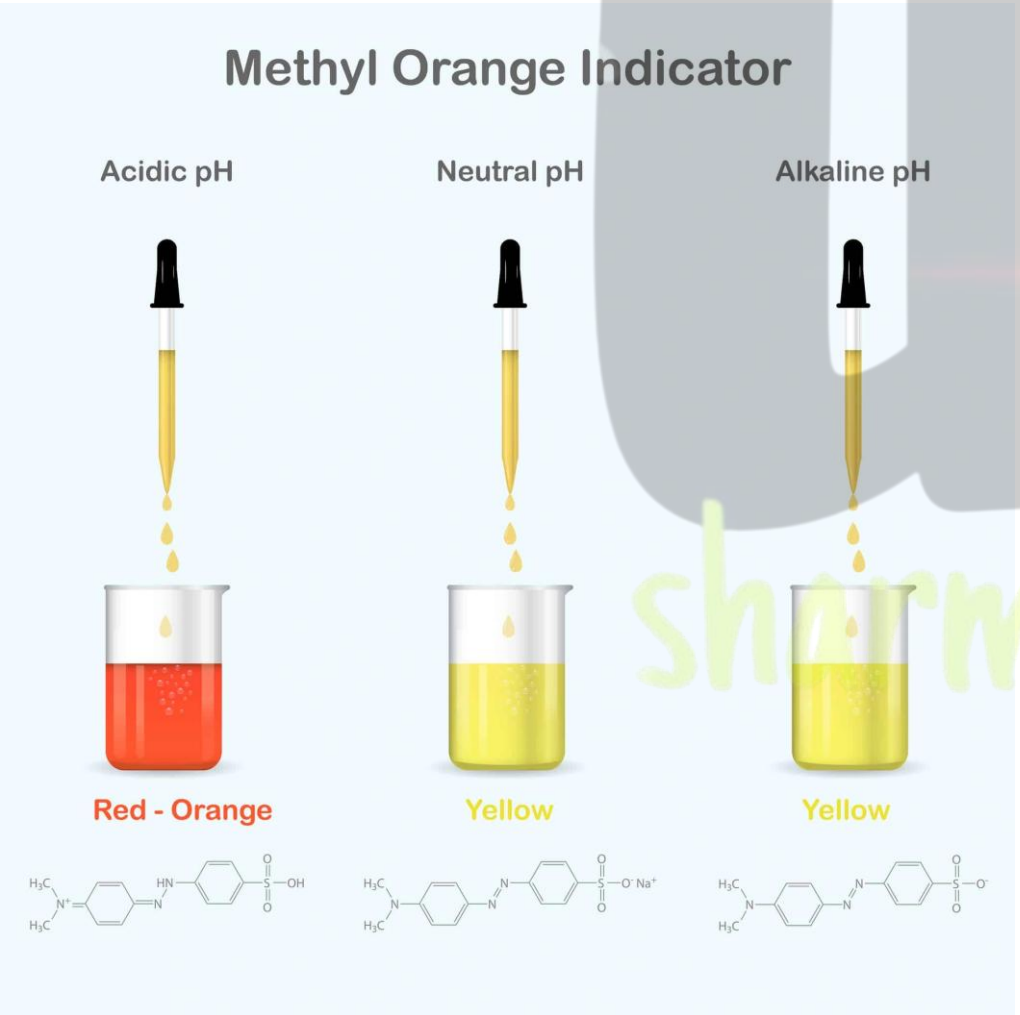
01. Natural Indicator

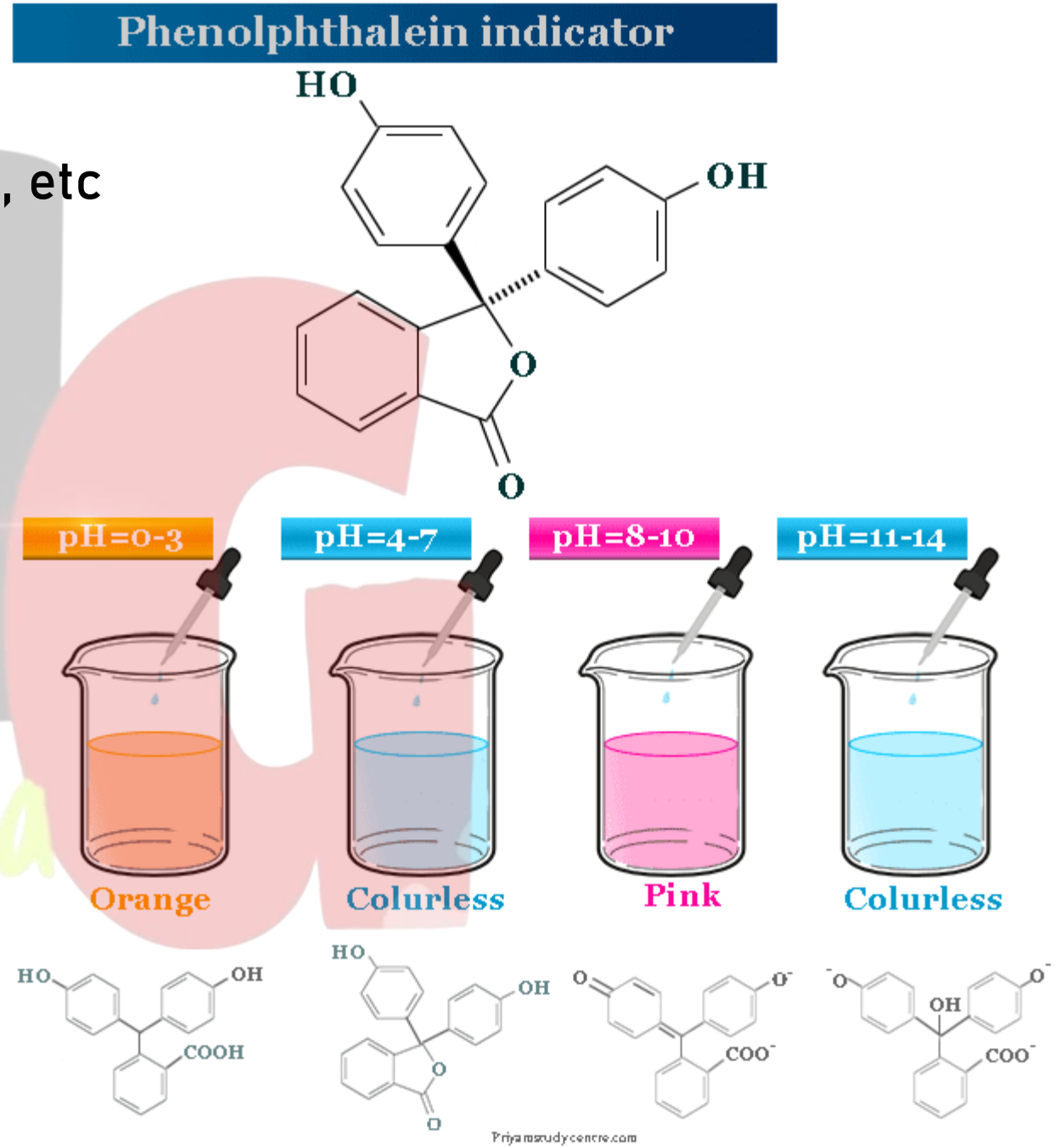
E.g. :- Litmus, Red Cabbage, Turmeric ,etc



