2 CHAPTER

Acids, Bases and Salts

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct.

Explanation:

- A turns phenolphthalein pink, indicating that A is a basic solution, as phenolphthalein turns pink in solutions with a pH greater than 7.
- When B is added to A, the pink colour disappears, suggesting that B is acidic. The acid neutralizes the base, causing the pH to drop below the range where phenolphthalein is pink.

2. Option (D) is correct.

Explanation: Solid calcium oxide reacts vigorously with water to form calcium hydroxide accompanied by the liberation of heat. From the information given above, it can be concluded that this is an exothermic reaction, and the solution formed is basic in nature, which means the pH is greater than 7.

3. Option (C) is correct.

Explanation: Tamarind juice turns blue litmus red because it is acidic in nature. The acid primarily present in tamarind is tartaric acid, which gives it a sour taste and acidic properties.

4. Option (B) is correct.

Explanation: The oxide that reacts with both HCl (acid) and KOH (base) to form corresponding acidic or basic salt and water is called as an amphoteric oxide. Among the given options, Al_2O_3 is an amphoteric oxide as it reacts with both acids and bases.

Reaction with HCl (acid):

$$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$$

Reaction with KOH (base):

$$Al_2O_3 + 2KOH \rightarrow 2KAlO_2 + H_2O$$

5. Option (B) is correct.

Explanation: Natural indicators are substances obtained from natural sources that change colour in the presence of acids or bases. Among the given options:

- Litmus is a natural indicator derived from lichens.
- Turmeric is a natural indicator derived from the turmeric plant.

6. Option (D) is correct.

Explanation: An aqueous solution of the salt turns blue litmus red, indicating that the solution is acidic in nature. This happens when the salt is formed from a strong acid and a weak base, resulting in an acidic solution. Among the given options HCl (a strong acid) reacts with NH_4OH (a weak base) to form NH_4Cl, which hydrolyses in water to produce an acidic solution.

7. Option (A) is correct.

Explanation: The salt present in tooth enamel is calcium phosphate, specifically hydroxyapatite, which is the crystalline form of calcium phosphate. This compound provides strength and rigidity to the enamel.

8. Option (C) is correct.

Explanation: When NaCl (neutral salt) is dissolved in distilled water, it dissociates completely into Na^+ and Cl^- ions. Neither of these ions hydrolyses in water, meaning they do not react with water to change the concentration of H^+ or OH^- ions. The solution remains neutral with a pH of 7 at standard conditions (25°C).

9. Option (C) is correct.

Explanation: Turmeric solution is a natural pH indicator that turns red in the presence of a base and remains yellow in neutral or acidic solutions. Among the given options, the liquid that turns turmeric solution red is ammonium hydroxide because it is a basic solution.

10. Option (B) is correct.

Explanation: The acid present in nettle sting is methanoic acid (commonly known as formic acid), The presence of methanoic acid is responsible for the irritation and burning sensation caused by a nettle sting.

11. Option (C) is correct.

Explanation: Bases are substances that release hydroxide ions (OH^-) in water or react with acids

to form salts and water. Among the given options, Sodium sulphate (Na_2SO_4) is a neutral salt formed from the reaction of a strong acid (H_2SO_4) and a strong base (NaOH). It does not release OH^- ions or behave as a base. Thus, sodium sulphate is not a base.

12. Option (B) is correct.

Explanation:

Colour	Solution	Colour of pH Paper	Approximate pH Value	Nature of Solution	Correctness	Explanation
(A)	Lemon juice	Orange	3	Basic	Incorrect	Lemon juice is acidic, not basic, though the pH and colour are correct.
(B)	Milk of magnesia	Blue	10	Basic	Correct	Milk of magnesia is basic, with correct pH value and colour on pH paper.
(C)	Gastric juice	Red	6	Acidic	Incorrect	Gastric juice is acidic, but its pH is much lower (1–3), not 6 as stated.
(D)	Pure water	Yellow	7	Neutral	Incorrect	Pure water is neutral, but pH paper for neutral solutions usually shows green.

