Acid, Base & Salt

Acids

Acids are substances which dissociate in aqueous solution to give hydrogen ions

Acids are sour in taste and turn blue litmus solution red.

Blue to Red

Example: **HCL, HNO_3, CH_3COOH and H_2So_4 are acids because they give hydrogen ions when dissolved in water.**

$$HCL \xrightarrow{H_2O} H^+ + Cl^-$$

$$HNO_3 \xrightarrow{H_2O} H^+ + No^-{}_3$$

Bases

Bases are substances which dissociate in aqueous solution to give hydroxide ions.

bitter taste and soapy touch and turn red litmus solution blue.

Red to Blue

Example: **NaoH, KoH, Ca $(oH)_2$ etc are bases because they give hydroxide ions when dissolved in water.**

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

$$Ca\ (oH)_2\ (S) \xrightarrow{H_2O} Ca^{2+}\ (aq) + oH^-\ (aq)$$

Strong Acids

The acids which are **completely ionized (H^+) in water** are called **strong acids**.

Example hydrochloric acid **(HCl)**, nitric acid **(HNO3)**, sulphuric acid **(H2SO4)** are strong acids because they are **fully ionized in aqueous solutions**.

$$HCl\,(aq) + H_2O(l) \longrightarrow H^+\,(aq) + Cl^-(aq)$$

Weak Acids

The acids which **inonise to only a very small** extent in water are called **weak acids**.

Example acetic acid **(CH_3COOH)**, hydrocyanic acid **(HCN)**, carbonic acid **(H_2CO_3)**, phosphoric acid **(H_3PO_4)** are weak acids because **they are only partially ionized in aqueous solutions.**

$$CH_3\,COOH\,(aq) + H_2O(l) \rightleftharpoons H^+\,(aq) + CH_3COO^-(aq).$$

Strong Bases

The bases which **completely ionize to give hydroxide ions (OH−)** are called **strong bases**.

Example sodium hydroxides **(NaOH)**, potassium hydroxide **(KOH)**, completely **dissociate in aqueous solution (water).**

Water soluble bases are also called alkalies (Basic)

$$NaOH\,(aq) \xrightarrow{water} Na+\,(aq) + OH-(aq).$$

Weak bases

The bases which **ionize to only small** extent in water to **give hydroxide ions (OH^-)**are called weak bases.

Example ammonium hydroxide **(NH_4OH)**, calcium hydroxide **($Ca(OH)_2$** are weak bases because **they only partially ionize in water.**

$$NH_4OH(aq) \overset{water}{\rightleftharpoons} NH^+_4\,(aq) + OH^-(aq).$$

Some Natural occurring acids

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

S.No.	Name of the Indicator	Colour Change With Acid	Colour Change with Base
A.	Blue litmus solution	To red	No change
B.	Red litmus solution	No change	To blue
C.	Turmeric	No change	To red
D.	Methyl orange	To red	To yellow
E.	Phenolphthalein (colourless)	No change	To pink

As per concentration, acids are of two types: **Concentrated acids and Dilute acids.**

(i) A concentrated acid is one which contains the min. possible amount of water in it.

(ii) A dilute acid is one which contains much more water in it. \

Note:

- ✓ A dilute acid is obtained by mixing the concentrated acid with water.
- ✓ The process of mixing concentrated acid with water is highly exothermic.
- ✓ This heat changes some of the water to steam explosively which can splash the acid on our face or clothes and causes acid burns.

