ACID, BASES AND SALTS

• One hundred and fifteen different element known to be present. these elements combine to form compounds.

• on the basis of their chemical properties, all the compound can be classify into three groups-

• Acid • Bases • Salts.

• What is Indicator?

• An indicator is a 'dye' that changes colour when it is put into acid or base.

• Indicator tellus whether the substance we are testing are acid or base by changing its colour.

• 3 most common indicators -

• Litmus • Methyl orange • Phenolphthalein

• Litmus can be used in the form of litmus solution or litmus paper.

• Two types - 1. Blue litmus 2. Red litmus

• An acid turns blue litmus to red.

• An Base (or alkali) turns red litmus to blue.

• So, it is a convenient way to find out whether a solution is acidic or basic is to test it with litmus and observe the change in colour which takes place.

a. If a drop of the given solution turns blue litmus to red then given sol. will be acidic in nature.

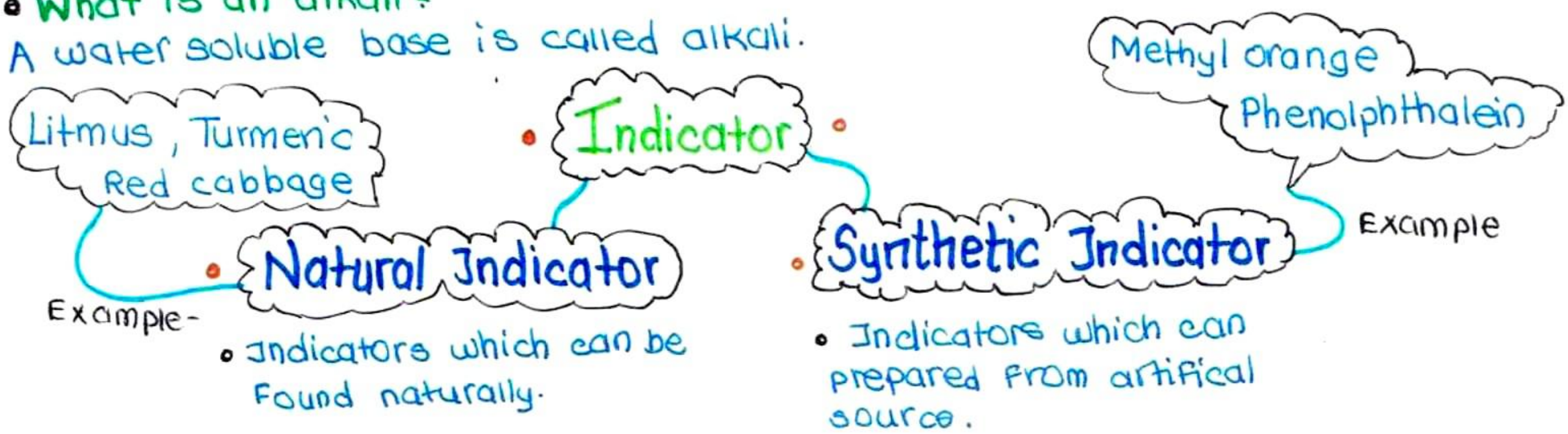
For ex- Orange juice turns blue to red litmus, so orangejuice is acidic in nature. That is, orange juice contains an acid.

b. If a drop of the given solution turns red litmus to blue then given solution will be basic in nature.

For ex- NaOH solution (caustic soda solution) turns red litmus to blue, so sodium hydroxide solution is basic in nature. therefore NaOH is a base.

• What is an alkali?

A water soluble base is called alkali.



- The colour change which takes place in methylorange are as follows -

1. Indicator gives red colour in acid solution.
2. Indicator gives yellow colour in basic solution.

- The neutral colour of methyl orange is - Orange

- The colour change which takes place in phenolphthalein are as follows -

1. Phenolphtalein indicator is colourless in acid solution.
2. Phenolphtalein indicator gives pink colour in basic solution

- What is universal indicator?
- Acid - base indicator is called universal indicator.
- It is a PH indicator made of a solution of several compounds that exhibit several smooth colour changes over a wide range PH value
- It indicate the acidity or alkalinity of solutions.

- Litmus -
- It is a natural indicator.
- Litmus solution is a purple dye which is extracted from a type of plant called lichen. (Belong to division Thallophyta)
- Acidic - Red
- Basic - Blue

- Red Cabbage -
- It is also an natural indicator.
- Acidic - Red
- Basic - Green
- **Hydrangea** - a flowering plant which are usually blue which turns pink in presence of a base.

- Olfactory indicators -
- The term 'olfactory' means 'relating to the sense of smell'.
- Those substance whose smell (or odour) changes in acidic or basic solutions are called olfactory indicators.
- Examples - onion and vanilla extract.
- Principle of indicator - work on the principle that when an acid or base is added to it, then its characteristic smell, cannot be detected.

- ACIDS -
- Acids are those chemical substance which are having a sour taste.
- Acids change the colour of blue litmus to red litmus.
- common fruits contain acids - Raw mango, raw grapes, lemon, orange and tamarind are sour in (acid) taste due to presence of acid.
- soured milk or curd also contain acid (LAB bacteria)

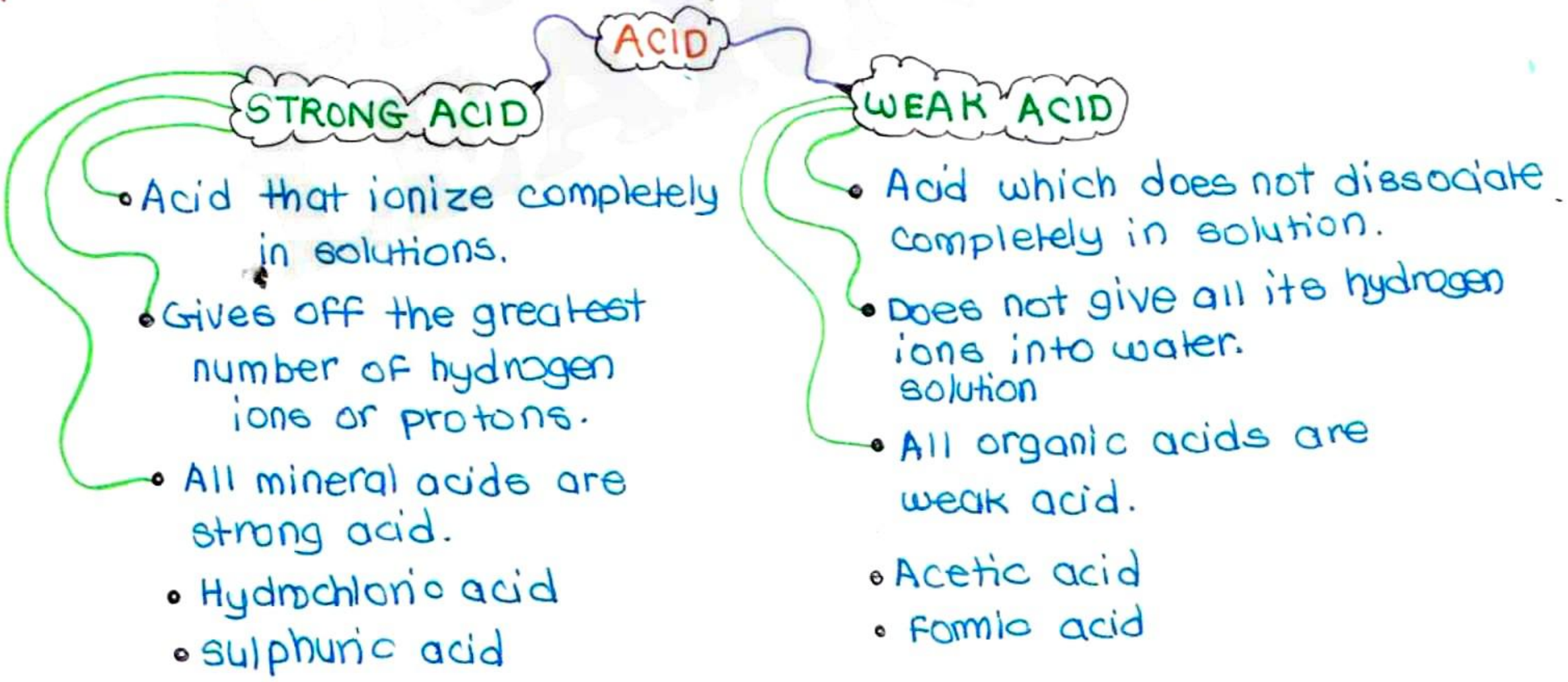
- **Organic acids**- These are weak acids.
- The acids present in plant materials and animals are called organic acids.
- some organic acids - Acetic acid, lactic acid, citric acid, Tartaric acid Oxalic Acid and Formic acid.

ORGANIC ACID		NATURAL SOURCE
Acetic acid	→	vinegar (sirka)
Citric acid	→	citrus Fruit
Lactic acid	→	sour milk or curd.
Tartaric acid	→	Tamarind and grapes
Oxalic acid	→	Tomato
Formic acid (Methanoic acid)	→	Ant sting and Needle leaf sting

- It is not hamful to eat or drink substance containing naturally occuring acid in them.

- **Mineral acids**- (strong acid)
- The acids prepared From the minerals of the earth. These are man-made acids.
- common acids - Hydrochloric acid, sulphuric acid, Nitric acids and carbonic acids.(weak acid)

★



- **Uses of Acids**-
  - Acetic acid- making pickles and tomato ketchup.
  - Tartaric acid- Baking powder.
  - Carbonic acid- Fizzy softdrink and soda water.

★ - Exception

- Concentrated and Dilute acids -
- A concentrated acid which contains the minimum possible amount of water in it.

"• concentration of acid is decreased by adding more water"

- A dilute acid is one which contains much more of water in it.
- When concentrated acid is added to water, then dilute acid is formed.

★ While diluting an acid, why is it recommended that the acids should be added to water and not water to the acid? (2M)

- The process of mixing conc. acid with water is highly exothermic process (Heat producing).
- So when a conc. acid and water are mixed together, a large amount of Δ (Heat) is evolved.
- This heat changes some of the water to steam explosively which can splash the acid on our face or clothes and cause acid burns.
- Even glass container may break due to excessive heating.

- PROPERTIES OF ACID -

1. Acid are sour in taste.
2. Acid turns blue litmus to red.
3. Acid conducts electricity (They are electrolytes).

- The solutions of all the acids conduct electricity, acid solution allow electric current to pass through them.