02. Synthetic Indicator

E.g. :- Phenolphthalein, methyl orange, etc



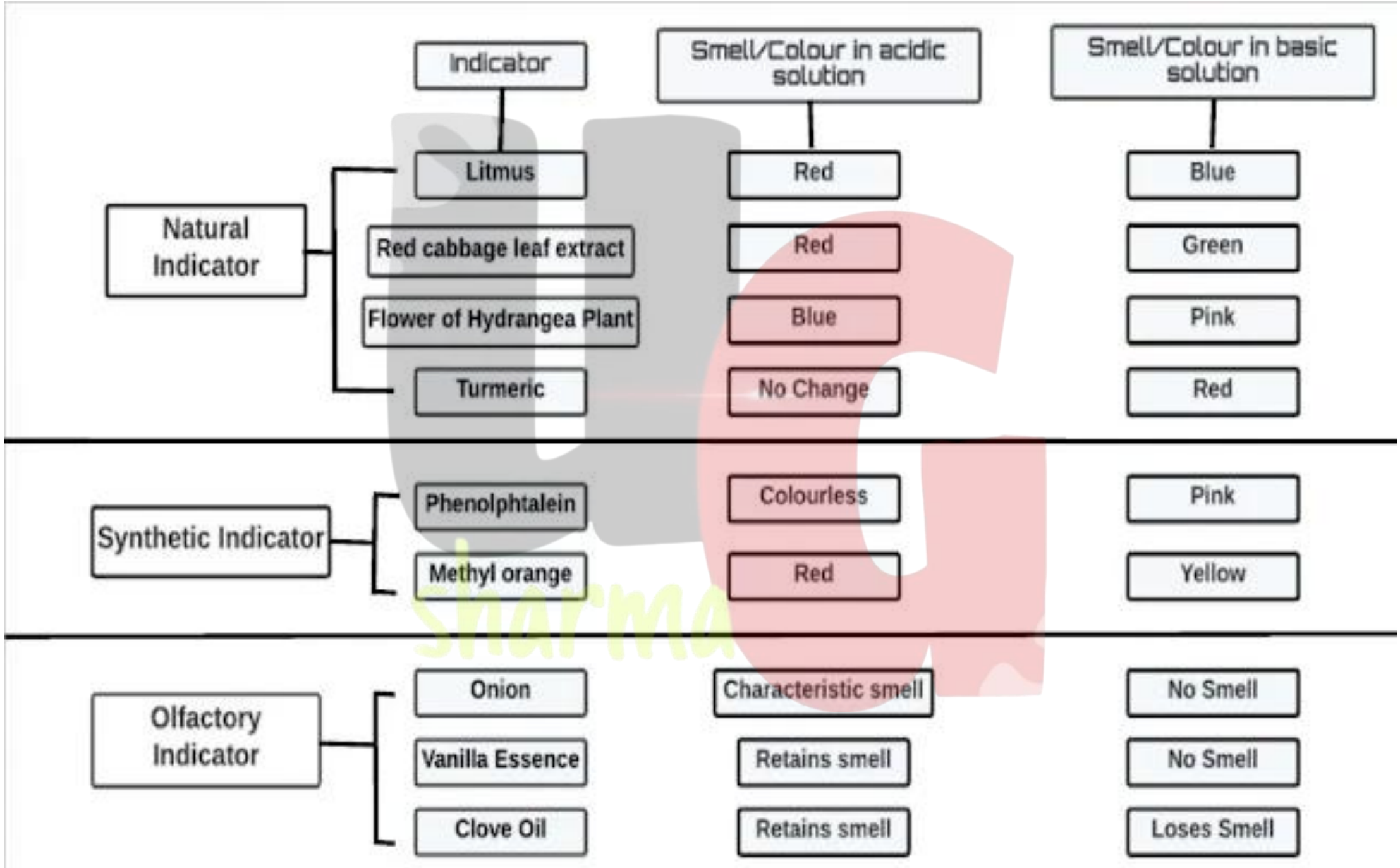


03. Olfactory Indicator

E.g. :-Onion, Vanilla Essence, Clove oil, etc.

OLFACTORY INDICATORS

	Acid	Base
 Onion	Remains smell	Loses it's smell
 Vanilla Extract	Remains smell	Loses it's smell
 Clove Oil	Remains smell	Loses it's smell

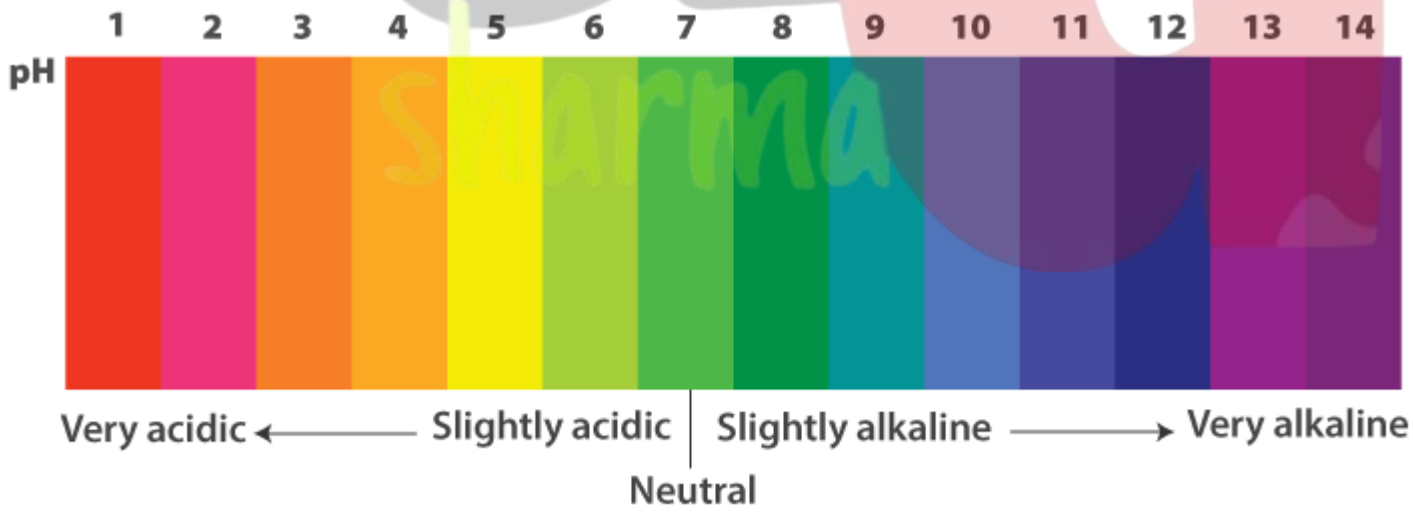

Indicator
Smell/Colour in acidic solution
Smell/Colour in basic solution
Natural Indicator
Litmus
Red
Blue
Red cabbage leaf extract
Red
Green
Flower of Hydrangea Plant
Blue
Pink
Turmeric
No Change
Red
Synthetic Indicator
Phenolphtalein
Colourless
Pink
Methyl orange
Red
Yellow
Olfactory Indicator
Onion
Characteristic smell
No Smell
Vanilla Essence
Retains smell
No Smell
Clove Oil
Retains smell
Loses Smell

Universal Indicator

It is a mixture of several indicators. It shows different colours at different concentration of H^+ ions in the solution.

pH Scale: A scale for measuring H^+ ion concentration in a solution. p in pH stands for 'potenz' a German word which means power.