13. Option (C) is correct.

Explanation: Washing soda is the common name for sodium carbonate decahydrate ($Na_2CO_3 \cdot 10H_2O$). It is a hydrated form of sodium carbonate, widely used in cleaning applications.

14. Option (D) is correct.

Explanation: Tomatoes contain oxalic acid, which contributes to their slightly sour taste.

15. Option (D) is correct.

Explanation:

- **$FeSO_4$ (Iron (II) Sulphate heptahydrate):** In its hydrated form, $FeSO_4.7H_2O$ contains 7 molecules of water of crystallisation.
- **$CuSO_4$ (Copper (II) Sulphate pentahydrate):** In its hydrated form, $CuSO_4.5H_2O$ contains 5 molecules of water of crystallisation.
- **$CaSO_4$ (Calcium sulphate):** Commonly known as gypsum, in its hydrated form, $CaSO_4.2H_2O$ contains 2 molecules of water of crystallisation.
- **Na_2CO_3 (Sodium carbonate decahydrate):** In its hydrated form, $Na_2CO_3.10H_2O$ contains 10 molecules of water of crystallisation.

  Thus, Na_2CO_3 has the maximum number of water of crystallisation, i.e., 10 molecules.

16. Option (B) is correct.

Explanation: Sodium hydroxide (NaOH) is an alkali because it dissolves in water and produces hydroxide ions. On the other hand, ferric hydroxide ($Fe(OH)_3$) is not an alkali because it is not soluble in water, even though it is a base. This is because all alkalis are bases, but not all bases are alkalis.

17. Option (C) is correct.

Explanation: Sodium carbonate decahydrate ($Na_2CO_3 \cdot 10H_2O$), also known as washing soda, is effective in removing both temporary and permanent hardness by precipitating calcium and magnesium ions.

18. Option (D) is correct.

Explanation: Baking soda (sodium hydrogen carbonate) is a base that is commonly used to delay the curdling of milk. When added to fresh milk, it increases the pH of the milk, making it more alkaline. This helps to prevent the milk from souring or curdling, thus extending its shelf life.

19. Option (C) is correct.

Explanation: Hydronium ions are formed by the reaction between hydrogen chloride gas and water. When hydrogen chloride gas dissolves in water, it reacts with the water molecules to form hydronium ions (H_3O^+) and chloride ions (Cl^-), according to the following chemical equation:

$$HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$$

The reaction involves the donation of a proton (H^+) from HCl to water, forming the hydronium ion (H_3O^+).

20. Option (C) is correct.

Explanation: Ammonium chloride (NH_4Cl) is acidic in nature because it is the salt of a strong acid (HCl) and a weak base (NH_3). When dissolved in water, it undergoes hydrolysis to produce hydronium ions (H_3O^+), making the solution acidic. Since the solution is acidic, the pH will be less than 7. The universal indicator paper turning pink confirms that the solution is acidic.

21. Option (A) is correct.

Explanation: An indicator, phenolphthalein is a substance that changes colour when it interacts with an acid or a base. It will be pink in basic solutions and clear in acidic ones. When phenolphthalein is added, X turns pink, indicating that it is basic in nature, whereas Y does not change colour, indicating that it is acidic in nature.

The reaction of sodium hydroxide (strong base) and carbonic acid (weak acid) produces sodium carbonate. As a result, it is basic in nature.

The salt of a strong acid, hydrochloric acid (HCl), and a weak base, ammonium hydroxide (NH_4OH), is ammonium chloride (NH_4Cl). As a result, an ammonium chloride aqueous solution is acidic in nature.