PROPERTIES OF ACIDS

1. Acids are sour in taste
2. Acid turns blue litmus red
3. It gives hydrogen ion when dissolves in water
4. Do not give any colour with phenolphthalein indicator
5. Do not absorb carbon dioxide gas
6. Acids do not react with ammonium salt
7. Acids are generally found in Vinegar, Curd, Spinach, lemons, Citrus fruits,

USES OF ACIDS

Sulphuric Acid (H_2SO_4)

1. It is used in making fertilizers
2. It is used in the production of steel and iron
3. It is used in petroleum refining
4. It is used to produce phosphoric acid
5. It used as a cleaning agent in industries to remove the rust from steel and iron

Nitric Acid (HNO_3)

1. It is used to produce ammonium nitrates to manufacture plastic, dye, and fertilizers
2. It is used in making explosives such as TNT
3. It is used in liquid-fueled rockets as an oxidizer
4. In its pure form, it is used in the removal of the wart

Hydrochloric Acid (HCl)

1. Production of glucose and corn sugar from starch
2. Refining of cane sugar
3. Making glue and gelatin
4. Manufacturing synthetic rubber and plastics
5. Purification of common salt

BASES

The solutions of substances like **caustic soda, lime and washing soda are bitter in taste** and **soapy to touch (slippery to touch)**. They are **called bases**.

For Example: Sodium oxide (Na_2O), Sodium hydroxide (NaOH), Ammonium hydroxide (NH_4OH), etc

DIFFERENT TYPES OF BASES

As per their strength, **bases are of two types: Strong Bases and Weak Bases.**

(i) Sodium hydroxide (NaOH) and Potassium hydroxide (KOH) are strong bases. Another name of **Sodium hydroxide is Caustic Soda** and **Potassium hydroxide is Caustic Potash**. They are corrosive to skin. '**Caustic means corrosive**'.

(ii) Magnesium hydroxide[$Mg(OH)_2$] and Ammonium hydroxide(NH_4OH) are weak bases.

As per their solubility, **bases are:**

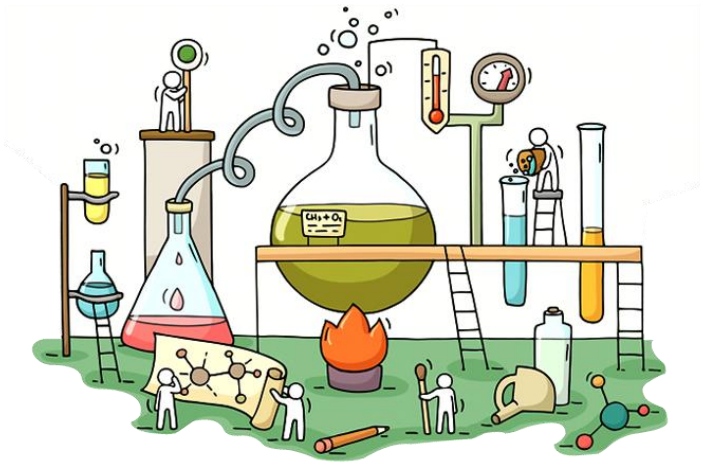
The bases which are soluble in water are called alkalis.

For example - Sodium hydroxide (NaOH), Potassium hydroxide (KOH), Barium hydroxide [$Ba(OH)_2$], etc.

The bases which are either partially soluble or insoluble in water are not alkalis.

For Example – Magnesium hydroxide [$Mg(OH)_2$], Ammonium hydroxide (NH_4OH) are only bases.

PROPERTIES OF BASES



1. **Bases have bitter taste.**
2. **Bases feel soapy to touch.**
3. **Bases turn red litmus blue.**
4. **Bases conduct electricity.**
5. **Bases are corrosive to skin.**

USES OF BASES

a) Sodium Hydroxide (NaOH)

- It is used as a **cleansing agent** and in the **manufacturing of washing soda**.
- **Sodium hydroxide** is also used as a **reagent in the laboratories.**
- It is used in the **preparation of soda lime.**
- It is used in the **extraction of aluminium by purifying bauxite.**

b) Ammonium Hydroxide (NH_4OH)

- **Ammonium hydroxide** solution is an important tool in the **manufacturing process of chemical fertilizers.**
- Ammonium hydroxide is also used in the production of **organic and inorganic chemicals containing nitrogen.**

