2 Acids, Bases and Salts

Drugs like Hydroxychloroquine (and most others) are made using various salts to easily dissolve in water within our body. Carbonated drinks give us a refreshing sensation only due to carbonic acid in the drink, which is created when carbon dioxide reacts with water. Soaps contain sodium hydroxide (base) that serves us the purpose of saponification and smoothness.

Topic Notes

- *Acids*
- *Bases*
- *Reaction of Acids with Bases*
- *Indicators*
- *Strength of Acids and Bases*
- *Salts*

TOPIC 1

ACIDS

On the basis of their chemical properties, all the chemical compounds can be classified into:

(1) Acids

(2) Bases

(3) Salts

In this chapter, we will be studying the various properties of acids and bases, synthetic, natural and olfactory indicators, behaviour of acids and bases in solutions, strength of acids and bases, pH and universal indicator, the importance of pH in everyday life, family of salts, chemicals obtained from common salt, their manufacture, properties and uses, and water of crystallization.

Acids are those chemical substances which have a sour taste and change the colour of blue litmus to red.

Classifications of Acids

(A) Based on the source, acids can be classified as mineral acids and organic acids.

Mineral Acids

The acids prepared from the minerals of the earth are called mineral acids. They are man-made acids.

Examples: Hydrochloric acid, sulphuric acid, nitric acid *etc.*

Organic Acids

The acids present in plant materials and animals are called organic acids or naturally occurring acids.

Few examples of naturally occurring acids along with their source are given below:

Name of Acid	Source
Lactic Acid	Curd
Methanoic Acid	Insect sting
Oxalic Acid	Tomato
Tartaric Acid	Tamarind
Citric Acid	Citrus fruits such as lemon, oranges, etc.
Acetic Acid	Vinegar

(B) Based on the degree of dissociation in water, acids can be classified as strong acids and weak acids.

Strong Acids

Acids that give rise to more H^+ ions in water are said to be strong acids. In other words, strong acids dissociate completely into hydrogen ions in water.

Examples: Hydrochloric acid, sulphuric acid.

Weak Acids

Acids which are partially ionized in water and give less H^+ ions in water are said to be weak acids. In other words, their degree of dissociation into hydrogen ions in water is not much.

Examples: Acetic acid, carbonic acid.

Properties of Acids

Physical Properties

(1) Acids have a sour taste.

(2) Acids are soluble in water.

(3) Acids turn blue litmus red.

(4) Acid solutions conduct electricity.

Chemical Properties of Acids

(1) **Reaction with metals :** Acids react with metals to form hydrogen gas. When a metal reacts with an acid, it displaces hydrogen from the acids. The metal combines with the remaining part of the acid and forms a compound called a salt.

$$\text{Acid} + \text{Metal} \longrightarrow \text{Salt} + \text{Hydrogen gas}$$

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

Example 1. Why should curd and sour substances not be kept in brass and copper vessels? [NCERT]

Ans. Curd is basically lactic acid. Similarly, sour substances also contain acids. We know that acids react with metals to form salt and water. Therefore, if curd and sour substances are stored in brass and copper vessels, the acid will react with the metal and may produce some salts which are poisonous and hence unfit for human consumption.

(2) **Reaction with metal carbonates and metal hydrogen carbonates:** Acids react with metal carbonates and metal hydrogencarbonates to form carbon dioxide gas.

$$\text{Metal carbonate/hydrogen carbonate} + \text{Acid} \rightarrow \text{Salt} + \text{carbon dioxide} + \text{water}$$

$$Na_2CO_{3(s)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

$$NaHCO_{3(s)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

Important

➥ *Test for carbon dioxide gas*

When carbon dioxide is passed through lime water, the lime water turns milky due to the formation of a white precipitate of calcium carbonate, $CaCO_{(3)}$

$$Ca(OH)_{2(aq)} + CO_{2(g)} \rightarrow CaCO_{3(s)} + H_2O_{(l)}$$

white precipitate formed first dissolves due to the formation of a soluble salt calcium hydrogencarbonate and the solution becomes clear again.

$$CaCO_{3(s)} + CO_{2(g)} + H_2O_{(l)} \rightarrow Ca(HCO_3)_{2(aq)}$$

Example 2. **A solution reacts with crushed egg-shells to give a gas that turns lime-water milky. The solution contains:**

(a) NaCl **(b) HCl**

(c) LiCl **(d) KCl** **[NCERT]**

Ans. *(b) HCl*

Explanation: As the gas evolved turns lime water milky, the gas is carbon dioxide. Moreover, the crushed egg shells contain calcium carbonate, which reacts with dilute HCl to give carbon dioxide, salt and water.

The equation for the reaction taking place is:

$$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

(3) Reaction with bases: Acids react with bases to form salt and water.

$$\text{Base} + \text{Acid} \longrightarrow \text{Salt} + \text{Water}$$

$$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$$

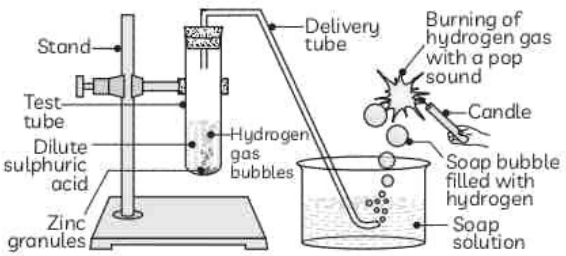
(4) Reaction with metal oxides: Acids react with metal oxides to form salt and water.

$$\text{Metal Oxide} + \text{Acid} \longrightarrow \text{Salt} + \text{Water}$$

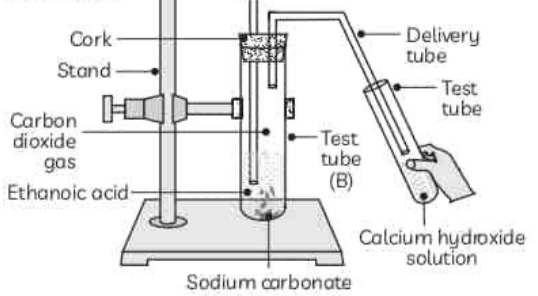
$$CuO_{(s)} + 2HCl_{(aq)} \longrightarrow CuCl_{2(aq)} + H_2O_{(l)}$$

Example 3. **Case Based:**

About 5 mL of dilute sulphuric acid is taken in a test tube 'A' and a few pieces of zinc granules are added to it. The gas evolved is passed through the soap solution. The activity is repeated with some more acids like HCl, HNO_3 and CH_3COOH.



Two more test tubes labeled as 'B' and 'C' are taken and about 0.5 g of sodium carbonate (Na_2CO_3) is taken in test tube 'B' and about 0.5 g of sodium hydrogencarbonate ($NaHCO_3$) in test tube 'C'. About 2 mL of dilute HCl is added to both the test tubes. The gas produced in each case is passed through lime water (calcium hydroxide solution).



[NCERT Activity 2.3, 2.5]

(A) A student recorded his observations on the gas produced in test tubes as:

	Test Tube 'A'	Test Tube 'B'	Test Tube 'C'
(a)	Hydrogen	Carbon dioxide	Oxygen
(b)	Sulphur dioxide	Hydrogen	Carbon dioxide
(c)	Sulphur dioxide	Carbon dioxide	Carbon dioxide
(d)	Hydrogen gas	Carbon dioxide	Carbon dioxide

Identify the correct observation:

(B) Which of the following observations are incorrect?

(I) When the gas evolved in test tube 'A' is passed through a soap solution, the soap bubbles formed extinguish a burning candle.

(II) When the gas evolved in test tube 'A' is passed through a soap solution, the soap bubbles burn with a pop sound when a burning candle is brought near a bubble.

(III) The gas evolved in test tube 'B' turns lime water milky.

(IV) The gas evolved in test tube 'C' burns with a pop sound.

(a) Both (I) and (IV) **(b) Both (II) and (III)**

(c) (I), (III) and (IV) **(d) (II), (III) and (IV)**

(C) Are the observations in test tube 'A' same when the activity is repeated with more acids like HCl, HNO_3 and CH_3COOH?

(D) Metal compound A reacts with dilute hydrochloric acid to produce effervescence. The gas evolved extinguishes a burning candle. Write a balanced chemical equation for the reaction if one of the compounds formed is calcium chloride.

carbonate or metal hydrogen carbonate, the gas evolved turns lime water milky.

Reason: **When excess carbon dioxide gas is passed through lime water, calcium hydrogen carbonate solution is formed.**

(a) Both (A) and (R) are true and (R) is the correct explanation of the (A).

(b) Both (A) and (R) are true, but (R) is not the correct explanation of the (A).

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.

Ans. (A) *(d) Test Tube A: hydrogen gas; Test Tube B: Carbon dioxide; Test Tube C: carbon doxide*

Explanation: The gas produced in test tube 'A' is hydrogen and that in test tubes 'B' and 'C' is carbon dioxide as the reactions taking place in the test tubes are given below:

Test tube 'A': $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

Test tube 'B': $Na_2CO_{3(s)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

(B) *(a) Both (I) and (IV)*

Explanation: The gas evolved in test tube 'A' is hydrogen gas, which burns with a pop sound.

The gas evolved in test tubes 'B' and 'C' is carbon dioxide which turns lime water milky.

(C) Yes, the same observations are seen when the activity is repeated with more acids like HCl, HNO_3 and CH_3COOH as metals react with acids and form hydrogen gas by displacing hydrogen atoms from the acid and also forms a salt.

For example, $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

(D) As the gas evolved on reacting metal compound with dilute hydrochloric acid produces effervescence and also extinguishes a burning candle, the gas evolved is carbon dioxide.

Since one of the compounds formed is calcium chloride, the metal A is calcium chloride, since metal carbonates react with acid to produce carbon dioxide gas, metal salt and water.

$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$

(E) *(b) Both (A) and (R) are true, but (R) is not the correct explanation of the (A).*

TOPIC 2

BASES

Bases are the chemical substances which have a bitter taste, are soapy to touch and turn red litmus blue. A base is a substance which dissolves in water to produce hydroxide ions (OH^-) in solution.

$$NaOH_{(s)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$$

Classification of Bases

Bases are of two types:

Strong Bases

A base which completely ionizes in water and thus produces a large amount of hydroxide ions is called a strong base.

Examples: Sodium hydroxide and potassium hydroxide.

Weak Bases

A base which is partially ionized in water and thus produces a small amount of hydroxide ions is called a weak base.

Examples: Ammonium hydroxide and calcium hydroxide.

Properties of Bases

Physical Properties

(1) Bases have bitter taste.

(2) Bases feel soapy to touch.

(3) Bases turn red litmus to blue.

(4) Bases conduct electricity in solution due to the presence of ions in water.

Chemical Properties

(1) Reaction with metals

Bases react with some metals to form hydrogen gas. The gas evolved burns with a pop sound showing that it is hydrogen gas.

Base + Metal $\longrightarrow$ Salt + Hydrogen gas

$2NaOH_{(aq)} + Zn_{(s)} \longrightarrow Na_2ZnO_{2(aq)} + H_{2(g)}$

Bases react with non-metallic oxides to produce salt and water.

Example: Carbon dioxide, which is a non-metallic oxide reacts with Calcium hydroxide, which is a base, to produce a salt and water.

and an acid, we can say that nonmetallic oxides are acidic in nature.