22. Option (B) is correct.

Explanation: When sulphur is burned in air, it reacts with oxygen to form sulphur dioxide (SO_2):

$$S + O_2 \rightarrow SO_2$$

When water is added to the test tube containing the fumes (SO_2), it dissolves to form sulphurous acid (H_2SO_3) which is a weak acid:

$$SO_2 + H_2O \rightarrow H_2SO_3$$

When the solution formed by the dissolution of sulphur dioxide in water is tested with litmus paper:

- Blue litmus paper turns red, indicating the solution is acidic.
- Red litmus paper remains red, as acids do not change the colour of red litmus paper

23. Option (B) is correct.

Explanation: (i) Hydrogen Carbonate of Sodium ($NaHCO_3$) does not contribute to water hardness.

(ii) Sulphate of Magnesium ($MgSO_4$) does contribute to water hardness.

(iii) Chloride of Calcium ($CaCl_2$) does contribute to water hardness.

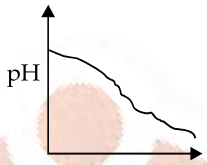
(iv) Carbonate of Sodium (Na_2CO_3) does not contribute to water hardness.

So, the correct choices are Chloride of Calcium and sulphate of magnesium.

24. Option (A) is correct.

Explanation: When milk turns into curd, the pH of the milk typically decreases over time. This is due to the fermentation process, where lactose (milk sugar) is converted into lactic acid by bacteria such as *Lactobacillus*. The increase in lactic acid lowers the pH, making the environment more acidic.

Graph A shows a continuous decrease in pH over time. This graph is consistent with what happens during the fermentation of milk into curd, as the production of lactic acid from lactose by bacteria should lead to a steady decline in pH.



A

25. Option (A) is correct.

Explanation: Acids: When exposed to blue litmus paper, acids turn it red because of the acidic nature.

Bases: When exposed to red litmus paper, bases turn it blue because of the basic nature. This is the fundamental property of litmus paper when testing for acidity and basicity.

26. Option (D) is correct.

Explanation: Plaster of Paris gets hard when mixed with water and this is the key property that makes Plaster of Paris effective as a building material. It allows for quick setting and forming of a hard layer, ideal for coatings, repairs, and finishing on walls and ceilings.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (D) is correct.

Explanation: While diluting an acid, it is preferred that the acid is added to water rather than the water being added to the acid, keeping the solution continuously stirred. This is because adding water to a concentrated acid is highly exothermic and releases a large amount of heat, which can cause an explosion and acid burns on the skin, clothing, and other body parts. Thus, assertion is false but reason is true.

2. Option (B) is correct.

Explanation: The acid must always be added to water with constant stirring because the process is highly exothermic and stirring continuously helps to evenly distribute the heat generated by the exothermic reaction, thus preventing localised overheating and possible violent reactions. When an acid is diluted with water, the concentration of ions per unit volume decreases because the acid is spread over a greater volume of solvent (water), thus lowering the concentration of the acid. Thus, both assertion and reason are true but reason is not the correct explanation of assertion.

3. Option (A) is correct

Explanation: Hydrogen chloride gas does not change the colour of dry blue litmus paper. This is because when HCl gas comes into contact with moist or wet litmus paper, it dissolves in the water present on the paper's surface and dissociates into H^+ and Cl^- ions. The presence of H^+ ions change the colour of blue litmus paper to red, indicating acidity. Thus, both assertion and reason are true and reason is the correct explanation of assertion.

Level - 2

CASE BASED QUESTIONS (4 Marks)

1. (i) Sodium chloride (NaCl) is formed from the reaction of:

- **Acid:** Hydrochloric acid (HCl)
- **Base:** Sodium hydroxide (NaOH)

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

(ii) Calcium sulphate ($CaSO_4$) contains:

- **Cation:** Calcium ion (Ca^{2+})
- **Anion:** Sulphate ion (SO_4^{2-})

(iii) (a) Salts having same cations but different anions belong to the same family of salts. Sodium chloride (NaCl) and washing soda ($Na_2CO_3 \cdot 10H_2O$) both belong to the same family of salts as they both have Na^+ as cation. They are formed by the neutralisation reaction of a strong base (NaOH) with an acid.

- Sodium chloride is formed from HCl and NaOH.
- Washing soda is formed from H_2CO_3 (carbonic acid) and NaOH.