4. Acids react with metals to form hydrogen gas.

- ★ Metal + Acid ⟶ Salt + Hydrogen gas

Example - When dilute sulphuric acid react with zinc metal, then zinc sulphate and hydrogen gas are formed -

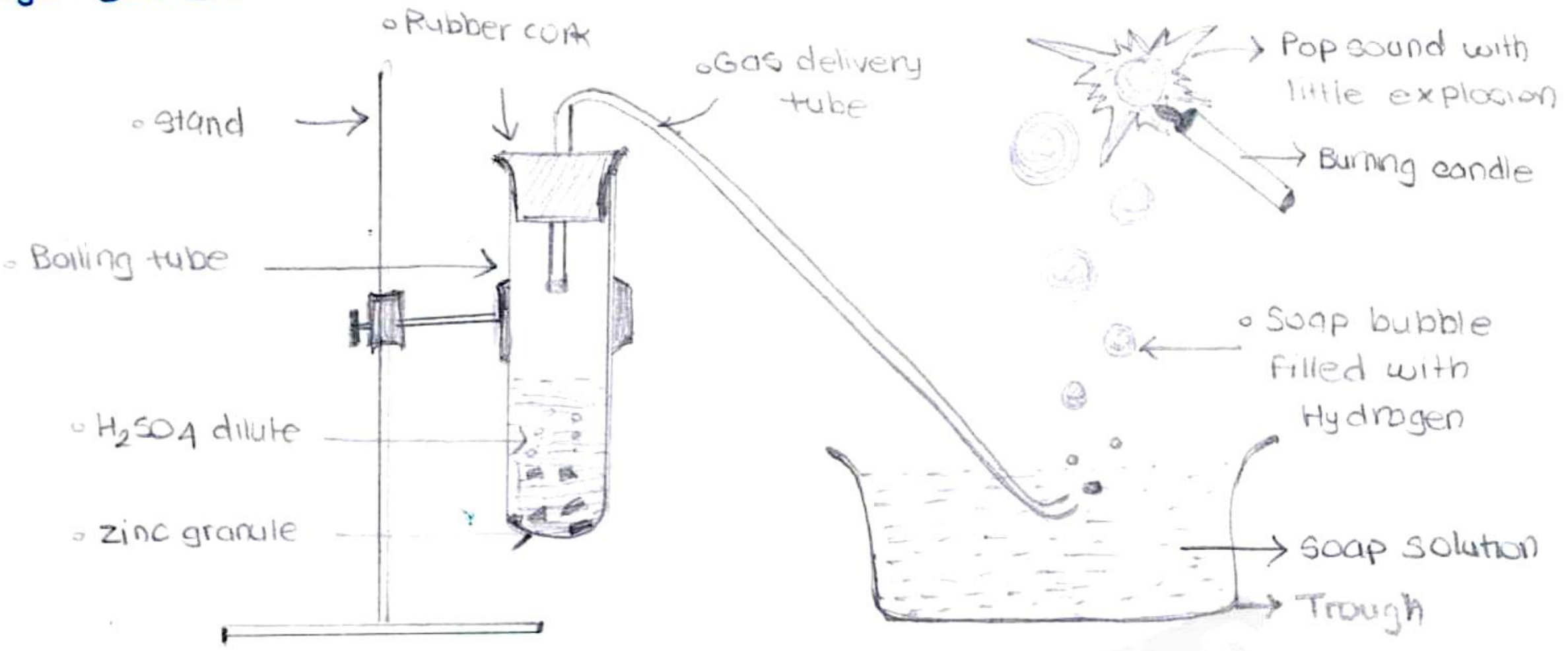
$$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

Zinc (A metal) + Sulphuric acid (Dilute) ⟶ Zinc sulphate (A salt) + Hydrogen

- Most of the acids reacts with metal to form salt and evolve H_2 gas.

- Experiment -
- Take a few pieces of zn granules in a boiling tube and add about 5ml of dil. H_2SO_4 acid to it.
- Formation of gas bubble on the surface of zn granules.
- Pass the gas being formed through soap solution taken in a trough. Gas filled bubble are formed in the soap solution which rise into the air.
- Bring a burning candle near a gas-filled soap bubble. The gas present in soap bubble burns with a 'pop sound'.

- only hydrogen gas burns making a ' pop sound. The gas present in soap bubble burns and react with dilute sulphuric acid with zinc metal.
- Dilute hydrochloric acid reacts with zinc to form zinc chloride and hydrogen gas.



- Experiment to show the reaction of dil. H_2SO_4 acid with zinc.

- Why the curd and other sour food stuff should not be kept in metal vessel?
- The curd and other food stuff should not be kept in metal vessels such as copper vessels because curd contains acids which react with metal of vessel to form poisonous metal compound which can cause food poisoning and damage to health.

5. Acid react with metal carbonate (and metal hydrogencarbonate) to form CO_2 gas.

- Metal carbonate + Acid ⟶ Salt + carbondioxide + water
- Metal hydrogencarbonate + Acid ⟶ Salt + carbondioxide + water

- Example - 1. When dilute hydrochloric acid reacts with sodium carbonate, then sodium chloride, carbon dioxide and water are formed.

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

sodium carbonate hydrochloric acid sodium chloride carbondioxide water

- The carbondioxide gas is formed of Brisk effervescence (the rapid escape of small bubbles of gas from the liquid.

- Example 2 - The carbon dioxide gas reacts with lime water (calcium hydroxide)

- $Ca(OH)_2(s) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$

calcium hydroxide (lime water) carbondioxide calcium carbonate (white ppt.) water

- The lime water turns milky when CO_2 is pass to form $CaCO_3$

b. If excess of carbon dioxide gas is passed through lime water, then the white precipitate formed first dissolves due to the formation of soluble salt calcium hydrogen carbonate.

- $CaCO_3(s) + CO_2(g) + H_2O(l) \longrightarrow Ca(HCO_3)_2(aq)$

Calcium carbonate (White ppt) | Carbondioxide | water | Calcium hydrogen carbonate (soluble in water)

- If someone is suffering from the problem of acidity after over eating why it is recommended to take baking soda as a remedy? (2M)

- This is because baking soda is sodium hydrogen carbonate which react with excess hydrochloric acid in the stomach and neutralises it. This give relief to the person suffering from acidity.

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

Sodium hydrogen carbonate | Hydrochloric acid | sodium chloride | carbon dioxide | water

- **Why is carbon - dioxide gas used to extinguish fire?**
- It is because carbon dioxide does not support combustion. When sprayed on burning object it stops the supply of oxygen and extinguish fire.

6. Acids react with bases (or alkali) to form salt and water –

- Acid + Base $\longrightarrow$ Salt + Water
- Actually here, when acid is treated with a base, the base neutralises the acid and destroy its acidity.
- Neutralisation reaction -
- The reaction between an acid and base to form salt and water is called Neutralisation reaction.
- Example-
  - $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$

Sodiumhydroxide | Hydrochloric acid | sodium chloride | water

- This is an example of neutralisation reaction. Here NaCl is neutral.
- Experiment of neutralisation reaction -
- we will use phenolphthalein solution as indicator in this experiment.
- The solution is a colourless indicator which gives pink colour in basic solution (or alkaline solution).
- Phenolphtalein indicator remains colourless in acidic solution as well as in neutral solution.
- Take about 5 ml of dilute NaOH solution in test tube. Add 2 or 3 drops of phenolphthalein indicator, the solution will turn pink.
- Add dilute HCl to the above sodium hydroxide solution dropwise and shake the test tube after addition.

- Now add a few drops of sodium hydroxide solution to above colourless mixture.
- The mixture becomes pink in colour, that is, the phenolphthalein indicator change it colour from colourless to pink, these is bcoz after adding a few drops of NaOH solution, the reaction mixture become basic again.

7. Acid reacts with metal oxide to form salt and water -

- Metal oxide + Acid ⟶ Salt + Water

- copper oxide(II) is a metal oxide, Dil. HCl react with ~~water~~ copper oxide (II) to form copper(II) chloride and water.

- $CuO_{(s)} + 2HCl_{(aq)} \longrightarrow CuCl_{2(aq)} + H_2O_{(l)}$

copper(II) oxide (Black) | Hydrochloric acid | copper(II) chloride (Bluegreen) | water

- These reaction between acid and metal oxide to form salt and water is similar to the neutralisation reaction.
- Note - It shows the basic nature of metal oxidees.

8. Acid reacts with metal hydroxide to form salt and water -

- Metal hydroxide + Acid ⟶ Salt + Water
- It also shows the neutralisation reaction.
- A substance X which is used as antacid reacts with dil HCl to produce a gas Y which used in one type of fire extinguisher. Name the substance X and gas Y. Write a balanced equation for chemical rx which takes place? (2M/3M)

- The substance 'X' which used to as antacid is sodium hydrogen carbonate ($NaHCO_3$). and 'Y' gas is carbondioxide.
- The antacid is called 'Milk of Magnesia which is used to remove indigestion. (caused by too much hydrochloric acid in the stomach).
- Magnesium hydroxide is basic in nature. It reacts with HCl acid present in the stomach and neutralises it.

- $NaHCO_{3(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(s)} + H_2O_{(l)} + CO_2\uparrow_{(g)}$

Sodium hydrogen carbonate (Baking soda) "X" | Hydrochloric acid | Sodium chloride (Neutralises) | water | carbondioxide "Y"

- This is an example of metal hydroxide which react with acid to form a basic compound.

8. Acids have corrosive nature -

- The mineral acids causes severe burns on skin and attack and eat up material like cloth, wood, metal structure so they are corrosive in nature.
- Example - • conc. sulphuric acid • conc. hydrochloric acid • conc. nitric acid
- Example - If conc. sulphuric acid falls on skin, it cuts the holes in the cloth and skin and totally burns the surface and produce black spots.
- Why acids never stored in metal container because -
- Acids have corrosive nature, so they gradually corrode and eat up the metal container.
- Acid should always store in container made up of glass and ceramics because they are not attacked by acids.
- Note - The mineral acids are strong bases, a hazard sign are usually printed or mark on it.

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

a. NaCl b. HCl c. KCl d. LiCl

solution - The egg shell are made up of calcium carbonate and gas which turns lime water milky is carbondioxide. carbondioxide gas can be formed by the action of an acid solution on calcium carbonate. so, the solution contain HCl. (Option B)

- WHAT DO ALL ACIDS HAVE IN COMMON -
- All the acids have or contain hydrogen.
- An acids is a substance which dissociates (or ionises) on dissolving in water to produce hydrogen ions. [H^+ ions]
- When acid is dissolve in water, it seprates out as positively charge hydrogen ions.
- For example - An aqueous solution of hydrochloric acid to form hydrogen ions by dissociation.

$$HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$$

Hydrochloric acid — Hydrogen ion — chloride ion

- It is the presence of hydrogen ions in hydrochloric acid solution which makes it behave like an acid.

Note - Hydrogen ions do not exist as H ions in solution, they attach themselves to the polar water molecules to form hydronium ions H_3O.

$$H^+ + H_2O \longrightarrow H_3O^+$$

Hydrogen ion + water → Hydronium ion.

