Class 10 (Science)

Chapter 2

Acids, Bases and Salts

Handwritten Notes

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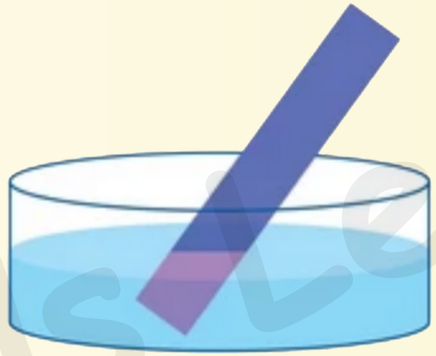
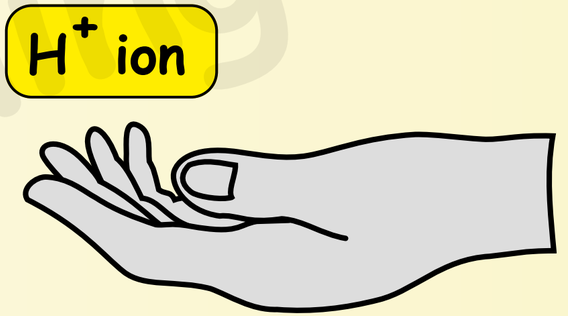
What is an Acid?

Acids are the substance that are sour in taste, turns blue litmus paper red, and gives H+ ions (protons) in their aqueous solution.

Sour in taste



Turns blue litmus paper red



Gives H^+ ions (protons)

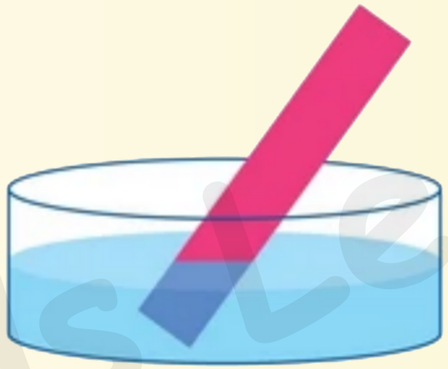
Examples of acids

- HCl (Hydrochloric acid)
- HNO_3 (Nitric acid)
- H_2SO_4 (Sulphuric acid)

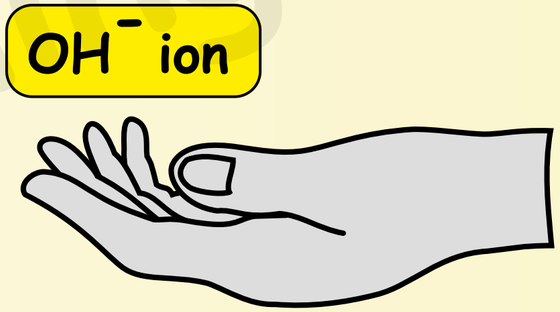
What is a Base?

Bases are the substance that are bitter in taste, turns red litmus paper blue, and gives OH- ions (hydroxide ions) in their aqueous solution.

Bitter in taste



Turns red litmus paper blue



Gives OH^- ions

Examples of bases

- NaOH (Sodium hydroxide or caustic soda)
- $Ca(OH)_2$ (Calcium hydroxide or slaked lime)
- KOH (Potassium hydroxide)

What are Alkalis?

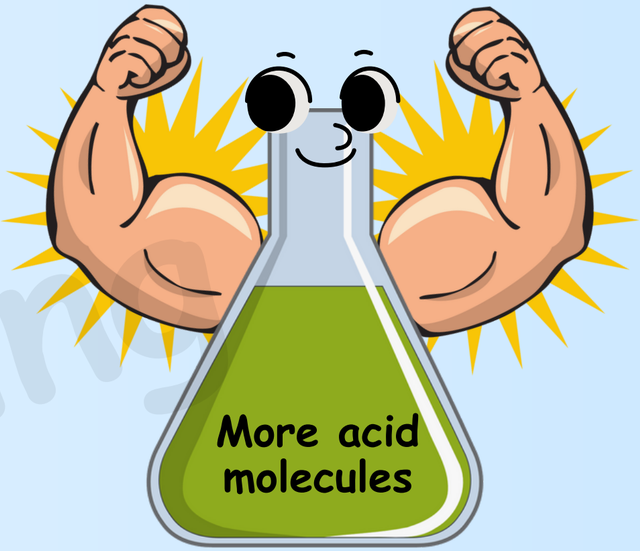
The bases that are soluble in water are called alkalis.

Remember:

All bases do not dissolve in water. An alkali is a base that dissolves in water.

Concentrated acid

Concentrated acids have a higher concentration of acid molecules compared to the solvent.
This means they are more potent and can react more vigorously.

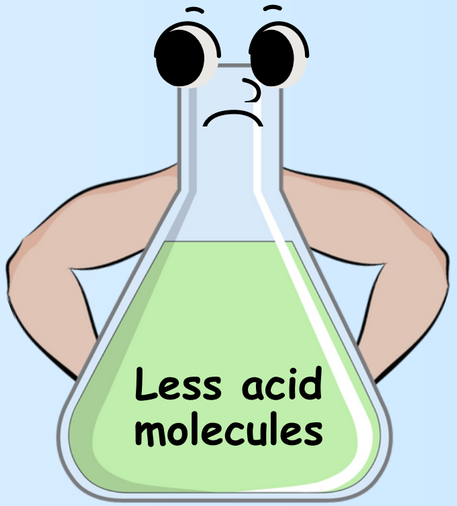


Examples

- Concentrated sulfuric acid
- Concentrated hydrochloric acid

Dilute acid

Dilute acids have a lower concentration of acid molecules compared to solvent. They are generally less reactive and safer to handle.

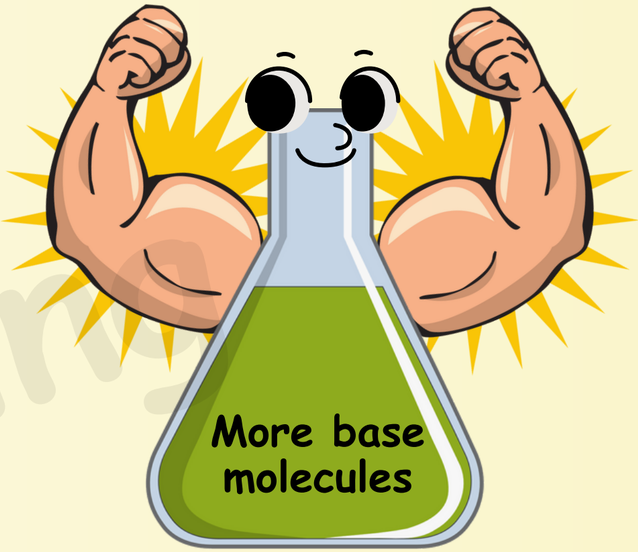


Examples

- Dilute sulfuric acid
- Dilute hydrochloric acid

Concentrated base

Concentrated bases have a higher concentration of base molecules compared to the solvent.

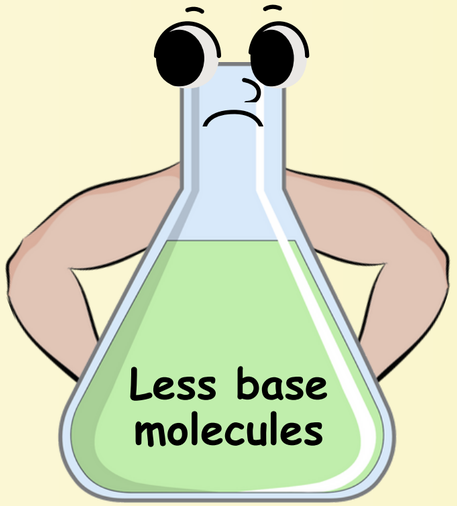


Examples

- Concentrated NaOH
- Concentrated KOH

Dilute base

Dilute bases have a lower concentration of base molecules compared to solvent.



Examples

- Dilute NaOH
- Dilute KOH

Acid-Base indicators

Acid-base indicators are substances that change their color or smell (odour) in the presence of an acid or a base.

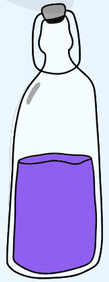
There are basically 3 types of indicators.

1) Natural indicators
2) Synthetic indicators and
3) Olfactory indicators

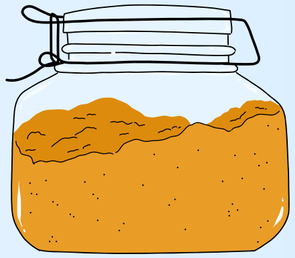
1) Natural indicators

These are indicators derived from naturally occurring sources.

Examples



Litmus solution (a purple dye extracted from lichen plant)



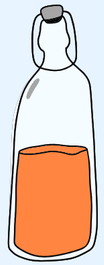
Turmeric

Red cabbage leaves

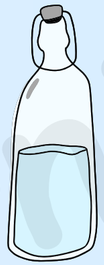
2) Synthetic indicators

These are indicators artificially created in laboratories through chemical synthesis.

Examples



Methyl orange

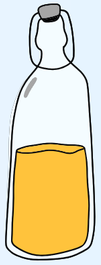


Phenolphthalein

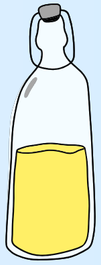
3) Olfactory indicators

These are substances that change their smell (odour) upon contact with acids or bases.

Examples



Vanilla essence



Clove oil

Chemical properties of Acids and Bases

1. Reaction with Metals
2. Reaction with Metal Carbonates and Metal Hydrogencarbonates
3. How do Acids and Bases react with each other?
4. Reaction of Metallic Oxides with Acids
5. Reaction of Non-metallic Oxides with Bases

1) Reaction with Metals

Acids and bases reacts with metal to form a compound called salt and releases hydrogen gas.

Acid/Base + Metal → Salt + Hydrogen gas

Examples

Acid + Metal: $H_2SO_4 + Zn \rightarrow ZnSO_4 + H_2$

Base + Metal: $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$

(Sodium zincate)

2) Reaction with Metal Carbonates and Metal Hydrogencarbonates

Acids react with metal carbonate/metal hydrogencarbonate to give a corresponding salt, carbon dioxide and water.