OR

(b) **pH Scale:** The pH scale is a logarithmic scale used to measure the acidity or basicity of aqueous solutions. It monitors the concentration of hydrogen ions (H^+) in a solution. The pH scale ranges between 0 and 14, where:

- pH less than 7 indicates acidity,
- pH equal to 7 indicates neutrality and
- pH greater than 7 indicates alkalinity or basicity.

The reaction of potassium hydroxide (KOH) and sulphuric acid (H_2SO_4) produces potassium sulphate (K_2SO_4).

The pH of aqueous solution of potassium sulphate is neutral with a pH of approximately 7, as it is formed by the reaction of a strong acid and a strong base.

2. (i) The solutions whose groups have pH value:
(1) Less than 7 are Group A and B
(2) Greater than 7 is Group C.

(ii) **pH Paper/Strips:** These are treated with a chemical that changes colour based on the pH of the solution it comes into contact with. It provides a quick and easy way to estimate the pH value.
pH Meter: A more accurate instrument that measures the voltage between two electrodes that is proportional to the pH of the solution. It provides a precise digital reading of the pH.

(iii) (a) Sour substances like lemon juice contain acids (e.g., citric acid in lemon) that can react with the copper oxide (tarnish) on the surface of copper vessels. The acid reacts with the copper oxide, forming a soluble copper compound that can be washed away, thus cleaning the vessel. For example, the reaction of citric acid with copper oxide can be represented as:

$$2CuO(s) + 2C_6H_8O_7(aq) \rightarrow Cu_2(C_6H_7O_7)_2(aq) + H_2O(l)$$

OR

(b) **Importance of pH in our daily life**

(1) Health and Medicine: The pH of the stomach is crucial for digestion and for maintaining a barrier against pathogens. Antacids are used to adjust the stomach's pH for comfort and health.

(2) Agriculture: Soil pH greatly influences plant growth. It affects the availability of nutrients and the activity of soil bacteria. Farmers adjust soil pH through the application of lime or fertilisers to optimise conditions for crop growth.

3. (i) Liquid 2 (pH = 12) has the lowest concentration of hydrogen ions because the lowest concentration of hydrogen ions corresponds to the liquid with the highest pH value.

(ii)
- No, gloves are not for keeping hands warm in this context.
- Yes, forceps provide better grip and help avoid contamination of the pH paper.
- Yes, gloves protect hands from potentially corrosive or harmful liquids.

(iii) (a) The pH of distilled water is 7 (neutral). On dipping in distilled water, the pH paper would turn green (neutral colour on the pH scale).

OR

(b) City B's rainwater (pH = 5) is more acidic than City A's rainwater (pH = 6) because a lower pH indicates higher acidity.

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. When solid sodium chloride is reacted with concentrated sulphuric acid, the gas evolved in the reaction is hydrogen chloride (HCl) gas.

(i) The gas evolved is hydrogen chloride (HCl) gas.

(ii) When tested with blue litmus paper:

(1) Dry blue litmus paper: No change will be observed because dry hydrogen chloride gas does not have acidic properties.

(2) Wet blue litmus paper: The blue litmus paper will turn red, indicating that the gas is acidic when dissolved in water to form hydrochloric acid.

Conclusion: Hydrogen chloride gas exhibits acidic properties when dissolved in water, turning wet blue litmus paper red.

2. (i) The compound 'X' is Plaster of Paris and its Chemical Formula is $CaSO_4 \cdot \frac{1}{2} H_2O$

(ii) **Baking Soda:** The chemical name for baking soda is sodium bicarbonate, with the formula $NaHCO_3$. It is a single chemical compound, consisting of sodium (Na), hydrogen (H), carbon (C), and three oxygen (O) atoms.

Baking powder: Baking powder is a mixture of two main components – baking soda (sodium bicarbonate) and an acidic compound, typically cream of tartar (potassium bitartrate). Some commercial baking powders also contain other acid salts, such as sodium aluminium sulphate.