- A common thing in all the acids is that they produce hydrogen ions [H^+ ions] when dissolved in water.
- Acidic behaviour of an acid solution is due to presence of hydrogen ions in it.
- Hydrochloric acid (HCl) shows acidic character because it ionises in aq. solution to form hydrogen ions, H^+ along with (chloride ions)

$$HCL(aq) \longrightarrow H^+(aq) + Cl^-(aq)$$

- Acetic acid (CH_3COOH) shows acidic character because it ionises in aq. solution to produce hydrogen ions.

$$CH_3COOH(aq) \longrightarrow CH_3COO^-(aq) + H^+(aq)$$

Acetic acid

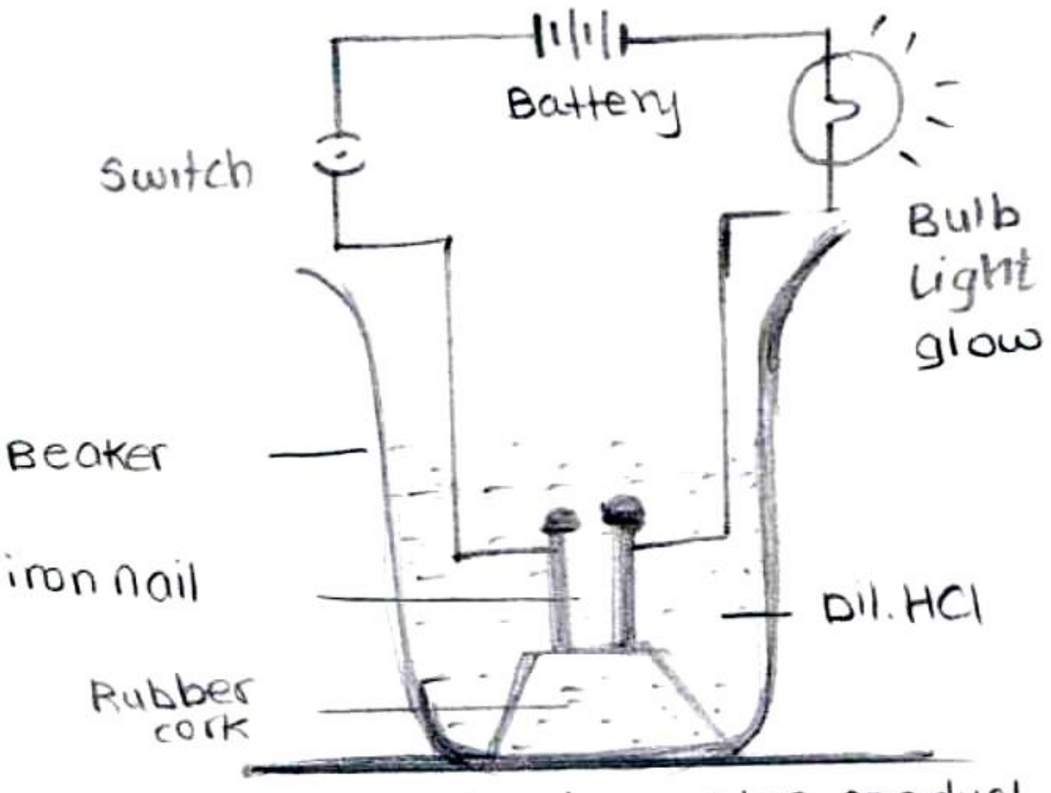
- Sulphuric acid (H_2SO_4) shows acidic character because it ionises in aq solution to give hydrogen ions.

$$H_2SO_4(aq) \longrightarrow 2H^+(aq) + SO_4^{2-}(aq)$$

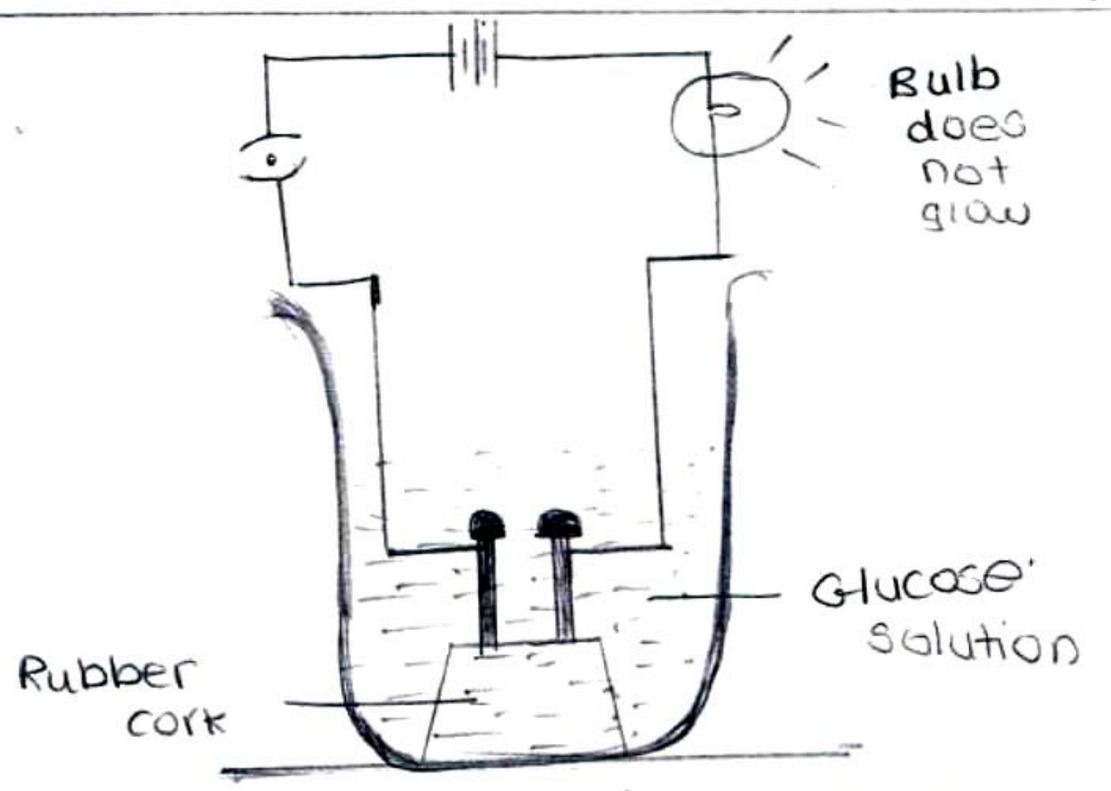
Que- Why the aqueous solution of glucose and alcohol do not show acidic character

- Because their hydrogen does not separate out as hydrogen ions [H^+ ion] on dissolving in water.
- The hydrogen containing compounds such as glucose and alcohol do'not behave as acids because they do not dissociate in water to produce H^+ ion.
- From this we conclude that though all the acids contain hydrogen, but all the hydrogen containing compound are not acids

- To show that all the compound containing Hydrogen are not acids -
- Take solution of HCl, SO_4^{2-}, glucose and alcohol, all these are hydrogen containing compound.
- Fix two iron nails on a rubber cork and place the cork in a beaker.
- Connect the nails to the two terminal of 6 volt battery through a switch and bulbs.
- Pour some dilute hydrochloric acid solution in the beaker and switch on the current. The bulb starts glowing. This shows that hydrochloric acid sol. taken in beaker conduct electricity. In fact, all the acid solutions conduct electricity.
- Let's us now take glucose solution in the beaker and switch on the current The bulb does not glow in the case. This shows that glucose does not conduct electricity, infact alcohol solution also does not conduct electricity.
- Due to the absence of ions glucose and alcohol solution do not conduct electricity.
- conclusion- we conclude that the hydrogen containing compounds such as glucose and alcohol are not categorised as acids because they do not dissociate in water to produce hydrogen ions.



a. HCl acid solution in water conduct electricity



b. Glucose solution in water does not conduct electricity.

Q. Why does distilled water not conduct electricity whereas rain water does?

- Distilled water does not conduct electricity because it does not contain any ionic compound (like acid, bases or salts) dissolved in it. and
- Rain water conduct electricity due to presence of carbonic acid in it. the rain water may also dissolve some or acids gases such as SO_2, NO_2 etc present in air to form acids which helps in conducting electricity.

Q. Why does an aqueous solution of an acid conduct electricity?

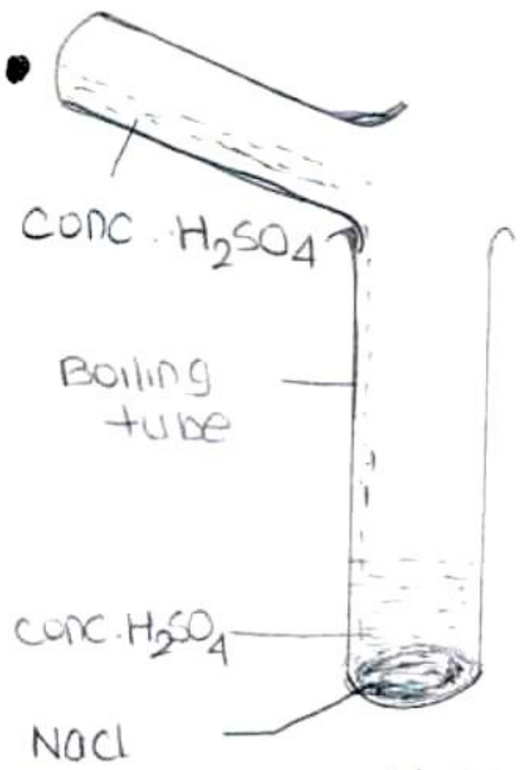
- The aqueous solution of an acid conducts electricity due to presence of charged particle called ions which are present in it.