Acid + Metal carbonate/metal hydrogencarbonate → Salt + CO2 + Water

Examples

Acid + Metal carbonate: $2HCl + Na_2CO_3 \longrightarrow 2NaCl + CO_2 + H_2O$

Acid + Metal Hydrogencarbonate: $HCl + NaHCO_3 \longrightarrow NaCl + CO_2 + H_2O$

3) How do Acids and Bases react with each other?

Acid and base reacts with each other to form a salt and water.

For example

$HCl + NaOH \longrightarrow NaCl + H_2O$

The reaction between an acid and a base to give a salt and water is known as a **neutralisation reaction**.

4) Reaction of Metallic Oxides with Acids

Metal oxide reacts with acid to give a corresponding salt and water.

Metal oxide + Acid → Salt + Water

Example

$CuO + 2HCl \longrightarrow CuCl_2 + H_2O$

Since metallic oxides react with acids to give salts and water, similar to the reaction of a base with an acid, metallic oxides are said to be **basic oxides**. In other words, **metal oxides are basic in nature**.

5) Reaction of Non-metallic Oxides with Bases

Non-metallic oxide reacts with base to give a corresponding salt and water.

Non-metallic oxide + Base → Salt + Water

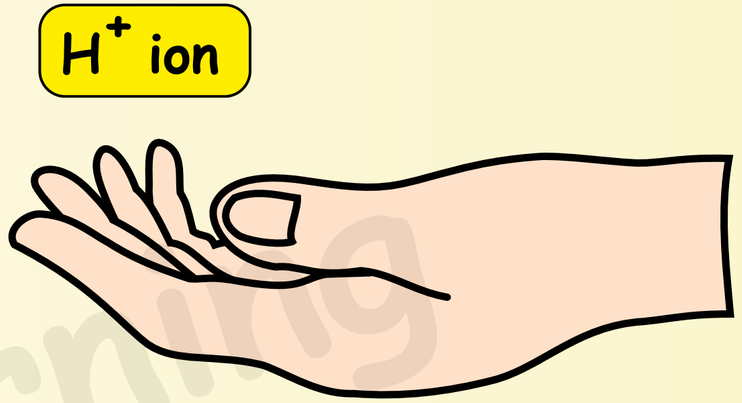
Example

$$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$$

Since this is similar to the reaction between a acid and a base, we can conclude that **nonmetallic oxides are acidic in nature**.

What do all acids have in common?

- All acids **have Hydrogen ion (H^+ ion)** as a cation.
- Acids **gives Hydrogen ions (H^+ ions) in a solution**.
- The H^+ ions present in an acids are responsible for their acidic properties.



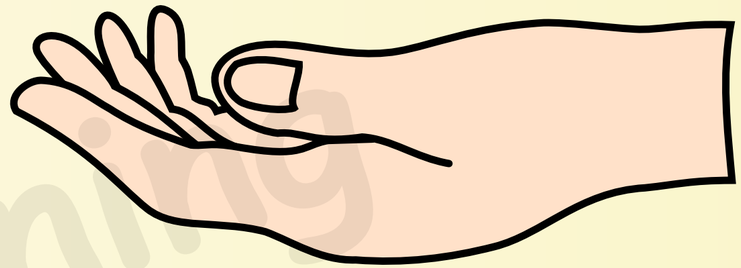
Examples

- HCl contains **H^+ ion** and Cl^- ion.
- H_2SO_4 contains **H^+ ion** and SO_4^{2-} ion.

What do all bases have in common?

- All bases **have Hydroxide ion (OH^- ion)** as an anion.
- Bases **gives Hydroxide ions (OH^- ions) in a solution**.
- The OH^- ions present in a bases are responsible for their basic properties.

OH^- ion



Examples

- NaOH contains Na^+ ion and **OH^- ion**.
- $Ca(OH)_2$ contains Ca^{2+} ion and **OH^- ions**.

What happens to an Acid or a Base in a water solution?

Acids: Acid have H^+ ion in it. So when the **acid reacts with water**, this H^+ ion reacts with water **to form H_3O^+ ion**.

→ For example: $HCl + H_2O \longrightarrow H_3O^+ + Cl^-$

Hydronium ion

→ Hydrogen ions cannot exist alone, but they exist after combining with water molecules.

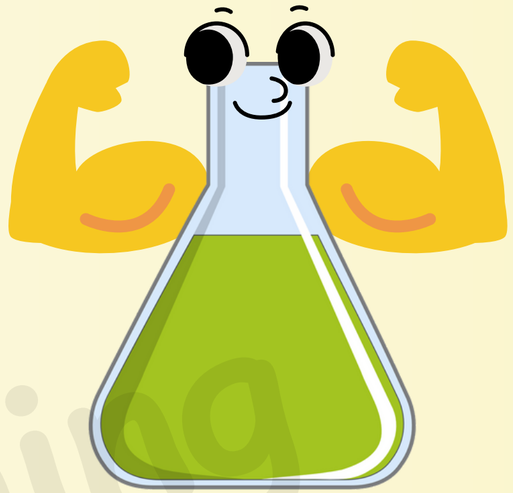
$H^+ + H_2O$ OR H_3O^+

→ Thus hydrogen ions must always be shown as $H^+(aq)$ or H_3O^+ (hydronium ion).

Bases: Bases generate **hydroxide ions (OH^- ions)** in water.

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

How strong are acid or base solutions?



The strength of acid or base can be determined by the concentration of H^+ and OH^- ions present in the solution. This can be done by using universal indicators.

Universal indicators

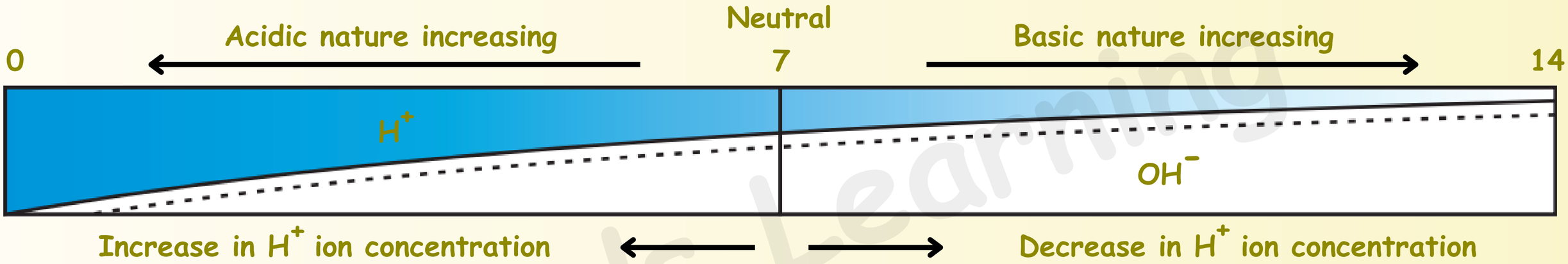
Universal indicator is a mixture of several indicators which shows different colours at different concentrations of hydrogen ions in a solution.

Example

→ pH paper

pH scale

pH is simply a number which indicates the acidic or basic nature of a solution.



→ If a substance has a **pH value less than 7, then** it is **acidic**.

→ If a substance has a **pH value greater than 7, then** it is **basic**.

→ If a substance has a **pH value equals to 7, then** it is **neutral**.

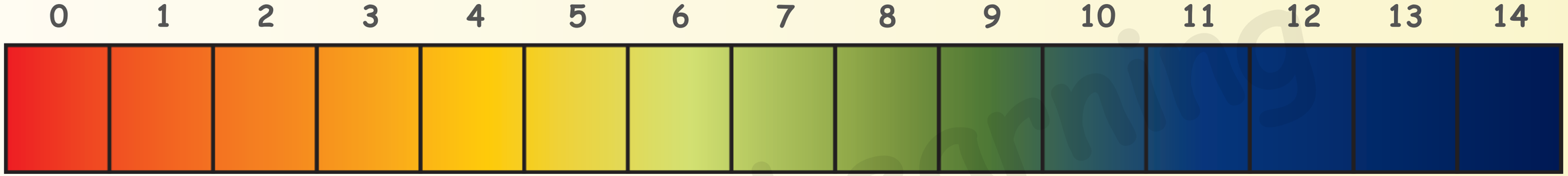
The amount of H^+ ions and OH^- ions determines the strength of acid and base respectively.

Remember:

- More H^+ ions, strong acid. Less H^+ ions, weak acid.
- More OH^- ions, strong base. Less OH^- ions, weak base.

pH of some common substances

pH paper shows different colors based on acidity and basicity of the substance.



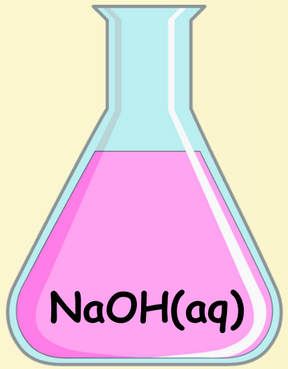
Gastric juice (about 1.2)

Lemon juice (about 2.2)

Pure water, blood (7.4)

Milk of magnesia (10)

Sodium hydroxide solution (about 14)

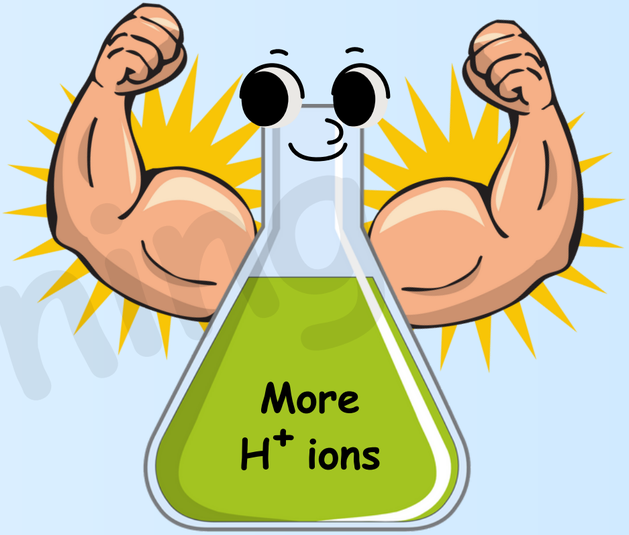


Strong acids and weak acids

Strong acid:

- Strong acids are those acids that **dissociates completely** in their aqueous solution.
- Strong acids **releases more H^+ ions** in their aqueous solution.