- It is the base chemical in **the manufacture of nitric acid**.
- **It remains active** in still water for **longer durations than chlorine**.
- Any wood that contains **tannic acid can be sealed** in a container **with ammonium hydroxide solution** to give a dark stained look to the wood.

c) Calcium Hydroxide [$Ca(OH)_2$]

- In the process of **sewage treatment**, calcium hydroxide is used as a **clarifying agent or as a flocculent**.
- Ca (OH)2 is used **in the paper industry** during the **Kraft process of converting wood into wood pulp**.
- It is a very important compound in **the preparation of ammonia**.
- It is also used **in pesticides, hair care products**, and the manufacture of **ebonite**.
- In root canal procedures, this compound is used to **fill the cavities in the human teeth**.

d) Magnesium Hydroxide [$Mg(OH)_2$]

- Used as a **food additive**.
- It is widely used in **waste-water treatment**.
- Used as a **fire retardant**.
- It is used in **gold mining**.
- Used in **warehouses**.

INDICATORS

An indicator is a 'dye' that changes **colour when it is put into an acid or a base**. An indicator gives different **colours in acid and base**.

A substance which contains an acid is said to be acidic whereas the substance which contains a base is said to be basic.

There are two types of indicators: Natural Indicators and Synthetic Indicators.

NATURAL INDICATORS

Natural indicator is a **substance which is found naturally** and can determine whether the substance is acidic or basic.

Some examples of natural indicators are turmeric, grape juice, red cabbage, cherries, onion, beetroot etc.

a) Litmus

Litmus is the most commonly used natural indicator available as **strips of paper called litmus paper or solution.** It is **extracted from lichens**. It turns to **red on addition of an acidic solution** and **turns blue on addition of a basic solution**.

There are two types of litmus paper: Red litmus paper and Blue litmus paper.

b) Turmeric

Turmeric powder dissolved in water is also used as a common natural indicator. It changes colour from **orange to red in basic solution**. **That is why a turmeric stain on white cloth turns red when it is washed with soap. It is because the soap solution is basic in nature and changes the colour of the turmeric stain.** Turmeric compound remains **yellow when acid or neutral solutions are added to it**.

SYNTHETIC INDICATORS

Synthetic indicators are indicators which are synthesized in the laboratory. Examples of synthetic indicators include **phenolphthalein, methyl orange etc**. **litmus paper is also an example of synthetic indicator.**

Phenolphthalein

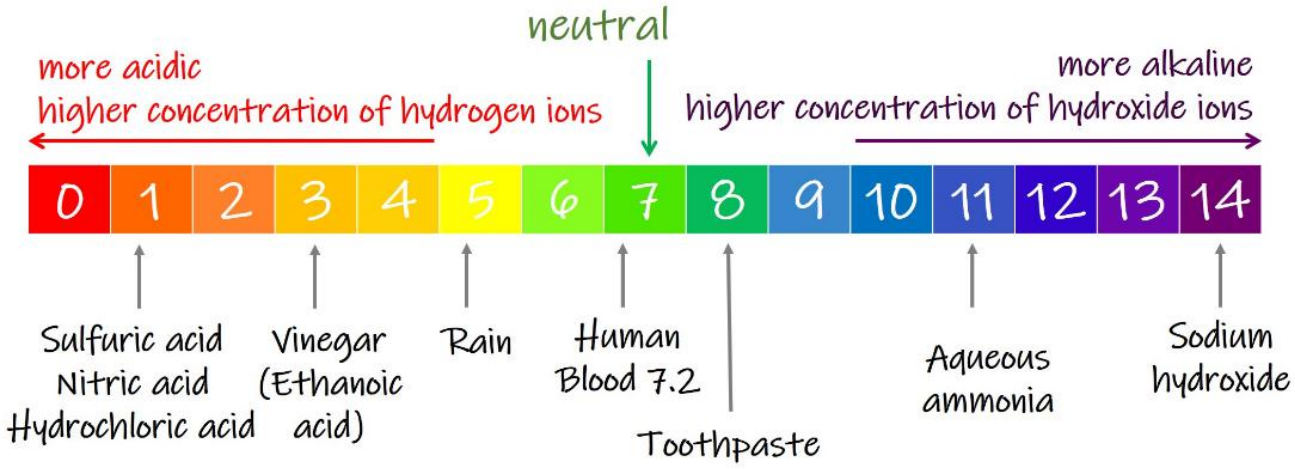
Phenolphthalein is **colourless indicator**. It gives a **pink colour in case of basic solution** and **remains colourless in case of acidic solution**.