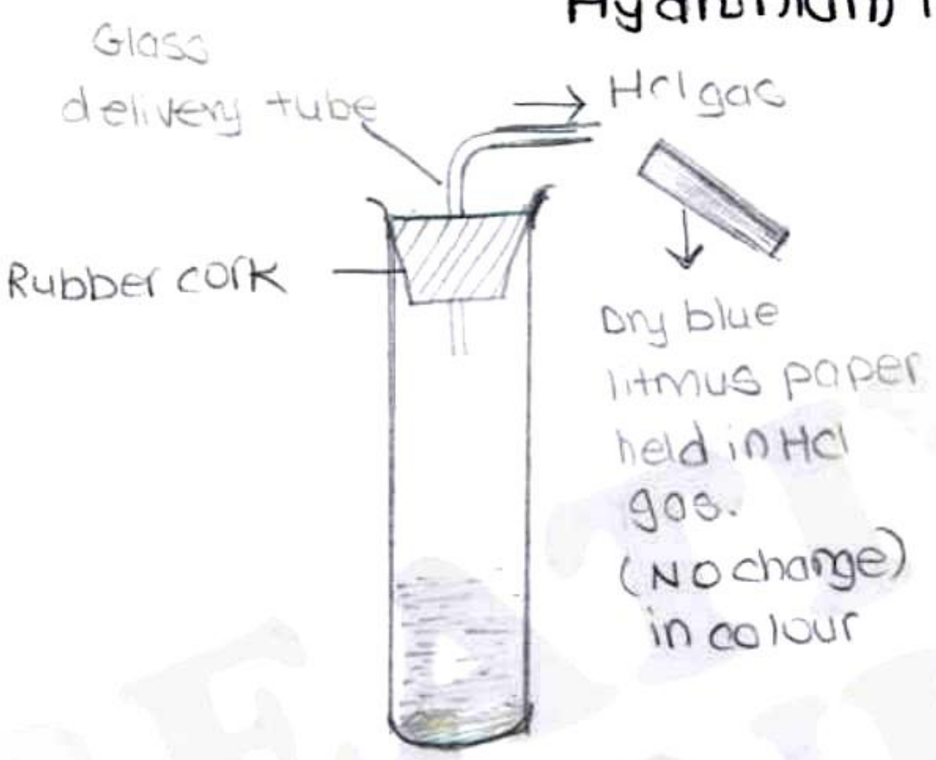
- Acids do not show acidic behaviour in Absence of water?
- The acidic behaviour of acid is due to the presence of hydrogen ions. The acids produce hydrogen ions only in the presence of water.
- In the absence of water, a substance will not form hydrogen ions and hence will not shaw its acidic behaviour.

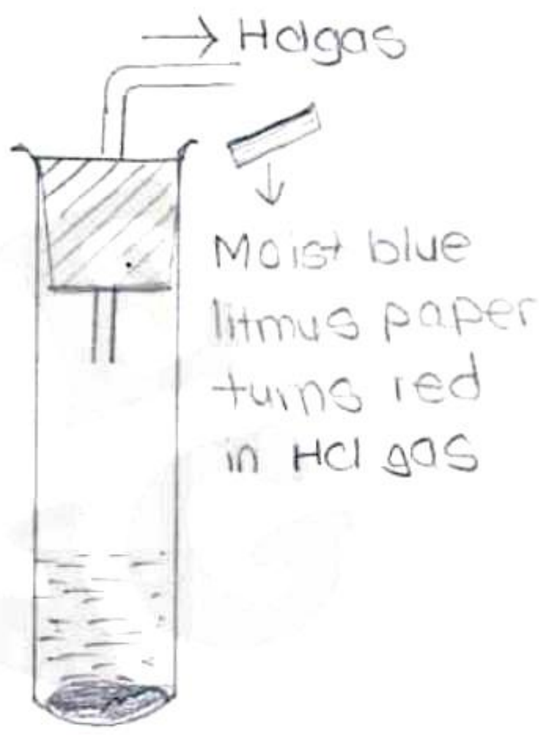
Experiment -

- Take about 1 g solid sodium chloride (NaCl) in a clean and dry boiling tube and add conc. sulphuric acid to it carefully. and fit the rubber cork over glass tube.
- conc. sulphuric acid reacts with sodium chloride to form hydrogen chloride gas. The hydrogen chloride gas starts coming out of the open end.
- Hold a 'dry' blue litmus paper in HCl gas. so there is no change in the colour of dry blue litmus paper. This shows that HCl gas does not behave as an acid in the absence of water.
- We now hold a 'moist' blue litmus paper in HCl gas. Now we will see that 'the moist' blue litmus paper to red. This shows that HCl gas show acidic behaviour in the presence of water.
- conculsion -

HCl gas does not show acidic behaviour in absence of water but it is shows acidic behaviour in presence of water.

- Why does dry HCl gas not change the colour of dry litmus paper?
- The dry HCl gas does not change the colour of dry blue litmus paper because it has no hydrogen ions [H^+ ions] in it.
- When Hcl gas dissolve in water, it form hydrogen ions and hence show acidic behaviour.
  - $HCl(g) \xrightarrow[\text{in water}]{\text{Dissolve}} H^+(aq) + Cl^-(aq)$
- The separation of H^+ ions from HCl molecule cannot occur in the absence of water, it only occurs in presence of water.
- Hcl gas reacts with water in which hydrogen ions written in the form of hydronium ions -
  - $HCl_{(g)} + H_2O_{(l)} \longrightarrow H_3O^+ + Cl^-$
    Hydronium ion
- 

a. Preparation of Hcl gas


b. Testing Hcl gas with dry litmus paper.


c. Testing Hcl gas with moist

• Strong Acids

- An acid which completely ionised in water and thus produce a large amount of hydrogen ions.
- Sulphuric acid (H_2SO_4) and nitric acid (HNO_3) are also strong acids because they are fully ionised in water to produce a large amount of Ht ions.
- Strong acids reacts with other subs. very rapidly.
- Strong acids also have a high electrical conductivity bcoz of high conc. of Ht ions in solution.
- All strong acids are strong electrolytes
- For example - Hcl completely ionised in water, so it is strong acid.

• Weak Acids

- An acid which is partially ionised in water and thus produces a small amount of hydrogen ions.
- Carbonic acid (H_2CO_3) and sulphurous acid (H_2SO_3) are also weak acids because they ionise partially in water to form a small amount of Ht ion.
- Weak acids reacts with other subs. very slowly.
- Weak acids also have a low electrical conductivity bcoz of the low conc. of Ht ions in solution.
- All weak acids are weak electrolyte.
- Acetic acid partially ionised in water, so it is weak acid.

• Uses of Mineral Acids in Industry -

- Sulphuric acid - Manufacture of fertilisers (like ammonium sulphate), paints dyes, chemicals, plastics, detergents.
- Nitric acid - Making fertilisers, explosive (like TNT - Trinitro Toluene)
- Hydrochloric acid - Removing oxide film from steel objects and removing 'scale' deposits from inside the boilers, dye stuffs, textile and leather industry.

• BASES •

- Bases are those chemical substance which have bitter taste.
- Bases are bitter in taste and soapy to touch.
- All the bases change the colour of red litmus to blue.
- Bases are the chemical opposite of acids. When bases are added to acids, they neutralise the effect of acids.
- All the metal oxides and metal hydroxide are bases.
- Metal carbonates and metal hydrogen carbonate are also considered to be base bcoz they neutralises the acids.
- Example - sodium carbonate (Na_2CO_3), calcium carbonate ($CaCO_3$) and sodium hydrogen carbonate ($NaHCO_3$) are also bases.

• Water Soluble Bases : Alkalis -

- A Base which is soluble in water is called Alkali. but most of the base do'nt dissolve in water but some bases dissolve in water.
- some common water soluble bases -
- sodium hydroxide (NaOH) • Potassium hydroxide (KOH) • calcium hydroxide ($CaOH_2$) • Magnesium hydroxide ($MgOH_2$)

Q. Why soluble bases are much more useful than insoluble bases?
- When the chemical reaction takes, it usually takes in aqueous solution so, the soluble bases are much more useful than insoluble bases.

• What All bases Have in common -

- A base is the substance which dissolve in water to produce hydroxide ions (OH^- ions) in solution.
- For example - Sodium hydroxide is a base because it dissolve in water to produce OH^- ions.

$$\underset{\text{sodium hydroxide (Alkali)}}{NaOH} \xrightarrow{\text{water}} \underset{\text{sodium ion}}{Na^+} + \underset{\text{Hydroxide ion}}{OH^-}$$

show basic behaviour due to presence of OH^- ion.

- Potassium hydroxide is a base which dissolve in water to give OH^- ions.

- $KOH(s) \longrightarrow K^+(aq) + OH^-(aq)$

Potassium hydroxide — potassium ions — Hydroxide ions.

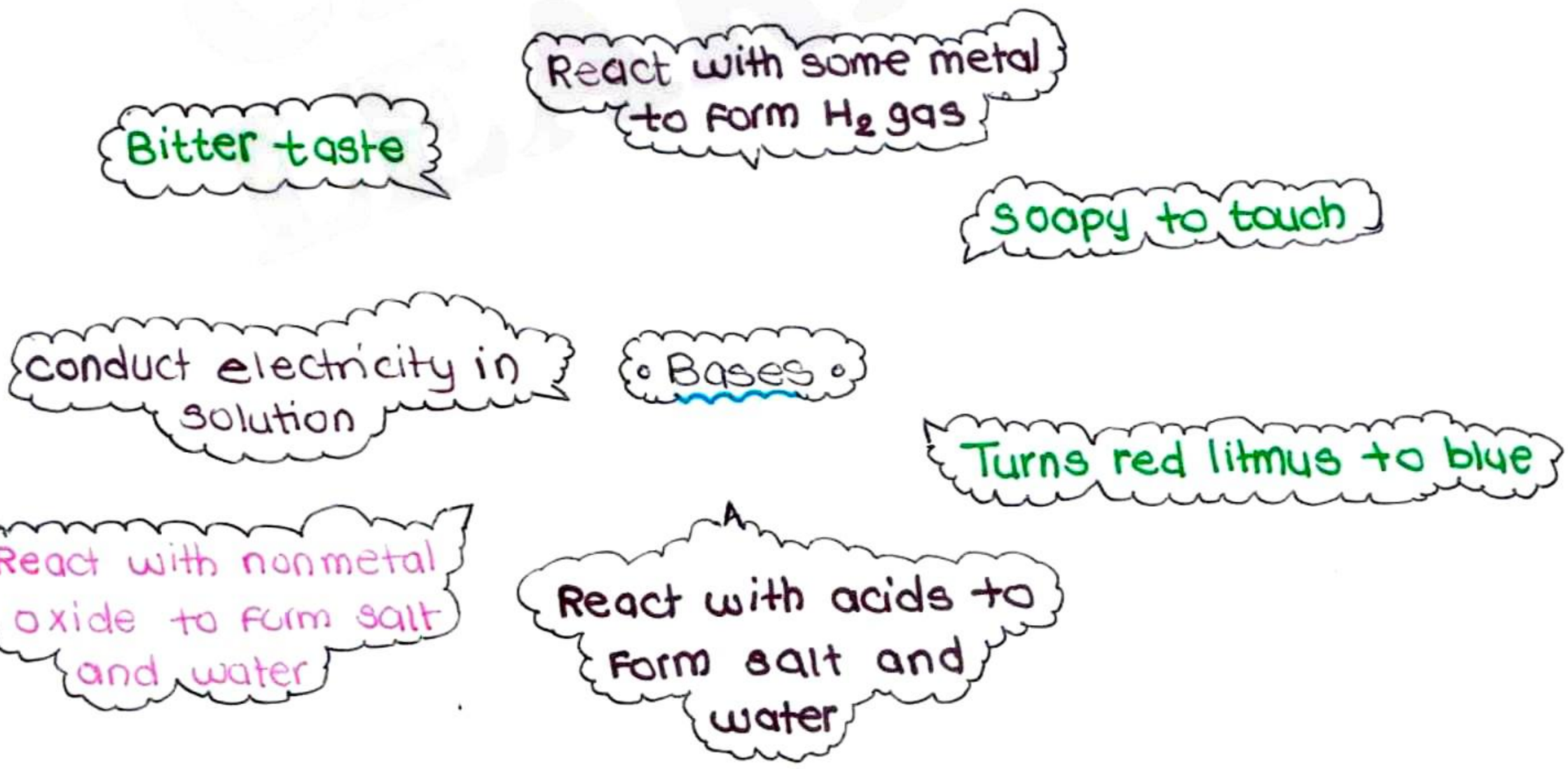
- Presence of OH^- ions indicates that it has basic or alkaline properties.