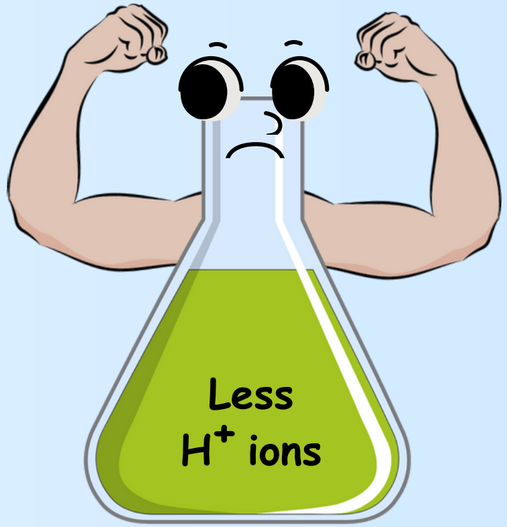
For example: H_2SO_4, HCl



Weak acid:

- Weak acids are those acids that **dissociates partially** in their aqueous solution.
- Weak acids **releases less H^+ ions** in their aqueous solution.

For example: CH_3COOH (acetic acid)



Strong bases and weak bases

Strong base:

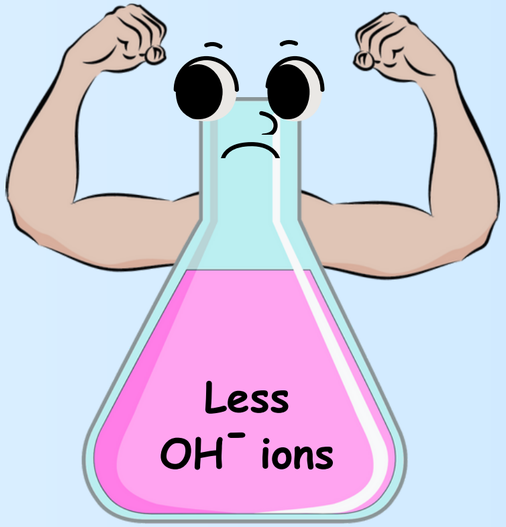
- Strong bases are those bases that **dissociates completely** in their aqueous solution.
- Strong bases **releases more OH^- ions** in their aqueous solution.

For example: NaOH

Weak base:

- Weak bases are those bases that **dissociates partially** in their aqueous solution.
- Weak bases **releases less OH^- ions** in their aqueous solution.

For example: NH_3 (ammonia)



Importance of pH in everyday life

1) Our body works within the pH range of 7.0 to 7.8.

→ Living organisms can survive only in a narrow range of pH change.

2) If pH of rain water is less than 5.6, it is called acid rain.

→ When acid rain flows into the rivers, it lowers the pH of the river water.

→ The survival of aquatic life in such rivers becomes difficult.

3) Our stomach produces hydrochloric acid (HCl).

- It helps in the digestion of food without harming the stomach.
- During indigestion the stomach produces too much acid and this causes pain and irritation.
- To get rid of this pain, people use antacids (bases) like Magnesium hydroxide (Milk of magnesia).

4) Plants require a specific pH range for their healthy growth.

- Plants grow better in the soil that has suitable pH for that growth.

5) Tooth decay starts when the pH of the mouth is lower than 5.5.

- Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth after eating.
- The best way to prevent this is to clean the mouth after eating food and by using toothpastes which are generally basic.

6) Bee-sting leaves a formic acid which causes pain and irritation.

- We can get relief by using mild base like baking soda on the stung area.

7) Stinging hair of nettle leaves inject methanoic acid causing burning pain.

- We can get relief by rubbing the area with the leaf of the dock plant (which is basic in nature).

Some naturally occurring acids

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

What are Salts?

Salt is an ionic compound that is formed by the neutralization reaction.

Neutralisation reaction

The reaction between an acid and a base to give a salt and water is known as a neutralisation reaction.

For example

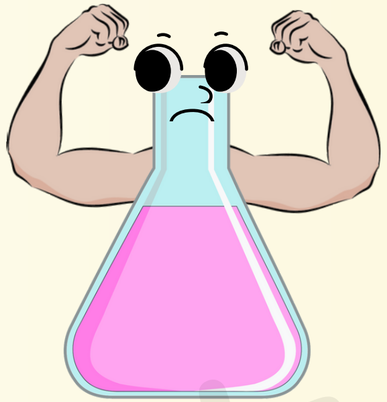
$HCl + NaOH \longrightarrow NaCl + H_2O$

pH of salts

Salts of a **strong acid** and weak base are **acidic** with pH value less than 7.

Strong acid

+



Weak base

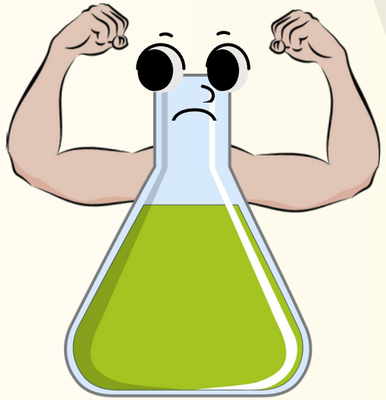
→

Acidic salt (pH < 7)

+

Water

Salts of a weak acid and **strong base** are **basic** with pH value greater than 7.



Weak acid

+

Strong base

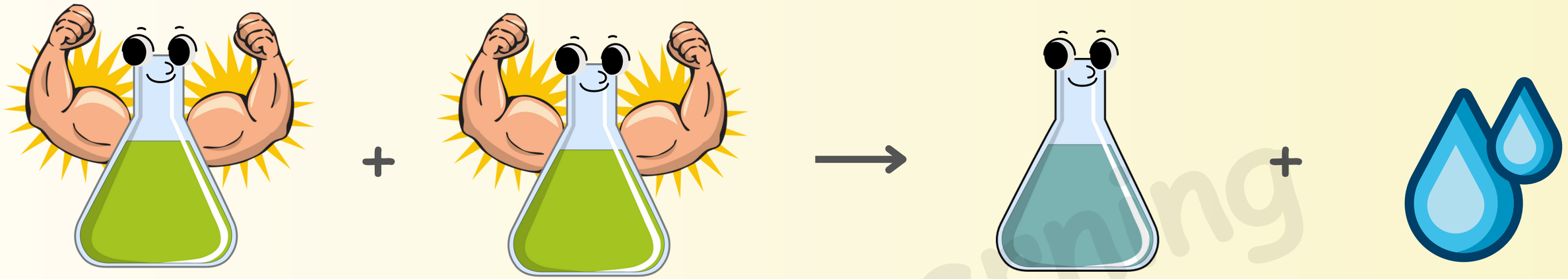
→

Basic salt (pH > 7)

+

Water

Salts of a **strong acid** and **strong base** are **neutral** with pH value of 7.



Strong acid + Strong base → Neutral salt (pH = 7) + Water

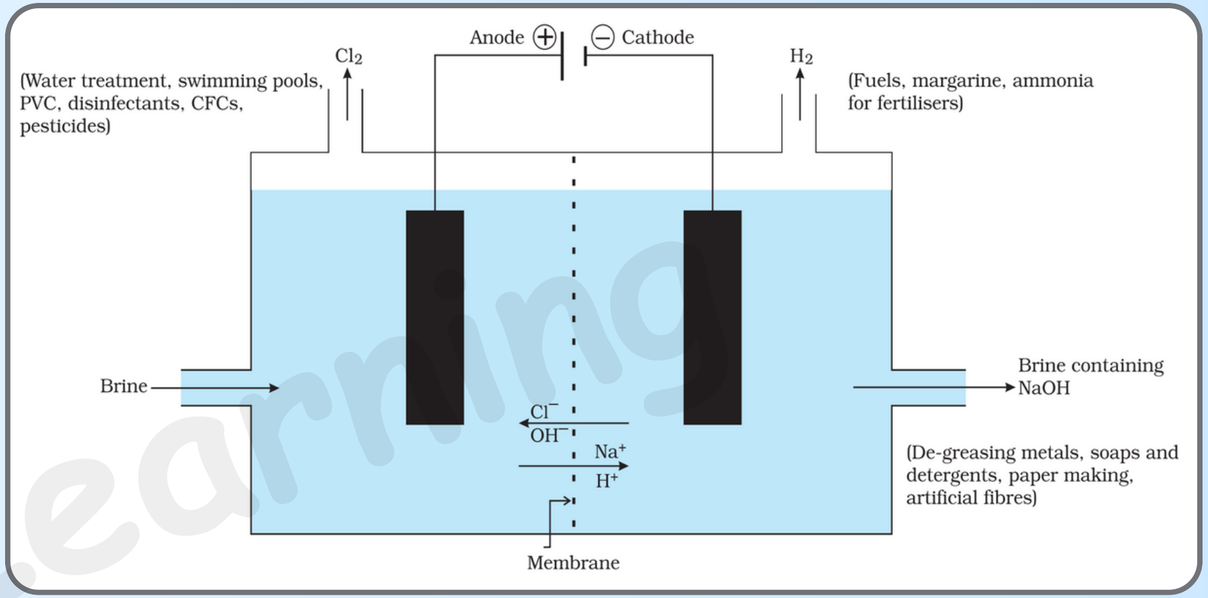
For example: NaCl is a neutral salt made of strong acid (HCl) and strong base (NaOH).

Chemicals from common salt

1. Sodium hydroxide ($NaOH$)
2. Bleaching powder ($CaOCl_2$)
3. Baking soda ($NaHCO_3$)
4. Washing soda ($Na_2CO_3.10H_2O$)
5. Plaster of Paris ($CaSO_4.\frac{1}{2}H_2O$)

1) Sodium hydroxide (NaOH)

When electricity is passed through an aqueous solution of sodium chloride (called brine), it decomposes to form sodium hydroxide.
The process is called the chlor-alkali process.



