

## 9th Science Lesson 14 Notes in English

## 14] Acids, Bases And Salts

## Introduction

- We know that the physical world around us is made of large number of **chemicals**.
- Soil, air, water, all the life forms and the materials that they use are all consist of chemicals.
- Out of such chemicals, acids, bases and salts are mostly used in everyday life.
- Let it be a fruit juice or a detergent or a medicine, they play a key role in our day-to- day activities.
- Our body metabolism is carried out by means of **hydrochloric acid** secreted in our stomach.

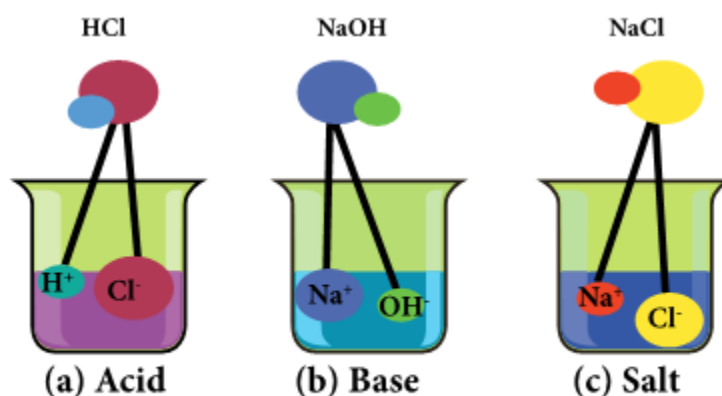


Figure 14.1 Acid, base and salt

- An acid is a the compound which is capable of forming **hydrogen ions** (H<sup>+</sup>) in **aqueous solution** whereas a base is a compound that forms **hydroxyl ions** (OH<sup>-</sup>) in solution.
- When an acid and a base react with each other, a neutral product is formed which is called **salt**.
- In this lesson let us discuss about them in detail.

## Acids

- Look at the pictures of some of the materials used in our daily life, given below: All these edible items taste similar i.e. sour.
- What causes them to taste sour?
- A certain type of chemical compounds present in them gives sour taste. These are called **acids**.
- The word 'acid' is derived from the Latin name "**acidus**" which means sour taste.
- Substances with sour taste are called **acids**.
- In 1884, a Swedish chemist **Svante Arrhenius** proposed a theory on acids and bases.
- According to **Arrhenius theory**, an acid is a substance which furnishes H<sup>+</sup> ions or H<sub>3</sub>O<sup>+</sup> ions in aqueous solution.



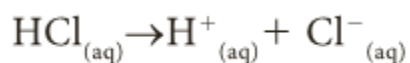
**Figure 14.2** Acid, base and salt in food

- They contain one or more replaceable hydrogen atoms.

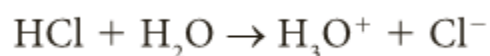
**Table 14.1** Acid and its source

Source	Acid Present
Apple	Malic acid
Lemon	Citric acid
Grape	Tartaric acid
Tomato	Oxalic acid
Vinegar	Acetic acid
Curd	Lactic acid
Orange	Ascorbic acid
Tea	Tannic acid
Stomach juice	Hydrochloric acid
Stings of Ant, Bee	Formic acid

- For example, when hydrogen chloride is dissolved in water, it gives H<sup>+</sup> and Cl<sup>-</sup> ions in water.

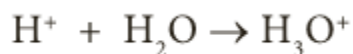


- What happens to an acid or a base in water? Do acids produce ions only in aqueous solution?
- Hydrogen ions in **HCl** are produced in the presence of water.



- The separation of H<sup>+</sup> ion from HCl molecules cannot occur in the absence of water.
- Hydrogen ions cannot exist alone, but they exist in combined state with water molecules.

- Thus, hydrogen ions must always be H<sup>+</sup> (or) **Hydronium** (H<sub>3</sub>O<sup>+</sup>).



**Table 14.2** Ions formed by acids

Acid	Molecular Formula	Ions formed		No. of replaceable hydrogen
Acetic Acid	CH <sub>3</sub> COOH	H <sup>+</sup>	CH <sub>3</sub> COO <sup>-</sup>	1
Formic Acid	HCOOH	H <sup>+</sup>	HCOO <sup>-</sup>	1
Nitric Acid	HNO <sub>3</sub>	H <sup>+</sup>	NO <sub>3</sub> <sup>-</sup>	1
Sulphuric Acid	H <sub>2</sub> SO <sub>4</sub>	2H <sup>+</sup>	SO <sub>4</sub> <sup>2-</sup>	2
Phosphoric Acid	H <sub>3</sub> PO <sub>4</sub>	3H <sup>+</sup>	PO <sub>4</sub> <sup>3-</sup>	3

- The following table enlists various acids and the ions formed by them in water.