Methyl Orange

Methyl orange is an **orange-pink coloured indicator** which is **orange in acidic medium** and **yellow in basic medium**.

PH (Potential of hydrogen)

A scale for measuring hydrogen ion conc. in a solution **called pH scale** has been developed. This scale measures from **0 (very acidic) to 14 (very alkaline) and 7 (Neutral) indicates.**



Importance of pH in our daily life

- Our stomach **produces hydrochloric acid**. This dilute **hydrochloric acid help in digestion of food**. **In case of indigestion our stomach produces acid in a very large quantity because of which we feel pain and irritation in our stomach (ACIDITY).** To get relief **from this pain, antacids** are used. **These antacids neutralize the excess acid** because they are basic in **nature and we get relief**.
- When pH of **rain water is less than 5.6 it is called acid rain**. **Flow of acidic rain in water bodies makes them acidic causing a threat to the survival of aquatic life.** It also results in damage of **structures made with marble** like Taj Mahal
- Plants require a specific range of **pH for their healthy growth. If pH of soil of any particular place is less or more than normal then the farmers add suitable chemicals to it.**
- Bacteria present in the mouth **produces acids by degradation of sugar and food particles** remaining in the mouth. **Tooth decay begins below the pH 5.6. Using**

toothpaste which is generally basic, can neutralise the excess acid and prevent tooth decay.

- **Bee sting or Nettle sting** contains **methanoic acid which causes pain and irritation.** Using a **weak base like baking soda neutralises the acid giving relief**.

NEUTRALISATION

The reaction in which an acid reacts with a base to form **salt and water is called neutralisation**.

Acid + Base———-> Salt + Water

Note:

Some heat is always evolved in a neutralisation reaction. This heat raises the temperature of **reaction mixture due to which the reaction mixture becomes hot.**

SALT

Sodium chloride is called as common salt. It is derived from sea water. Rock Salt is mined like coal, is brown coloured and crystalline is shape.

Salt is a compound formed from **an acid by the replacement of the hydrogen in the acid by a metal**.

For Example: Sodium Chloride (Common Salt) etc. Salts are formed when acids react with bases.

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

PROPERTIES OF SALT

- Salts are **coloured or colourless solids.**
- They have **high melting and boiling points**.
- They are **soluble in water.**
- Salts **conduct electricity (in molten state).**