Note- When solution of a base is diluted by mixing more water in it, then the concentration of (OH^- ions) per unit volume decreases.

- **Strong Base-**
- A base which completely ionises in water and thus produce a large amount of (OH^- ions) is called strong base.
- Sodium hydroxide ($NaOH$) and potassium hydroxide (KOH) are strong base. bcoz they completely ionise on dissolving in water to produce a large amount of OH^- ions.

- **Weak Base -**
- A base which is partially ionised in water and thus produce a small amount of (OH^- ions).
- Ammonium hydroxide (NH_4OH), calcium hydroxide $Ca(OH)_2$ and Magnesium hydroxide ($Mg(OH)_2$) - dissolve in water to produce a small amount of OH^- ions.

- **Properties of Bases-**



- We will now discuss in detail-
- **Bases react with some metal to form hydrogen gas-**
- For example- When sodium hydroxide solution is heated with zinc, then sodium zincate and Hydrogen gas. are formed

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

- Note - All the metals do not react with basee to form salts and hydrogen gas.
- Bases reacts with acids to form salt and water-
- Ex - When sodium hydroxide reacts with sulphuric acid, then sodium sulphate and water are formed.

$$2NaOH(aq) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$$

Sodium hydroxide (Base) | Sulphuric acid | Sodium sulphate (salt) | Water

- This is an example of neutralisation reaction.
- When an acid and base combine then the real neutralisation reaction occurs due to the combination of hydrogen ions present in acid and hydroxide ions present in base to form water.

$$H^+(aq) + OH^-(aq) \xrightarrow[\text{reaction}]{\text{Neutralisation}} H_2O(l)$$

Hydrogen ion | Hydroxide ion | water

- Bases react with non metal oxides to form salt and water-
  - **Non-metal oxide + Base ⟶ Salt + Water**
- calcium hydroxide is base and carbon dioxide is a nonmetal oxide.
- calcium hydroxide solution reacts with carbondioxide to produce calcium carbonate and water-

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

calcium hydroxide | carbondioxide | calcium carbonate | water

- The non-metal oxide are acidic in nature.
- Uses of Bases -
- Sodium hydroxide - manufacture of soap, paper and rayon.
- Calcium hydroxide - also called slaked lime, manufacture of bleaching powder.
- Magnesium hydroxide - used as 'antacid' to neutralise excess acid in the stomach and cure indigestion.
- Sodium carbonate - used as washing soda and for softneing hard water
- sodium hydrogencarbonate - used as baking soda in cooking Food, as an antacid to cure indigestion and in soda acid fire extinguishers.

- Strength of acid and base solution - PH scale
- In 1909 Sorenson devised a scale (known as PH scale) on which the strength of acid solution as well as basic solution could be represent by making use of the hydrogen ion concentration.
- He linked the hydrogen ion concentration of acid and base solution to the simple number 0 to 14 on his PH scale.
-

$$\text{PH of Solution} \propto \frac{1 \text{ (inversely proportional)}}{\text{H+ ion concentration}}$$

- Solution has high concentration of hydrogen ions has low PH value.
- Solution has low concentration of hydrogen ions has high PH value.
- Term pH - p stands - 'Potenz' - means 'power'
  H stands - 'Hydrogen ion concentration' - $[H]^+$
- The strength of an acid or base is measured on a scale of numbers called PH scale.
-
  - Neutral substance - PH of exactly 7
  - Acidic solutions - PH of less than 7
  - Basic solutions - PH of more than 7
- Pure water is a neutral substance (it neither is acidic nor basic).
- Sugar solution and sodium chloride solution are also neutral.
- Neutral substance show no change in litmus paper.

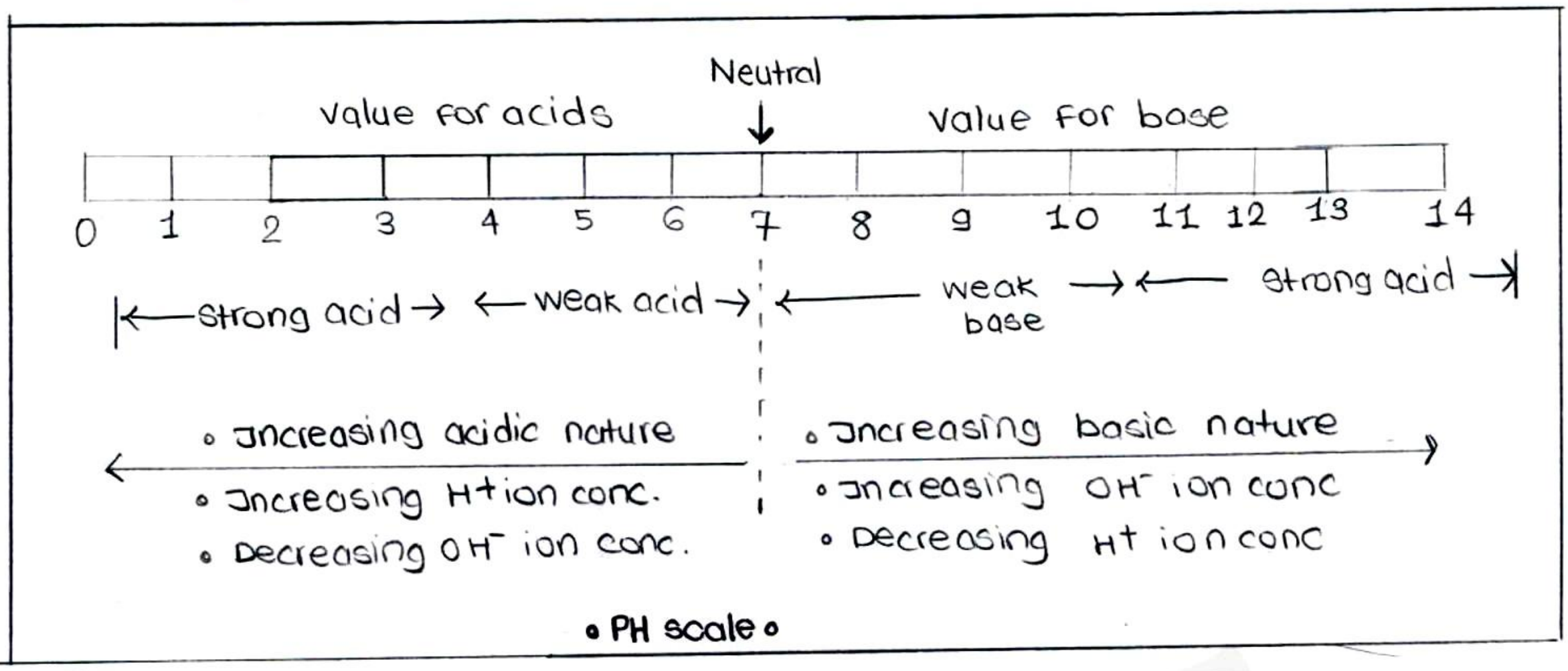
Note- More acidic a solution, lower will be its PH.

- Solution of PH 1 is much more acidic than another solution of PH 4
- Solution PH of 0, 1, 2 and 3 - strong acids — ACID —
- Solution PH of 4, 5 and 6 - weak acids

Note- solutions having PH less than 7 are acidic in nature, hence they turns blue litmus to red.

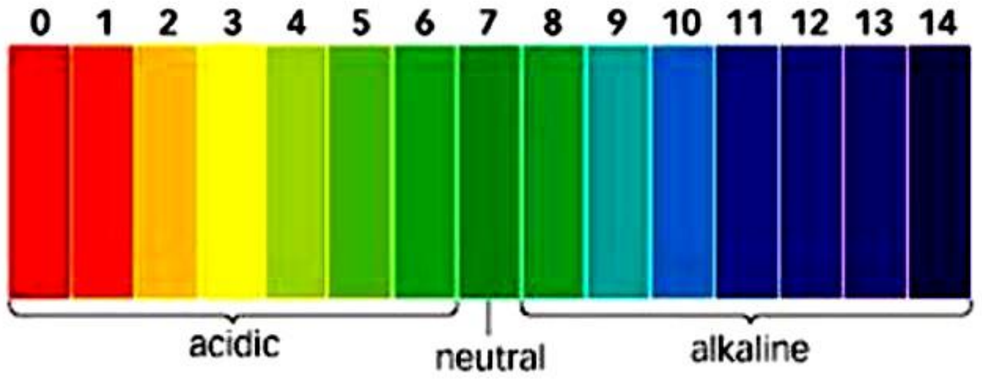
- Bases or basic solution have a PH more than 7.
- The more basic a solution is, the higher will be its PH.
- Solution PH of 8, 9, 10 - Weak bases — BASE —
- Solution PH of 11, 12, 13 and 14 - strong bases
- The higher the PH, the stronger the base.
- substance having PH more than 7 are basic in nature and they turns red litmus to blue.
- The PH of solution decreases from 7 to 0, the H+ ion concentration increases, strength also increases.

- The PH of solution increases from 7 to 14, the H+ion concentration in the solution goes on increasing, the strength of base also goes on increasing.



- Universal Indicator-
- It is a mixture of many different indicators which gives different PH value of entire PH scale.
- It is a common method of measuring the PH of solution.
- The indicator shows different colours at different conc. of H+ion.
- When an acid and base solution is added to the universal indicator, the indicator produces a new colour.
- The colour produced by indicator is used to find the PH value of acid or base solution by matching the colour chart.
- By these, we can make out whether the given solution is a strong acid, weak acid, strong base or weak base.
- common indicator-
- The indicator can tell us whether the given substance is an acid or base.
- The common indicator cannot tell us the relative strength of acid and base.