### Classification of Acids

- Acids are classified in different ways as given below:

#### (a) Based on their sources:

- Organic Acids:** Acids present in plants and animals (living things) are organic acids. Example: HCOOH, CH<sub>3</sub>COOH
- Inorganic Acids:** Acids prepared from rocks and minerals are inorganic acids or mineral acids. Example: HCl, HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>

#### (b) Based on their Basicity

- Monobasic Acid:** Acid that contain only one replaceable hydrogen atom per molecule is called monobasic acid.
- It gives one hydrogen ion per molecule of the acid in solution. Example: HCl, HNO<sub>3</sub>
- Dibasic Acid:** An acid which gives two hydrogen ions per molecule of the acid in solution. Example: H<sub>2</sub>SO<sub>4</sub>, H<sub>2</sub>CO<sub>3</sub>
- Tribasic Acid:** An acid which gives three hydrogen ions per molecule of the acid in solution. Example: H<sub>3</sub>PO<sub>4</sub>

**(c) Based on Ionisation**

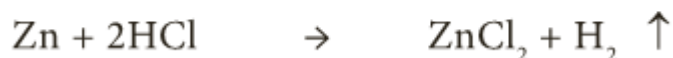
- Acids get ionised in water (produce H<sup>+</sup> ions) completely or partially.
- Based on the extent of ionisation acids are classified as below.
- **Strong Acids:** These are acids that ionise completely in water. Example: HCl
- **Weak Acids:** These are acids that ionise partially in water. Example: CH<sub>3</sub>COOH.

**(d) Based on Concentration**

- **Concentrated Acid:** It has relatively large amount of acid dissolved in a solvent.
- **Dilute Acid:** It has relatively smaller amount of acid dissolved in solvent.

**Properties of Acids**

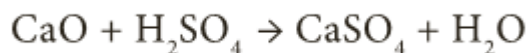
- They have sour taste.
- Their aqueous solutions conduct electricity since they contain ions.
- Acids turns blue litmus red.
- Acids react with active metals to give hydrogen gas.



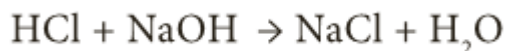
- Acids react with metal carbonate and metal hydrogen carbonate to give carbon dioxide.



- Acids react with metallic oxides to give salt and water.



- Acids react with bases to give salt and water.



- The reaction is known as **neutralisation reaction**.

**Activity 1**

- Take about 10 ml of dilute hydrochloric acid in a test tube and add a few pieces of zinc granules into it.
- What do you observe?
- Why are bubbles formed in the solution?
- Take a burning candle near a bubble containing hydrogen gas, the flame goes off with a 'Popping' sound.
- This confirms that metal displaces hydrogen gas from the dilute acid.

**Caution:**

- Care must be taken while mixing any concentrated inorganic acid with water.
- The acid must be added slowly and carefully with constant stirring to water since it generates large amount of heat.
- If water is added to acid, the mixture splashes out of the container and it may cause burns.

**Uses of Acids**

- Sulphuric acid is called **King of Chemicals** because it is used in the preparation of many other compounds.
- It is used in **car batteries** also.
- Hydrochloric acid is used as a **cleansing agent** in toilets.
- Citric acid is used in the preparation of **effervescent salts** and as a food preservative.
- Nitric acid is used in **the manufacture of fertilizers, dyes, paints and drugs**.
- Oxalic acid is used to **clean iron and manganese deposits** from quartz crystals.
- It is also used as **bleach** for wood and removing black stains.
- Carbonic acid is used in **aerated drinks**.
- Tartaric acid is a constituent of **baking powder**.

**Aquaregia**

- We know that metals like gold and silver are not reactive with either HCl or HNO<sub>3</sub>. But the mixture of these two acids can dissolve gold.
- This mixture is called **Aquaregia**.
- It is a mixture of hydrochloric acid and nitric acid prepared optimally in a molar ratio of 3:1.
- It is a yellow-orange fuming liquid.
- It is a highly corrosive liquid, able to attack gold and other substances.
- **Chemical formula:** 3 HCl + HNO<sub>3</sub>
- **Solubility in Water:** Miscible in water
- **Melting point:** - 42°C (- 44°F, 231K)
- **Boiling point:** 108°C (226°F, 381K)
- The term aquaregia is a Latin phrase meaning '**King's Water**'.
- The name reflects the ability of aquaregia to dissolve the noble metals such as gold, platinum and palladium.