3. (i) $CuSO_4 \cdot 5H_2O \xrightarrow{\Delta} CuSO_4 + 5H_2O$

Copper sulphate (Blue) — Anhydrous copper sulphate (White)

This equation represents the heating of hydrated copper sulphate, where it loses its water molecules and turns from blue to anhydrous white copper sulphate.

(ii) $2NaHCO_3(s) \xrightarrow{\Delta} Na_2CO_3(s) + H_2O(l) + CO_2(g)$

Sodium bicarbonate — Sodium Carbonate — Water — Carbon dioxide

This equation shows the thermal decomposition of sodium bicarbonate (baking soda) into sodium carbonate, water vapour, and carbon dioxide gas, typically occurring during baking.

4. (i) The compound formed is copper chloride and the colour of the solution is bluish-green.

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

5. X = NaCl (Sodium chloride);
Y = H_2 (Hydrogen gas);
Z = Cl_2 (Chlorine gas);
B = Bleaching powder ($CaOCl_2$)

$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$
(X) (Z) (Y)

$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$
(B)

6. (i) 'Y' is calcium sulphate hemihydrate, commonly known as Plaster of Paris. $\left(CaSO_4 \cdot \frac{1}{2}H_2O\right)$

'X' is gypsum. ($CaSO_4.2H_2O$)

(ii) 'X' (gypsum) can be reobtained from 'Y' plaster of paris by the process of hydration. When plaster of paris is mixed with water, it reabsorbs the water molecules and becomes gypsum.

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

7. (i) M is highly acidic so it produces more H^+ ions, hence it gives red colour with universal indicator.

(ii) If M and N are mixed neutralisation takes place and a neutral salt is produced which gives green colour with universal indicator. As M is highly acidic and N is highly basic so the salt produced is a neutral salt.

8. (i) Dipti will be able to identify the solution containing dilute sodium hydroxide by mixing pairs of the substances.

(ii) The observation that will help her make this identification is the formation of a salt and water, which is indicative of a neutralisation reaction. When an acid is mixed with a base (sodium hydroxide), they will neutralise each other, resulting in the formation of water and a salt. This reaction is exothermic, so she will also observe a temperature rise.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. (i) The pH of a sample of tomato juice is 4.6. This indicates that the juice is likely to taste sour and it is slightly acidic. Acids typically taste sour, which explains the sourness of tomato juice.

(ii) A strong acid (e.g., HCI) completely ionises in water, meaning it dissociates entirely into hydrogen ions (H^+) and the corresponding anions. A weak base (e.g., NH_4OH) partially ionises in water, meaning only a small fraction of its molecules produce hydroxide ions (OH^-), while the rest remain undissociated.

(iii) Acid rain (pH < 5.6), caused by SO_2 and NO emissions, lowers the pH of water bodies, making them acidic. This disrupts the reproductive, respiratory, and metabolic functions of aquatic life. It also dissolves toxic metals like aluminium, further harming fish and amphibians, and creates an inhospitable environment for survival.

2. The common name of compound $CaSO_4.\frac{1}{2}H_2O$ is Plaster of Paris and its chemical name is calcium sulphate hemihydrate.

Plaster of Paris is prepared by heating gypsum to about 373 K (100°C). During this procss, gypsum loses water molecules and forms calcium sulphate hemihydrate.

$$CaSO_4.2H_2O \xrightarrow{373\ K} CaSO_4.\frac{1}{2}H_2O + \frac{3}{2}H_2O$$

When Plaster of Paris reacts with water, it reabsorbs water molecules and forms gypsum ($CaSO_4.2H_2O$) again. This reaction is responsible for the hardening of Plaster of Paris.

$$CaSO_4 \cdot \frac{1}{2}H_2O + \frac{3}{2}H_2O \rightarrow CaSO_4.H_2O$$

3. The pH of a solution is a measure of its acidity or alkalinity on a scale ranging from 0 to 14. It represents the concentration of hydrogen ions (H^+) present in the solution. A pH value:

- Less than 7 indicates an acidic solution.
- Equal to 7 indicates a neutral solution (pure water).
- Greater than 7 indicates an alkaline (basic) solution.