Base + Non-metallic oxide $\longrightarrow$ Salt + Water

$$Ca(OH)_{2(aq)} + CO_{2(g)} \longrightarrow CaCO_{3(s)} + H_2O_{(l)}$$

TOPIC 3

REACTION OF ACIDS WITH BASES

Acids react with bases to form salt and water. This is known as neutralization reaction as the effect of a base is nullified by an acid and vice-versa.

Example: $NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

Neutralization Reaction

The reaction between an acid and a base to give a salt and water is known as a neutralization reaction. In general, a neutralization reaction can be written as:

Acid + Base $\longrightarrow$ Salt + Water

Example 4. 10 mL of a solution of NaOH is found to be completely neutralised by 8 mL of a given solution of HCl. If we take 20 mL of the same solution of NaOH, the amount HCl solution (the same solution as before) required to neutralise it will be

(a) 4 mL **(b) 8 mL**

(c) 12 mL **(d) 16 mL [NCERT]**

Ans. *(d) 16 mL*

Explanation: As 10 mL of NaOH solution is completely neutralized by 8 mL of HCl solution, 16 mL of HCl solution will be required to neutralize 20 mL of NaOH solution.

Similarities among Acids and Bases

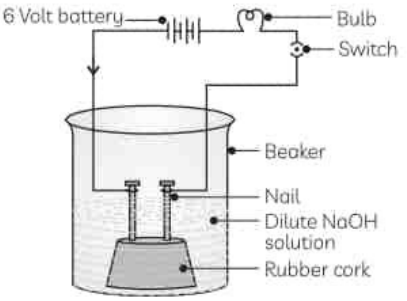
All acids have similar chemical properties. All acids generate hydrogen gas on reacting with metals, so hydrogen is common to all acids.

Acids produce hydrogen ions, $H^+_{(aq)}$, in solution, which are responsible for their acidic properties.

Solutions of acids and bases conduct electricity as both acids and bases dissociate into hydrogen ions (H^+) and hydroxide ions (OH^-) respectively, which are responsible for conduction of electric current through the solution.

Example 5. Case Based:

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. below.



Now pour some dilute HCl in the beaker and switch on the current. Repeat with other solutions one by one. **[NCERT]**

(A) Four students recorded the following observations. Identify the correct observation:

	Electrolyte	Observation
(a)	Dilute HCl	Bulb does not glow
(b)	Glucose	Bulb glows
(c)	Dilute NaOH	Bulb glows
(d)	Alcohol	Bulb glows

(B) The activity is repeated with alcohol as the electrolyte. Which of the following statement(s) is (are) correct?

(I) Bulb will not glow because electrolyte is not acidic.

(II) Bulb will glow because alcohol contains Hydrogen and provides ions for conduction of electricity.

(III) Bulb will not glow because alcohol does not provide ions for conduction of electricity.

(IV) Bulb will glow because it depends upon the type of electrolytic solution.

(a) (I) and (III) **(b) (II) and (IV)**

(c) (III) only **(d) (IV) only**

(C) Why do HCl, HNO_3, etc., show acidic characters in aqueous solutions while solutions of compounds like alcohol and glucose do not show acidic character? [NCERT]

conduct electricity? [NCERT]

(E) **Assertion : An aqueous solution of glucose conducts electricity.**

Reason : Electric current is carried through solution by ions.

(a) Both (A)and R are true, and (R) is correct explanation of the assertion (A).

(b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion (A).

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.

Ans. **(A)** *(c) Electrolyte: Dilute HCl; Observation: Bulb glows*

Explanation: The bulb glows when electrolyte is an acid or a base as in both cases ions are produced in aqueous solution due to which current flows through the solution.

(B) *(c) (III) only*

(C) Solutions like HCl, HNO_3 etc. how acidic characters in aqueous solutions as they contain the cation H+ and produce hydrogen ions, $H+_{(aq)}$ in solution. Whereas, solutions of compounds such as alcohol and glucose do not form any such ions and hence they do not show acidic character.

(D) An aqueous solution of an acid conducts electricity as acids dissociate into hydrogen ions (H^+) in solution, which is responsible for conduction of electricity through the solution.

(E) *(d) (A) is false, but (R) is true.*

Explanation: An aqueous solution of glucose does not conduct electricity as glucose does not dissociate into ions even in solution. Electric current will flow in a solution only by ions, as happens in the case of aqueous solution of acids and bases.

Example 6. Why does distilled water not conduct electricity, whereas rain water does? [NCERT]

Ans. Electric current is conducted in solutions by ions. As distilled water does not contain any ions, it does not conduct electricity. However, rain water conducts electricity due to the presence of small amounts of acidic oxides in rain water such as SO_2, NO_2 which make it a better conductor of electricity.

Hydrogen or Hydronium Ions

All acids produce hydrogen ions (H^+) only in presence of water. The separation of H^+ ion from HCl molecules cannot occur in the absence of water.

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$

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^+).

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

Hydroxide Ions

Bases produce hydroxide ions (OH^-) in water.

Example: When sodium hydroxide is dissolved in water, it dissociates to form Na^+ ions and OH^- ions.

$$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$$

Alkalies

All bases are not soluble in water. The bases which are soluble in water are called alkalis.

Example 7. How is the concentration of hydroxide ions (OH^-) affected when excess base is dissolved in a solution of sodium hydroxide? [NCERT]

Ans. A solution of sodium hydroxide is strongly basic due to the formation of hydroxide ions (OH^-).

$$NaOH_{(s)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$$

When excess base is dissolved in such a solution, the concentration of hydroxide ions will increase further.

Explanation of Neutralization Reactions

Neutralization reaction between acids and bases can be explained in terms of hydrogen ions produced by acids and hydroxide ions produced by bases as follows:

$$\text{Acid} + \text{Base} \longrightarrow \text{Salt} + \text{Water}$$

$$H\boxed{X + M}OH \longrightarrow MX + HOH$$

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$$

Dilution of Acids and Bases

When an acid or a base is added to water, lot of heat is produced. The process of dissolving an acid or a base in water is a highly exothermic reaction.

The process of mixing an acid or base with water results in decrease in the concentration of ions (H_3O^+/OH^-) per unit volume and this process is called dilution. The acid or the base is said to be diluted.

The acid must always be added slowly to water with constant stirring. If water is added to a concentrated

splash out and cause burns.

Example 8. **While diluting an acid, why is it recommended that the acid should be added to water and not water to the acid?** [NCERT]

Ans. Dilution of a concentrated acid is a highly exothermic process. If we add water to the concentrated acid, the mixture may splash and cause severe burn injuries due to the large amount of heat produced. It is therefore recommended that acid should be added to the water drop by drop with constant stirring so water.

Example 9. **How is the concentration of hydronium ions (H_3O^+) affected when a solution of an acid is diluted?** [NCERT]

Ans. When a solution of an acid is diluted by adding acid to the water, the concentration of hydronium ions decreases due to the increase in the volume of the solution. As the number of hydronium ions remains the same on diluting the acid, their concentration decreases.

TOPIC 4

INDICATORS

These are substances which tell us whether a substance is an acid or a base by change in colour or odour when added into the substance.

Types of Indicators

Indicators are classified in the following ways:

Natural Indicators

Natural indicators are the substances obtained from natural sources such as a dye, flower, leaf, etc., in plants.

Examples: Litmus (purple coloured dye extracted from the lichen plant), red cabbage leaf extract, *etc.*

The table below shows the effect of some common natural indicators on acids and bases:

S. No.	Indicator	Colour in Acidic Medium	Colour in Basic Medium
(1)	Litmus	Red	Blue
(2)	Red cabbage leaf extract	Red	Green
(3)	Flower of hydrangea plant	Blue	Pink
(4)	Turmeric	No change (Yellow)	Red

Important

➥ *The yellow stain of curry on a white cloth, which turns reddish-brown when scrubbed with soap is due to the fact that soap solution changes the colour of turmeric to red-brown as it is basic in nature. And when the cloth is rinsed with water, the basic soap gets removed and the stain turns to yellow again.*

Example 10. **You have been provided with three test tubes. One of them contains distilled water and the other two contain an acidic solution and a basic solution, respectively. If you are given only red litmus paper, how will you identify the contents of each test tube?** [NCERT]

Ans. Label the three test tubes as A, B and C. Take a small amount of each of the three given liquids in these test tubes A, B and C. First, dip red litmus paper one by one in each test tube. The liquid which will turn red litmus paper blue is basic in nature.

Remove this test tube as it has been identified as containing a basic solution.

Next, put a drop of solution from the remaining two test tubes on the blue litmus paper (which was earlier red in colour but turned blue on adding basic solution to it).

The solution which turns blue litmus paper red is acidic in nature. The solution that does not change the colour of either red litmus or blue litmus is neutral in nature, which is distilled water.

Synthetic Indicators

Synthetic indicators are the compounds synthesized in a chemistry lab or industrially rather than compounds found in nature.

Examples: Phenolphthalein, Methyl orange.

The table below shows the effect of some common synthetic indicators on acids and bases:

S. No.	Indicator	Colour in Acidic Medium	Colour in Basic Medium
(1)	Phenolphthalein	Colourless	Pink
(2)	Methyl Orange	Red	Yellow

Olfactory Indicators

These are the substances whose odour or smell changes in acidic or basic medium.

The table below shows the effect of some common olfactory indicators on acids and bases:

S. No.	Indicator	Colour in Acidic Medium	Colour in Basic Medium
(1)	Onion extract	Characteristic smell	No smell
(2)	Vanilla essence	Retains smell	No smell
(3)	Clove oil	retains smell	No smell

Important

➥ *Olfactory indicators are used to ensure the participation of visually impaired students in the laboratory for distinguishing between acidic and basic substances.*

TOPIC 5

STRENGTH OF ACID AND BASES

The strength of acids and bases depends on the number of H^+ ions and OH^- ions produced, respectively.

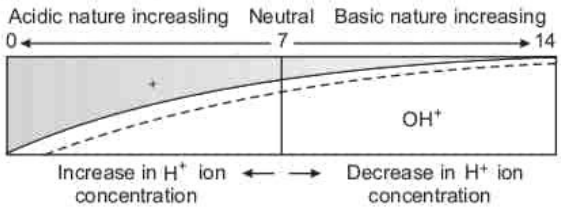
More the number of H^+ ions produced in solution, stronger is the acid and more the number of OH^- ions produced in solution, stronger is the base.

If we take hydrochloric acid and acetic acid of the same concentration, say one molar, then these produce different amounts of hydrogen ions.

The pH Scale

It is a scale for measuring hydrogen ion concentration in a solution. The *p* in pH stands for 'potenz' in German, meaning power. On the pH scale we can measure pH from 0 (very acidic) to 14 (very alkaline).

Higher the hydronium ion concentration, lower is the pH value. The pH of a neutral solution is 7.



Important

➥ *The solution having lower pH will have more hydrogen ion concentration.*

pH of some Common Substances

S. No.	Solution	Colour of pH paper	Approximate pH value	Nature of substance
(1)	Saliva (before meal)	Red	6.5 – 6.9	Acidic
(2)	Saliva (after meal)	Red	5.1 – 5.5	Acidic
(3)	Lemon juice	Red	2.2 – 2.4	Acidic
(4)	Colourless aerated drink	Red	3.0 – 3.5	Acidic
(5)	Carrot juice	Red	4.0 – 4.5	Acidic
(6)	Coffee	Red	4.5 – 5.5	Acidic
(7)	Tomato juice	Red	4.0 – 4.4	Acidic
(8)	Tap water	No effect	7	Neutral
(9)	1 M NaOH	Blue	14.0	Alkaline
(10)	1 M HCl	Red	1.0	Acidic

Example 11. **Do basic solutions also have $H^+_{(aq)}$ ions? If yes, then why are these basic? [NCERT]**

Ans. Yes, basic solutions also have hydrogen ions. They are basic because in such solutions, the concentration of hydroxide ions is much greater than the concentration of hydrogen ions.