- ph is equal to 7 → neutral solution
- pH is less than 7 → acidic solution
- pH more than 7 → basic solution



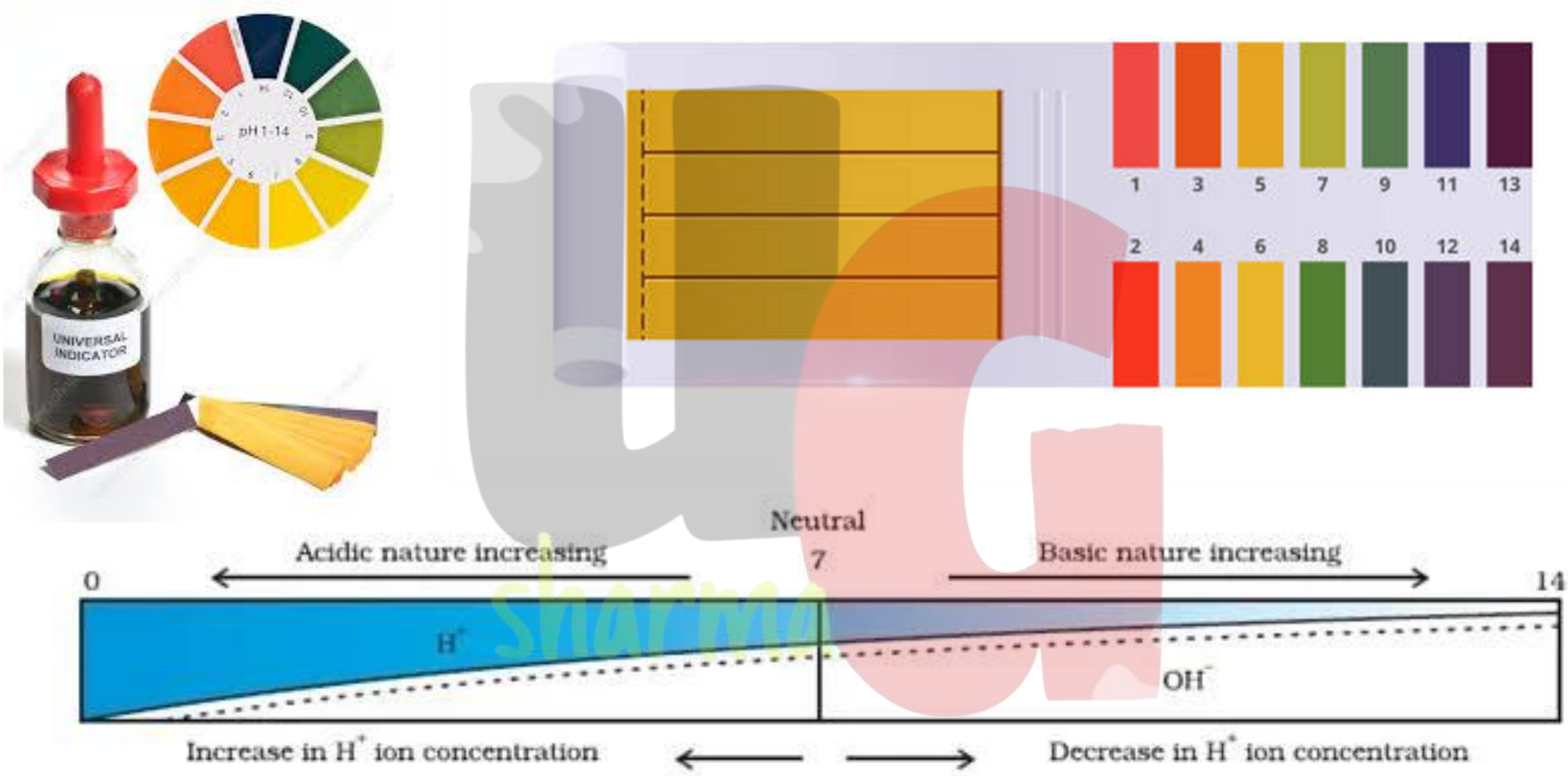
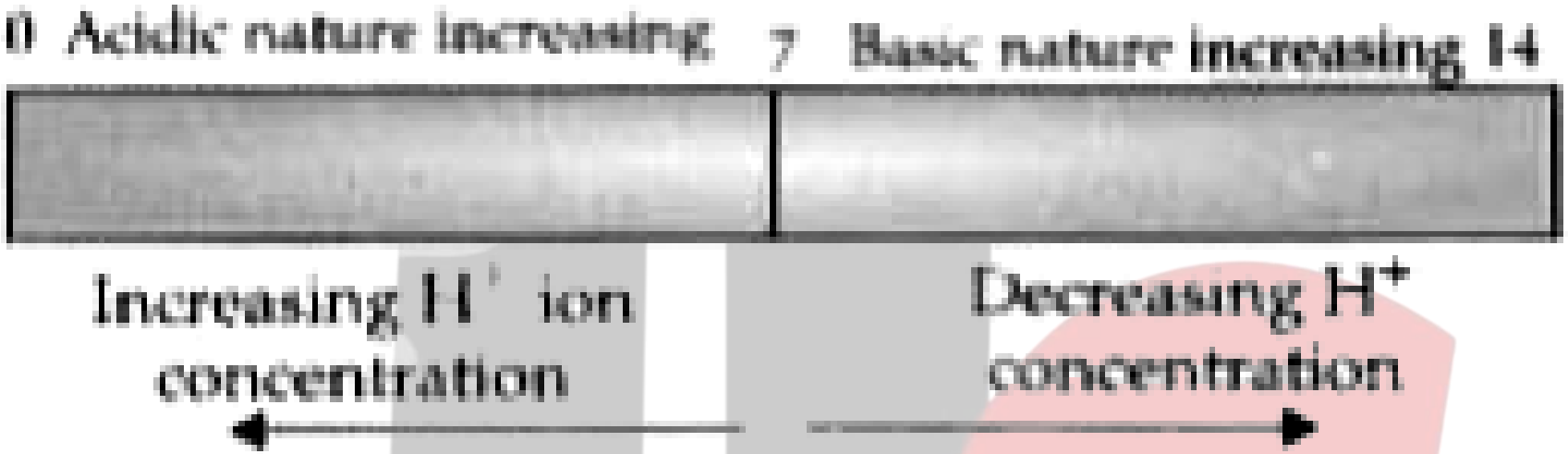


Figure 2.6 *Variation of* pH *with the change in concentration of* $H^+(aq)$ *and* $OH^-(aq)$ *ions*