Formation reaction

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

Uses of Sodium hydroxide

Used for de-greasing metals

Used in soaps and detergents

Used in Paper making

Used in making artificial fibers

2) Bleaching powder ($CaOCl_2$)

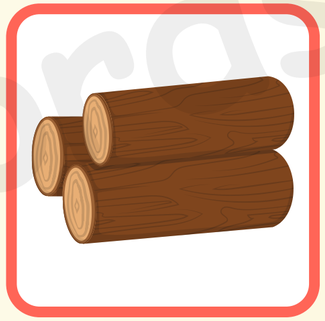
Bleaching powder is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$].

Formation reaction

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

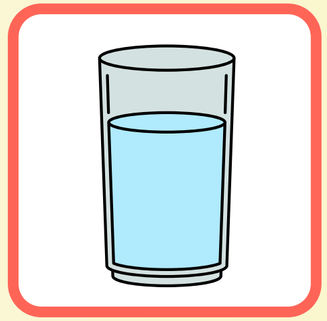
Uses of Bleaching powder

Bleaching cotton and linen



Bleaching wood pulp in paper factories

Used as oxidizing agent in industries



To make drinking water germ free

3) Baking soda ($NaHCO_3$)

Baking soda is produced when salt reacts with water, carbon dioxide and ammonia.

Formation reaction

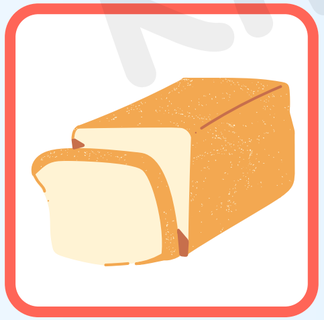
$$NaCl + H_2O + CO_2 + NH_3 \longrightarrow NH_4Cl + NaHCO_3$$

Baking soda (or sodium-hydrogencarbonate)

On heating, it decomposes to give sodium carbonate with the evolution of carbon dioxide.

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$$

Uses of Baking soda



Making baking powder

Used in antacids for stomach acidity

Used in soda-acid fire extinguishers

4) Washing soda ($Na_2CO_3.10H_2O$)

Washing soda is obtained by recrystallisation of sodium carbonate (Na_2CO_3).

Formation reaction

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

Sodium carbonate

Washing soda

Uses of washing soda

Used in glass, soap and paper industries

Used in manufacturing of borax

Used as cleaning agent for domestic purpose

Used for removing permanent hardness of water

5) Plaster of Paris ($CaSO_4 . \frac{1}{2} H_2O$)

When gypsum is heated at 373 K (100 deg C), it loses water molecules and becomes calcium sulphate hemihydrate, which is called Plaster of Paris.

Formation reaction

$$CaSO_4 . 2H_2O \xrightarrow{100\ ^\circ C} CaSO_4 . \frac{1}{2} H_2O + 1\frac{1}{2} H_2O$$

(Gypsum) (Plaster of Paris)

When Plaster of Paris is mixed with water, it changes to gypsum once again giving a hard solid mass.

$$CaSO_4 . \frac{1}{2} H_2O + 1\frac{1}{2} H_2O \longrightarrow CaSO_4 . 2H_2O$$

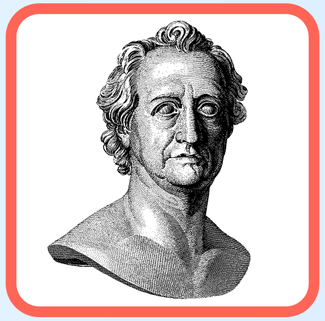
(Plaster of Paris) (Gypsum)

(POP + water)

(Gypsum)

Uses of Plaster of Paris

Used to support fractured bones

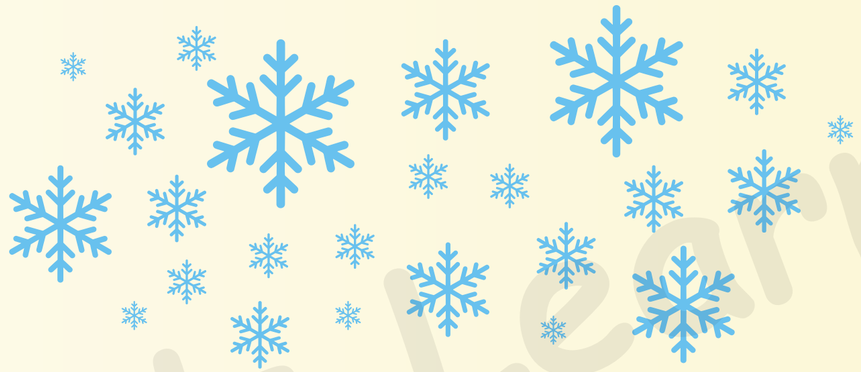


Used in toys, statues and decorations

Used in making surface smooth

Water of crystallisation

Water of crystallisation is the fixed number of water molecules present in one formula unit of a salt.



For example

→ Washing soda ($Na_2CO_3.10H_2O$)

One formula unit of Washing soda contains 10 molecules of water as a water of crystallisation.

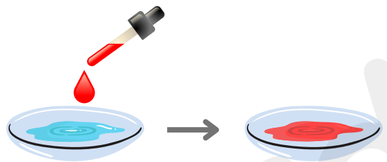
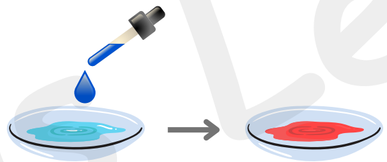
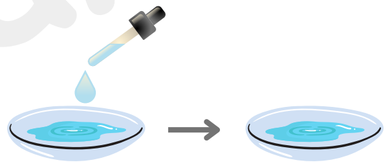
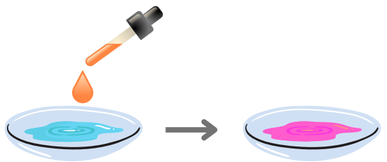
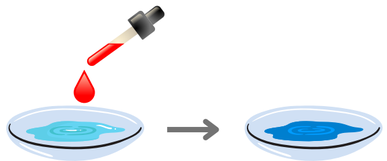
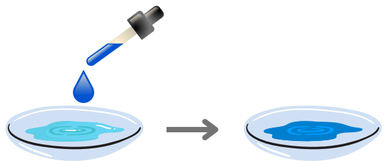
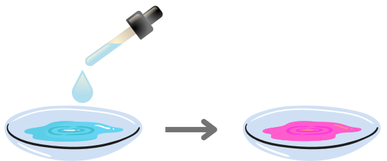
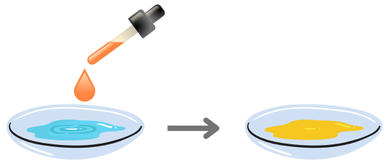
→ Gypsum ($CaSO_4.\ 2H_2O$)

One formula unit of Gypsum contains 2 molecules of water as a water of crystallisation.

Activity 2.1

Activity 2.1

- Collect the following solutions from the science laboratory– hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3), acetic acid (CH_3COOH), sodium hydroxide (NaOH), calcium hydroxide [$Ca(OH)_2$], potassium hydroxide (KOH), magnesium hydroxide [$Mg(OH)_2$], and ammonium hydroxide (NH_4OH).
- Put a drop of each of the above solutions on a watch-glass one by one and test with a drop of the indicators shown in Table 2.1.
- What change in colour did you observe with red litmus, blue litmus, phenolphthalein and methyl orange solutions for each of the solutions taken?
- Tabulate your observations in Table 2.1.

	Sample solution	Red litmus solution/paper	Blue litmus solution/paper	Phenolphthalein solution	Methyl orange solution
Acids	HCl	No change (remains red) 	Turns red 	No change (remains colorless) 	Turns pinkish red 
	H_2SO_4				
	HNO_3				
	CH_3COOH				
Bases	$NaOH$	Turns blue 	No change (remains blue) 	Turns pinkish red 	Turns yellow 
	$Ca(OH)_2$				
	KOH				
	$Mg(OH)_2$				
	NH_4OH				

Blue litmus: It turns red in acid.

Red litmus: It turns blue in base.

Phenolphthalein: It turns pinkish red in bases.

Methyl orange: It turns pinkish red in acids, and turns yellow in bases.

Activity 2.2

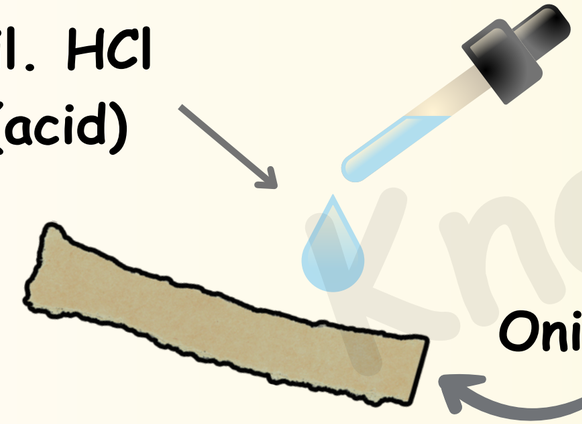
Activity 2.2

- Take some finely chopped onions in a plastic bag along with some strips of clean cloth. Tie up the bag tightly and leave overnight in the fridge. The cloth strips can now be used to test for acids and bases.
- Take two of these cloth strips and check their odour.
- Keep them on a clean surface and put a few drops of dilute HCl solution on one strip and a few drops of dilute NaOH solution on the other.
- Rinse both cloth strips with water and again check their odour.
- Note your observations.
- Now take some dilute vanilla essence and clove oil and check their odour.
- Take some dilute HCl solution in one test tube and dilute NaOH solution in another. Add a few drops of dilute vanilla essence to both test tubes and shake well. Check the odour once again and record changes in odour, if any.
- Similarly, test the change in the odour of clove oil with dilute HCl and dilute NaOH solutions and record your observations.