**Uses of Aquaregia**

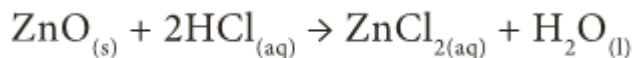
- (1) It is used chiefly to dissolve metals such as gold and platinum.
- (2) It is used for cleaning and refining gold.

**Bases**

- According to **Arrhenius theory**, bases are substances that ionise in water to form **hydroxyl ions (OH<sup>-</sup>)**.
- There are some metal oxides which give salt and water on reaction with acids. These are also called **bases**.
- Bases that are soluble in water are called **alkalis**.
- A base reacts with an acid to give salt and water only.



- For example, **zinc oxide (ZnO)** reacts with **HCl** to give the salt zinc chloride and water.



- Similarly, **sodium hydroxide ionises** in water to give hydroxyl ions and thus get dissolved in water.
- So it is an alkali.



- Bases contain one or more replaceable oxide or hydroxyl ions in solution.

**Table 14.3** Ions formed by bases in water.

Base	Molecular Formula	Ions formed		No. of replaceable hydroxyl ion
Calcium oxide	CaO	Ca <sup>2+</sup>	O <sup>2-</sup>	1
Sodium oxide	Na <sub>2</sub> O	Na <sup>+</sup>	O <sup>2-</sup>	1
Potassium hydroxide	KOH	K <sup>+</sup>	OH <sup>-</sup>	1
Calcium hydroxide	Ca(OH) <sub>2</sub>	Ca <sup>2+</sup>	OH <sup>-</sup>	2
Aluminium hydroxide	Al(OH) <sub>3</sub>	Al <sup>3+</sup>	OH <sup>-</sup>	3

- Table 14.3 enlists various bases and ions formed by them in water.

## Classification of Bases

### (a) Based on their Acidity

- **Monoacidic Base:** It is a base that ionises in water to give one hydroxide ion per molecule.  
Example: NaOH, KOH
- **Diacidic Base:** It is a base that ionises in water to give two hydroxide ions per molecule.  
Example: Ca(OH)<sub>2</sub>, Mg(OH)<sub>2</sub>
- **Triacidic Base:** It is a base that ionises in water to give three hydroxide ions per molecule.  
Example: Al(OH)<sub>3</sub>, Fe(OH)<sub>3</sub>

### (b) Based on concentration

- **Concentrated Alkali:** It is an alkali having a relatively high percentage of alkali in its aqueous solution.

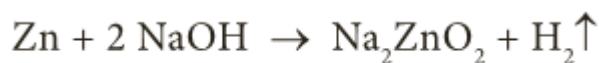
- **Dilute Alkali:** It is an alkali having a relatively low percentage of alkali in its aqueous solution.

### (c) Based on Ionisation

- **Strong Bases:** These are bases which ionise completely in aqueous solution. Example: NaOH, KOH
- **Weak Bases:** These are bases that ionise partially in aqueous solution. Example: NH<sub>4</sub>OH, Ca(OH)<sub>2</sub>

### Properties of Bases

- a. They have **bitter taste**.
- b. Their aqueous solutions have **soapy touch**.
- c. They turn **red** litmus blue.
- d. Their aqueous solutions **conduct electricity**.
- e. Bases react with metals to form salt with the liberation of hydrogen gas.



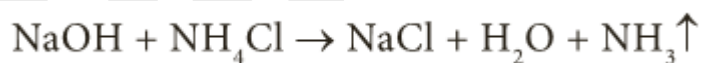
- f. Bases react with non-metallic oxides to produce salt and water. Since this is similar to the reaction between a base and an acid, we can conclude that non-metallic oxides are acidic in nature.



- g. Bases react with acids to form salt and water. The above reaction between a base and an acid is known as **Neutralisation reaction**.



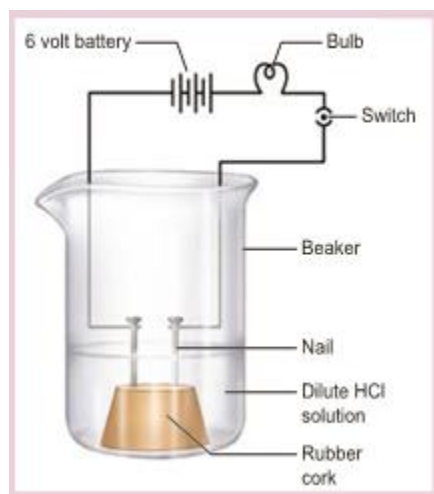
- h. On heating with ammonium salts, bases give ammonia gas.