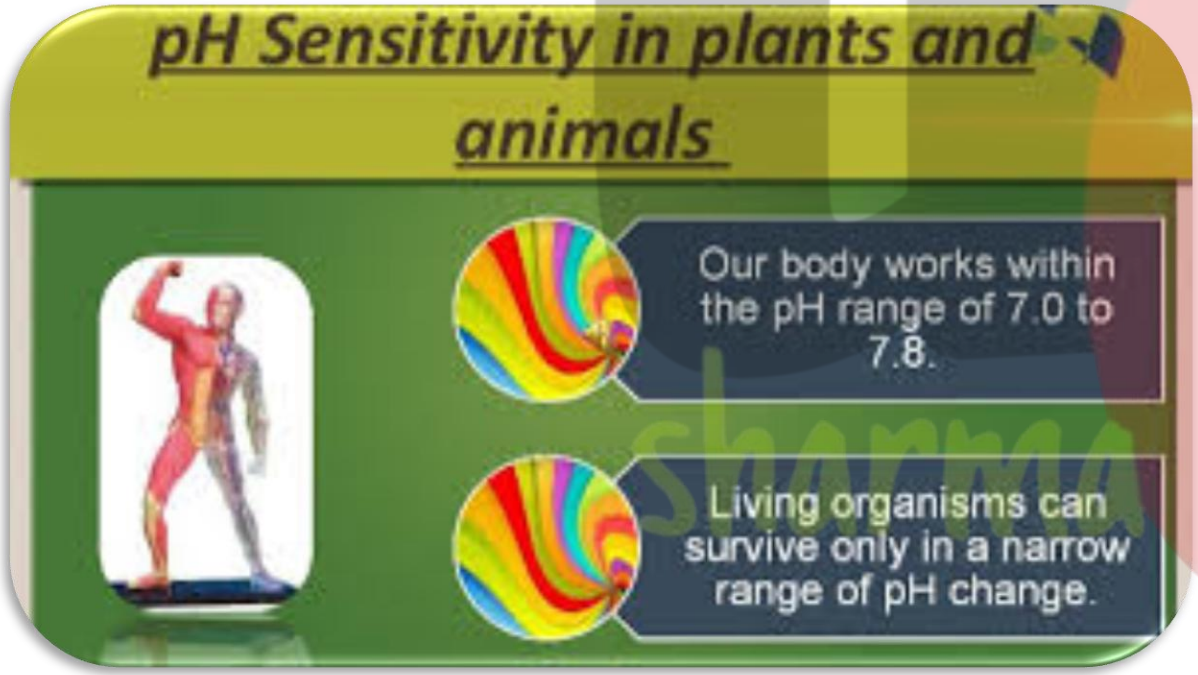


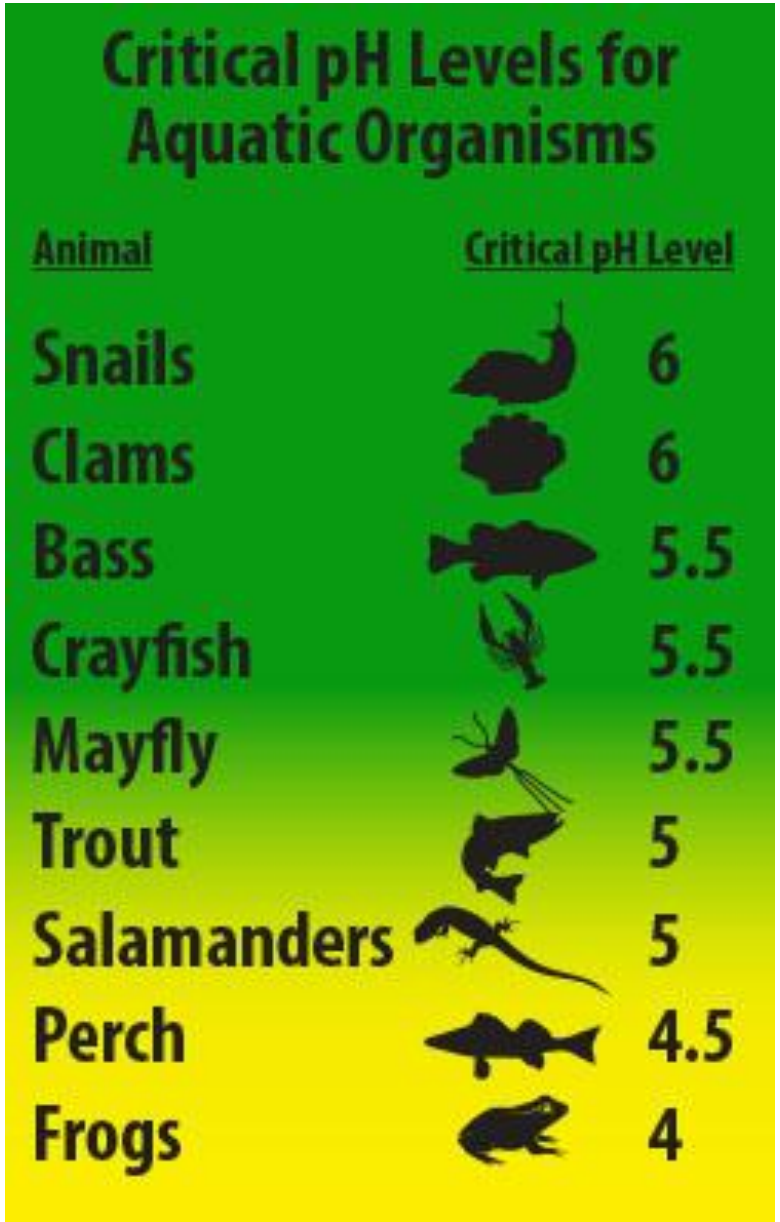
- On diluting acid :- pH increase (↑)
- On diluting a base :- pH decrease (↓)

Importance of pH in everyday life

01. Plants and animals are pH sensitive

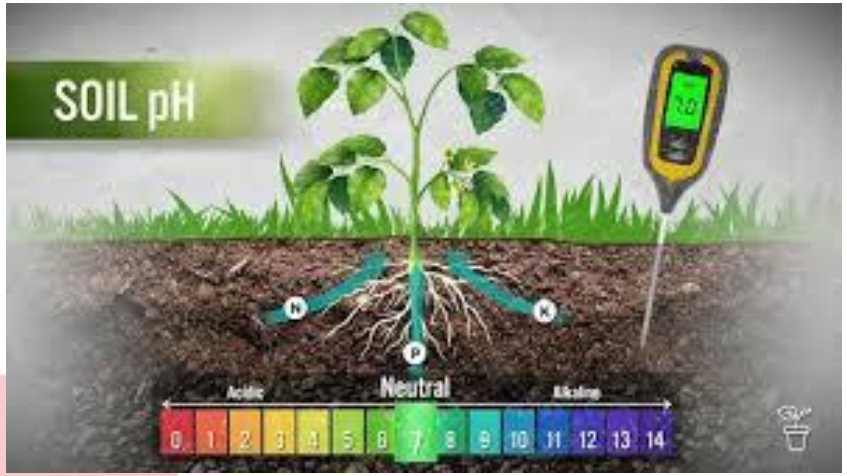
- Our body works within pH range of 7 – 7.8
- pH of rain water less than 5.6 is called acidic rain.





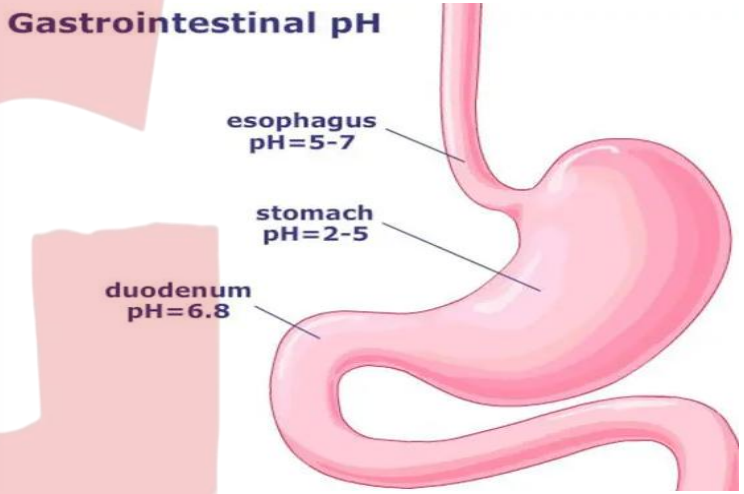
02. pH of the soil

- Plants required a specific pH range for their healthy growth.



03. pH in our digestive system

- Dilute HCl helps in digestion without harming the stomach.
- Excess acid cause indigestion, to cure we need to take antacid as milk of magnesia [$Mg(OH)_2$].