Higher the concentration of hydroxide ions, more basic is the solution.

Example 12. **Five solutions A, B, C, D and E when tested with universal indicator showed pH as 4, 1, 11, 7 and 9, respectively. Which solution is**

(A) neutral?

(B) strongly alkaline? **(C) strongly acidic?**

(D) weakly acidic? **(E) weakly alkaline?**

Arrange the pH in increasing order of hydrogen-ion concentration. [CBSE 2010, NCERT]

pH values as:

(A) 4 (B) 1
(C) 11 (D) 7
(E) 9

(A) Solution D is neutral as it has pH value equal to 7.
(B) Solution C is strongly acidic as it has pH value greater than 7 and closer to 14.
(C) Solution B is strongly acidic as it has pH value less than 7 and closer to 0.
(D) Solution A is weakly acidic as it has pH value less than 7 and closer to 7.
(E) Solution E is weakly basic as it has pH value greater than 7 and closer to 7.

As pH of a solution varies inversely as the H+ ion concentration, the pH value in increasing order of H+ ion concentration is:
C < E < D < A < B

Universal Indicator

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

The colours produced by the universal indicator at various values of pH are given below:

pH	Colour	pH	Colour	pH	Colour
0	Dark Red	5	Orange Yellow	10	Navy Blue
1	Red	6	Greenish Yellow	11	Purple
2	Red	7	Green	12	Dark Purple
3	Orange Red	8	Greenish Blue	13	Violet
4	Orange	9	Blue	14	Violet

Importance of pH in Everyday Life

Plants and animals are pH sensitive: 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.

Acid Rain: When 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 which makes the survival of aquatic life in such rivers very diffcult.

pH of soil: Plants require a specific pH range for their healthy growth. Farmers often treat their soil with basic substances such as quick lime (calcium oxide) or slaked lime (calcium hydroxide) if the soil is found to be acidic.

pH in our digestive system and acidity: Our stomach produces hydrochloric acid which helps in the digestion of food without harming the stomach. During indigestion the stomach produces too much called antacids to get rid of this pain by neutralizing the excess acid.

Example of antacid: Magnesium hydroxide (Milk of magnesia)

pH of milk: The pH of fresh milk is 6, which is slightly acidic. The milkman, therefore, adds a small amount of sodium hydrogencarbonate, which is basic in nature, so as to shift the pH of fresh milk to make it slightly alkaline so as to preserve the fresh milk for longer time.

Example 13. Fresh milk has a pH of 6. How do you think the pH will change as it turns into curd? Explain your answer.

[CBSE 2012, 11, 10, 09, NCERT]

Ans. The pH of fresh milk will decrease from 6 as it turns into curd as lactic acid is produced during curd formation, which lowers the pH of fresh milk.

Example 14. A milkman adds a very small amount of baking soda to fresh milk.

(A) Why does he shift the pH of the fresh milk from 6 to slightly alkaline?

(B) Why does this milk take a long time to set as curd? [CBSE 2012, 11, NCERT]

Ans. (A) As the fresh milk has a pH of 6, it is slightly acidic. The milkman therefore adds a very small amount of a basic substance such as baking soda to fresh milk to shift the pH from 6 to slightly alkaline so that milk does not turn sour easily.

(B) This milk is slightly alkaline due to which it will take longer to form curd and become sour since its pH value is now greater than 7.

pH change as the cause of tooth decay: Tooth decay starts when the pH of the mouth is lower than 5.5. Tooth enamel, made up of calcium phosphate is the hardest substance in the body. Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth after eating. Using toothpastes, which are generally basic, for cleaning the teeth can neutralise the excess acid and prevent tooth decay.

Self defence by animals and plants through chemical warfare: Bee-sting leaves an acid which causes pain and irritation. Use of a mild base like baking soda on the stung area gives relief. Stinging hair of nettle leaves inject methanoic acid causing burning pain.

herbaceous plant that grows in the wild, have stinging hair, which cause painful stings when touched accidentallydue to the methanoic acid secreted by them. However, nature provides neutralization options in the form of dock plant, which often grows beside the nettle in the wild, whose leaf is rubbed on the stung area to provide relief from pain and irritation.

think a farmer would treat the soil of his fields with quick lime (calcium oxide) or slaked lime (calcium hydroxide) or chalk (calcium carbonate)? [NCERT]

Ans. A farmer would treat the soil of his fields with quicklime or slaked lime or chalk if the soil has become acidic as all these fertilizers are basic. This will neutralize the acidic nature of the soil.

TOPIC 6

SALTS

Salts are produced when an acid reacts with a base and such reactions are known as neutralization reactions.

Family of Salts

Salts having the same positive or negative radicals are said to belong to the same family.

Examples:

(1) NaCl and Na_2SO_4 belong to the family of sodium salts as they have the common positive radical, namely, sodium.

(2) KCl and $CaCl_2$ belong to the family of chloride salts as they both have the common negative radical, namely,chloride.

pH of Salts

Salts may be neutral, acidic or basic depending upon the strength of the acid and base from which it has been derived or formed.

Neutral Salts

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

Examples:

(1) NaCl: Obtained from strong acid, HCl and strong base NaOH.

(2) K_2SO_4: Obtained from strong acid, H_2SO_4 and strong base KOH.

Acidic Salts

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

Examples:

(1) NH_4Cl: Obtained from strong acid, HCl and weak base NH_4OH.

(2) $(NH4)_2SO_4$: Obtained from strong acid, H_2SO_4 and weak base NH_4OH.

Basic Salts

Salts of a strong base and weak acid are basic in nature, with pH value more than 7.

Examples:

(1) $CaCO_3$: Obtained from weak acid, H_2CO_3, and strong base, $Ca(OH)_2$.

(2) CH_3COONa: Obtained from weak acid, CH_3COOH, and strong base, NaOH.

Common Salt

The salt formed by the combination of hydrochloric acid and sodium hydroxide solution is called sodium chloride and is the salt that is used in food.

Preparing Common Salt

(1) Seawater contains many salts dissolved in it. Sodium chloride is separated from these salts by the process of evaporation.

(2) Deposits of solid salt are also found in several parts of the world. These large crystals are often brown due to impurities. This is called rock salt. Beds of rock salt were formed when seas of bygone ages dried up. Rock salt is mined like coal.

Chemicals Obtained from Common Salt

Common salt is an important raw material for various materials of daily use, such as sodium hydroxide, baking soda, washing soda, bleaching powder and many more.

Sodium Hydroxide

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.

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

Chlorine gas is given off at the anode, and hydrogen gas at the cathode.

Sodium hydroxide solution is formed near the cathode.

Uses of sodium hydroxide

(1) It is used for making soaps and detergents.

(2) It is used for making artificial textile fibres such as rayon.

(4) It is used in purifying bauxite ore from which aluminium metal is extracted.

(5) It is used in de-greasing metals, oil refining, and making dyes and bleaches.

Uses of chlorine

(1) It is used to sterilize drinking water supply and the water in swimming pools as it is a disinfectant.

(2) It is used in the production of bleaching powder.

(3) It is used in the production of hydrochloric acid.

(4) It is used to make plastics such as PVC (polyvinyl chloride), pesticides, CFCs, chloroform, paints and dye-stuffs.

(5) It is used for making solvents for dry cleaning (such as trichloroethane).

Uses of hydrogen

(1) It is used in the hydrogenation of oils to obtain solid fats called vegetable ghee.

(2) It is used in the production of hydrochloric acid.

(3) It is used to make ammonia for fertilizers.

(4) It is used to make methanol.

(5) Liquid hydrogen is used as a fuel for rockets.

Uses of hydrochloric acid

(1) It is used for cleaning iron sheets before tin plating or galvanisation.

(2) It is used in the preparation of chlorides such as ammonium chloride which is used in dry cells.

(3) It is used in medicines and cosmetics.

(4) It is used in textile, dyeing and tanning industries.

(5) It is used in making plastics like PVC.

Bleaching Powder

Bleaching powder is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$]. Bleaching powder is represented as $CaOCl_2$, though the actual composition is quite complex.

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

Properties of bleaching powder

(1) It is a white powder which gives a strong smell of chlorine.

(2) It is soluble in cold water.

(3) It reacts with dilute acids to produce chlorine.

Uses of bleaching powder

(1) It is used for bleaching cotton and linen in the textile industry, for bleaching wood pulp in paper factories and for bleaching washed clothes in laundry.

(2) It is used as an oxidising agent in many chemical industries; and

(3) It is used for disinfecting drinking water to make it free of germs.

treatment with chlorine yields bleaching powder. **[NCERT]**

Ans. When dry slaked lime or calcium hydroxide is treated with chlorine gas, we get bleaching powder.

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

Baking Soda

The chemical name of the compound is sodium hydrogencarbonate ($NaHCO_3$). It is produced using sodium chloride as one of the raw materials.

$$NaCl + H_2O + CO_2{}^{+}\ NH_3 \longrightarrow NH_4Cl + NaHCO_3$$

Properties of baking soda

(1) It consists of white crystals which are sparingly soluble in water.

(2) It is a mild, non-corrosive base.

(3) Its solution in water is mildly alkaline.

(4) When heated, it decomposes to give sodium carbonate with the evolution of carbon dioxide gas.

(5) The following reaction takes place when it is heated during cooking:

$$2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$$

Uses of sodium hydrogencarbonate

(1) For making baking powder, which is a mixture of baking soda (sodium hydrogencarbonate) and a mild edible acid such as tartaric acid. When baking powder is heated or mixed in water, the following reaction takes place:

$NaHCO_{3(aq)}$ + H + (from tartaric acid) $\longrightarrow$ $CO_{2(g)}$ + $H_2O_{(l)}$ + Sodium salt of acid

Carbon dioxide produced during the reaction causes bread or cake to rise making them soft and spongy.

(2) Sodium hydrogencarbonate is also an ingredient in antacids. Being alkaline, it neutralises excess acid in the stomach and provides relief.

(3) It is also used in soda-acid fire extinguishers.

Example 17. What will happen if a solution of sodium hydrocarbonate is heated? Give the equation of the reaction involved. **[NCERT]**

Ans. When a solution of sodium hydrogen carbonate is heated, carbon dioxide is liberated along with the formation of sodium carbonate and water. The equation of the reaction involved is given below:

$$2NaHCO_{3(s)} \xrightarrow{\text{Heat}} Na2CO_{3(s)} + H_2O_{(l)} + CO_{2(g)}$$

Washing soda

Sodium carbonate is obtained by heating baking soda and recrystallisation of sodium carbonate gives washing soda ($Na_2CO^3 10H_2O$).

$$Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3{\cdot}10H_2O$$

(1) It is a transparent crystalline solid.
(2) It is soluble in water.
(3) The solution of washing soda in water is alkaline which turns red litmus blue.
(4) It has cleansing properties due to which it is used in detergents.

Uses of washing soda

(1) Sodium carbonate (washing soda) is used in glass, soap and paper industries.
(2) It is used in the manufacture of sodium compounds such as borax.
(3) Sodium carbonate can be used as a cleaning agent for domestic purposes.
(4) It is used for removing permanent hardness of water.