Onion

These onion-treated strips has a sulfur compounds.

dil. HCl
(acid)

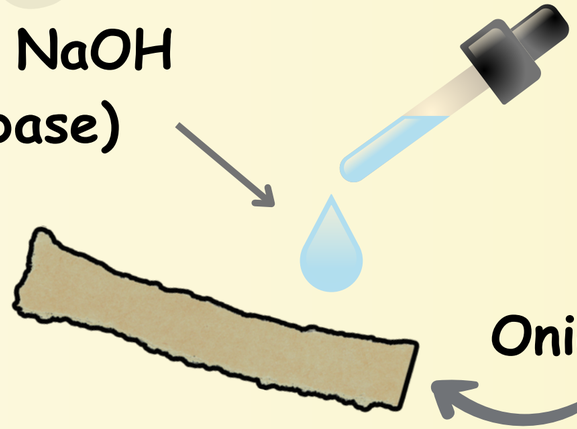


Onion treated strip
(acidic)

Observation

Smell remains as it is.

dil. NaOH
(base)

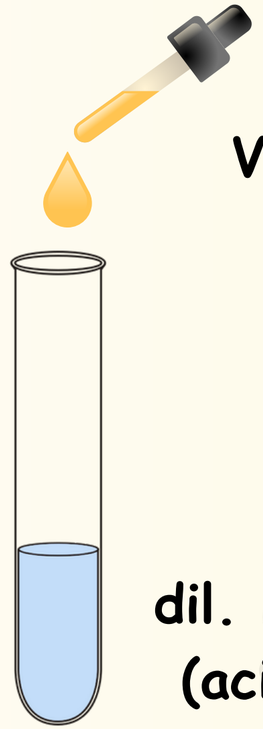


Onion treated strip
(acidic)

Observation

Smell disappears.

Vanilla essence / clove oil



Vanilla essence / clove oil

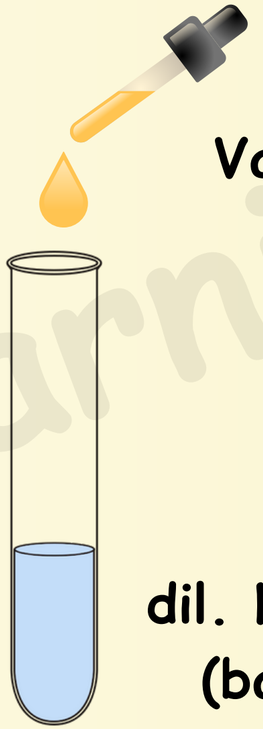
(acidic)

dil. HCl

(acid)

Observation

Smell remains as it is.



Vanilla essence / clove oil

(acidic)

dil. NaOH

(base)

Observation

Smell disappears.

Why this happened?

- Onion, vanilla and clove oil are the olfactory indicators that are slightly acidic in nature.

- When these acidic olfactory indicators reacts with acids, their smell remains as it is, and when they reacts with base, its smell disappears.

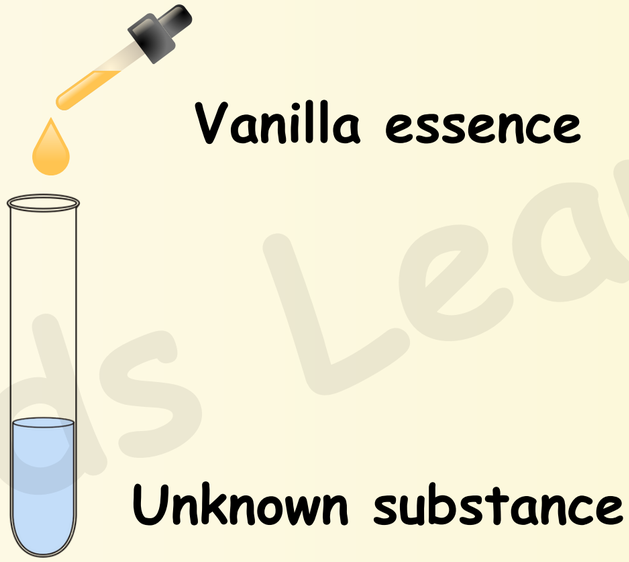
Remember:

→ Olfactory indicators (like onion, vanilla, clove oil) + Acid = Smell remains as it is 

→ Olfactory indicators (like onion, vanilla, clove oil) + Base = Smell disappears 

Question

Que: When a vanilla essence is added to the unknown substance, its smell disappears. Identify whether the unknown substance is acidic or basic.



Ans: - Vanilla essence is an olfactory indicator which is slightly acidic in nature. And it loses its smell only when it reacts with the base.

- So the unknown substance is basic in nature.

Activity 2.3

Activity 2.3

CAUTION: This activity needs the teacher's assistance.

- Set the apparatus as shown in Fig. 2.1.
- Take about 5 mL of dilute sulphuric acid in a test tube and add a few pieces of zinc granules to it.
- What do you observe on the surface of zinc granules?
- Pass the gas being evolved through the soap solution.
- Why are bubbles formed in the soap solution?
- Take a burning candle near a gas filled bubble.
- What do you observe?
- Repeat this Activity with some more acids like HCl, HNO_3 and CH_3COOH.
- Are the observations in all the cases the same or different?

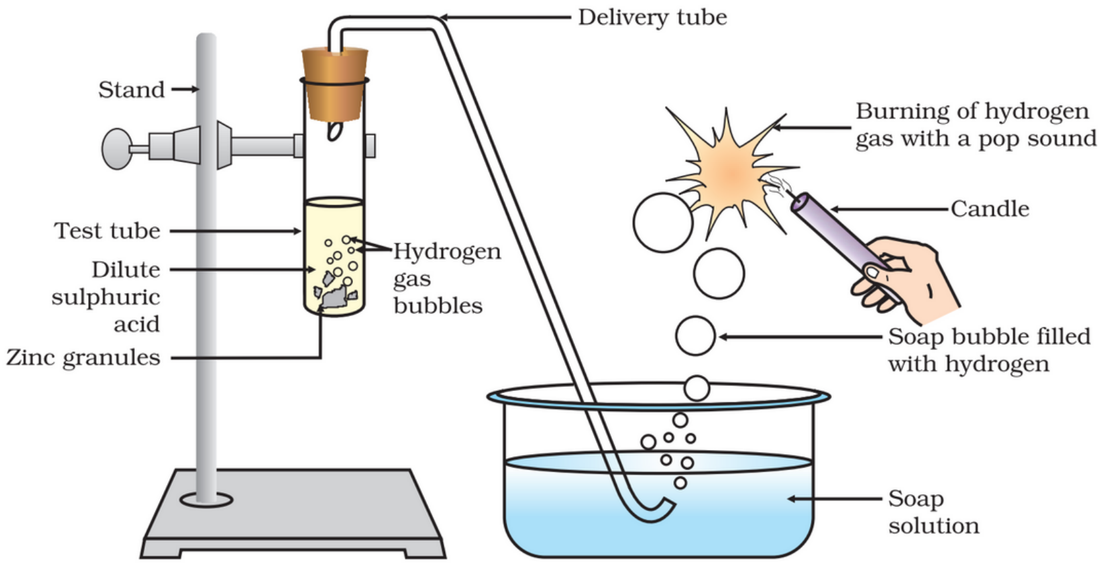


Figure 2.1 *Reaction of zinc granules with dilute sulphuric acid and testing hydrogen gas by burning*

Reaction involved:

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

Questions

Que: **What will you observe when zinc granules reacts with dilute sulphuric acid?**

Ans: - When zinc granules react with dilute sulfuric acid, you will observe the evolution of hydrogen gas from the surface of zinc granules.

- Also these reactions are exothermic reactions, meaning heat will liberate during this reactions.

- The chemical equation for the reaction is as follows:

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

Que: **Why do we hear the pop sound when a burning candle is kept near the exit of the delivery tube in the above activity?**

Ans: - The pop sound occurs when the burning candle is brought near the exit of the delivery tube because the hydrogen gas being released from the reaction between the zinc and the acid combusts upon contact with the flame of the candle.

- This combustion reaction produces a small explosion, resulting in the pop sound.

Que: **What happens when CH3COOH (acetic acid) is used in the above activity?**

Ans: - CH3COOH (acetic acid) is a weak acid. And due to its weaker acidic properties, the reaction between CH3COOH and zinc will proceed at a slower rate and produce less hydrogen gas.

- Therefore, the rate of bubble formation and the intensity of the reaction will be lower compared to strong acids.

Activity 2.4

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.

Reaction involved:

$$Zn + 2NaOH \longrightarrow \underset{\text{(Sodium zincate)}}{Na_2ZnO_2} + H_2$$

Questions

Que: **What happens when a metal reacts with a base? Give one example.**

Ans: - When a metal reacts with a base, it undergoes a displacement reaction and forms a salt and a liberates a hydrogen gas.

- **For example:** When granulated zinc metal reacts with sodium hydroxide solution, a salt (sodium zincate) is formed and a hydrogen gas is evolved.

- The reaction can be represented as:

$$Zn + 2NaOH \longrightarrow \underset{\text{(Sodium zincate)}}{Na_2ZnO_2} + H_2$$

Activity 2.5

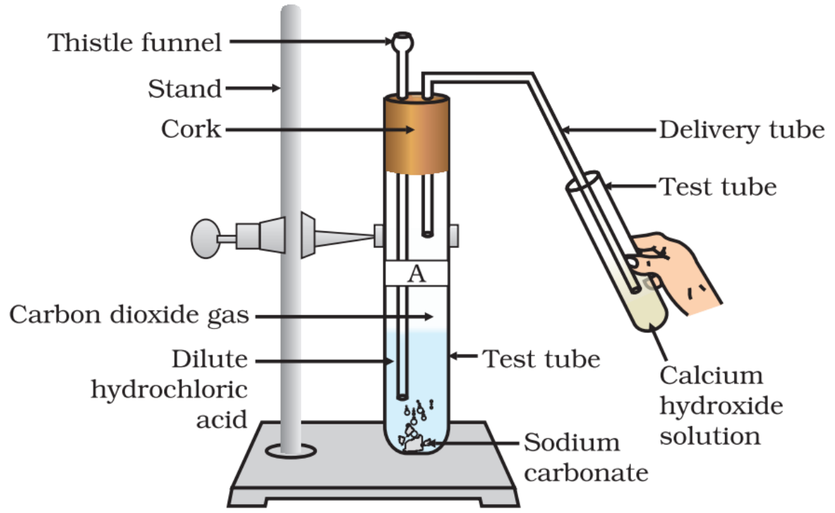


Figure 2.2
Passing carbon dioxide gas through calcium hydroxide solution

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.