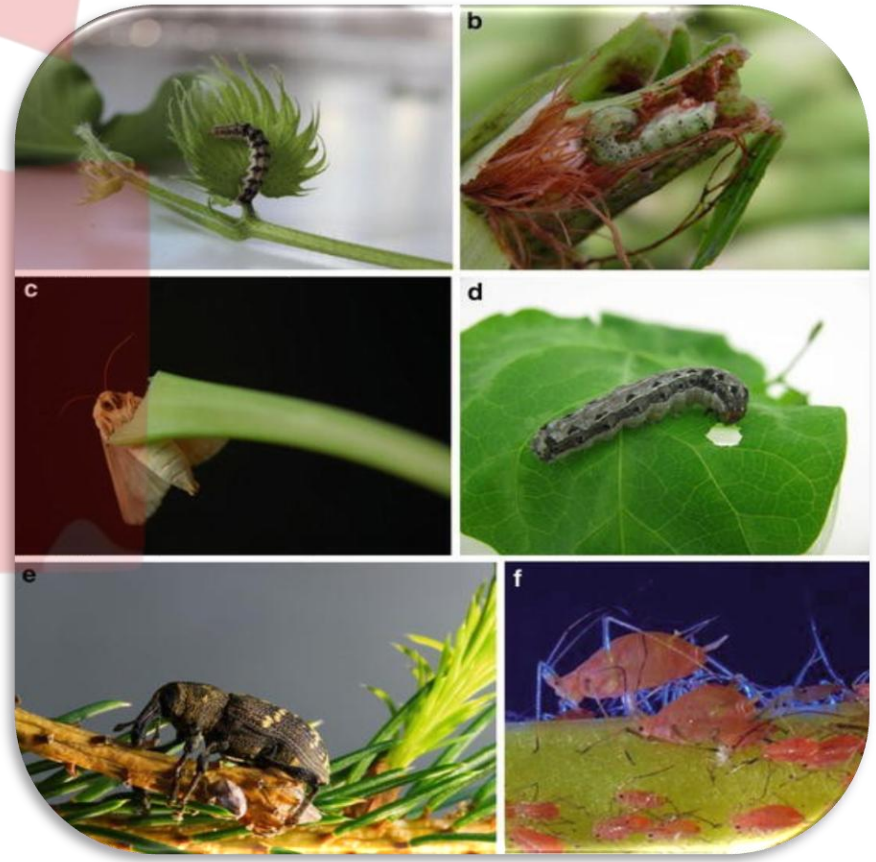


04. pH change cause tooth decay

- Tooth decay starts when pH of mouth is lower than 5.5 .

05. Self defence by plants animals

- Bee sting leaves an acid which cause pain & irritation.
- Sting hair of nettle leaves inject methanol acid cause pain & burning sensation .
- Give relief by using mild bases.



QUESTIONS

1. Why should curd and sour substances not be kept in brass and copper vessels?
2. Which gas is usually liberated when an acid reacts with a metal? Illustrate with an example. How will you test for the presence of this gas?
3. Metal compound A reacts with dilute hydrochloric acid to produce effervescence. The gas evolved extinguishes a burning candle. Write a balanced chemical equation for the reaction if one of the compounds formed is calcium chloride.

Ans 1 :-

- Curd and other sour substances contain acids (e.g., lactic acid in curd).
- Brass and copper are metals, and they react with acids.
- This reaction leads to the formation of harmful or toxic metallic salts, which can contaminate the food and make it unfit for consumption, potentially causing health issues like food poisoning.
- The reaction can also lead to the corrosion of the vessels.

Ans 2:-

•<u>Gas liberated</u>:

Hydrogen gas (H_2) is usually liberated when an acid reacts with a metal.

•<u>Example</u>:

When dilute hydrochloric acid (Hcl) reacts with zinc metal (Zn), hydrogen gas is produced along with zinc chloride .

$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

•<u>Test for hydrogen gas</u>:

Bring a burning splinter or matchstick near the mouth of the test tube containing the gas. If the gas is hydrogen, it will burn with a "pop" sound.

Ans 3:-

•Balanced Chemical Equation:

$CaCO_3(s) + HCl(aq) \rightarrow CaCL_2(aq) + CO_2(g) + H_2O(l)$

Ques 3. Metal compound A reacts with dilute hydrochloric acid to produce effervescence. The gas evolved extinguishes a burning candle. Write a balanced chemical equation for the reaction if one of the compounds formed is calcium chloride.

Ans :-

- Identification of Gas:

The gas that extinguishes a burning candle and produces effervescence is carbon dioxide (CO_2).

- Identification of Metal Compound A: Since calcium chloride ($CaCl_2$) is formed and carbon dioxide is evolved, the metal compound A must be a calcium carbonate ($CaCO_3$)
- Balanced Chemical Equation:
- $CaCO_3\ (s) + HCl\ (aq) \rightarrow CaCl_2\ (aq) + CO_2\ (g) + H_2O\ (l)$

QUESTIONS

1. Why do HCl, HNO_3, etc., show acidic characters in aqueous solutions while solutions of compounds like alcohol and glucose do not show acidic character?
2. Why does an aqueous solution of an acid conduct electricity?
3. Why does dry HCl gas not change the colour of the dry litmus paper?
4. While diluting an acid, why is it recommended that the acid should be added to water and not water to the acid?
5. How is the concentration of hydronium ions (H_3O^+) affected when a solution of an acid is diluted?
6. How is the concentration of hydroxide ions (OH^-) affected when excess base is dissolved in a solution of sodium hydroxide?

QUESTIONS

1. You have two solutions, A and B. The pH of solution A is 6 and pH of solution B is 8. Which solution has more hydrogen ion concentration? Which of this is acidic and which one is basic?
2. What effect does the concentration of $H^+(aq)$ ions have on the nature of the solution?
3. Do basic solutions also have $H^+(aq)$ ions? If yes, then why are these basic?
4. Under what soil condition do you think a farmer would treat the soil of his fields with quick lime (calcium oxide) or slaked lime (calcium hydroxide) or chalk (calcium carbonate)?

The basicity of an acid refers to the number of hydrogen ions (H^+) that one molecule of the acid can donate (or replaceable) in a chemical reaction.

Monobasic acids:

These acids can donate one hydrogen ion per molecule. Examples include hydrochloric acid (HCl) and nitric acid (HNO_3).

▪Dibasic acids:

These acids can donate two hydrogen ions per molecule. Sulfuric acid (H_2SO_4) is a common example.

▪Tribasic acids:

These acids can donate three hydrogen ions per molecule. Phosphoric acid (H_3PO_4) is a tribasic acid.

Acid	No. of H^+	Basicity
HCl	1	Monobasic
HNO_3	1	Monobasic
H_2SO_4	2	Dibasic
H_3PO_4	3	Tribasic

SALTS

- Salts are the ionic compounds which are produced after the neutralization reaction between acid and base.
- Acid + Base → Salt + Water
- Salts are electrically neutral.

Family of Salt:

Salts having common acidic or basic radicals are said to belong to same family.

Example: Sodium chloride (NaCl) and Calcium chloride ($CaCl_2$) belong to chloride family.

Calcium chloride ($CaCl_2$) and calcium sulphate ($CaSO_4$) belong to calcium family.

Zinc chloride ($ZnCl_2$) and Zinc sulphate ($ZnSO_4$) belong to zinc family.

pH of salts

i. Strong Acid + Strong base → Neutral Salt : pH = 7
ii. Weak Acid + Weak base → Neutral Salt : pH = 7
iii. Weak Acid + Strong base → Basic Salt : pH > 7
iv. Strong Acid + Weak base → Acidic Salt : pH < 7

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	$CH_3COOH + NH_4OH \rightarrow CH_3COONH_4 + H_2O$

ACIDIC, BASIC & NEUTRAL SALTS

Strong Acid + Strong Base → Neutral Salt + H_2O

HCl + NaOH → NaCl + H_2O

Strong Acid + Weak Base → Acidic Salt + H_2O

HCl + NH_4OH → NH_4Cl + H_2O

Weak Acid + Strong Base → Basic Salt + H_2O

CH_3COOH + NaOH → CH_3COONa + H_2O

Weak Acid + Weak Base → Neutral Salt + H_2O

CH_3COOH + NH_4OH → CH_3COONH_4 + H_2O

Common Salt

- It is neutral salt.