PH	colour	PH	colour	PH	colour
0	Dark red	6	Greenish yellow	13	Violet
1	Red	7	Green	14	Violet
2	Red	8	Greenish blue		
3	Orange red	9	Blue		
4	orange	10	Navy Blue		
5	Orange yellow	11	Purple		
		12	Dark Purple		



- Water will produce a green colour with universal indicator.
- For example - if on putting the drop of a solution on the universal indicator paper, the paper turns dark red, then PH will be around 0 and hence it is strong acid.
- When the colour will be orange, the PH will be 4 and will be weak acid.
- IMPORTANCE OF PH IN EVERYDAY LIFE - 3M|2M
- The PH plays an important role in many activites of our everyday life.

1. PH in Our Digestive system -

- Our stomach produces Hcl. This dil. Hcl help in digesting the food. without harming the stomach.
- sometimes excess of acids produce in stomach being by overeating cause indigestion which produce pain and irritation.
- Inorder to cure the indigestion, we can take bases like Antacid.
- Antacid are group of mild bases which do not have toxic effects on body.
- Being basic it react with Hcl and neutralises the effect of excess acid.

- common Antacids -

Magnesium hydroxide (Milk of magnesia)

sodium hydrogen carbonate (Baking soda)

Q. Explain the PH changes as the cause of tooth decay. How can tooth decay caused by PH change can prevented? (3M)

- When we eat food containing sugar, the bacteria present in our mouth break the sugars to form acids.
- Tooth decay form or starts when the PH of acid formed in the mouth falls below 5.5. bcoz of these strong acid, it is enough to attack the enamel of tooth and corrode it. This leads to tooth decay.
- Tooth enamel is made of calcium phosphate (which is hardest material) in our body, but starts getting corodded when PH is lower than 5.5.
- The best way to prevent tooth decay is to clean the mouth after eating food. (Prevention)
- using toothpaste which contain bases to neutralise the effect of tooth decay.

3. Plants and Animals are sensitive to PH changes-

- Soil PH and Plant growth- (2M) Reason Based
- Most the plants grow best when the PH of soil is close to 7.
- The soil PH is also affected by the use of chemical fertiliser. in the field.
- The PH of the acidic soil can reach as low as 4 and that of basic soil can go upto 8.3.
- chemical are added to the soil to make plants suitable for growth.
- If the soil is too acidic (having low PH) then it is treated with material like quicklime (CaO) or slaked lime ($Ca(OH)_2$) or chalk ($CaCO_3$)
- All the materials are bases they react with soil and decrease its acidity
- Thus a, farmer add quicklime, slaked lime or chalk in there fields to decrease the acidity.
- However, the soil is too basic having high PH, then it can be reduced by adding organic or decaying omatter which contain acidic material.

- PH change and survival of animals-
- The PH plays an important role in the survival of animals, including human beings.
- Our body works well in or within a narrow range PH- 7 to 7.8.
- Que- Explain how PH change in the lake water can endanger the lives of aquatic animals. What can be done to lessen the danger to life of aquatic animal in lake?
- The aquatic animals survive in the narrow range of PH value.
- When too much acid rain can lower the PH of the lake water to such extent that survival chances of the aquatic animal are being difficult. The PH of acid rain is about 5.6.
- The high acidity of lake water can kill the aquatic animals.
- To prevent these $CaCO_3$ is often added to acidic lake water to neutral the acid that comes from acid rain.
- Hence, these prevents the fish in the lake being killed.

- Self Defence by Animal and Plant through chemical warfare-

Q. What happens during a bee sting? what is its remedy?

- When a honey bee stings a person, it injects an acidic liquid into skin which causes immense pain and irritation.
- Remedy- Rubbing a base like baking soda over a sting area, which gives relief and neutralise the area and cancels its effect.

Q. What happens during a wasp sting? What its remedy?

- When wasp sting it injects an alkaline liquid into the skin.
- Remedy - Rubbing a mild acid like vinegar on the area of the skin gives relief, because being an acidic substance, ~~the~~ vinegar on the sting area neutrallees the effect.

Note - Bee sting is acidic in nature and wasp sting is basic in nature.

Q what happens during a ant sting? what its remedy?

- The ant sting injects the methanolc acid into the skin of person causing burning pain.
- Being acidic, an ant sting can be neutralised by rubbing a mild base like baking soda on the affected area.

Q. What happens during a nettle plant sting? what its remedy?

- When a person happens to touch the leaves of nettle plant, the stingning hair of nettle leaves inject methanoic acid into the skin of, causing buming pain.
- It can neutrallee by rubbing baking soda over the sting area, even a nature itself provided remedy for sting which is a dock plant.
- The dock plant contain some basic chemical in them which neutralises the sting

• SALTS •

- A salt is a compound formed from an acid by the replacement of Hydrogen in acid by a metal.
- Salts are formed when acids reacts with bases.
- Salts has two parents - an acid and an base
- The first part of the name of salt derived from the name of base.
- The second part of the name of salt comes from the name of acid.
- For example - The name of a salt called 'sodium chloride' comes from Sodium hydroxide base and HCl acid.
- The salts of 'hydrochloric acid' are called 'chlorides'.
- The salts of 'sulphuric acid' are called 'sulphate'
- The salts of 'nitric acid' are called 'nitrates'
- The salts of 'carbonic acid' are called 'carbonates'
- The salts of 'acetic acid' are called acetates.
- Salts are mostly solids, they are mostly high melting and boiling point.
- Salts are usually soluble in water and conduct electricity.
- Salts conduct ions electricity due to presence of ions in them.
- Salts are ionic compounds, every salts consist positively charge ion (cation) and negatively charge ion called anion.

- **Family of salts-**
- The salts having the same positive ions are said to belong to a family of salts.
- For example - sodium chloride ($NaCl$) and sodium sulphate (Na_2SO_4) belong to the same family of salts called sodium salts (because they both contain the same positively charged ions, sodium ions Na^+)
- Similiary - sodium chloride ($NaCl$) and potassium chloride (KCl) belong to the same family of salts called 'chloride salts'. (because they both contain the same negatively charged ions, chloride ions Cl^-)

- **Important family of salts -**
  - sodium salt
  - chloride salt
  - calcium salts
  - Magnesium salts
  - zinc salts
  - Aluminium salts
  - copper salts
  - carbonate salts

- **The PH of salt solutions -**
  The aq. solution of many salts are neutral, but some salts are produce acidic or basic solutions when dissolved in water.
- **The PH value of some of the salt solution -**

Salt solution	PH	Nature
Sodium chloride solution	7	Neutral
Ammonium chloride solution	6	Acidic
Sodium carbonate solution.	9	Basic

- The acidic and basic nature of some salt solution can be explained on basis of hydrolysis of salt.
- The salts of strong acids and weak bases gives acidic sol.-
- Example - Ammonium chloride (NH_4Cl) is salt of strong acid HCl and weak base ammonium hydroxide (NH_4OH), so an aqueous sol. of ammonium chloride is acidic in nature. (PH less than 7)
- When ammonium chloride is dissolved in water, it gets hydrolysed to form ammonium hydroxide and hydrochloric acid-

$$NH_4Cl(s) + H_2O(l) \underset{\text{Hydrolysis}}{\rightleftharpoons} NH_4OH(aq) + HCl(aq)$$

Ammonium chloride — Water — Ammonium hydroxide (weak base) — Hydrochloric acid (strong acid)

- Now, HCl acid is a strong acid which is fully ionised and gives a large amount of H^+ ions. and NH_4OH is a weak base due to OH^- ions.
- The salts of weak acids and strong bases give basic solutions -
- Example - sodium carbonate (Na_2CO_3) is the salt of a weak acid carbonic acid (H_2CO_3) and strong base sodium hydroxide ($NaOH$), so an aq. solution of Na_2CO_3 will basic in nature.

$$Na_2CO_3(s) + 2H_2O(l) \underset{\text{Hydrolysis}}{\rightleftharpoons} 2NaOH(aq) + H_2CO_3(aq)$$

Sodium carbonate — Water — Sodium hydroxide (strong base) — carbonic acid. (Weak acid)

• Now, sodium hydroxide is strong base which is fully ionised and gives a large amount of OH^- ions, other hand carbonic acid is weak acid which is only slightly ionised and gives H^+ ions.

• Common salt (Sodium chloride) -

• The common salt is a white powder which is used in preparing food, especially vegetable and pulses.

• common salt is also known as just 'salt'. chemical name of common salt is Sodium chloride (NaCl). it is a neutral salt.

• sodium chloride can be made in the laboratory by combination of NaOH and HCl.

• $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$

Sodium hydroxide — Hydrochloric acid — Sodium chloride (common salt) — Water

• The sodium chloride solution formed here can be evaporated to obtain solid sodium chloride salt.

• How common salt is obtained-

• common salt occure naturally in seawater and as rock salt. It occurs dissolved form in sea water. and occurs in solid form as rock salt.

• common salt from sea water-

• common salt is obtained from sea-water by the process of evaporation.

• Done as follows-

• Sea water is trapped in large, shallow pools and allowed to stand there.

• The sun's heat evapourates the water slowly and common salt left behind.

• This salt is impure because it has other salts which is mixed in it. and purified to form pure NaCl.

• common salts from Underground Deposit -

• The large crystals of common salt found in underground deposits are called Rock salt.

• Rock salt is usually brown due to the presence of impurties in it.

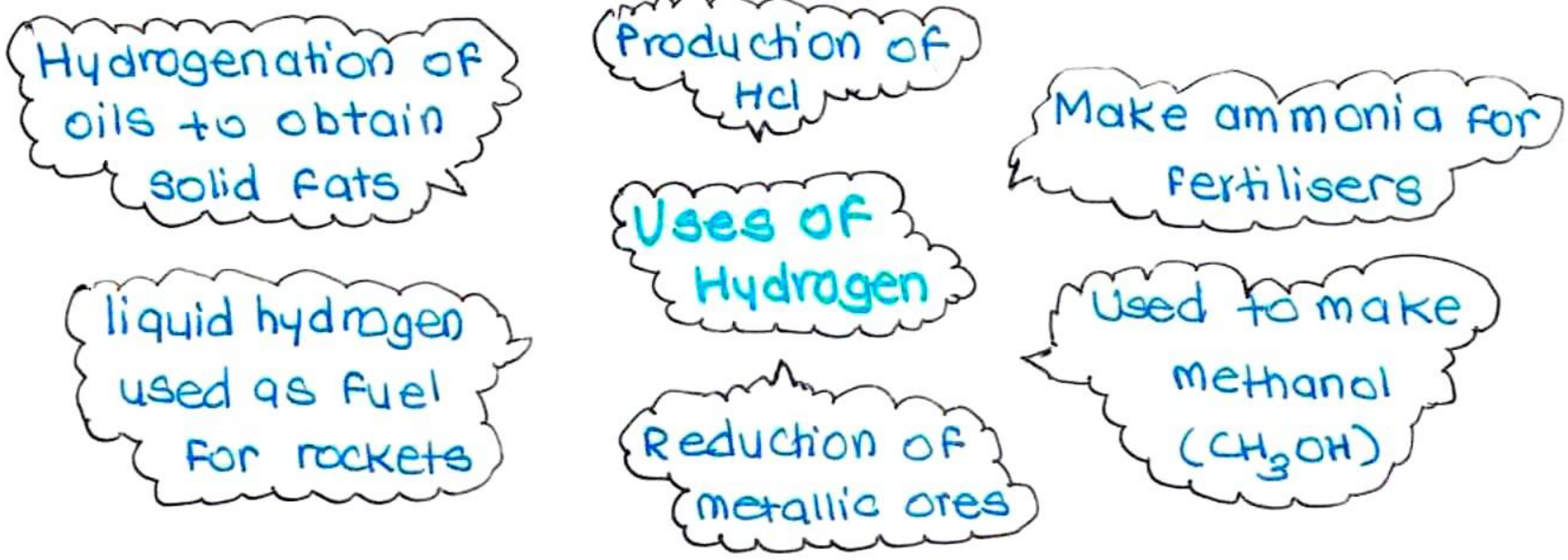
• Rock salt is mineral formed underground deposits just like coal.