Reaction involved:

Test tube A: $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

Test tube B: $NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$

On passing the carbon dioxide gas through lime water;

$$\underset{\text{(Lime water)}}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\text{(White precipitate)}}{CaCO_3(s)} + H_2O$$

Questions

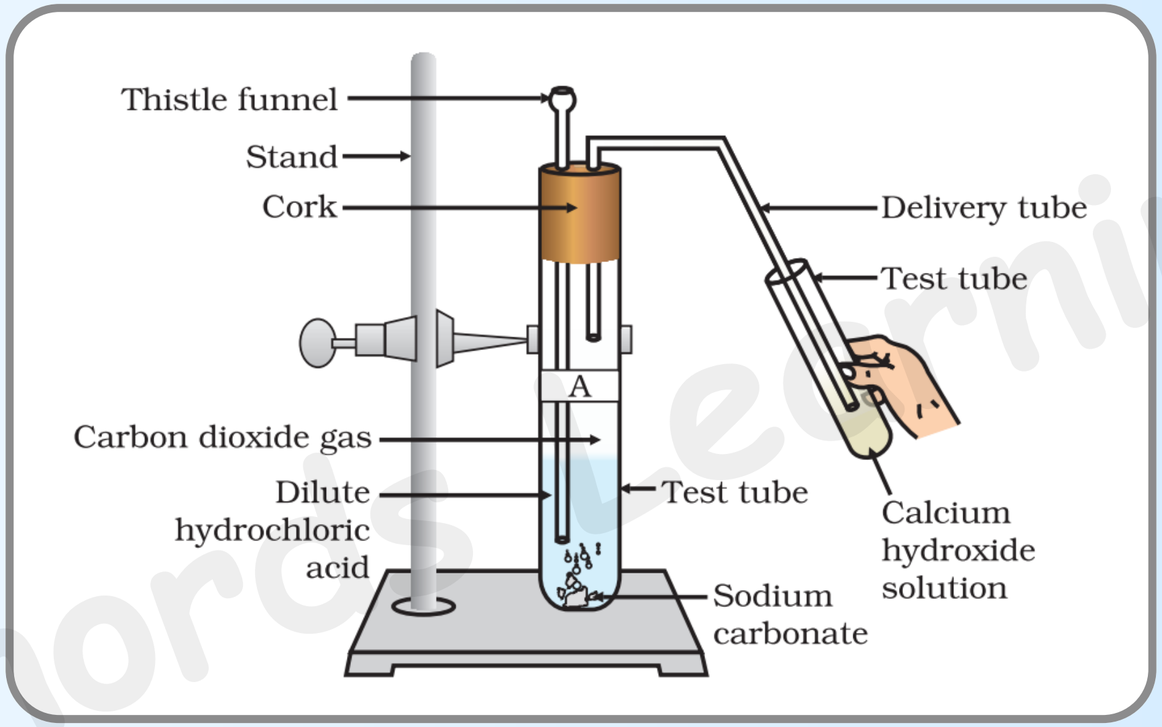
Que: **What happens when a metal carbonates reacts with acids? Explain with an example.**

Ans: - The metal carbonate reacts with the acid, it forms the corresponding salt of the metal, water, and carbon dioxide gas.

- Here is an example of the reaction between sodium carbonate (metal carbonate) and hydrochloric acid.

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$$

Que: What happens when the CO2 gas is passed over the calcium hydroxide solution in the test tube? Explain with a chemical reaction.



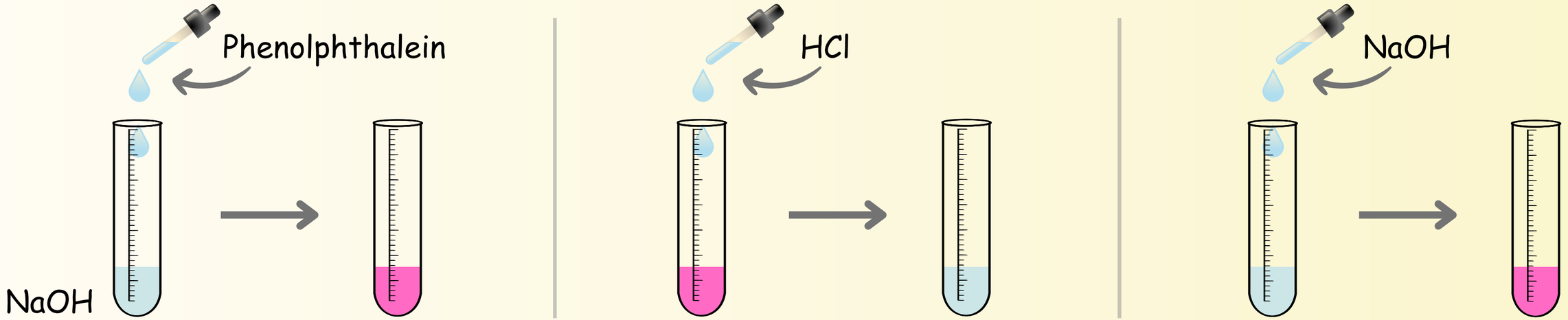
Ans: - When carbon dioxide gas is passed over calcium hydroxide solution [Ca(OH)2], it reacts to form calcium carbonate ($CaCO_3$) and water. The calcium carbonate appears as a solid white precipitate in the test tube. The chemical equation for this reaction is as follows;

$$\underset{\text{(Lime water)}}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\text{(White precipitate)}}{CaCO_3(s)} + H_2O$$

Activity 2.6

Activity 2.6

- Take about 2 mL of dilute NaOH solution in a test tube and add two drops of phenolphthalein solution.
- What is the colour of the solution?
- Add dilute HCl solution to the above solution drop by drop.
- Is there any colour change for the reaction mixture?
- Why did the colour of phenolphthalein change after the addition of an acid?
- Now add a few drops of NaOH to the above mixture.
- Does the pink colour of phenolphthalein reappear?
- Why do you think this has happened?



What have you learnt?

Side note: Phenolphthalein is an indicator which is colorless.

→ Phenolphthalein + Base = Pink color

→ Phenolphthalein + Acid = Colorless

- In the above activity, the phenolphthalein reacts with base (NaOH) and it turns pink in color. But when acid (HCl) is added to this test tube, it again turns colorless.

- And again when base (NaOH) is added to this test tube, the solution turns to pink again.

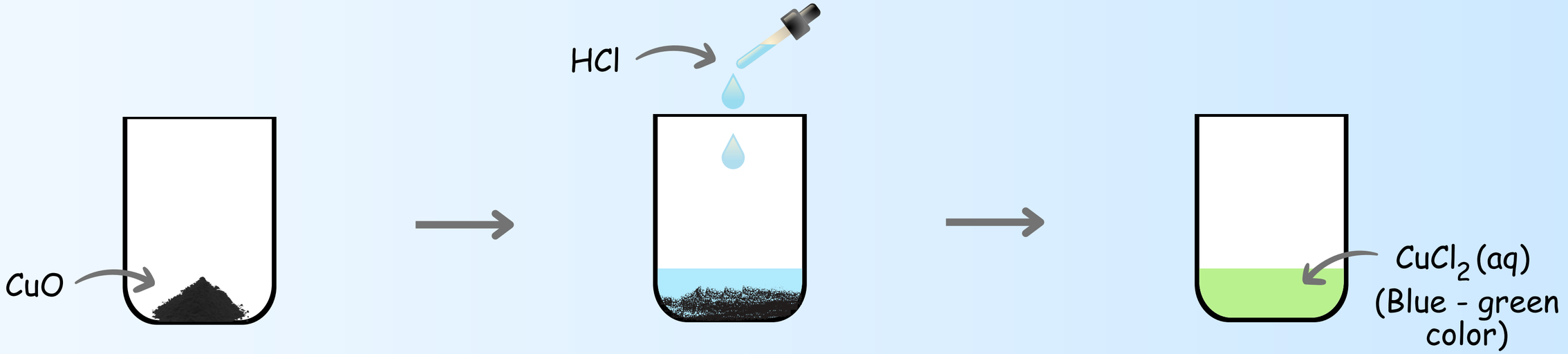
- So in the above activity, we have observed that the effect of a base is nullified by an acid and vice-versa.

- The reaction between an acid and a base to give a salt and water is known as a neutralisation reaction.

Activity 2.7

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?



Reaction involved:

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

Questions

Que: **What happens when a metal oxides reacts with acids? Explain with an example.**

Ans: - The metal oxide reacts with the acid to form the corresponding salt of the metal and water.

- Here is an example of the reaction between copper oxide (metal oxide) and hydrochloric acid.

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

- During this reaction, the color of the solution turns blue-green, which indicated the presence of copper chloride (CuCl2).

Que: **When dilute hydrochloric acid is added to the metal oxide, it forms salt and water. Identify whether the metal oxide is acidic or basic.**

Ans: - When dilute hydrochloric acid is added to a metal oxide and it forms salt and water, which is similar to the acid reacting with base to form salt and water.

Acid + Base = Salt + water

Acid + Metal oxide = Salt + water

- As the metal oxide is capable of neutralizing the acid, it is considered basic in nature.