  $NaOH\ (aq) + HCl\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l)$
- Sodium chloride is also known as table salt or common salt.
- Sodium chloride is used to enhance the taste of food.
- Common Salt is obtained from sea water by the process of evaporation.
- It is used for melting ice.
- The common salt thus obtained is an important raw material for various materials of daily use, such as sodium hydroxide, baking soda, washing soda, bleaching powder and many more.

PRODUCT MADE FROM COMMON SALT

Caustic Soda
Sodium Hydroxide
($NaOH$)

Used to make soaps, detergent, paper & artificial fibers like rayon

Baking Soda
Sodium Hydroxide Carbonate ($NaHCO_3$)

Used to make baking powder, antacids and soda-acid fire extinguisher. Help s to fasten cooking process

Washing Soda
Hydrated Sodium Carbonate ($Na_2CO_3.10H_2O$)

Used to make borax, glass, soap and paper. Used as clenaning agent & remove permanent hardness of water

Bleaching Powder
Calcium Oxychloride ($CaOCl_2$)

Used to purify drinking water & for bleaching cotton & linen in the textile Industry

01. Sodium Hydroxide (NaOH)

- Commonly Known as " **Caustic Soda**".

Preparation :-

- By the process of electrolysis.
- When electricity is passed through an aqueous solution of NaCl (c/d brine), it decomposes to form sodium hydroxide (NaOH).
- This process is called **"Chlor–alkali process"** because chlor for chlorine & alkali for base(NaOH)

$$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$$

- At anode : Cl_2 gas
- At Cathode : H_2 gas
- Near cathode : NaOH solution is formed

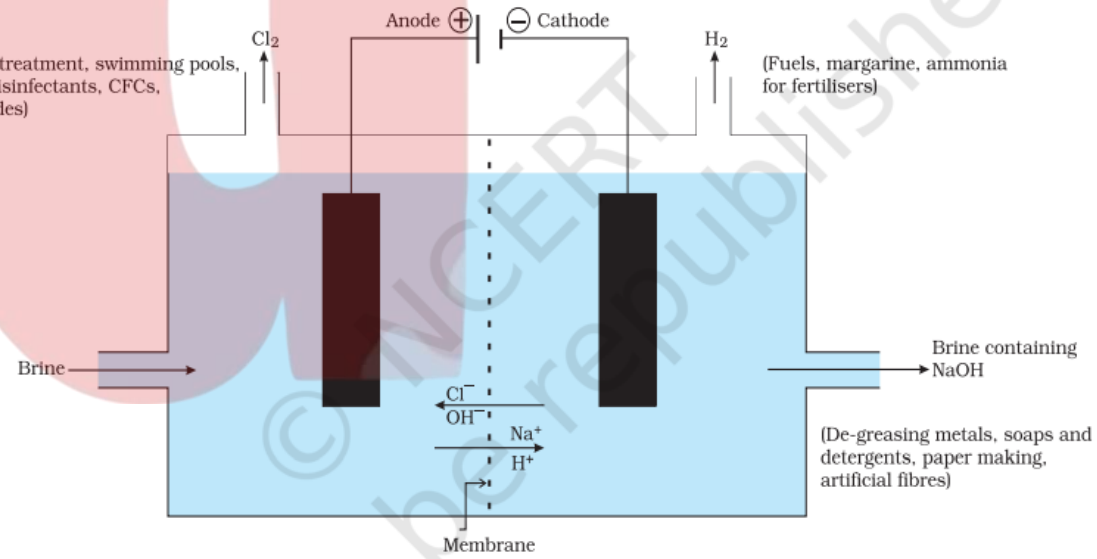


Figure 2.8 Important products from the chlor-alkali process

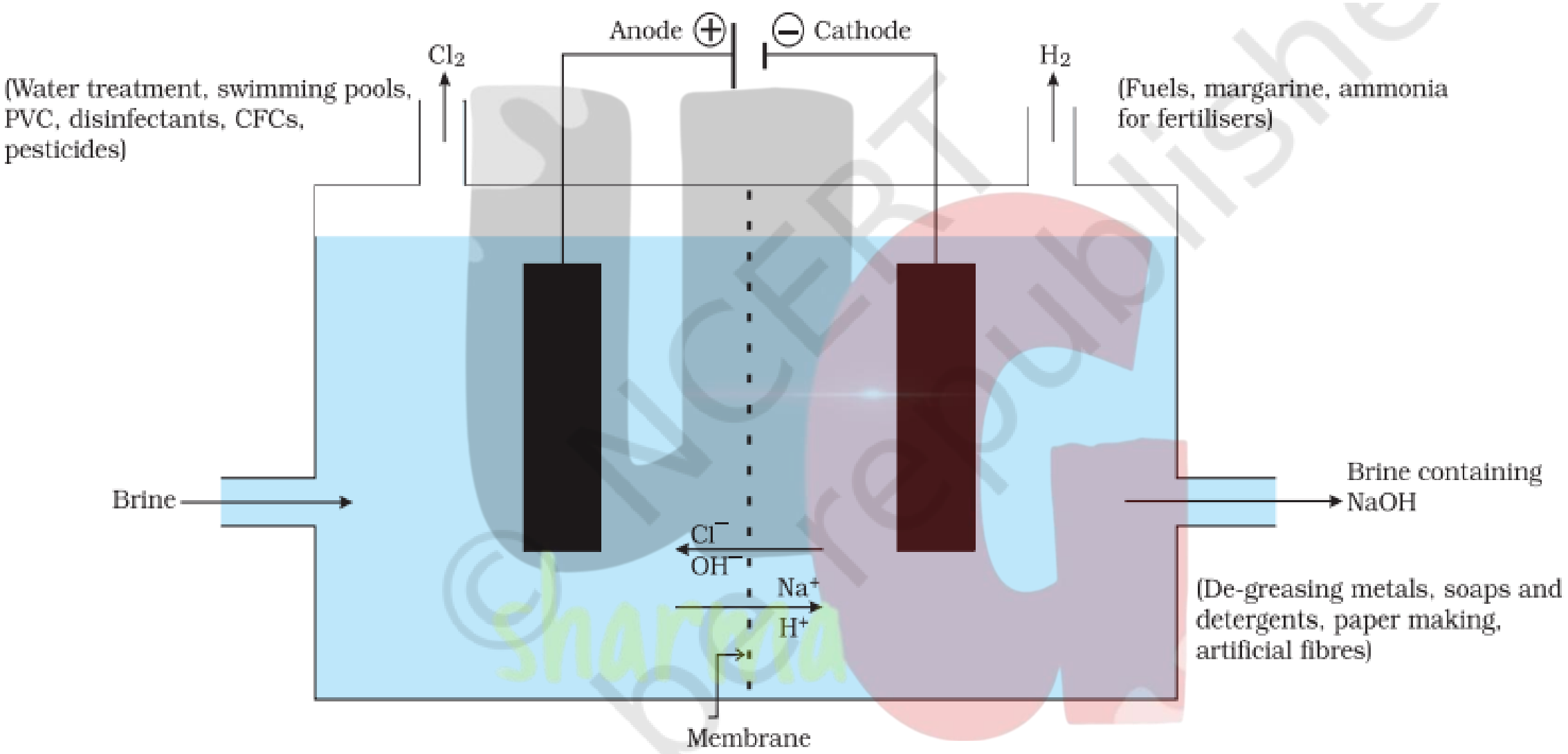


***Figure 2.8** Important products from the chlor-alkali process*

Uses :~

- H_2 :~ Fuel , margarine (Dalada), ammonia for fertiliser
- Cl_2 :~ Water treatment , swimming pools, PVC, disinfectants, CFCs, pesticides.