City B's water is more acidic, as a lower pH value indicates a higher concentration of hydrogen ions ($[H^+]$).

If the rain from city B (pH 5.3) flows into a pond, it lowers the pond's pH, making the water more acidic. Acidic water disrupts enzyme activity and metabolism

in aquatic organisms, releases toxic metals like aluminium that poison aquatic life, and damages their respiratory and reproductive systems. This creates an inhospitable environment, threatening the survival of aquatic species.

4. (i) (a) **Acid:** Hydrochloric acid (HCl) and **Base:** Sodium hydroxide (NaOH)

(b) **Acid:** Sulphuric acid (H_2SO_4) and **Base:** Ammonium hydroxide (NH_4OH)

(ii) **Sodium chloride (NaCl):** It is neutral in nature because it is formed from a strong acid (HCl) and a strong base (NaOH), resulting in a salt that does not affect the pH of water.

Ammonium sulphate ($(NH_4)_2SO_4$): It is acidic in nature because it is formed from a strong acid (H_2SO_4) and a weak base (NH_4OH). The stronger acidic component dominates, making the salt acidic.

5. (i) (a) Production of too much acid in stomach during indigestion leads to pain and irritation. Antacid is given in such case to neutralise the acid of the stomach. The antacids neutralise the excess acid. Magnesium hydroxide (milk of magnesia) is a mild base, often used for this purpose.

(b) In case of a honeybee, sting formic acid is released into the skin which causes pain and irritation. To reduce the pain caused due to the sting, bases like baking soda are used which neutralize acid and relieve the pain. Stinging hair of nettle leaves inject methanoic acid causing burning pain. It is also treated with rubbing mild base.

(ii) When the milk is turned into curd then its pH value decreases. This is due to the production of lactic acid in curd, which is acidic in nature.

6. (i) Bacteria present in the mouth produce acid by degradation of sugar and food particles which remain in the mouth after eating. When the pH in the mouth falls below 5.5, tooth decay starts. The acid produced in the mouth attack the enamel thereby, creating tooth decay.

(ii) The basic salt X obtained by heating baking soda followed by crystallisation is sodium carbonate (Na_2CO_3). Sodium carbonate has two industrial uses:

(1) Glass manufacturing: Sodium carbonate is used in the production of glass as a fluxing agent. It helps to lower the melting point of the glass mixture, allowing it to be moulded and shaped easily. It also aids in the removal of impurities from the glass.

(2) Water treatment: Sodium carbonate is used in water treatment processes to adjust the pH of water. It can help neutralise acidic water and prevent corrosion in pipes and equipment.

(iii) Copper sulphate crystals turn white on heating due to the loss of water molecules. Copper sulphate crystals contain water molecules as part of their structure, and when heated, these water molecules are driven off, leaving behind an anhydrous form of copper sulphate. The anhydrous copper sulphate is white in colour, as opposed to the blue colour of the hydrated copper sulphate crystals.

7. 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 because of the products formed-chlor for chlorine and alkali for sodium hydroxide.

(i) $NaCl(aq) + H_2O(l) \rightarrow NaOH(aq) + \frac{1}{2}Cl_2(g) + \frac{1}{2}H_2(g)$

Gases Evolved:

(i) **Anode (positive electrode):** Chlorine gas (Cl_2) is evolved.

(ii) **Cathode (negative electrode):** Hydrogen gas (H_2) is evolved.