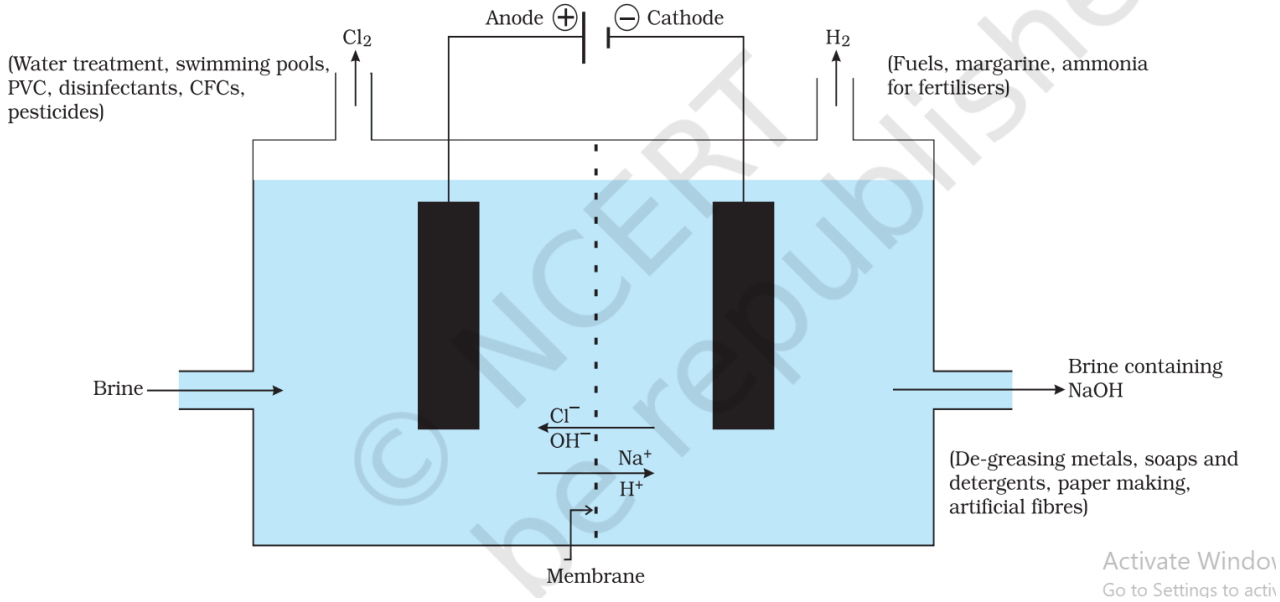
Use of Salt

- **Washing Soda**
- **Bleaching Power**
- **Used in our food as a preservative and provides flavour to food**
- **Used in industries**

Sodium Hydroxide (NaOH)

Common Name – caustic soda

It is prepared by the method **called chlor-alkali process**. It is called so because we get chlorine and an **alkali (NaOH) in this process.**



Calcium oxy chloride (CaOCl) The chlorine gas released in brine formation is used to prepare bleach.

$$\underset{Calcium\ Hydroxide}{Ca(OH)_2} + \underset{Chlorine}{Cl_2} \rightarrow \underset{bleaching\ powder}{CaOCl_2} + \underset{Water}{H_2O}$$

Uses of Calcium oxy chloride

- for bleaching **cotton and linen in textile industries,wood pulp in paper industry**
- Used as **disinfectant of water**
- Used as an **oxidising agent.**

Sodium Hydrogen Carbonate (NaHCO)

Common name is Baking Soda. It is mild corrosive base

$$\text{Heating } NaHCO_3 \ + \ H_2O \ + \ CO_2$$

$$NaHCO_3 \xrightarrow{heat} Na_2CO_3 + H_2O + CO_2$$

Uses Sodium Hydrogen Carbonate (NaHCO)

- Produced causes dough to rise and **help to make cakes and pastries spongy.**
- Used as **ingredients of antacids**
- For prepare in baking soda **(baking powder + mild edible acid)**
- Used in **soda-acid extinguishers**

Washing Soda Preparation

Re-crystallisation of sodium carbonate

$$Na_2CO_3 + 10H_2O \xrightarrow{Heat} Na_2CO_3 \cdot 10H_2O$$

Uses Sodium corbonate

- **Manufacture of Borax.**
- **Glass, soap and paper industries cleansing agent for domestic purposes.**
- **Removing permanent hardness of water.**

Water of Crytallization: fixed number of water molecules present in on formula unit of a salt.