- Chemicals from common salt -
- SODIUM HYDROXIDE - commonly called caustic soda. NaOH - Formula
- It is used in many industries and hence produced on large scale.
- Production of sodium hydroxide -
- The raw material for producing sodium hydroxide is sodium chloride
- It is produced by electrolysis of conc. aqueous solution of sodium chloride (which is called brine).
- When electricity is passed through it's concentrated solution of NaCl decomposes to form sodium hydroxide, chlorine and hydrogen.

$$2NaCl_{(aq)} + 2H_2O_{(l)} \xrightarrow{\text{Electricity}} 2NaOH_{(aq)} + Cl_{2(g)} + H_{2(g)}$$

Sodium chloride (Brine) — Water — Sodium hydroxide (caustic soda) — Chlorine — Hydrogen

- During, electrolysis chlorine gas is produced at the anode (+ve electrode) and hydrogen gas is produced at cathode (-ve electrode).
- NaOH solution is formed near the cathode.
- Q. Why process of electrolysis of NaCl is called as chlor-alkali process?
- It is called so because of the products formed: chlor for chlorine and alkali for sodium hydroxide.
- The three useful products obtained by electrolysis of NaCl is NaOH, Cl_2, H_2.



- **WASHING SODA** - Na_2CO_3 (Formula) - $Na_2CO_3.10H_2O$
- Washing soda is sodium carbonate containing 10 molecules of water of crystallisation.
- Washing soda is sodium carbonate decahydrate.
- Sodium carbonate which does not contain any water of crystallisation is called anhydrous sodium carbonate.
- Na_2CO_3 - Soda ash • Washing soda is important chemical obtained from sodium chloride.
- Production of Washing soda -
- Washing soda prepare in three steps -
- A cold and concentrated solution of sodium chloride is reacted with ammonia and carbon dioxide to obtain sodium hydrogen carbonate.

- $NaCl + NH_3 + H_2O + CO_2 \longrightarrow NaHCO_3 + NH_4Cl$

Sodium chloride, Ammonia, water, carbondioxide → Sodium hydrogen carbonate, Ammonium chloride

- Sodium hydrogen carbonate is seprated by filtration, dried and healed it. On heating, sodium hydrogen carbonate decomposes to form Sodium carbonate.

- $2NaHCO_3 \xrightarrow{Heat} Na_2CO_3 + CO_2 + H_2O$

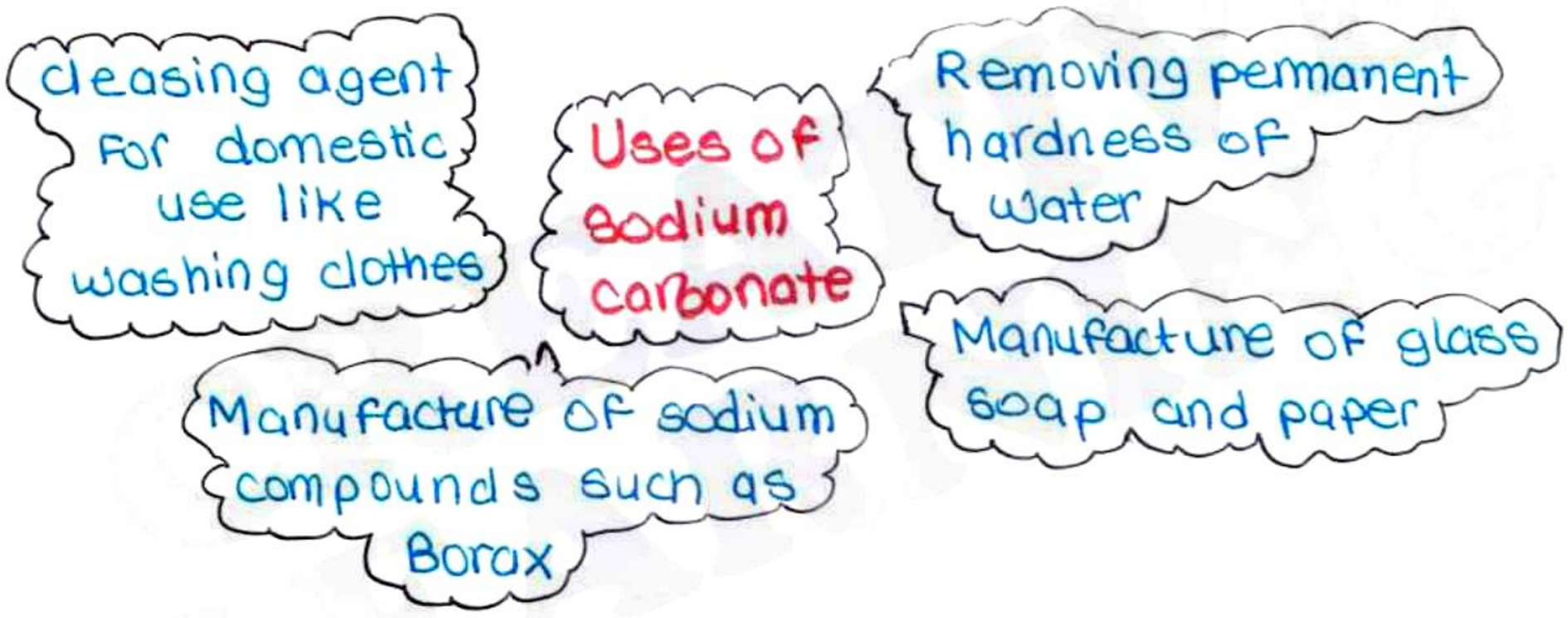
Sodium hydrogencarbonate → Sodium carbonate, water

- The anhydrous sodium carbonate obtained here is soda ash.
- Anhydrous sodium carbonate is dissolved in water and recrystallised to get washing soda crystals containing 10 molecules of water of crystallisation.

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

Anhydrous sodium carbonate + Water → Sodium carbonate decahydrate (Washing soda)

- **Properties of Washing soda-**
- It is transparent crystalline solid.
- It is soluble in water.
- It is alkaline which turns red litmus to blue
- Detergent properties because it removes dirt and grease from clothes which are dirty one.



- **BAKING SODA -**
- chemical name - Sodium hydrogen carbonate
- formula - $NaHCO_3$ also called sodium bicarbonate.
- **Production of sodium hydrogen carbonate -**
- Sodium hydrogen carbonate is produced on a large scale by reacting a cold and conc. solution of NaCl with ammonia and carbon dioxide.

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

Sodium chloride + Ammonia + Water + carbon dioxide → Sodium hydrogen carbonate (Baking soda) + Ammonium chloride

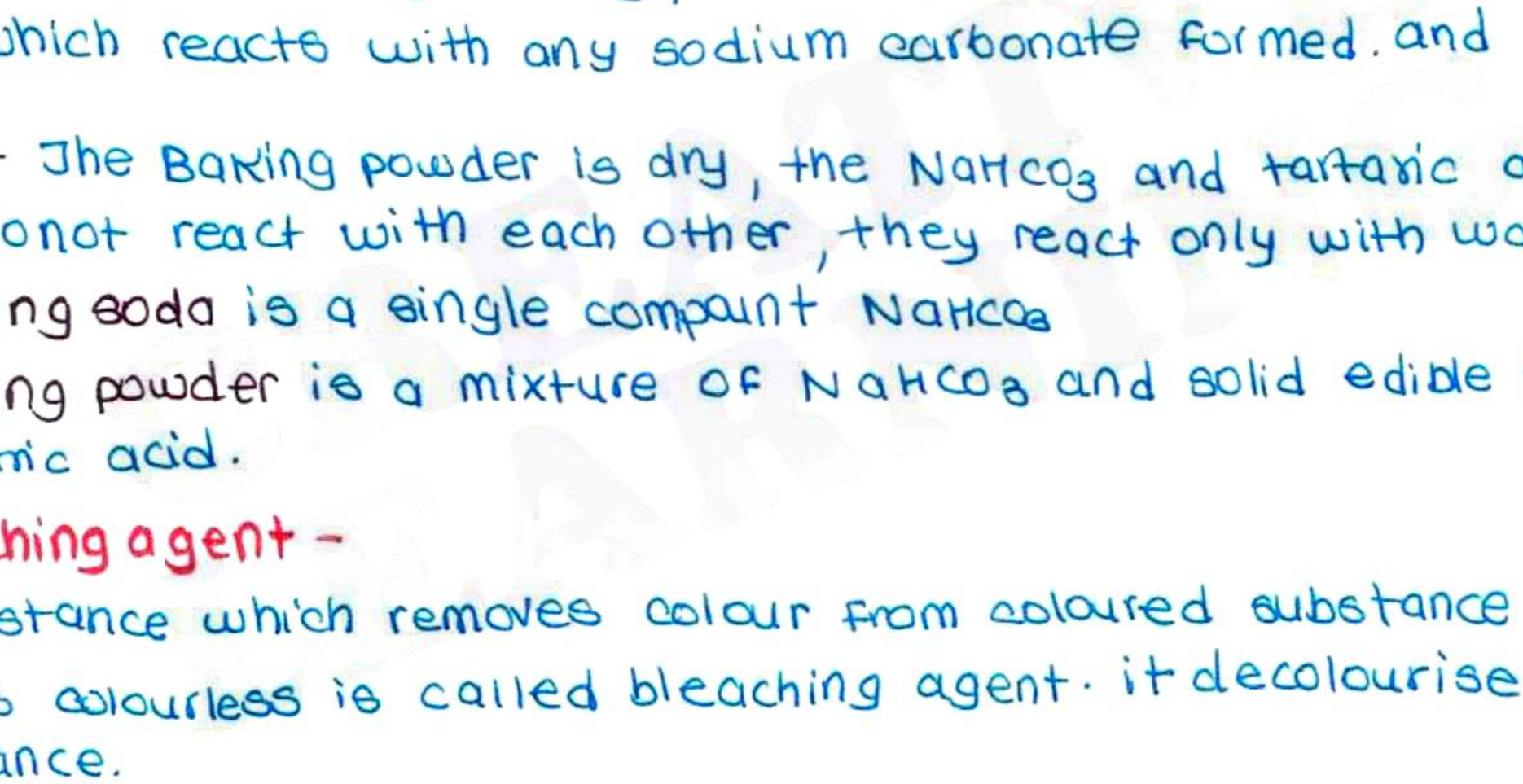
- **Properties of Baking soda -**
- consist of white crystals which are sparingly soluble in water.
- It is a mild, non-corrosive base and the sol. of sodium hydrogen carbonate in water is mildly alkaline.