### Activity 2

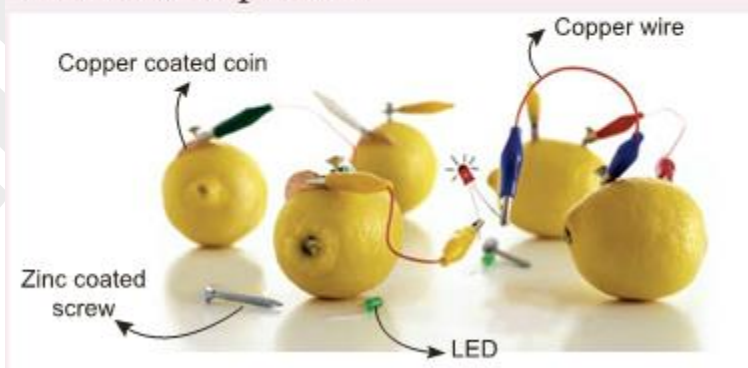
- Take solutions of hydrochloric acid or sulphuric acid. Fix two nails on a cork and place the cork in a 100 ml beaker.
- Connect the nails to the two terminals of a 6V battery through a bulb and a switch as shown in Figure.





- Now pour some dilute HCl in the beaker and switch on the current.
- Repeat the activity with dilute sulphuric acid, glucose and alcohol solutions.
- What do you observe now?
- Does the bulb glow in all cases?
- In the above activity you can observe that the bulb will start glowing only in the case of acids.
- But, you will observe that glucose and alcohol solution do not conduct electricity.
- Glowing of the bulb indicates that there is a flow of electric current through the solution.
- The electric current is carried through the solution by ions.
- Repeat the same activity using alkalis such as sodium hydroxide and calcium hydroxide.
- **Try Yourself:** Construct a Lemon cell as shown in picture. Copper wire Copper coated coin

**Try Yourself: Construct a Lemon cell as shown in picture.**



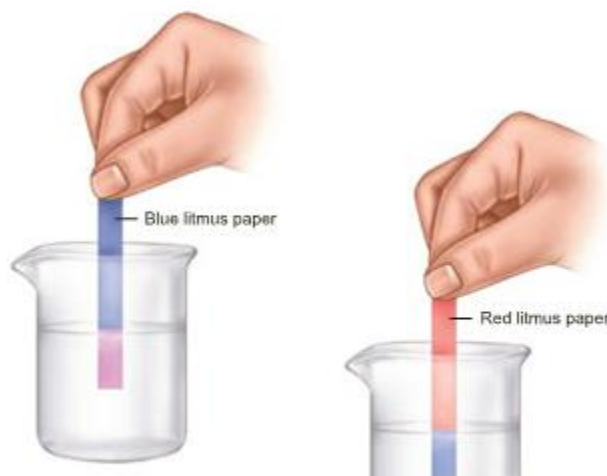
### Uses of Bases

- I Sodium hydroxide is used in the manufacture of soap.
- II Calcium hydroxide is used in white washing of building.
- III Magnesium hydroxide is used as a medicine for stomach disorder.
- IV Ammonium hydroxide is used to remove grease stains from cloths.



### Tests for Acids and Bases

- Test with a litmus paper:** An acid turns blue litmus paper into red. A base turns red litmus paper into blue.
- Test with an indicator Phenolphthalein:** In acid medium, phenolphthalein is colourless. In basic medium, phenolphthalein is pink in colour.



**Figure 14.3** Test for acid and base using litmus paper

- Test with an indicator Methyl orange:** In acid medium, methyl orange is pink in colour. In basic medium, methyl orange is yellow in colour.



**Figure 14.4** Test for acid and base using indicator

**Table 14.4** Acid base indicator

Indicator	Colour in acid	Colour in base
Litmus	Blue to Red	Red to Blue
Phenolphthalein	Colourless	Pink
Methyl orange	Pink	Yellow

### Activity 3

- Collect the following samples from the science laboratory – Hydrochloric acid, Sulphuric acid and Nitric acid, Sodium hydroxide, Potassium hydroxide.
- Take 2 ml of each solution in a test tube and test with a litmus paper and indicators phenolphthalein and Methyl orange.
- Tabulate your observations.