- $CuSO_4 \cdot 5H_2O$
- $CaSO_4 \cdot 2H_2O$
- $CaSO_4 \cdot \frac{1}{2}H_2O$

Plaster of Paris

$$CaSO_4 \cdot 2H_2O \xrightarrow{373K} CaSO_4\,\tfrac{1}{2}H_2Oa$$

When Plaster of Paris is mixed with water it changes to gypsum.

$$\underset{POP}{CaSO_4 \cdot \tfrac{1}{2}H_2O} + 1\tfrac{1}{2}H_2O \rightarrow \underset{GYPSUM}{CaSO_4.2H_2O}$$

Use of Plaster of Paris

- Making toys
- Decorative material
- Smoothening surfaces
- Plaster for fractured bones

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

Do You Know?

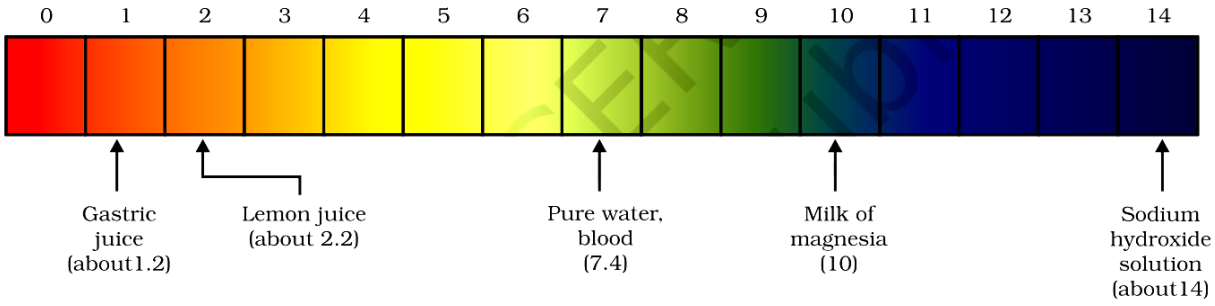
Nature provides neutralisation options

Nettle is a herbaceous plant which grows in the wild. Its leaves have stinging hair, which cause painful stings when touched accidentally. This is due to the methanoic acid secreted by them. A traditional remedy is rubbing the area with the leaf of the dock plant, which often grows beside the nettle in the wild. Can you guess the nature of the dock plant? So next time you know what to look out for if you accidentally touch a nettle plant while trekking. Are you aware of any other effective traditional remedies for such stings?

Do You Know?

Acids in other planets

The atmosphere of venus is made up of thick white and yellowish clouds of sulphuric acid. Do you think life can exist on this planet?



S. No.	Solution	Colour of pH paper	Approx--imate pH value	Nature of substance
1	Saliva (before meal)			
2	Saliva (after meal)			
3	Lemon juice			
4	Colourless aerated drink			
5	Carrot juice			
6	Coffee			
7	Tomato juice			
8	Tap water			
9	1M NaOH			
10	1M HCl			