Activity 2.8

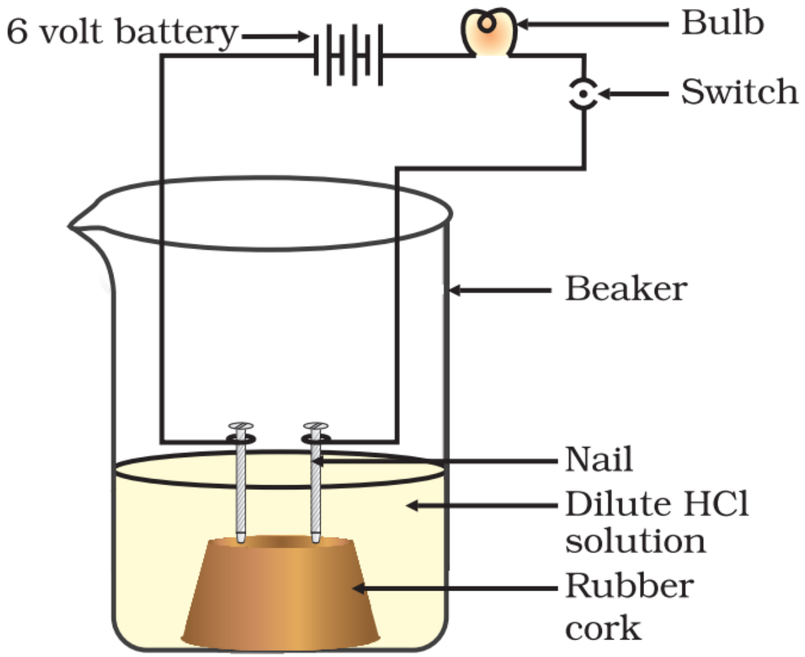


Figure 2.3
Acid solution in water conducts electricity

Activity 2.8

- Take solutions of glucose, alcohol, hydrochloric acid, sulphuric acid, etc.
- Fix two nails on a cork, and place the cork in a 100 mL beaker.
- Connect the nails to the two terminals of a 6 volt battery through a bulb and a switch, as shown in Fig. 2.3.
- Now pour some dilute HCl in the beaker and switch on the current.
- Repeat with dilute sulphuric acid.
- What do you observe?
- Repeat the experiment separately with glucose and alcohol solutions. What do you observe now?
- Does the bulb glow in all cases?

Observations

→ The bulb will start glowing in the case of acids (i.e. HCl and H_2SO_4).

→ The bulb will not glow in the case of a glucose and alcohol.

- Glowing of bulb indicates that there is a flow of electric current through the solution.

- The electric current is carried through the acidic solution by ions.

What have you learnt?

→ All the acids produces H^+ ions in solution.

→ All the bases produces OH^- ions in solution.

Questions

Que: **Why does an aqueous solution of an acid conduct electricity?**

Ans: - An aqueous solution of an acid conducts electricity because acids ionize or dissociate in water, producing ions that can carry electric charge.

- Acids produces hydrogen ions (H+ ions) in solution. These hydrogen ions can carry electric charge through the solution.

Activity 2.9

Activity 2.9

- Take about 1g solid NaCl in a clean and dry test tube and set up the apparatus as shown in Fig. 2.4.
- Add some concentrated sulphuric acid to the test tube.
- What do you observe? Is there a gas coming out of the delivery tube?
- Test the gas evolved successively with dry and wet blue litmus paper.
- In which case does the litmus paper change colour?
- On the basis of the above Activity, what do you infer about the acidic character of:
  (i) dry HCl gas
  (ii) HCl solution?

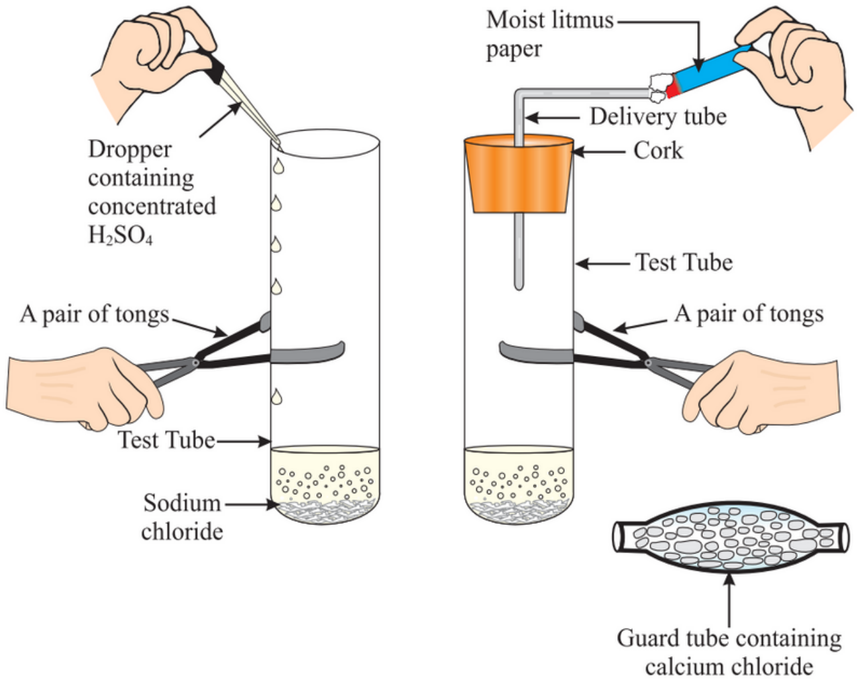


***Figure 2.4** Preparation of* HCl *gas*

Note to teachers: If the climate is very humid, you will have to pass the gas produced through a guard tube (drying tube) containing calcium chloride to dry the gas.

Reaction involved:

$$2NaCl(s) + H_2SO_4(l) \longrightarrow Na_2SO_4(s) + 2HCl(g)$$

Observations

- Dry HCl gas is an acidic gas and it will come out from the delivery tube.
- When dry blue litmus paper is brought near this HCl gas, the litmus will not turn red.
- But when moist blue litmus paper is brought near this HCl gas, the litmus will turn red.

What have you learnt?

- This experiment suggests that hydrogen ions (H+ ions) in HCl are produced in the presence of water.
- The separation of H+ ion from HCl molecules cannot occur in the absence of water.
- Hydrogen ions cannot exist alone, but they exist after combining with water molecules.
- Thus hydrogen ions must always be shown as H+ (aq) or hydronium ion (H_3O^+).

Questions

Que: **Why does dry HCl gas not change the colour of the dry litmus paper?**

Ans: - Dry HCl gas does not change the color of dry litmus paper because it does not contain water.

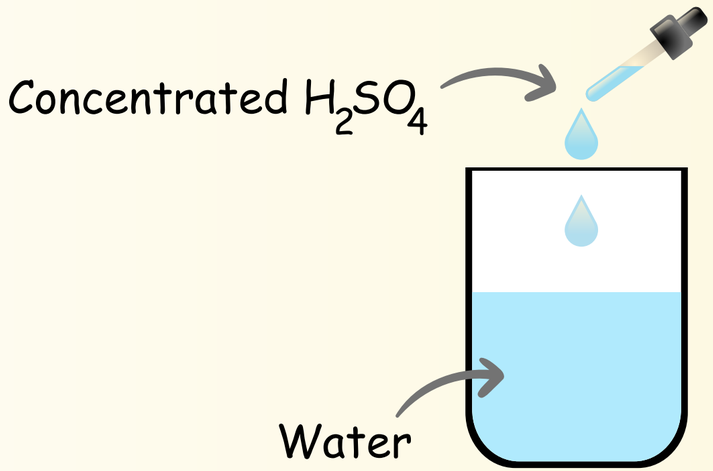
- Litmus paper changes color in the presence of acidic or basic solutions due to the presence of water which is responsible for ionization of acids or bases.

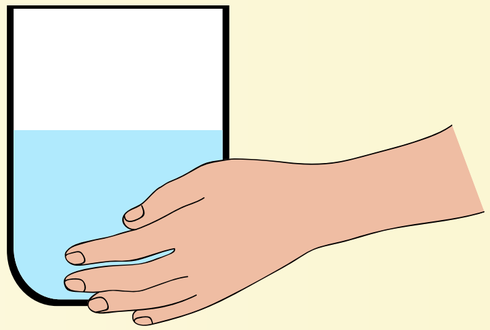
- Dry HCl gas lacks the water needed for ionization, so it cannot produce hydrogen ions (H+) responsible for acidic properties. Therefore, it does not react with dry litmus paper.

Activity 2.10

Activity 2.10

- Take 10 mL water in a beaker.
- Add a few drops of concentrated H_2SO_4 to it and swirl the beaker slowly.
- Touch the base of the beaker.
- Is there a change in temperature?
- Is this an exothermic or endothermic process?
- Repeat the above Activity with sodium hydroxide pellets and record your observations.





Observation

→ The process of dissolving an acid or a base in water is a **highly exothermic** one.

Questions

Que: **While diluting an acid, why is it recommended that the acid should be added to water and not water to the acid?**

Ans: - It is recommended to add acid to water rather than water to acid while diluting because adding water to acid can result in a highly exothermic reaction, potentially causing the solution to splash or boil, leading to dangerous accidents.

- The glass container may also break due to excessive local heating. So it is always recommended to add acid to the water.

Activity 2.11

Activity 2.11

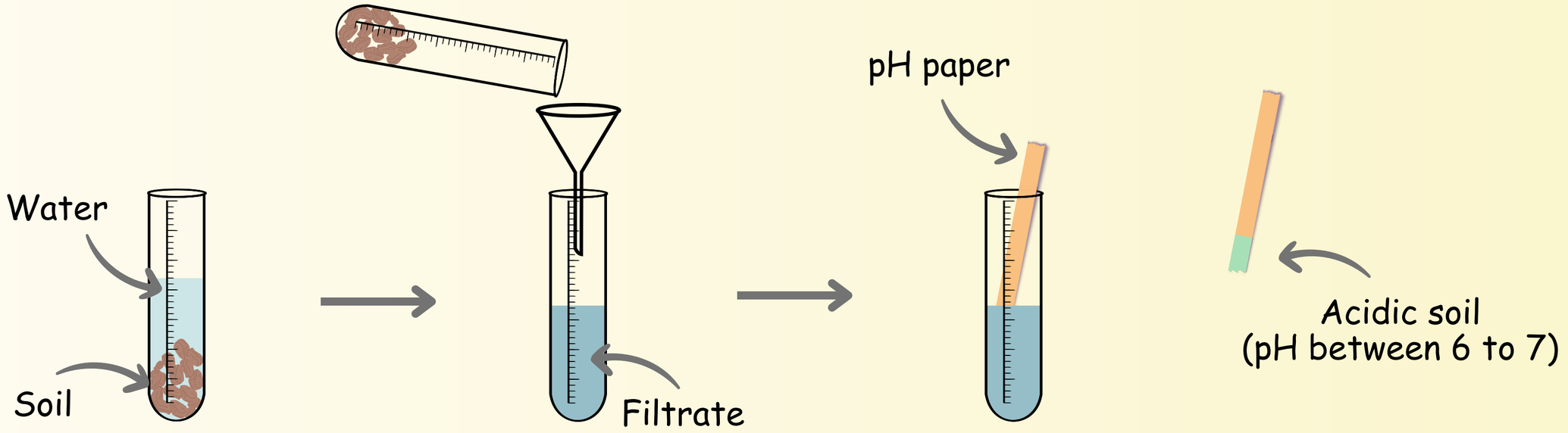
- Test the pH values of solutions given in Table 2.2.
- Record your observations.
- What is the nature of each substance on the basis of your observations?