Example 18. Name the sodium compound which is used for softening hard water. [NCERT]

Ans. The sodium compound which is used for softening hard water is sodium carbonate ($Na_2CO_3 10H_2O$).

Plaster of Paris

On heating gypsum at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate ($CaSO_4 \frac{1}{2} H_2O$).

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

This is called Plaster of Paris, the substance which doctors use as plaster for supporting fractured bones in the right position.

Properties of plaster of paris

(1) It is a white powder.
(2) It has a property of setting into a hard mass on wetting with water which is due to its hydration to form crystals of gypsum which set to form a hard solid mass. Plaster of Paris should therefore be stored in moisture proof containers.

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

Note: Only half a water molecule is shown to be attached as water of crystallisation. It is written in this form because two formula units of $CaSO_4$ share one molecule of water.

(1) Plaster of Paris is used for making toys, materials for decoration and for making surfaces smooth.
(2) It is used for setting fractured bones in the right position by doctors.
(3) It is used as a fire-proofing material.
(4) It is used in chemical laboratories for sealing air gaps in apparatus.

Example 19. Plaster of Paris should be stored in a moisture-proof container. Explain why? [NCERT]

Ans. Plastic of Paris should be stored in moisture proof containers because if it comes in contact with water, it sets into a hard solid mass, Gypsum.

The equation for the reaction taking place is:

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

Water of Crystallization

Water of crystallisation is the fixed number of water molecules present in one formula unit of a salt. Five water molecules are present in one formula unit of copper sulphate. Chemical formula for hydrated copper sulphate is $CuSO_{(4)}.5H_2O$.

Copper sulphate crystals which seem to be dry contain water of crystallisation. When we heat the crystals, this water is removed and the salt turns white.

$$CuSO_4.5H_2O \longrightarrow CuSO_4 + 5H_2O$$

The dehydration of copper sulphate crystals is a reversible process. When water is added to anhydrous copper sulphate, it gets hydrated and turns blue:

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4$$

Some examples of hydrated salts:

(1) Copper sulphate – $CuSO_4.5H_2O$
(2) Sodium carbonate (washing soda) – $Na_2CO_3.10H_2O$
(3) Calcium sulphate (Gypsum) – $CaSO_4.2H_2O$
(4) Iron sulphate – $FeSO_4.7H_2O$

[1 mark]

Multiple Choice Questions

1. What happens when the solution of an acid is mixed the solution of a base in a test tube?

(I) The temperature of the solution increases

(II) The temperature of the solution decreases

(III) The temperature of the solution remains the same

(IV) Salt formation takes place

(a) Only (I) (b) (I) and (III)

(c) (I) and (III) (d) (I) and (IV)

[NCERT Exemplar]

Ans. *(d) (I) and (IV)*

Explanation: When an acid reacts with a base, a neutral salt is formed by the neutralisation process. As the neutralisation process is an exothermic reaction, the temperature of the solution increases.

$$\text{Acid} + \text{Base} \longrightarrow \text{Salt} + \text{Water}$$

2. If 10 mL of H_2SO_4 is mixed with 10 mL of $Mg(OH)_2$ of the same concentration, the resultant solution will give the following colour with universal indicator:

(a) Red (b) Yellow

(c) Green (d) Blue [CBSE 2020]

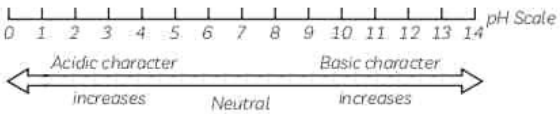
Ans. *(c) Green.*

Explanation: If 10 mL of H_2SO_4 is mixed with 10 mL of $Mg(OH)_2$ of the same concentration, the resultant solution be $MgSO_4$ which is a neutral salt and universal indicator will give the green colour in this solution:

$$\underset{\text{(Acid)}}{H_2SO_{4(aq)}} + \underset{\text{(Base)}}{Mg(OH)_{2(aq)}} \longrightarrow \underset{\text{(salt)}}{MgSO_{4(aq)}} + \underset{\text{(water)}}{2H_2O}$$

Related Theory

When an acid reacts with a base it forms salt and water. As a result acidic properties disappear. The process is called neutralisation. For a neutral solution, pH is 7. The solution having pH 7 will turn green in colour in universal indicator.



3. Which of the following salts does not contain water of crystallisation?

(a) Blue vitriol (b) Baking soda

(c) Washing soda (d) Gypsum

[CBSE 2015]

4. A visually challenged student, has to perform a lab test to detect the presence of acid in a given solution. The acid-base indicator preferred by him will be:

(a) Blue litmus

(b) Clove oil

(c) Red cabbage extract

(d) Hibiscus extract [CBSE 2020]

Ans. *(b) Clove oil*

Explanation: Clove oil is an olfactory indicator. These are the substances which give one type of odour in acidic medium so a visually challenged student prefers to use clove oil as an acid-base indicator.

As in basic solutions, the smell of clove oil disappears while the smell is retained when mixed with an acid, on the other hand, blue litmus, red cabbage extract and hibiscus extract would not be used as acid-base indicator because in these indicators there will be a change in the colour.

5. Baking soda is a mixture of:

(a) Sodium carbonate and acetic acid

(b) Sodium carbonate and tartaric acid

(c) Sodium hydrogen carbonate and tartaric acid

(d) Sodium hydrogen carbonate and acetic acid [CBSE 2020]

6. Which of the following gives the correct increasing order of acid strength?

(a) Water < acetic acid < hydrochloric acid

(b) Water < hydrochloric acid < acetic acid

(c) Acetic acid < water < hydrochloric acid

(d) Hydrochloric acid < water < acetic acid

[NCERT Exemplar]

7. What is observed when we pour a drop of acetic acid first on red and then on blue litmus papers?

(a) Red litmus paper becomes colourless and blue litmus paper remains blue.

litmus paper remains blue.

(c) Red litmus paper remains red and blue litmus paper turns red.

(d) Red litmus paper turns blue and blue litmus paper turns red. [CBSE 2016]

8. **Sodium hydrogen carbonate when added to acetic acid evolves a gas. Which of the following statements are true about the gas evolved?**

(I) It turns lime water milky.

(II) It extinguishes a burning splinter.

(III) It dissolves in a solution of sodium hydroxide.

(IV) It has a pungent odour.

(a) (I) and (II)

(b) (I), (II) and (III)

(c) (II), (III) and (IV)

(d) (I) and (IV) **[CBSE 2013]**

Ans. *(b) (I), (II) and (III)*

Explanation: Reaction of sodium hydrogen carbonate with acetic acid forms sodium acetate and water with carbon dioxide (CO_2) gas.

$$NaHCO_3 + CH_3COOH \longrightarrow CH_3COONa + CO_2 + H_2O$$

Sodium hydrogen carbonate — Acetic acid — Sodium acetate

CO_2 does not have a pungent smell but it shows all the other three properties:

(1) turns lime water milky,

(2) is a non-supporter of combustion and

(3) absorbed by strong alkalis such as NaOH.

9. **Common salt besides being used in kitchen can also be used as the raw material for making:**

(I) Washing soda **(II) Bleaching powder**

(III) Baking soda **(IV) Slaked lime**

(a) (I) and (II) **(b) (I), (II) and (IV)**

(c) (I) and (III) **(d) (I), (III) and (IV)**

[NCERT Exemplar]

10. **To protect tooth decay we are advised to brush our teeth regularly. The nature of the toothpaste commonly used is:**

(a) Acidic **(b) Neutral**

(c) Basic **(d) Corrosive**

[CBSE 2014, 13]

Ans. *(c) Basic*

Explanation: The tooth paste commonly used is alkaline or basic in nature as they contain bicarbonate in their composition.

The base reacts with the acid formed during bacterial action in the mouth and neutralises its bad effects. Thus, preventing tooth decay. So, they can neutralize the effect of extra acids being formed in the mouth cavity which are mainly responsible for tooth decay.

Related Theory

When we eat sweet things, the pH of our mouth falls below 5.5 (moderately acidic) as the oral bacteria releases acid while acting on sugars present in our food. The acidic conditions are capable of corroding the enamel which is made up of calcium phosphate. This causes the tooth to decay.

11. **Match the chemical substances given in Column I with their appropriate application given in Column II:**

Column I	Column II
(A) Bleaching Powder	(1) Preparation of glass
(B) Baking Soda	(2) Production of H_2 and Cl_2
(C) Washing Soda	(3) Decolourisation
(D) Sodium Chloride	(4) Antacid

Codes:	A	B	C	D
(a)	2	1	4	3
(b)	3	2	4	1
(c)	3	4	1	2
(d)	2	4	1	3

12. **Which of the following phenomena occur, when a small amount of acid is added to water?**

(I) Ionisation **(II) Neutralisation**

(III) Dilution **(IV) Salt formation**

(a) (I) and (II) **(b) (I) and (III)**

(c) (II) and (III) **(d) (II) and (IV)**

[NCERT Exemplar]

13. **A sample of soil is mixed with water and allowed to settle. The clear supernatant solution turns the pH paper yellowish-orange. Which of the following would change the colour of this pH paper to greenish-blue:**

(a) Lemon juice **(b) Vinegar**

(c) Common salt **(d) An antacid**

Explanation: pH paper gives greenish blue colour in weak alkaline medium so antacid [$Mg(OH)_2$] which is an alkaline compound will show greenish blue color on pH paper.

Related Theory

Lemon fruit contains citric acid, vinegar has acetic acid and common salt is the neutral salt the clear super natant solution turns the pH paper yellowish-orange means the given sample of soil is acidic so it can be neutralised by base/alkaline solution.

14. Which of the following is not a mineral acid?

(a) Hydrochloric acid (b) Citric acid

(c) Sulphuric acid (d) Nitric acid

[NCERT Exemplar]

15. Which of the following is/are true when $HCl_{(g)}$ is passed through water?

(I) It does not ionise in the solution as it is a covalent compound.

(II) It ionises in the solution.

(III) It gives both hydrogen and hydroxyl ions in the solution.

(IV) It forms hydronium ion in the solution due to the combination of hydrogen ion with water molecule.

(a) Only (I) (b) Only (III)

(c) (II) and (IV) (d) (III) and (IV)

[CBSE 2017, 13]

Ans. *(c) (II) and (IV)*

Explanation: HCl, being a polar covalent compound, easily ionses in water to form hydronium (H_3O^+) and chloride ions (Cl^-). HCl (a strong acid) ionises completely in water to produce H^+ and Cl^- ions. H^+ ion combines with water molecules to produce hydronium ions.

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

$$H^+ + H_2O \longrightarrow \underset{\text{Hydronium ion}}{H_3O^+}$$

16. Which among the following is not a base?

(a) NaOH (b) KOH

(c) NH_4OH (d) C_2H_5OH

[NCERT Exemplar]

Ans. *(d) C_2H_5OH*

Explanation: C_2H_5OH is not a base. C_2H_5OH is an organic compound with –OH functional group that is known as alcohol. It cannot give ions in a solution. Thus, it cannot be a basic compound.