### Strength of Acidic or Basic solutions

#### pH Scale

- A scale for measuring **hydrogen ion concentration** in a solution is called **pH scale**.
  - The 'p' in pH stands for '**potenz**' in German meaning power.
  - pH scale is a set of numbers from 0 to 14 which is used to indicate whether a solution is acidic, basic or neutral.
- (1) **Acids have pH less than 7**
  - (2) **Bases have pH greater than 7**
  - (3) **A neutral solution has pH equal to 7**

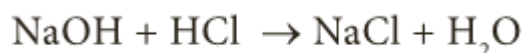
#### Salts

- When you say salt, you may think of the common salt.
- Sea water contains many salts dissolved in it.
- Sodium chloride is separated from these salts.
- There are many other salts used in other fields.
- Salts are the products of the reaction between acids and bases.
- Salts produce positive ions and negative ions when dissolved in water.

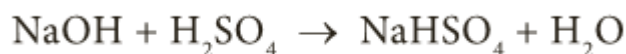


#### Types of Salts

- **Normal Salts:** A normal salt is obtained by complete neutralization of an acid by a base.



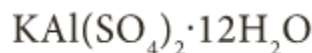
- **Acid Salts:** It is derived from the partial replacement of hydrogen ions of an acid by a metal.



- When a calculated amount of a base is added to a polybasic acid, acid salt is obtained.
- **Basic Salts:** Basic salts are formed by the partial replacement of hydroxide ions of a diacidic or triacidic base with an acid radical.



- **Double Salts:** Double salts are formed by the combination of the saturated solution of two simple salts in equimolar ratio followed by crystallization. For example, potash alum is a mixture of potassium sulphate and aluminium sulphate.



### Properties of Salts

- Salts are **mostly solids** which melt as well as boil at high temperature.
- Most of the salts are soluble in water. For example, chloride salts of potassium and sodium are soluble in water.
- But, silver chloride is insoluble in water
- They are odourless, mostly white, cubic crystals or crystalline powder with salty taste.
- Salt is hygroscopic in nature.

### Water of Crystallisation

- Many salts are found as crystals with water molecules. These water molecules are known as **water of crystallisation**.
- Salts that contain water of crystallisation are called **hydrated salts**.
- The number of molecules of water hydrated to a salt is indicated after a dot in its chemical formula.
- For example, copper sulphate crystal have five molecules of water for each molecule of copper sulphate.
- It is written as  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  and named as copper sulphate pentahydrate.
- This water of crystallisation makes the copper sulphate blue.
- When it is heated, it loses its water molecules and becomes white.



**Figure 6.7** Hydrated Salt

- Salts that do not contain water of crystallisation are called **anhydrous salt**. They are generally found as powders.
- Fill in the blanks in the following table based on the concept of water of crystallisation.

## Identification of Salts

### (i) Physical examination of the salt.

- The physical examination of the unknown salt involves the study of colour, smell and density. This test is not much reliable.

### (ii) Dry heating Test.

- This test is performed by heating a small amount of salt in a dry test tube.
- After all the water get evaporated, the dissolved salts are sedimented in the container.

### (iii) Flame Test.

Colour of the flame	Inference
Brick red	$\text{Ca}^{2+}$
Golden Yellow	$\text{Na}^+$
Pink Violet	$\text{K}^+$
Green Fleshes	$\text{Zn}^{2+}$

- Certain salts on reacting with concentrated hydrochloric acid (HCl) form their chlorides.
- The paste of the mixture with con.
- HCl is introduced into the flame with the help of platinum wire.
- When HCl is added with a carbonate salt, it gives off  $\text{CO}_2$  gas with brisk effervescence.

## Uses of Salts

### Common Salt (Sodium Chloride - NaCl)

- It is used in our daily food and used as a preservative.

### Washing Soda (Sodium Carbonate- $\text{Na}_2\text{CO}_3$ )

- I It is used in softening hard water.
- II It is used in glass, soap and paper industries.

### Baking Soda (Sodium bicarbonate - $\text{NaHCO}_3$ )

- I It is used in making of baking powder which is a mixture of baking soda and tartaric acid.
- II It is used in soda-acid fire extinguishers.
- III Baking powder is used to make cakes and bread, soft and spongy.
- IV It neutralizes excess acid in the stomach and provides relief.