- Action of Heat - When $NaHCO_3$ is heated, then it decomposes to give sodium carbonate with the evolution of CO_2 gas.

$$2NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3 + CO_2 + H_2O$$

sodium hydrogen carbonate → sodium carbonate + carbon dioxide + water

- The reaction takes during the cooking of food.



- Advantage of using baking powder is that tartaric acid is present in it which reacts with any sodium carbonate formed and neutralise it.
- Note - The Baking powder is dry, the $NaHCO_3$ and tartaric acid present in it donot react with each other, they react only with water.
- Baking soda is a single compound $NaHCO_3$
- Baking powder is a mixture of $NaHCO_3$ and solid edible acid such as citric acid.
- **Bleaching agent -**
- A substance which removes colour from coloured substance and makes colourless is called bleaching agent. it decolourises coloured substance.
- **Disinfectant -**
- A substance which is used to kill the bacteria.

•BLEACHING POWDER•

- Bleaching powder is calcium oxychloride.
- chemical formula - $CaOCl_2$ also called as chloride of lime.
- **Preparation of Bleaching powder-**
- Bleaching powder is prepared by passing chlorine gas over dry slaked lime

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

calcium hydroxide (slaked lime) + chlorine → calcium oxychloride (Bleaching powder) + water

- Properties of Bleaching Powder -
- Bleaching powder is a white powder which gives a strong smell of Cl_2.
- It is soluble in cold water. The small insoluble portion always left behind is the lime present in it.
- Bleaching powder reacts with dilute acids to produce chlorine.

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

- Forex - When bleaching powder is treated with an excess of dil. H_2SO_4, all the chlorine present in it is -

- $CaOCl_2 + H_2SO_4 \longrightarrow CaSO_4 + Cl_2 + H_2O$

calcium oxychloride — sulphuric acid — calcium sulphate — chlorine — water

- The real bleaching agent present in bleaching powder is chlorine. The bleaching action of chlorine is due to its oxidising property.
- Some coloured substance turns colourless when oxidised by chlorine.

USES OF BLEACHING POWDER

- It is used for washing clothes in laundry
- Used for disinfecting drinking water supply, for making drinking water free from germs
- Used for bleaching cotton and linen in textile industry
- Used for bleaching wood pulp in paper industry.
- Manufacture of chloroform ($CHCl_3$)
- Making wool unshrinkable

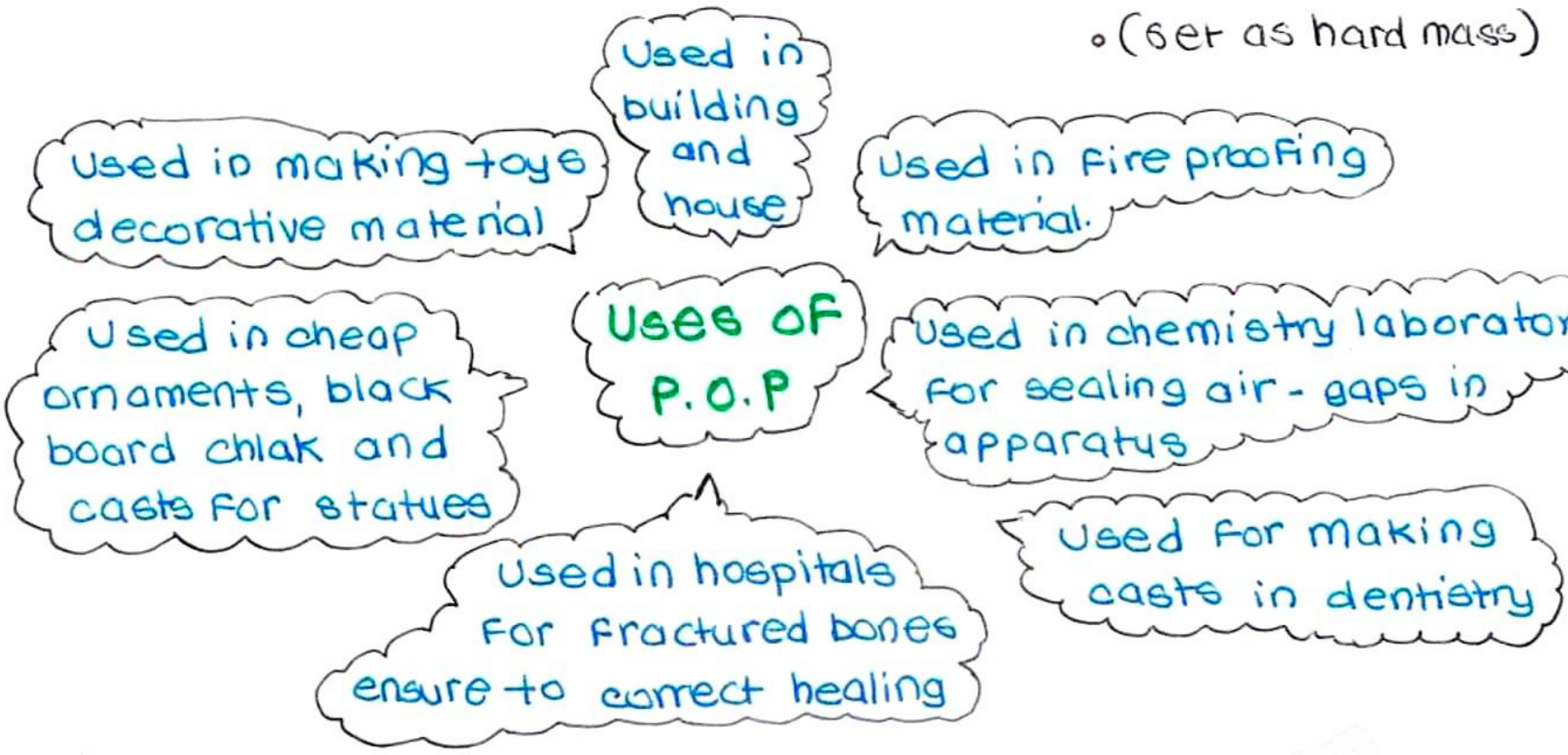
• PLASTER OF PARIS •

- It is calcium sulphate hemihydrate.
- Formula - $CaSO_4 \cdot \frac{1}{2} H_2O$, commonly called P.O.P.
- The name plaster of Paris came from the fact that it was first of all made by heating gypsum which was mainly found in Paris.

Properties of P.O.P

- It is a white powder
- Remarkable property of setting into hard mass on wetting with water → Reason - When water is added to P.O.P it turns into hard mass due to hydration of gypsum.
- Plaster of Pan's should be stored in moisture proof container bcoz the presence of moisture can cause slow setting of P.O.P by bringing about its hydration. (2M)

- $CaSO_4 . \frac{1}{2} H_2O + 1\frac{1}{2} H_2O \longrightarrow CaSO_4 . 2H_2O$
- Plaster of Pan's
- water
- Gypsum
- (Set as hard mass)



- WATER of CRYSTALLISATION: HYDRATED SALTS -
- The water molecules which form part of the structure of a crystal (of a salt) are called water of crystallisation.
- The salts which contain water of crystallisation are called hydrated salts.
- Every hydrated salt has fixed no. of molecule of crystallisation in its 'formula unit'.
- For example -
- $CuSO_4 . 5H_2O$ - crystal contain 5 molecules of water of crystallisation in one formula unit.
- It is called copper sulphate pentahydrate.
- $Na_2CO_3 . 10H_2O$ - crystal contain 10 molecules of water of crystallisation in one formula unit.
- It is called sodium carbonate decahydrate
- $CaSO_4 . 2H_2O$ - crystal contain 2 molecules of water of crystallisation in one formula unit.
- It is called calcium sulphate dihydrate.

Note - Water of crystallisation is part of 'crystal structure' of a salt. since water of crystallisation is not free water, it does not wet the salt.

- The water of crystallisation gives the crystals of the salt their shape and in some cases, impart them colour.
- For example - The presence of water of crystallisation in $CuSO_4$ crystal impart blue colour $CuSO_4 . 5H_2O$ is blue, but when mix with water imparts blue colour.

• Action of Heat on hydrated salts -

• When hydrated salts are heated strongly, they lose their water of crystallisation. By losing water of crystallisation, the hydrated salts lose their regular shape and colour and become colourless powdery substance.

• The salts which have lost their water of crystallisation are called anhydrous salts. it has no water of crystallisation..

• Ex- copper sulphate crystals ($CuSO_4.5H_2O$) are blue in colour. When $CuSO_4$ are heated strongly, they lose all the water of crystallisation and form anhydrous $CuSO_4$.

$$\underset{\text{Hydrated copper sulphate (Blue)}}{CuSO_4.5H_2O} \xrightarrow{\text{Heat}} \underset{\text{Anhydrous copper sulphate (White)}}{CuSO_4} + \underset{\text{water}}{5H_2O}$$

• The dehydration of $CuSO_4$ crystals is a reversible process.

When water is added to anhydrous $CuSO_4$, it gets hydrated and turns blue due to the formation of hydrated copper sulphate-

$$\underset{\text{Anhydrous copper sulphate (white)}}{CuSO_4} + \underset{\text{water}}{5H_2O} \longrightarrow \underset{\text{Hydrated copper sulphate (Blue)}}{CuSO_4.5H_2O}$$

• Anhydrous $CuSO_4$ turns blue on adding water. This property of anhydrous copper sulphate is used to detect the presence of moisture in a liquid.

• EXPERIMENT -

• Aim - To show the action of heat on $CuSO_4$ crystals.

• Take some $CuSO_4$ crystals in dry boiling tube.

• Heat the crystals strongly by keeping the boiling tube over the flame of the burner for sometime.

• on heating the blue $CuSO_4$ crystal turns white and a powdery sub. is formed, we can also see tiny droplets of water in boiling tube.

• cool the boiling tube and add 2 or 3 drops of water on white $CuSO_4$ powder form above

• The blue colour of $CuSO_4$ crystal is restored. They become blue again.