17. Identify the correct representation of reaction occurring during chloralkali process.

(a) $2NaCl_{(l)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(l)} + Cl_{2(g)} + H_{2(g)}$

(b) $2NaCl_{(l)} + 2H_2O_{(aq)} \longrightarrow 2NaOH_{(aq)} + Cl_{2(g)} + H_{2(aq)}$

(c) $2NaCl_{(aq)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + Cl_{2(aq)} + H_{2(aq)}$

(d) $2NaCl_{(aq)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + Cl_{2(g)} + H_{2(g)}$

[NCERT Exemplar]

18. Which of the following statements is true for acids?

(a) Bitter and change red litmus to blue.

(b) Sour and change red litmus to blue.

(c) Sour and change blue litmus to red.

(d) Bitter and change blue litmus to red.

[NCERT Exemplar]

19. Zinc granules on treating with an acid X, form zinc sulphate ($ZnSO_4$) salt along with the evolution of a gas Y, which burns with a pop sound when brought near to a burning candle. Identify acid X and gas evolved Y.

(a) X-sulphuric acid and Y-oxygen gas

(b) X-hydrochloric acid and Y-oxygen gas

(c) X-sulphuric acid and Y-hydrogen gas

(d) X-hydrochloric acid and Y-hydrogen gas

[Diksha]

Ans. *(c) X-sulphuric acid and Y-hydrogen gas*

Explanation: When an acid reacts with a metal, hydrogen gas is liberated. In the given reaction, when dilute sulphuric acid reacts with zinc granules, hydrogen gas is liberated and zinc sulphate solution is formed:

$$\underset{\text{Zinc}}{Zn_{(s)}} + \underset{\substack{\text{Sulphuric}\\\text{acid}}}{H_2SO_{4(aq)}} \rightarrow \underset{\substack{\text{Zinc}\\\text{sulphate}}}{ZnSO_{4(aq)}} + \underset{\text{Hydrogen}}{H_{2(g)}}$$

The presence of hydrogen gas is tested by bringing a lighted candle near it. When a lighted candle is brought near the test tube containing hydrogen gas, it burns with a 'pop' sound making a little explosion.

Hence, acid X is sulphuric acid and gas Y is hydrogen gas.

20. Which of the following solutions in water does not conduct electricity?

(a) Hydrochloric acid (b) Sodium chloride

(c) Glucose (d) Sulphuric acid

[Diksha]

Explanation: The aqueous solution of an acid conducts electricity because of the presence of charged particles called 'ions' in it. When hydrochloric acid (HCl) is dissolved in water, its aqueous solution contains hydrogen ions (H^+) and chloride ions (Cl^-). These ions carry electric current. So, due to the presence of H^+ and Cl^- ions, a solution of hydrochloric acid conducts electricity.

On the other hand, the hydrogen-containing compound such as glucose is not categorized as acid because it does not produce hydrogen ions or some other ions, when dissolved in water, and hence does not conduct electricity.

Therefore, the answer is glucose.

21. **Which of the following will turn phenolphthalein pink?**

(a) $NaOH_{(aq)}$ **(b)** $HCl_{(aq)}$

(c) $CH_3COOH_{(aq)}$ **(d)** H_2O **[Diksha]**

22. **Which one of the following is not a use of washing soda:**

(a) Sodium carbonate (washing soda) is used in glass, soap and paper industries.

(b) It is used in the manufacture of sodium compounds such as borax.

(c) Sodium carbonate can be used as a cleaning agent for domestic purposes.

(d) It is used for disinfecting water.

Ans. *(d) It is used for disinfecting water.*

Explanation: The compound that is used for disinfecting water is bleaching powder. However, washing soda is used for removing permanent hardness of water.

23. **The approximate pH values of four salts is given below. Select the row(s) containing the correct information.**

	Name of Salt	pH
(I)	Potassium Sulphate	10
(II)	Ammonium nitrate	5
(III)	Sodium acetate	3
(IV)	Sodium hydrogen carbonate	8

(a) Both (I) and (II)

(b) Both (II) and (III)

(c) Both (III) and (IV)

(d) Both (II) and (IV)

24. **Zinc granules react with a substance X, form a salt sodium zincate along with the evolution of a gas Y which burns with a pop sound when brought near a burning candle. Identify the substance X and gas evolved Y.**

	X	Y
(a)	Acetic acid	Hydrogen
(b)	Sodium hydroxide	Hydrogen
(c)	Sodium hydroxide	Oxygen
(d)	Zinc hydroxide	Hydrogen

Ans. *(b) X is Sodium hydroxide and Y is hydrogen.*

Explanation: When zinc granules react with sodium hydroxide, salt sodium zincate is formed along with hydrogen gas, which burns with a pop sound.

The equation of the reaction taking place is:

$$2NaOH_{(aq)} + Zn_{(s)} \longrightarrow Na_2ZnO_{2(aq)} + H_{2(g)}$$

25. **Which of the following salts belong to the same family of salts?**

(I) sodium chloride and sodium acetate

(II) calcium sulphate, magnesium sulphate

(III) sodium carbonate and sodium hydrogen -carbonate

(IV) sodium chloride and magnesium sulphate

(a) Both (I) and (II)

(b) Both (I) and (III)

(c) (I), (II) and (III)

(d) (I), (III) and (IV)

26. **A student noted his observations regarding acidic or basic nature of salts as below:**

(I) Sodium chloride is a neutral salt

(II) Ammonium chloride is a basic salt

(III) Sodium carbonate is a neutral salt

(IV) Copper sulphate is an acidic salt

Select the incorrect observations:

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

Ans. *(b) Both (II) and (III)*

Explanation: The salts of strong acids and strong bases give neutral solutions. Therefore, sodium chloride is a neutral salt as it is obtained from sodium hydroxide (a strong base) and hydrochloric acid (a strong acid).

The salts of strong acids and weak bases give acidic solutions. Therefore, ammonium chloride and copper sulphate are acidic salts as am-

hydroxide (a weak base) and hydrochloric acid (a strong acid), and copper sulphate is obtained from copper hydroxide (a weak base) and sulphuric acid (a strong acid).

The salts of weak acids and strong bases give basic solutions. Therefore, sodium carbonate is a basic salt as it is obtained from carbonic acid (a weak acid) and sodium hydroxide(a strong base).

Assertion-Reason Questions

For the following questions, two statements are given—one labeled Assertion (A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

(a) Both (A) and (R) are true and (R) is the correct explanation of the (A).

(b) Both (A) and (R) are true, but (R) is not the correct explanation of the (A).

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.

27. Assertion (A) : HCl gas does not change the colour of dry blue litmus paper.

Reason (R) : Acids always produce hydrogen ions.

Ans. *(b) Both (A) and (R) are true, but (R) is not the correct explanation of the (A).*

Explanation: HCl gas does not change the colour of dry litmus paper but changes colour of moist litmus paper as acids produce hydrogen ions only in solution.

28. Assertion (A) : Generally, the colour of indicators changes in particular pH range.

Reason (R) : Indicators are weak acids or weak base and exhibit different colours in molecular form and ionic form.

Ans. *(a) (A) and (R) are true and (R) is the correct explanation of the (A).*

Explanation: Since indicators are weak acids or weak bases, their percentage of existence in molecular state and in ionized state depends on the strength of acidic/basic/neutral solution to which they are added. Hence their colours change at a particular pH range.

29. Assertion (A): Zinc reacts with sodium hydroxide solution and hydrogen gas is evolved.

Reason (R) : The reaction is carried out in the presence of water to evolve hydrogen gas.

30. Assertion (A): While diluting an acid, water is slowly added to acid with constant stirring.

Reason (R) : The process of dissolving an acid in water is a highly exothermic reaction.

31. Assertion (A) : Metal oxides are acidic in nature.

Reason (R) : Calcium hydroxide reacts with carbon dioxide to form a salt and water.

Ans. *(d) (A) is false, but (R) is true.*

Explanation: The reaction of calcium hydroxide with carbon dioxide to form a salt and water is similar to the reaction between an acid and a base. Therefore, non-metal oxides are acidic in nature.

32. Assertion (A) : When copper sulphate crystals are heated in a dry boiling tube, they turn white.

Reason (R) : Water of crystallization is the number of water molecules present in one formula unit of a salt.

Ans. *(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).*

Explanation: Copper sulphate crystals which seem to be dry contain water of crystallisation. When we heat the crystals, this water is removed and the salt turns white.

$$CuSO_4.5H_2O \longrightarrow CuSO_4 + 5H_2O$$

33. Assertion (A) : When copper oxide is added to dilute hydrochloric acid, the colour of the solution becomes blue-green.

Reason (R) : Copper (II) chloride is formed.

Ans. *(a) (A) and (R) are true and (R) is the correct explanation of the (A).*

Explanation: When copper oxide is added to dilute hydrochloric acid, the colour of the solution becomes blue-green due to the formation of Copper (II) chloride, which is blue-green in colour.

Very Short Answer Type Questions

34. What types of ions are formed: (a) when an acid is dissolved in water (b) when a base is dissolved in water ?

base. Compared to pH of pure water, what will be the pH of (a) solution of A (b) solution of B?

Ans. pH of pure water is 7. As A is a soluble acid, its pH will be less than that of pure water whereas pH of B will be more than that of pure water as it is a soluble base.

36. When electricity is passed through a common salt solution, sodium hydroxide is produced along with the liberation of two gases "X" and "Y". "X" burns with a pop sound whereas "Y" is used for disinfecting drinking water. Identify X and Y.

Ans. The reaction is chlor-alkali process. As X burns with a pop sound, X is hydrogen gas. Y is chlorine gas which is used for disinfecting drinking water.

37. Which bases are called alkalis? Give one example of alkali. [CBSE 2010, 09]

Ans. The bases that are soluble in water are called alkalies. One example of an alkali is sodium hydroxide, NaOH.

38. Name the acid and base that have com stituted the salt ammonium nitrate [CBSE 2010]

39. Oxides of metals are basic while those of non-metals are acidle, Explain. [CBSE 2010]

Ans. Oxides of metals are basic as they react with acids to produce salt and water.

$$CuO + 2HCl \longrightarrow CuCl_2 + H_2O$$

Oxides of non-metals are acidic as they react with bases to produce salt and water.

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

40. Write a balanced chemical eauatin for the renction between sodium carbonals and hydrochloric acid indicating the physical state of reactions and the products. [CBSE 2010]

Ans. The balanced equation for the reaction between sodium carbonate and hydrochloric acid is given below:

$$Na_2CO_{3(s)} + 2HCl_{(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

41. Give reasons for the following:

(A) Only one half of water molecule is shown in the formula of Plaster of Paris.

an antacid.

(C) On strong heating, blue coloured copper sulphate crystals turn white.

[CBSE 2020]

42. A student prepared solutions of (I) an acid and (II) a base in two separate beakers. She forgot to label the solutions and litmus paper is not available in the laboratory. Since, both the solutions are colourless, how will she distinguish between the two?

[CBSE 2017]

Ans. In the absence of litmus, other natural or synthetic substances can be used to test acid and bases. Such substances are called indicators. Indicators such as methyl orange and phenolphthalein can be used to test the nature of a solution.