**Bleaching powder (Calcium Oxychloride -  $\text{CaOCl}_2$ )**

- I It is used as disinfectant.
- II It is used in textile industry for bleaching cotton and linen.

**Plaster of Paris (Calcium Sulphate Hemihydrate -  $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ )**

- I It is used for plastering bones.
- II It is used for making casts for statues.

**Activity 5**

- Boil about 100 ml of ground water in a vessel to dryness.
- After all the water get evaporated observe the inner wall of the vessel.
- Can you observe any deposits?
- This is the deposit of dissolved salts present in water.

**MORE TO KNOW:****FACTS:**

- All acids essentially contain one or more hydrogens.
- But all the hydrogen containing substances are not acids.
- For example, methane ( $\text{CH}_4$ ) and ammonia ( $\text{NH}_3$ ) also contain hydrogen.
- But they do not produce  $\text{H}^+$  ions in aqueous solution.
- Few metals do not react with acid and liberate hydrogen gas. For example: Ag, Cu.
- All alkalis are bases but not all bases are alkalis. For example: NaOH and KOH are alkalis whereas  $\text{Al}(\text{OH})_3$  and  $\text{Zn}(\text{OH})_2$  are bases.
- The term acidity is used for base, which means the number of replaceable hydroxyl groups present in one molecule of a base.
- Few metals do not react with sodium hydroxide. Example: Cu, Ag, Cr

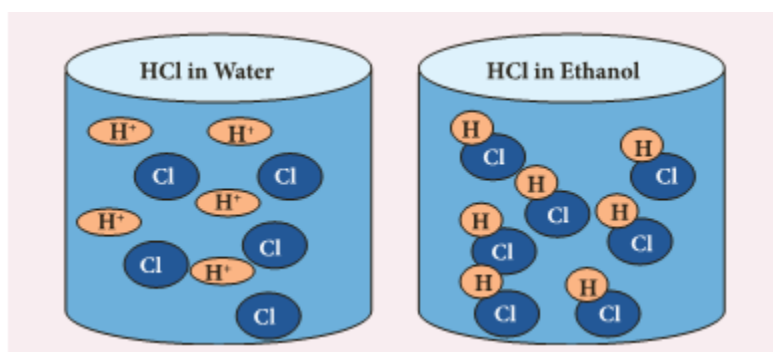
**Monobasic**

- For acids, we use the term **basicity** that refers to the number of replaceable hydrogen atoms present in one molecule of an acid.
- For example, **acetic acid** ( $\text{CH}_3\text{COOH}$ ) has **four hydrogen atoms** but only one can be replaced.
- Hence it is monobasic.

**Ionisation**

- Ionisation is the condition of being dissociated into ions by **heat or radiation or chemical reactions or electrical discharge**.

**Role of water in acid solution**



- Acids show their properties only when dissolved in water.
- In water, they ionise to form  $H^+$  ions which determine the properties of acids.
- They do not ionise in organic solvents.
- For example, when HCl is dissolved in water it produces  $H^+$  ions and  $Cl^-$  ions whereas in organic solvents like ethanol they do not ionise and remain as molecule.

#### EXTRA POINTS:

- **Acids:** Substance which furnishes  $H^+$  ions  $H_3O^+$  ions when dissolved in water.
- **Bases:** Substance which furnishes  $OH^-$  ions when dissolved in water.
- **Salts:** Product of reaction between acids and bases.
- **Indicators:** Chemical substances used to find out whether the given solution is acid or base.
- **pH Scale:** Scale used to find out Hydrogen ion concentration in a solution.
- **pH Paper:** Paper used to find out whether the given solution is acidic or basic or neutral in nature.
- **Aquaregia:** Mixture of hydrochloric acid and nitric acid prepared optimally in a molar ratio of 3 : 1.
- **Hygroscopic substance:** Substance which absorbs water from the surroundings.

#### Activity 4

Fill in the blanks in the following table based on the concept of water of crystallisation.

Salt	Formula of anhydrous salt	Formula of hydrated salt	Name of hydrated salt
Zinc sulphate	$ZnSO_4$	$ZnSO_4 \cdot 7H_2O$	
Magnesium chloride	$MgCl_2$		Magnesium chloride hexahydrate
Iron (II) sulphate		$FeSO_4 \cdot 7H_2O$	Iron (II) sulphate heptahydrate
Calcium chloride	$CaCl_2$	$CaCl_2 \cdot 2H_2O$	
Sodium thiosulphate	$Na_2S_2O_3$		Sodium thiosulphate pentahydrate