1. HCl :~ Cleaning steels, medicines

- NaOH :~ De-greasing metals, soaps & detergents, paper making, artificial fibres
- Cl_2 + NaOH :~ Bleach : Household bleaches , bleaching fabrics.

Questions :~

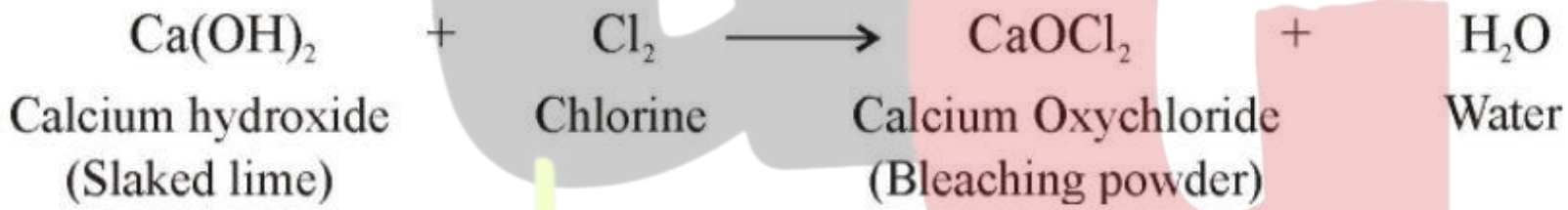
1. What is brine ?
2. What do you mean by chlor-alkali process ?
3. What happens at the anode and cathode during electrolysis?
4. Why is the process called the chlor-alkali process?
5. What are the products of the chlor-alkali process?

02. Bleaching powder ($CaOCl_2$)

- Chemical name :- **Calcium oxychloride**
- It is also known as **chloride of lime**.

Preparation :-

- It is produced by the action of chlorine (produce during preparation of caustic soda) on dry slaked lime [$Ca(OH)_2$].



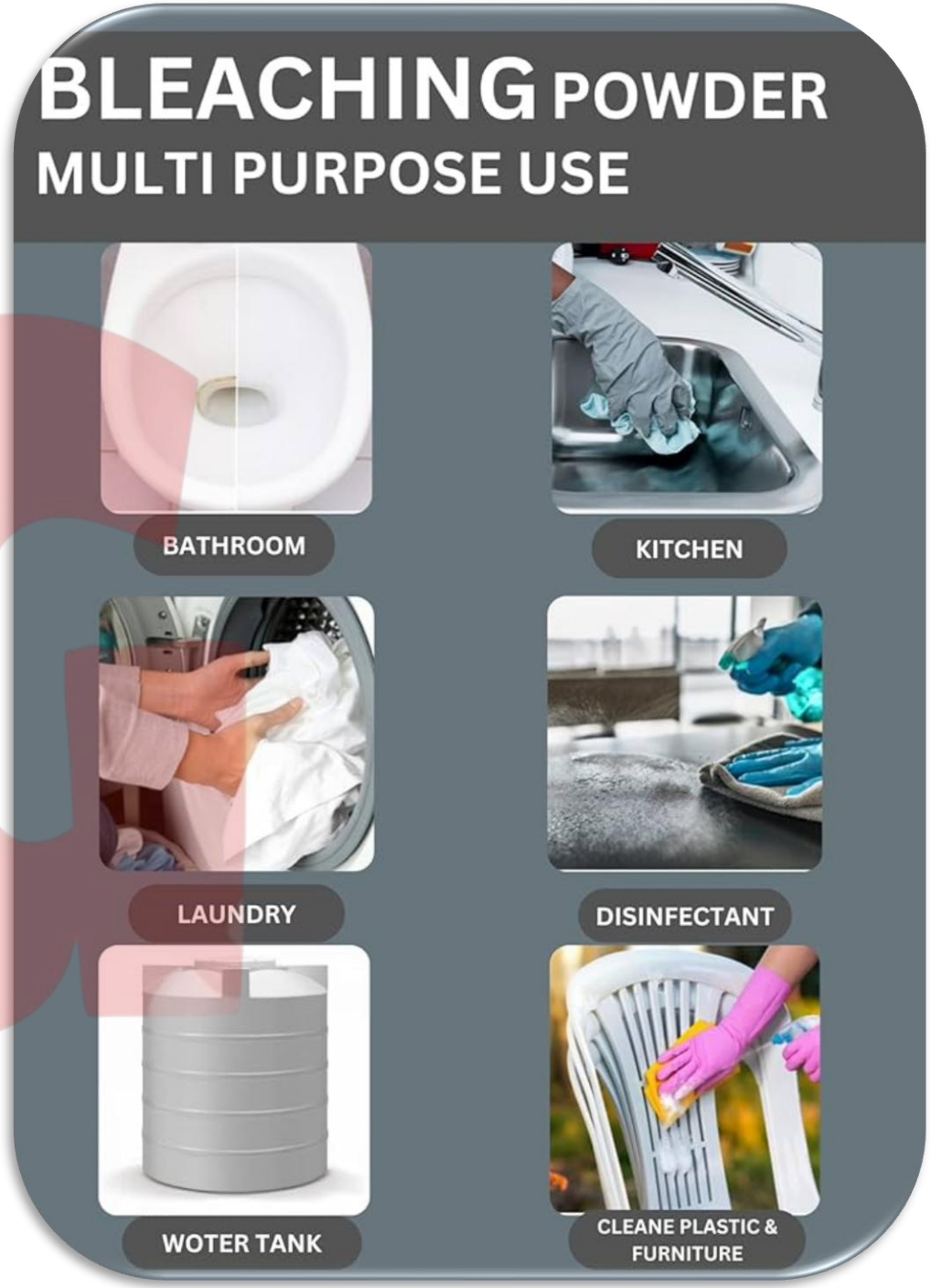
Note :~

- Bleaching powder reacts with dilute acids to produce chlorine.
- The real bleaching agent present in bleaching powder is chloride.

Uses :-

- Bleaching cotton and linen in the textile industry
- Bleaching wood pulp in paper factories
- Bleaching washed clothes in laundry
- Oxidizing agent in chemical industries
- Disinfecting drinking water.

Bleaching powder used in swimming pool cleaning



03. Baking Soda ($NaHCO_3$)

- The chemical name of the compound is sodium hydrogencarbonate (NaHCO3).
- Commonly used in the kitchen for making tasty crispy pakoras, etc.
- Sometimes it is added for faster cooking.

Preparation :-

- It is produced using sodium chloride as one of the raw materials.

$$\underset{\text{Sodium Chloride (Common salt)}}{NaCl} + \underset{\text{Ammonia}}{NH_3} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbon dioxide}}{CO_2} \longrightarrow \underset{\text{Sodium Hydrogen-Carbonate (Baking soda)}}{NaHCO_3} + \underset{\text{Ammonium chloride}}{NH_4Cl}$$

- It is a mild non-corrosive basic salt.
- The following reaction takes place when it is heated during cooking

$$\underset{\text{Sodium Hydrogen-Carbonate (Baking soda)}}{2NaHCO_3} \xrightarrow{\text{Heat}} \underset{\text{Sodium Carbonate}}{Na_2CO_3} + \underset{\text{Carbon dioxide}}{CO_2} + \underset{\text{Water}}{H_2O}$$

Uses :-

- For making baking powder which is mixture of baking soda & edible acid as tartaric acid. When baking powder is heated or mixed with water CO_2 is produced which causes bread and cake to rise making them soft and spongy.