These indicators show change in their colour in acidic, neutral and basic solutions. We can also use natural indicators such as turmeric and grape juice. A few indicators with characteristic colour change are shown below:

pH Indicator	Colour in Acidic Medium	Colour in Neutral Medium	Colour in Basic Medium
Litmus	Red	Purple	Blue
Phenol red	Yellow	Red	Red
Phenol-phthalein	Colourless	Colourless	Pink
Methyl orange	Red/Pink	Orange	Yellow
Turmeric	Yellow	Yellow	Reddish brown
Red cabbage juice	Red	Purple	Bluish green

43. Fill in the missing data in the given table.

Name of the Salt	Formula	Salt obtained from	
		Base	Acid
Ammonium chloride	NH_4Cl	NH_4OH	—
Copper sulphate	—	—	H_2SO_4
Sodium chloride	NaCl	NaOH	—
Magnesium nitrate	$Mg(NO_3)_2$	—	HNO_3

Name of the Salt	Formula	Salt obtained from	
		Base	Acid
Potassium sulphate	K_2SO_4	—	—
Calcium nitrate	$Ca(NO_3)_2$	$Ca(OH)_2$	—

[NCERT Exemplar]

Ans.

Name of the Salt	Formula	Salt obtained from	
		Base	Acid
Ammonium chloride	NH_4Cl	NH_4OH	HCl
Copper sulphate	$CuSO_4$	$Cu(OH)_2$	H_2SO_4
Sodium chloride	NaCl	NaOH	HCl
Magnesium nitrate	$Mg(NO_3)_2$	$Mg(OH)_2$	HNO_3
Potassium sulphate	K_2SO_4	KOH	H_2SO_4
Calcium nitrate	$Ca(NO_3)_2$	$Ca(OH)_2$	HNO_3

(1) Acid: HCl

$NH_4OH + HCl \longrightarrow NH_4Cl + H_2O$

(2) Formula: $CuSO_4$ and base: $Cu(OH)_2$

$H_2SO_4 + Cu(OH)_2 \longrightarrow CuSO_4 + 2H_2O$

(3) Acid: HCl

$NaOH + HCl \longrightarrow NaCl + H_2O$

(4) Base: $Mg(OH)_2$

$Mg(OH)_2 + 2HNO_3 \longrightarrow Mg(NO_3)_2 + 2H_2O$

(5) Base: KOH and Acid: H_2SO_4

$2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O$

(6) Acid: HNO_3

$Ca(OH)_2 + 2HNO_3 \longrightarrow Ca(NO_3)_2 + 2H_2O$

44. How is washing soda prepared from sodium carbonate? Give its chemical equation. State the type of this salt. Name the type of hardness of water which can be removed by it? [CBSE 2020]

45. (A) You are given two solutions A and B and their pH is 6 and 8 respectively. Answer the following:

(i) Which of the two solutions have more hydrogen ion concentration?

(ii) Which is acidic and which is basic?

(B) What is dilution?

pH of solution B = 8

(i) Solution A will have the higher hydrogen ion concentration.

Explanation: We know that the pH of any solution is inversely proportional to the hydrogen ion concentration. This means that the solution that has lower pH number will have the higher hydrogen ion concentration.

(ii) Also solution A is acidic and solution B is basic because H^+ ion concentration is higher in acidic solution.

(B) Mixing an acid or base with water results in decrease in concentration of ions (H_3O^+/ OH^-) per unit volume. Such process is called dilution and the acid or base is said to be dituted. The process of dissolving an acid or a base in water is a highly exothermic reaction.

46. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid (HCl) is added to test tube A, while acetic acid (CH_3COOH) is added to test tube B. In which test tube will the fizzing occur more vigorously and why?

47. Crystals of a substance changes their color on heating in a closed vessel but regained it after sometime, when they were allowed to cool down.

(A) Name one such substance.

(B) Explaain the phenomenon involved.

[CBSE 2012]

Ans. (A) One such substance whose crystals changes its colour from blue to white on heating in a closed vessel for some time is hydrated copper sulphate, $CuSO_4.5H_2O$.

(B) Hydrated salts contain molecules of water known as water of crystallization. When such crystals are heated in a closed container, they lose their water of crystallization and hence change of colour is observed.

Related Theory:

When a salt which has lost its water of crystallization due to heating is left to cool down, it absorbs moisture from air and regains its water of crystallisation and thus, also its color.

48. The pH of the mouth of a person is lower than 5.5. What changes will occur in

controlled? Write any two measures.

[CBSE 2012, 2011, 2010]

Ans. When the pH of the mouth of a person is lower than 5.5, the acid produced by the action of bacteria on sugar and food particles in mouth corrodes even the tooth enamel which is made up of calcium phosphate. This leads to dental caries and tooth decay.

following measures:

(1) By using tooth pastes, which are generally basic in nature, as they can neutralize the excess acid produced in the mouth and hence help in preventing tooth decay.

(2) By regular brushing of teeth twice a day and especially after eating sweets and chocolates.

COMPETENCY BASED Questions (CBQs)

[1, 4 & 5 marks]

49. *A chemistry student placed a strip of blue litmus paper and a strip of red litmus paper in a glass dish. Then she added a drop of dilute sulphuric acid to each strip of litmus paper. She observed that the blue litmus paper turned red, but the red litmus paper did not change color. Next she placed a drop of sodium hydroxide (NaOH) on other strips of blue and red litmus paper. This time, the red litmus paper turned blue, but the blue litmus paper did not change. Finally, she put a drop of distilled water on strips of blue and red litmus paper. Neither strip changed color. She repeated the tests several times with the same results. The student concluded that acids turn blue litmus paper red; bases, such as sodium hydroxide, turn red litmus paper blue. As water did not affect either red or blue litmus paper, she reasoned that water was not an acid or a base, but a neutral substance.*

Keeping these results in mind, the student poured a little sodium hydroxide into a beaker containing red and blue litmus paper. Then she added hydrochloric acid (HCl) drop by drop until the solution became neutral. She determined that a new, neutral substance had formed in the beaker. The substance was table salt, or sodium chloride (NaCl), which is one of many salts formed from an acid and a base.

(A) If a drop of an unknown substance turns blue litmus paper red, but does not change red litmus paper, what will be the substance - an acid or a base?

(B) When strips of blue and red litmus paper are put in a beaker filled with a clear solution, neither litmus paper changes color. What can you say about the solution?

(C) Based on the results of this experiment, when would a salt be formed?

(D) What happens when nitric acid is added to egg shell?

Ans. (B) The solution must be neutral.

(D) Calcium carbonate is main component of egg shell so when we add nitric acid to egg shell, it reacts with calcium carbonate to form soluble calcium nitrate and water with brisk effervescence of carbon dioxide gas.

$$CaCO_{3(s)} + 2HNO_{3(aq)} \longrightarrow Ca(NO_3)_{2(aq)} + CO_{2(g)} + H_2O$$

50. *When we smile, our teeth become visible. So, we should ensure that we have a beautiful set of teeth as it makes our smile even more beautiful! Tooth enamel is the thin outer covering of the tooth. This tough shell is the hardest tissue in the human body. Enamel covers the crown which is the part of the tooth that's visible outside of the gums.*

Calcium phosphate is present in tooth enamel. Its nature is:

(a) Basic **(b) Acidic**

(c) Neutral **(d) Amphoteric**

[CBSE 2014, 13]

Explanation: Calcium phosphate $Ca_3(PO_4)_2$ is a basic salt, as it is formed by the combination of a weak acid (phosphoric acid) and a slightly stronger base (calcium hydroxide).

$$\underset{\text{Calcium hydroxide}}{3Ca(OH)_2} + \underset{\text{Phosporic acid}}{2H_3PO_4} \rightarrow \underset{\text{Calcium phosphate}}{Ca_3(PO_4)_2} + 6H_2O$$

51. *Patrick read about an industrial process for the electrolysis of sodium chloride solutions. It is the technology used to produce chlorine and sodium hydroxide which are commodity chemicals required by industry. 35 million tons of chlorine were prepared by this process in 1987. Industrial scale production began in 1892. Usually the process is conducted on a brine (an aqueous solution of NaCl), in which case NaOH, hydrogen, and chlorine are formed. When using calcium chloride or potassium chloride, the products contain calcium or potassium instead of sodium. Related processes are known that use molten NaCl to give chlorine and sodium metal or condensed hydrogen chloride to give hydrogen and chlorine.*

(A) Name the process referred to in the above passage.

(B) Where are the products of the above process produced?

(C) Write the chemical equation for the reaction taking place in the process.

(D) How is bleaching powder prepared from one of the products formed in this industrial process?

Ans. (A) The process referred to in the passage is chlor-alkali process because of the products formed - chlor for chlorine and alkali for sodium hydroxide.

(C) The chemical equation for the reaction taking place is:

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

52. *Neetu's friend suffered a fracture in her foot while riding her bicycle. She had to be admitted to the nursing home and the doctor plastered her foot.*

The chemical formula for Plaster of Paris is:

(a) $CaSO_4 \cdot 2H_2O$ **(b)** $CaSO_4 \cdot H_2O$

(c) $CaSO_4 \cdot \frac{1}{2} H_2O$ **(d)** $2CaSO_4 \cdot H_2O$

[CBSE 2020]

Ans. *(c)* $CaSO_4 . \frac{1}{2} H_2O$

Explanation: Chemical name of Plaster of Paris is calcium sulphate hemihydrate. It is written in this form because two formula units of $CaSO_4$ share one molecule of water.

Related Theory

- *When gypsum is heated at 373K, it loses water molecules.*

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

- *It is a white powder used by the doctors for supporting fractured bones. It is also used for making toys, materials for decoration and for making surfaces smooth.*

53. *Sabina studied in history about Mahatma Gandhi's Dandi March and came to know that sodium chloride was an important symbol in our struggle for freedom. She started exploring from the internet as she was anxious to know what all we can do with this salt other than using it as a table salt to make food tasty. Table salt is also used to preserve food, facilitates transport of nutrients and oxygen and used as raw material to form various salts.*

Based on the understanding of the given passage and the related studied concepts, answer the following questions:

(A) Name two salts of daily use for which common salt (sodium chloride) is the raw material.

(B) Draw a diagram of chloralkali process and write its equation.

lab, one should always wear a laboratory coat and be very careful while performing experiments. Some students have the bad habit of creating nuisance for other students which distracts the students and may cause serious accidents such as spilling of acid or can cause burn injuries.

If a few drops of a concentrated acid accidentally spills over the hand of a student, what should be done?

(a) Wash the hand with a saline solution

(b) Wash the hand immediately with plenty of water and apply a paste of sodium hydrogen carbonate

(c) After washing with plenty of water, apply a solution of sodium hydroxide on the hand

(d) Neutralise the acid with a strong alkali

[CBSE 2014]

Ans. *(b) Wash the hand immediately with plenty of water and apply a paste of sodium hydrogen carbonate*

Explanation: In such an accident, washing the hands with water will dilute the acid and wash it out. Any remaining acid will be neutralized with sodium hydrogen carbonate (baking soda) as it is a base. This will minimize the effect of damage caused by acid to the skin.

Remember, too strong a base (like NaOH) can be corrosive.

55. *Take about 2 mL of dilute NaOH solution in a test tube and a small amount of copper oxide in a beaker. Add two drops of phenolphthalein solution in the test tube. Add dilute HCl solution in both the test tube and the beaker drop by drop while stirring. Now add a few drops of NaOH to the mixture in the test tube.*

[NCERT Activity 2.6, 2.7]

are added to the test tube,

(a) The solution turns pink in colour

(b) The solution turns colourless

(c) The solution turns red

(d) The solution turns yellow

(B) Four students recorded their observations on adding dilute HCl to the beaker containing copper oxide. Select the correct observation:

Student	Observation-I	Observation-II
(a)	Solution becomes colourless	Copper oxide dissolves
(b)	Solution becomes blue-green in colour	Copper oxide dissolves
(c)	Solution becomes blue green in colour	Copper oxide is formed as a precipitate
(d)	Solution becomes colourless	Copper chloride solution is colourless

(C) Select the correct observation(s):

When dilute HCl solution is added to the test tube drop by drop (after adding two drops of phenolphthalein solution) and then a few drops of NaOH solution are added to this mixture:

(I) The solution turns colourless on adding dilute HCl

(II) The solution turns pink on adding dilute HCl

(III) The solution turns colourless again on adding NaOH to the mixture.