Product Formed: When the gases chlorine and hydrogen combine, they form hydrogen chloride (HCl).

$$Cl_2(g) + H_2(g) \rightarrow 2HCl(g)$$

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) **(1) Strongly acidic** → Solution B with pH 1.
(2) Strongly alkaline → Solution C with pH 13.
(3) Weakly acidic → Solution A with pH 4.
(4) Neutral → Solution D with pH 7.
(5) Weakly alkaline → Solution E with pH 10.
The pH can be arranged in the increasing order of the concentration of hydrogen ions as:
C < E < D < A < B

(ii) (1) **An Acidic Salt:**
Name: Ammonium chloride
Formula: NH_4CI
Parent Acid: Hydrochloric acid (HCI)
Parent Base: Ammonium hydroxide (NH_4OH)

(2) **A Basic Salt:**
Name: Sodium carbonate
Formula: Na_2CO_3
Parent Acid: Carbonic acid (H_2CO_3)
Parent Base: Sodium hydroxide (NaOH)

2. (i) When heated, the hydrated crystals of ferrous sulphate ($FeSO_4 \cdot 7H_2O$) lose their water molecules, forming anhydrous ferrous sulphate and releasing water vapour, which condenses as droplets. Thus, the water droplets observed in the tube are due

to the loss of water of crystallisation from ferrous sulphate crystals.

(ii) Initially, green crystals of ferrous sulphate ($FeSO_4 \cdot 7H_2O$) will turn into a white solid (anhydrous $FeSO_4$) as it loses water. Upon further heating, the anhydrous $FeSO_4$ decomposes, producing a brown residue of ferric oxide (Fe_2O_3).

(iii) Each molecule of ferrous sulphate ($FeSO_4$) crystal has 7 molecules of water of crystallisation.

Molecular formulas of crystalline forms:

(I) Copper sulphate: $CuSO_4.5H_2O$

(II) Sodium carbonate: $Na_2CO_3.10H_2O$

(iv) **Preparation:** Plaster of Paris ($CaSO_4 \cdot \frac{1}{2} H_2O$) is obtained by heating gypsum ($CaSO_4 \cdot 2H_2O$) to about 373 K. During heating, gypsum loses its water of crystallization to form Plaster of Paris.

$$CaSO_4.2H_2O \xrightarrow[373\ K]{\Delta} CaSO_4 \cdot \frac{1}{2} H_2O + 1\frac{1}{2} H_2O$$

Uses of Plaster of Paris:

1. Used for making moulds, statues, and decorative items.
2. Used for repairing fractures in bones by forming orthopaedic casts.

3. (i) X : Tartaric acid (found in tamarind).

Y : Baking soda (Sodium bicarbonate).

Z : Baking powder (a mixture of baking soda and a mild edible acid like tartaric acid).

Chemical formula of 'Y': $NaHCO_3$ (Sodium bicarbonate).

(ii) **Preparation of 'Y' (Baking soda):**

- Baking soda ($NaHCO_3$) is prepared by reacting sodium chloride (NaCl) with carbon dioxide (CO_2), water (H_2O) and ammonia (NH_3):

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

When baking powder (Z) is added to dough and heated, baking soda ($NaHCO_3$) reacts with the acid (tartaric acid or others) in the mixture to produce carbon dioxide gas (CO_2). The CO_2 gas forms bubbles in the dough, causing it to expand and making the cake soft and spongy.

$$NaHCO_3 + H^+ \rightarrow CO_2 + H_2O + Na^+$$

(iii) Magnesium hydroxide is a mild base that is used as an antacid as it neutralises excess stomach acid and provides relief from acidity. Its chemical formula is $Mg(OH)_2$.

4. (i) **Observation:** Bubbles of gas are released.

Reason: When metals react with acids, they produce hydrogen gas is (H_2) as a by-product. This gas released in the form of bubbles.

(ii) No, the original metal cannot be recovered by evaporating the acid. This is because the process involves a chemical change, not a physical one. When a metal reacts with an acid, it forms a salt and releases hydrogen gas. The metal is chemically transformed into ions that are part of the salt, so evaporation will only leave behind the salt, not the original metal.

(iii)
- When a metal 'dissolves' in an acid, it undergoes a chemical reaction, forming a new compound (a salt) and releasing hydrogen gas.
- When sugar dissolves in water, it is a physical change, where sugar molecules disperse into the water without forming a new substance. Sugar can be recovered by evaporation, while the metal cannot.