S. No.	Solution	Colour of pH paper	Approx--imate pH value	Nature of substance
1	Saliva (before meal)	Green	7.4	Basic
2	Saliva (after meal)	Yellow-green	6	Acidic
3	Lemon juice	Orange	2.5	Acidic
4	Colourless aerated drink	Yellow-green	6	Acidic
5	Carrot juice	Yellow	5.5	Acidic
6	Coffee	Orange	5	Acidic
7	Tomato juice	Orange	4	Acidic
8	Tap water	Green	6.5 to 8	Acidic/Basic
9	1M NaOH	Dark blue	14	Basic
10	1M HCl	Red	0	Acidic

Activity 2.12

Activity 2.12

- Put about 2 g soil in a test tube and add 5 mL water to it.
- Shake the contents of the test tube.
- Filter the contents and collect the filtrate in a test tube.
- Check the pH of this filtrate with the help of universal indicator paper.
- What can you conclude about the ideal soil pH for the growth of plants in your region?



Questions

Que: **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)?**

Ans: - A farmer would treat the soil of his fields with quicklime (calcium oxide), slaked lime (calcium hydroxide), or chalk (calcium carbonate) under **acidic soil conditions.**

- These substances are bases that will neutralize the acidity and raise the pH of the soil.

Activity 2.13

Activity 2.13

- Write the chemical formulae of the salts given below.
  Potassium sulphate, sodium sulphate, calcium sulphate, magnesium sulphate, copper sulphate, sodium chloride, sodium nitrate, sodium carbonate and ammonium chloride.
- Identify the acids and bases from which the above salts may be obtained.
- Salts having the same positive or negative radicals are said to belong to a family. For example, NaCl and Na_2SO_4 belong to the family of sodium salts. Similarly, NaCl and KCl belong to the family of chloride salts. How many families can you identify among the salts given in this Activity?

Sulphate salts

Chloride salts

Sodium salts

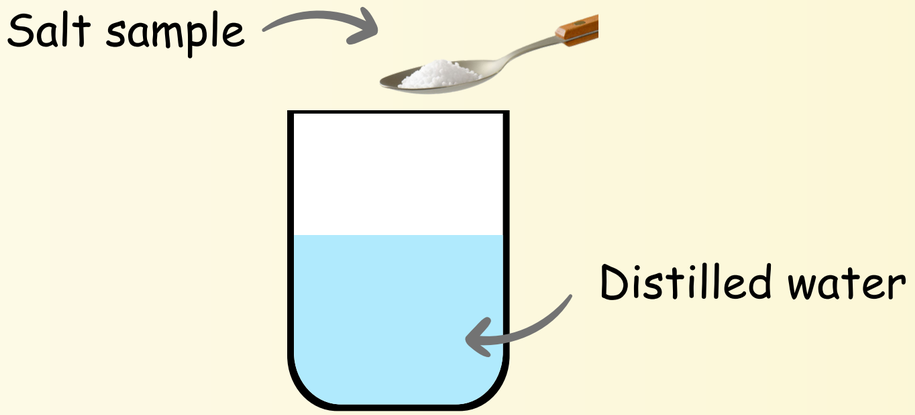
Salts	Chemical formulae	Base used	Acid used
Potassium sulphate	K_2SO_4	KOH	H_2SO_4
Sodium sulphate	Na_2SO_4	NaOH	H_2SO_4
Calcium sulphate	$CaSO_4$	$Ca(OH)_2$	H_2SO_4
Magnesium sulphate	$MgSO_4$	$Mg(OH)_2$	H_2SO_4
Copper sulphate	$CuSO_4$	$Cu(OH)_2$	H_2SO_4
Sodium chloride	NaCl	NaOH	HCl
Sodium nitrate	$NaNO_3$	NaOH	HNO_3
Sodium carbonate	Na_2CO_3	NaOH	H_2CO_3
Ammonium chloride	NH_4Cl	NH_4OH	HCl

Trick: **Aage "OH" add karo** to base milega, aur **piche "H" add karo** to acid milega

Activity 2.14

Activity 2.14

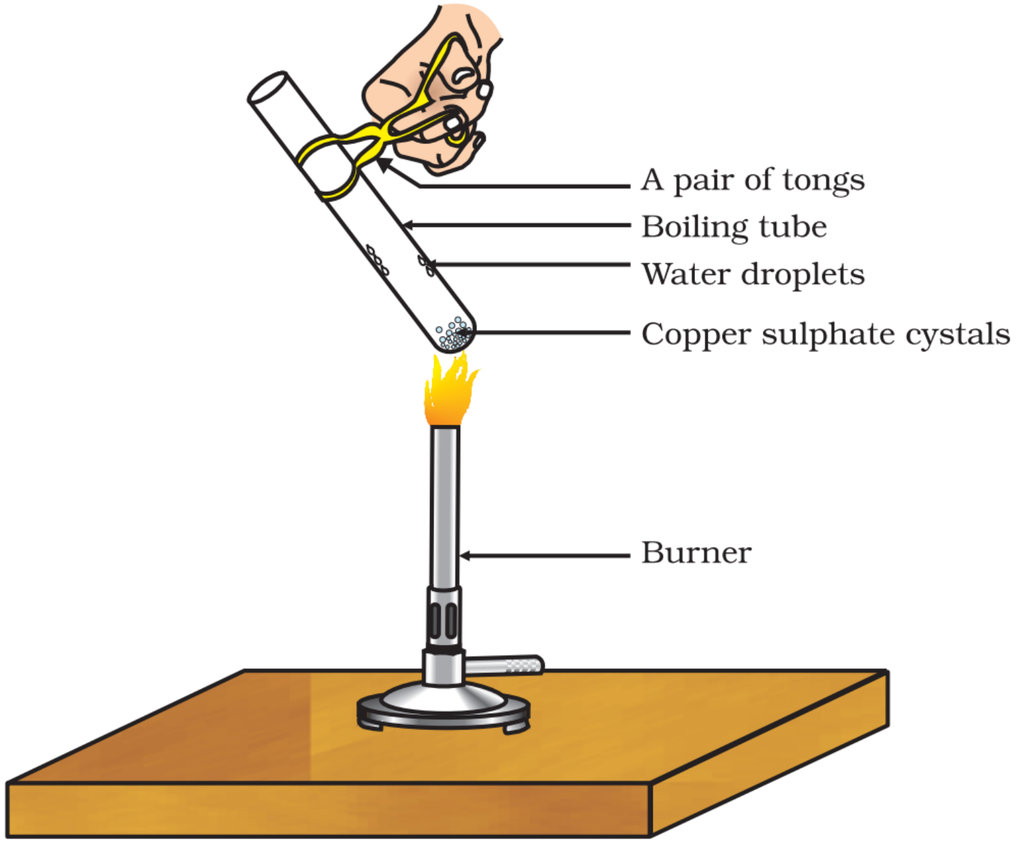
- Collect the following salt samples – sodium chloride, potassium nitrate, aluminium chloride, zinc sulphate, copper sulphate, sodium acetate, sodium carbonate and sodium hydrogencarbonate (some other salts available can also be taken).
- Check their solubility in water (use distilled water only).
- Check the action of these solutions on litmus and find the pH using a pH paper.
- Which of the salts are acidic, basic or neutral?
- Identify the acid or base used to form the salt.
- Report your observations in Table 2.4.



	Salts	pH	Base used	Acid used
Neutral salt	Sodium chloride	pH = 7 (Neutral salt)	NaOH	HCl
	Potassium nitrate	pH = 7 (Neutral salt)	KOH	HNO_3
Acidic salts	Aluminum chloride	pH < 7 (Acidic salt)	$Al(OH)_3$	HCl
	Zinc sulphate	pH < 7 (Acidic salt)	$Zn(OH)_2$	H_2SO_4
	Copper sulphate	pH < 7 (Acidic salt)	$Cu(OH)_2$	H_2SO_4
Basic salts	Sodium acetate	pH > 7 (Basic salt)	NaOH	CH_3COOH
	Sodium carbonate	pH > 7 (Basic salt)	NaOH	H_2CO_3
	Sodium hydrogencarbonate	pH > 7 (Basic salt)	NaOH	H_2CO_3

- Salts of a **strong acid** and a **strong base** are **neutral** (pH value of 7).
- Salts of a **strong acid** and **weak base** are **acidic** (pH value less than 7).
- Salts of a **strong base** and **weak acid** are **basic** (pH value more than 7).

Activity 2.15



Activity 2.15

- Heat a few crystals of copper sulphate in a dry boiling tube.
- What is the colour of the copper sulphate after heating?
- Do you notice water droplets in the boiling tube? Where have these come from?
- Add 2-3 drops of water on the sample of copper sulphate obtained after heating.
- What do you observe? Is the blue colour of copper sulphate restored?

Observation

- Heating copper sulfate **changes its color from blue to white** due to the loss of water molecules.
- Water droplets are formed in the boiling tube from the released water vapor during heating.
- **Adding water** to the heated **copper sulfate restores its blue color** as it rehydrates to form hydrated copper sulfate.

What have you learnt?

- The **salts contains some water molecules** in it; for example, the formula of copper sulfate is $CuSO_4 . 5H_2O$. So **copper sulfate has 5 molecules of water**.

- This fixed number of water molecules ($5H_2O$) present in one formula unit of a copper sulfate is the **water of crystallisation**.