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

(From any acid)

- As ingredient in antacid.
- It neutralizes excess acid in the stomach.
- Used as soda-acid fire extingishers.

04. Washing Soda ($Na_2CO_3.10H_2O$)

- It is basic salt and chemical name is sodium carbonate decahydrate

Preparation :-

- Recrystallization of sodium carbohydrate (obtained from heating baking soda) gives washing soda

$$\underset{\text{Baking Soda}}{2NaHCO_3} \longrightarrow \underset{\text{Sodium carbonate}}{Na_2CO_3} + \underset{\text{Carbon dioxide}}{CO_2} + \underset{\text{Water}}{H_2O}$$

$$\underset{\text{Anhydrous sodium carbonate(Soda ash)}}{Na_2CO_3} + 10H_2O \xrightarrow{\text{Recrystallisation}} \underset{\text{Washing soda}}{Na_2CO_3.10H_2O}$$

Properties :-

Transparent , alkaline , soluble in water..

Uses :-

- Used in glass, soap and paper industries.
- It is used in the manufacture of sodium compounds such as borax.
- Used as a cleaning agent for domestic purposes.
- Used for removing permanent hardness of water.

05. Plaster of Paris ($CaSO_4.\frac{1}{2}H2O$)

- Commonly known as P.O.P
- Chemical name is “calcium sulphate hemihydrate”.

Preparation :-

- On heating gypsum ($CaSO_4$) at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate (P.O.P)

$$\underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow{373\ K} \underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + \frac{3}{2}H_2O$$

- It is not possible to have a half molecule of a water. The actual formula is $2CaSO_4H_2O$, one $CaSO_4$ unit comes to half molecule of water.
- It is white powder and on mixing with water it changes to gypsum.

$$\underset{\text{(Plaster of Paris)}}{CaSO_4 \cdot \frac{1}{2}H_2O} + 1\frac{1}{2}H_2O \rightarrow \underset{\text{(Gypsum)}}{CaSO_4 \cdot 2H_2O}$$

Uses :-

- Doctors use P.O.P for supporting fractured bones
- For making toys, materials for decorations
- For making surfaces smooth.

Water of Crystallisation

The water molecules which form part of structure of a crystal (of a salt) are called water of crystallization.

or

Water of crystallization refers to water molecules that are chemically bound within the crystal structure of a compound.

Hydrated Salt :- Salts that contain water of crystallization are called hydrated salts.

Example :- $CuSO_4 5H_2O$ has 5 molecule of water

$Na_2CO_3.10H_2O$ has 10 molecule of water

$CaSO_4.2H_2O$ has 2 molecule of water

$FeSO_4.7H_2O$ has 7 molecule of water

❖ Due to presence of water in $CuSO_4 5H_2O$ is blue, $FeSO_4.7H_2O$ is green and $CaSO_4.2H_2O$ & $Na_2CO_3.10H_2O$ are white

WATER OF CRYSTALLIZATION

❖ When hydrated salts are heated strongly , they lose their water crystallization cause in lose of their regular shape & colour

$$CuSO_4.5H_2O \xrightarrow{heat} CuSO_4 + 5H_2O$$

Hydrated copper sulphate (Blue) → Anhydrous copper sulphate (White) + Water (Goes away)

Anhydrous copper sulphate turns blue on adding water.

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4.5H_2O$$

Anhydrous copper sulphate (White) + Water → Hydrated copper sulphate (Blue)

Washing Soda

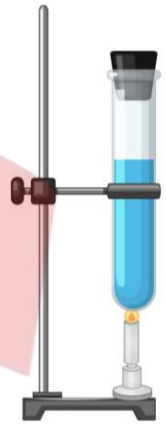
$Na_2CO_3.10H_2O$

Gypsum

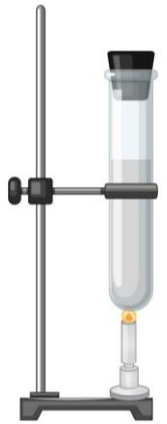
$CaSO_4.2H_2O$

Copper Sulphate Pentahydrate

$CuSO_4.5H_2O$



Hydrated Salt copper (II) sulfate pentahydrate $CuSO_4.5H_2$



Anhydrous Salt copper (II) sulfate $CuSO_4$

Blue vitriol	$CuSO_4.5H_2O$
Glauber's salt	$Na_2SO_4.10H_2O$
Gypsum	$CaSO_4.2H_2O$
Green vitriol	$FeSO_4.7H_2O$
White vitriol	$ZnSO_4.7H_2O$
Epsom salt	$MgSO_4.7H_2O$

Acidity of a base

- The acidity of a base refers to the number of hydroxyl ions (OH-) that a base can produce in an aqueous solution.

Base	No. of OH^-	Basicity
NaOH	1	Monoacidic
KOH	1	Monoacidic
$Ca(OH)_2$	2	Diacidic
$Al(OH)_3$	3	Triacidic

QUESTIONS

1. What is the common name of the compound $Ca(ClO)_2$?
2. Name the substance which on treatment with chlorine yields bleaching powder.
3. Name the sodium compound which is used for softening hard water.
4. What will happen if a solution of sodium hydrocarbonate is heated? Give the equation of the reaction involved.
5. Write an equation to show the reaction between Plaster of Paris and water.

EXERCISES

1. A solution turns red litmus blue, its pH is likely to be

   (a) 1 (b) 4 (c) 5 (d) 10

2. A solution reacts with crushed egg-shells to give a gas that turns lime-water milky. The solution contains

   (a) NaCl (b) HCl (c) LiCl (d) KCl

3. 10 mL of a solution of NaOH is found to be completely neutralised by 8 mL of a given solution of HCl. If we take 20 mL of the same solution of NaOH, the amount HCl solution (the same solution as before) required to neutralise it will be

   (a) 4 mL (b) 8 mL (c) 12 mL (d) 16 mL

4. Which one of the following types of medicines is used for treating indigestion?

   (a) Antibiotic

   (b) Analgesic

   (c) Antacid

   (d) Antiseptic

5. Write word equations and then balanced equations for the reaction taking place when –

   (a) dilute sulphuric acid reacts with zinc granules.

   (b) dilute hydrochloric acid reacts with magnesium ribbon.

   (c) dilute sulphuric acid reacts with aluminium powder.

   (d) dilute hydrochloric acid reacts with iron filings.

6. Compounds such as alcohols and glucose also contain hydrogen but are not categorised as acids. Describe an Activity to prove it.

7. Why does distilled water not conduct electricity, whereas rain water does?

8. Why do acids not show acidic behaviour in the absence of water?
9. Five solutions A,B,C,D and E when tested with universal indicator showed pH as 4,1,11,7 and 9, respectively. Which solution is
   (a) neutral?
   (b) strongly alkaline?
   (c) strongly acidic?
   (d) weakly acidic?
   (e) weakly alkaline?

   Arrange the pH in increasing order of hydrogen-ion concentration.
10. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid (HCl) is added to test tube A, while acetic acid (CH_3COOH) is added to test tube B. Amount and concentration taken for both the acids are same. In which test tube will the fizzing occur more vigorously and why?
11. Fresh milk has a pH of 6. How do you think the pH will change as it turns into curd? Explain your answer.
12. A milkman adds a very small amount of baking soda to fresh milk.
   (a) Why does he shift the pH of the fresh milk from 6 to slightly alkaline?
   (b) Why does this milk take a long time to set as curd?
13. Plaster of Paris should be stored in a moisture-proof container. Explain why?
14. What is a neutralisation reaction? Give two examples.
15. Give two important uses of washing soda and baking soda.

sharma