(IV) The solution turns pink again on adding NaOH to the mixture

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(D) Identify the option that correctly describes the products formed in the test tube and beaker on adding dilute HCl:

	Test Tube	Beaker
(a)	Sodium chloride + hydrogen	Copper chloride + hydrogen

	+ water	hydrogen
(c)	Sodium chloride + hydrogen	Copper chloride + water
(d)	Sodium chloride + water	Copper chloride + water

(E) Select the incorrect statement(s):

(I) Reaction of sodium hydroxide with dilute hydrochloric acid is a displacement reaction.

(II) Reaction of copper oxide with dilute hydrochloric acid is a double displacement reaction.

(III) Reaction of sodium hydroxide with dilute hydrochloric acid is a neutralization reaction.

(IV) Reaction of copper oxide with dilute hydrochloric acid is a neutralization reaction.

(a) Only (I)

(b) Only (II)

(c) Both (I) and (IV)

(d) Both (II) and (III)

Ans. (A) *(a) The solution turns pink in colour*

Explanation: Phenolphthalein is a colourless reagent which is used as an indicator as it changes the colour to pink in a basic solution. As dilute NaOH is a basic solution, its colour changes to pink on adding a few drops of phenolphthalein solution.

(D) *(d) Test Tube: Sodium chloride + water; Beaker: Copper chloride + water*

Explanation: The products formed in the test is sodium chloride and water and that in beaker is copper chloride and water.

When sodium hydroxide reacts with dilute hydrochloric acid, it forms sodium chloride and water:

When copper oxide reacts with HCl, it forms copper chloride and water:

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

(E) *(a) Only (I)*

Explanation: Reaction of sodium hydroxide with dilute hydrochloric acid is a neutralization reaction which is also a double displacement reaction as products are formed by exchange of ions between the reactants.

dilute hydrochloric acid is also a neutralization reaction which is also a double displacement reaction.

Whereas in a displacement reaction, a more reactive substance displaces a less reactive substance from its compound as in the reaction between a metal such as zinc and dilute hydrochloric acid.

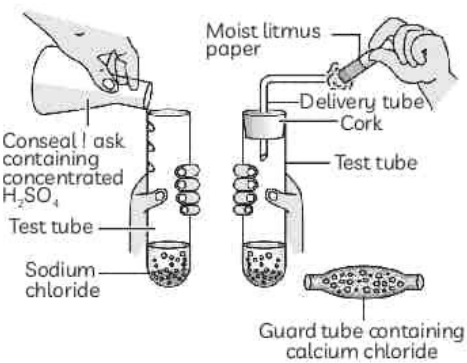
56. *Sumit along with his friend went to a nearby shopping mall. They were standing under a tree when an ant stung his friend on his hands due to which his friend's hand was paining a lot.*

Name the acid along with its chemical formula present in ant sting.

Ans. The acid present in ant sting is methanoic acid (formic acid). The chemical formula is HCOOH.

Explanation: When an ant stings, it leaves formic acid (Methanoic acid) which causes pain and irritation. To get relief from the sting, mild base like baking soda can be applied on the stung.

57. *Take about 1g solid NaCl in a clean and dry test tube and set up the apparatus as shown in Figure.*



Add some concentrated sulphuric acid to the test tube. **[NCERT]**

(a) Hydrogen

(b) Hydrogen chloride

(c) Hydrogen sulphide

(d) Sulphur dioxide

(B) A student tested the gas coming out of the delivery tube first with dry blue litmus paper and then with wet litmus paper and noted down the following observations.

Select the correct observation:

	Dry Blue Litmus Paper	Wet Blue Litmus Paper
(a)	No change	Turns red
(b)	Turns red	No change
(c)	Turns red	Turns red
(d)	No change	No change

(C) If climate is humid, the gas evolved is passed through a guard tube containing:

(a) Calcium hydroxide

(b) Calcium carbonate

(c) Calcium sulphate

(d) Calcium chloride

(D) Select the incorrect statement(s):

(I) Hydrogen ions in HCl are produced even in absence of water.

(II) Hydrogen ions can exist alone.

(III) Hydrogen ions exist after combining with water molecules.

(IV) Hydrogen ions in HCl are produced only in presence of water

(a) Only (I)

(b) Both (I) and (II)

(c) Both (I) and (III)

(d) Both (II) and (IV)

(E) Hydrogen ions must always be shown as $H^+(aq)$ or hydronium ion (H_3O^+) as:

(a) Hydrogen ions combine with water to form hydronium ions

(b) Hydrogen gas dissociates into ions.

(c) All acids dissociate into hydrogen ions in presence of a base.

(d) Hydrogen ions separate from acids on passing electricity.

Ans. (A) *(b) Hydrogen chloride*

Explanation: When concentrated sulphuric acid is added to sodium chloride, the following reaction takes place:

(C) *(d) Calcium chloride*

Explanation: During the preparation of hydrogen chloride gas, the gas is usually passed through the guard tube containing calcium chloride during humid climate, as calcium chloride is a good drying agent and absorbs moisture from the gas.

(D) *(b) Both (I) and (II)*

Explanation: The separation of H+ ion from HCl molecules cannot occur in the absence of water.

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$

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^+).

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

58. *Acids and bases represent two important classes of chemical compounds. In every day life, acids and bases play a role in everything from digestion of the foods you eat to the function of the medicine you take and even the cleaning products you use. Without acids and bases, many of the products in your home today would not have much use. Acids and bases are also important in atmospheric, geological, and physiological processes because they have unique chemical properties. Acids and bases have unique chemical properties because of the atomic composition of these compounds and how these compounds interact with other atoms and molecules.*

The pH of some common substances is shown below:

(A) The nature of calcium phosphate present in tooth enamel is:

(a) Basic (b) Amphoteric

(c) Acidic (d) Neutral

(B) What is the pH value of saliva after meal?

(a) between 0 and 4

(b) between 4 and 5

(c) between 5 and 6

(d) between 6 and 7

(C) Given below are four statements. Select the incorrect statement(s):

(I) Pain and irritation during indigestion is due to the excess acid produced by the stomach.

(II) People use antacids to get rid of this pain which are bases.

mild acid.

(IV) Antacids neutralize the excess acid produced in the stomach.

(a) Only (I) (b) Only (II)

(c) Only (III) (d) (III) and (IV)

(D) The pH level of the human body is:

(a) Less than 7, acidic

(b) Equal to 7, Neutral

(c) More than 7, basic

(d) None of the above

(E) A student tabulated the naturally occurring acidic substances and the acid contained in them.

	Natural Source	Acid found
(I)	Vinegar	Methanoic acid
(II)	Nettle sting	Acetic acid
(III)	Tomato	Oxalic acid
(IV)	Orange	Citric acid

Select the option containing the correct acid found in them:

(a) Both (I) and (II)

(b) Both (III) and (IV)

(c) Both (II) and (IV)

(d) Both (I) and (III)

Ans. (B) *(c) between 5 and 6*

Explanation: The pH of saliva after meals is around 5.8 due to the increased activity of bacteria on the food that we eat.

(C) *(c) Only (III)*

Explanation: Antacids are bases which help in getting rid of the pain and irritation during indigestion by neutralizing the excess acid produced in the stomach. Milk of magnesia or magnesium hydroxide is a mild base which is used as an antacid.

(E) *(b) Both (III) and (IV)*

Explanation: Vinegar contains acetic acid, whereas nettle sting contains methanoic acid.

59. *If you think the best way to put out a fire is by dousing it with water, you'd be surprised to know you're wrong. As it turns out, not all fires are created equal, and there is more than one way to extinguish them safely.There are situations where you should not use water to deal with a fire at all. For example, an electrical fire.*

Name the chemicals used in acid fire extinguisher and the gas evolved from it when it is used ?

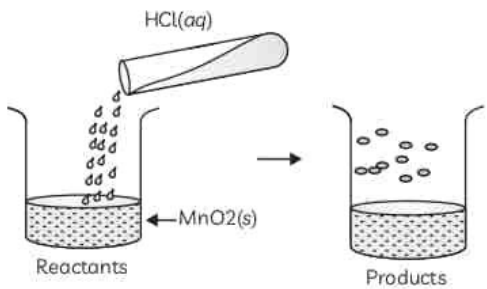
Ans. The chemicals used in soda acid fire extinguisher are sodium hydrogen carbonate and sulphuric acid.

The gas evolved when the two reactants react is carbon dioxide which is used for extinguishing electrical fires.

The reaction taking place between the two chemicals is

$$2NaHCO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + 2CO_2 + 2H_2O$$

60. *The reaction between MnO_2 with HCl is depicted in the following diagram. It was observed that a gas with belaching abilities was released.*



(A) **The chemical reaction between MnO_2 and HCl is an example of:**

(a) displacement reaction

(b) combination reaction

(c) redox reaction

(d) decomposition reaction.

(B) **Chlorine gas reacts with ..... to form bleaching powder.**

(a) dry $Ca(OH)_2$

(b) dil. solution of $Ca(OH)_2$

(c) conc. solution of $Ca(OH)_2$

(d) dry CaO

following:

(a) MnO_2 is getting reduced whereas HCl is getting oxidized

(b) MnO_2 is getting oxidized whereas HCl is getting reduced.

(c) MnO_2 and HCl both are getting reduced.

(d) MnO_2 and HCl both are getting oxidized.

(D) In the above discussed reaction, what is the nature of MnO_2 ?

(a) Acidic oxide (b) Basic oxide

(c) Neutral oxide (d) Amphoteric oxide

(E) What will happen if we take dry HCl gas instead of aqueous solution of HCl?

(a) Reaction will occur faster.

(b) Reaction will not occur.

(c) Reaction rate will be slow

(d) Reaction rate will remain the same.

[CBSE Question Bank 2021]

Ans. (A) *(c) redox reaction*

Explanation: When MnO2 reacts with HCl, the following reaction takes place in which chlorine gas is also evolved, which has bleaching properties.

$$MnO_2 + 4HCl \longrightarrow MnCl_2 + Cl_2 + 2H_2O$$

In this reaction, Hydrochloric acid is oxidized to chlorine and Manganese dioxide is reduced to manganese dichloride. As both oxidation and reduction are taking place in this reaction, it is a redox reaction.

(B) *(a) dry $Ca(OH)_2$*

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

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

(C) (a) MnO_2 is getting reduced whereas HCl is getting oxidized.

Explanation: In the reaction between MnO_2 and HCl, MnO_2 is getting reduced to manganese dichloride as it is losing oxygen atoms. Whereas, HCl is getting oxidized to chlorine by the removal of oxygen.

Related Theory

- Oxidation is the addition of oxygen to a substance or removal of hydrogen from a substance.
- Reduction is the addition of hydrogen to a substance or removal of oxygen from a substance.
- Oxidising agent is the substance which provides oxygen for oxidation or which removes hydrogen.
- Reducing agent is the substance which provides hydrogen for reduction or which removes oxygen.