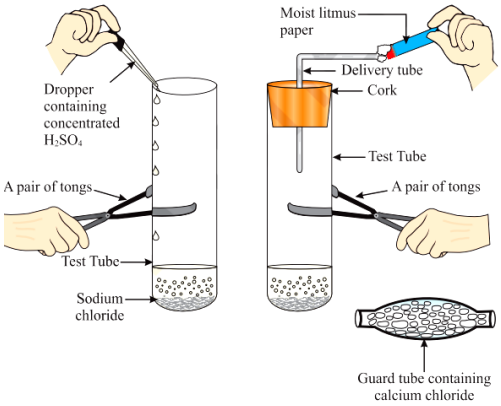


Figure 2.4 *Preparation of* HCl *gas*

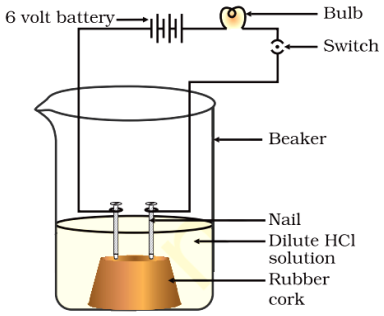


Figure 2.3
Acid solution in water conducts electricity

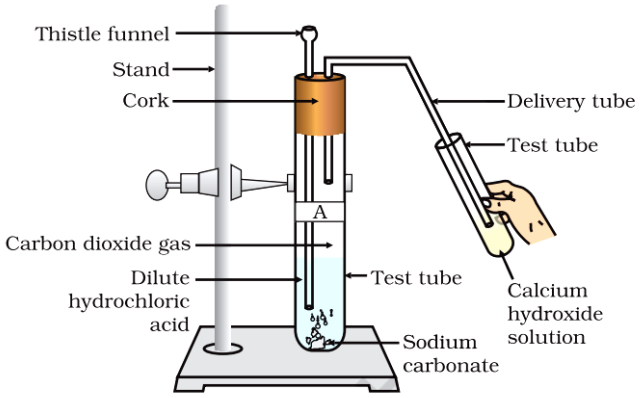


Figure 2.2
Passing carbon dioxide gas through calcium hydroxide solution

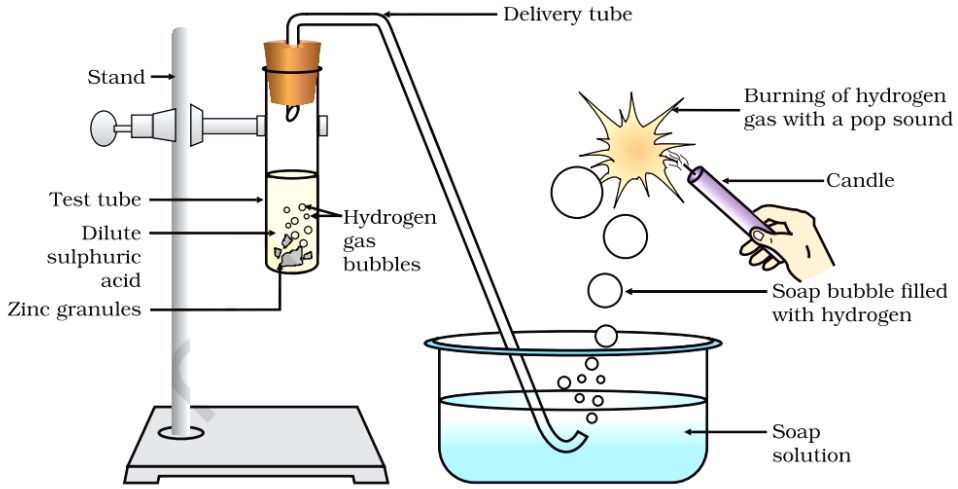


Figure 2.1 *Reaction of zinc granules with dilute sulphuric acid and testing hydrogen gas by burning*

Do You Know?

Litmus solution is a purple dye, which is extracted from lichen, a plant belonging to the division Thallophyta, and is commonly used as an indicator. When the litmus solution is neither acidic nor basic, its colour is purple. There are many other natural materials like red cabbage leaves, turmeric, coloured petals of some flowers such as *Hydrangea*, *Petunia* and *Geranium*, which indicate the presence of acid or base in a solution. These are called acid-base indicators or sometimes simply indicators.

(II) **Preparing a soda-acid fire extinguisher**

The reaction of acids with metal hydrogencarbonates is used in the fire extinguishers which produce carbon dioxide.

- Take 20 mL of sodium hydrogencarbonate ($NaHCO_3$) solution in a wash-bottle.
- Suspend an ignition tube containing dilute sulphuric acid in the wash-bottle (Fig. 2.10).
- Close the mouth of the wash-bottle.
- Tilt the wash-bottle so that the acid from the ignition tube mixes with the sodium hydrogencarbonate solution below.
- You will notice discharge coming out of the nozzle.
- Direct this discharge on a burning candle. What happens?