Explanation: As MnO_2 reacts with HCl to form salt, water and chlorine gas, it is a basic oxide since it reacts with an acid. Moreover, oxides of metals are basic in nature whereas oxides of non-metals are acidic in nature.

(E) *(b) Reaction will not occur*

Explanation: A substance shows its acidic properties only in presence of water as it is able to dissociate into H^+ ions, which is responsible for its acidic properties.

So, if we use dry HCl, then no reaction will take place as HCl will not be able to dissociate into ions as shown by the following reaction:

$$HCl + H_2O \quad H_3O+ + Cl-$$

61. *Frothing in Yamuna :*

The primary reason behind the formation of the toxic foam is high phosphate content in the wastewater because of detergents used in dyeing industries, dhobi ghats and households. Yamuna's pollution level is so bad that parts of it have been labelled 'dead' as there is no oxygen in it for aquatic life to survive.

(A) Predict the pH value of the water of river Yamuna if the reason for froth is high content of detergents dissolved in it.

(a) 10-11 (b) 5-7

(c) 2-5 (d) 7

(B) Which of the following statements is correct for the water with detergents dissolved in it?

(a) low concentration of hydroxide ion (OH^-)and high concentration of hydronium ion (H_3O^+)

(b) high concentration of hydroxide ion (OH^-) and low concentration of hydronium ion (H_3O^+)

(c) high concentration of hydroxide ion (OH^-) as well as hydronium ion (H_3O^+)

(d) equal concentration of both hydroxide ion (OH^-) and hydronium ion (H_3O^+).

solutions P, Q, R and S

Solution	pH value
P	2
Q	9
R	5
S	11

Which of the following correctly represents the solutions in increasing order of their hydronium ion concentration?

(a) P > Q > R > S **(b)** P > S > Q > R

(c) S < Q < R < P **(d)** S < P < Q < R

(D) High content of phosphate ion in river Yamuna may lead to:

(a) decreased level of dissolved oxygen and increased growth of algae

(b) decreased level of dissolved oxygen and no effect of growth of algae

(c) increased level of dissolved oxygen and increased growth of algae

(d) decreased level of dissolved oxygen and decreased growth of algae

(E) If a sample of water containing detergents is provided to you, which of the following methods will you adopt to neutralize it?

(a) Treating the water with baking soda

(b) Treating the water with vinegar

(c) Treating the water with caustic soda

(d) Treating the water with washing soda

[CBSE Question Bank 2021]

Ans. (A) *(a) 10 – 11*

Explanation: Detergents are basic in nature having pH value of 10-11. As the froth has a high content of detergents dissolved in it, the pH value of water of river Yamuna will be 10 -11.

(B) *(b) high concentration of hydroxide ion (OH^-) and low concentration of hydronium ion (H_3O^+)*

Explanation: As detergents are basic in nature, the concentration of hydroxide ions will be less.

Related Theory

When bases are dissolved in water, they dissociate into hydroxide ions.

For example, $NaOH(aq) \longrightarrow Na^+(aq) + OH^-(aq)$

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

(C) *(c) S < Q < R < P*

Explanation: The pH of a substance is related to the concentration of hydrogen or hydronium ions. An acid has a high concentration of hydronium ions and a low pH value whereas a base has a high pH value and a low concentration of hydronium ions.

So, we can say, lower the pH value, more is the concentration of hydronium ions. Therefore, the hydronium ion concentration is least in S, followed by Q, R and then P which has the maximum concentration of hydronium ions.

(D) *(a) decreased level of dissolved oxygen and increased growth of algae*

Explanation: When the amount of phosphate ions in water increases, it leads to decreased level of dissolved oxygen which is harmful for the aquatic organisms. This leads to an increased growth of algae due to presence of nutrients.

Related Theory

Eutrophication is the process in which a water body becomes overly enriched with nutrients, leading to plentiful growth of simple plant life. The excessive growth (or bloom) of algae and plankton in a water body are indicators of this process.

(E) *(b) Treating the water with vinegar*

Explanation: As detergents are basic in nature, an acid will neutralize it. Out of the substances mentioned, only vinegar is acidic, as it is 5 – 8% solution of ethanoic acid in water.

SHORT ANSWER Type-I Questions (SA-I)

[3 marks]

62. **A metal compound *X* reacts with dilute hydrochloric acid to produce brisk effervescence. The gas evolved forms a white precipitate when passed through lime water. Write balanced chemical equations involved in the above mentioned chemical reactions.**

63. Explain the action of dilute hydrochloric acid on the following with balanced chemical equations and observations for the reactions:

(A) Magnesium ribbon

(B) Sodium hydroxide

(C) Crushed egg shells

(A) **Magnesium ribbon :** A thin ribbon of magnesium metal used in laboratory demonstrations and in the magnesium lamp.

(B) **Sodium hydroxide:** There is no noticeable change in the appearance of the solution, it remains colorless like water.

$$HCl + NaOH \longrightarrow NaCl + H_2O + heat$$

(C) **Crushed egg shells:** Egg shells contain calcium carbonate $CaCO_3$ So when we react $CaCO_3$ with HCl, the egg shells completely dissolve and there will be brisk effervescence due to CO_2

$$CaCO_3 + HCl \longrightarrow CaCl_2 + H_2O + CO_2$$

64. What is the effect of following on acetic acid?

(A) litmus test.

(B) addition of a pinch of baking soda.

Ans. (A) **Effect on litmus:** Blue litmus turns red which proves that acetic acid is acidic in nature.

(B) **Reaction with baking soda:** A gas is evolved which turns lime water milky.

The gas produced is carbon dioxide due to the action of CH_3COOH on $NaHCO_3$, which turns lime water milky

$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2$$

65. Answer the following:

(A) How is tooth decay related to pH? How can it be prevented?

(B) What is the change in colour of pH paper dipped in a solution having a pH = 13?

Ans. (A) When we eat food containing sugar, then the bacteria present in our mouth break down the sugar to form acids such as lactic acid. This acid lowers the pH in the mouth making it acidic. Tooth decay starts when the pH of acid formed in the mouth falls below 5.5. This is because then the acid becomes strong enough to attack the enamel of our teeth and corrode it. This sets in tooth decay.

The best way to prevent tooth decay is to clean the mouth thoroughly after eating food by rinsing it with lots of clean water. Many tooth pastes contain bases to neutralise the mouth acid. The pH of tooth paste is about 8.0. Therefore, using the tooth paste, which is generally basic, for cleaning the tooth can neutralise the excess acid in mouth and prevent tooth decay.

minimum hydrogen ion concentration i.e. alkaline solution and so will change colour of pH paper to light violet colour.

66. A solution 'X' gives orange colour when a drop of it falls on pH paper, while another solution 'Y' gives bluish colour when a drop of it falls on pH paper. What is the nature of both the solutions? Determine the pH of solutions 'X' and 'Y'. **[CBSE 2013]**

67. On adding a few drops of universal indicator in three colourless solutions *X*, *Y* and *Z* taken separately in three test tubes, a student observed the changes in colour as green in *X*, red in *Y* and blue in *Z*.

(A) Arrange *X*, *Y* and *Z* in increasing order of their pH values.

(B) Which one of the three, *X*, *Y* and *Z*, will change the colour of phenolphthalein ? Why ?

OR

State the observation and inference made by a student when he brings (A) a wet blue litmus paper and (B) a wet red litmus paper in contact with the gas liberated during thermal decomposition of ferrous sulphate.

Ans (A) *Y*, *X*, *Z*

(B) *Z*, because it is basic in nature and the bases turn phenolphthalein pink.

OR

(A) **Observation:** The moist blue litmus paper will turn red.

Inference: The gas liberated is acidic in nature.

(B) **Observation:** Wet red litmus paper will remain red.

Inference: The gas liberated is acidic in nature.

[CBSE Marking Scheme 2019]

68. Answer the following:

Mention the pH range within which our body works. Explain how antacids give relief from acidity. Write the name of one such antacid.

Ans. Our body works roughly between 7.3 to 7.5 pH range.

Acidity means excess of acid level in stomach. Antacid contains basic salt and are alkaline. So when we take antacid it reacts with excess acid of stomach and neutralizes it.(neutralization reaction takes place between acid and base).

Milk of Magnesia is a commonly used antacid.

olfactory indicators. What is the effect of adding sodium hydroxide solution to these olfactory indicators?

Ans. Olfactory Indicators: Substances which change their smell when mixed with acid or

Two olfactory indicators are onion and vanilla.

When sodium hydroxide solution is added to an olfactory indicator it loses its characteristic smell.

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

70. A cloth strip dipped in onion juice is used for testing a liquid 'X'. The liquid 'X' changes its odour. Which type of an indicator is onion juice? The liquid 'X' turns blue litmus red. List the observations the liquid 'X' will show on reacting with the following:

(A) Zinc granules

(B) Solid sodium carbonate

(C) Write the chemical equations for the reactions involved. [CBSE 2020]

Ans. Onion juice is an olfactory indicator. Those substances whose smell or odour changes in acidic or basic solution are called olfactory indicator. The liquid 'X' turns blue litmus red. It is an acidic liquid.

Observations when liquid 'X' reacts with

(A) **Zinc granules:** When zinc granules are added an acid in a test tube a Vigorous reaction takes place with evolution of hydrogen gas.

The test tube becomes hot.

When a burning match stick is brought near a gas filled bubble, the gas present in the bubble burns with a popsound.

(B) Solid sodium carbonate: When liquid 'X' reacts with solid sodium carbonate, a salt, carbon dioxide and water are formed.

Brisk effervescence of carbon dioxide gas is produced.

When CO_2 is passed through lime water, lime water turns milky.

(C) Chemical equations

(I) $\underset{\text{Zinc (metal)}}{Zn_{(s)}} + \underset{\text{Dilute Sulphuric acid}}{H_2SO_{4(aq)}} \longrightarrow \underset{\text{zinc (sulphate salt)}}{ZnSO_{4(aq)}} + \underset{\text{Hydrogen gas}}{H_{2(g)}}$

(II) $\underset{\text{Sodium carbonate}}{Na_2CO_{3(s)}} + \underset{\text{Sulphuric acid}}{H_2SO_{4(aq)}} \longrightarrow \underset{\text{Sodium sulphate}}{Na_2SO_{4(aq)}} + \underset{\text{Carbon dioxide}}{CO_{2(g)}} + \underset{\text{water}}{H_2O_{(l)}}$

71. Varun took a sample A and added dilute hydrochloric acid to it. A colorless, odorless gas X was evolved which turned lime water milky.

(A) Identify sample A and the gas X evolved.

(B) Write a chemical equation to explain the reaction between sample A and hydrochloric acid.

(C) Why does the gas X turn lime water milky? [Diksha]

LONG ANSWER Type Questions (LA)

[5 marks]

72. Define water of crystallisation. Give the chemical formula for two compounds as examples. How can it be proved that the water of crystallisation makes a difference in the state and colour of the compounds? [CBSE 2020]

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

For Examples: copper sulphate crystals $CuSO_4.5H_2O$ – copper sulphate crystals contain 5 molecules of water of crystallisation in one formula unit.

Sodium carbonate crystals (washing soda crystals) contain 10 molecules of water and its formula is $Na_2CO_3{\cdot}10H_2O$.

The water of crystallisation gives the crystals of the salts. their shape and colour. For example,

copper sulphate crystals imparts them blue colour and crystalline shape.

Heat a few crystals of $CuSO_4 \cdot 5H_2O$ which are blue in colour in a dry boiling tube.

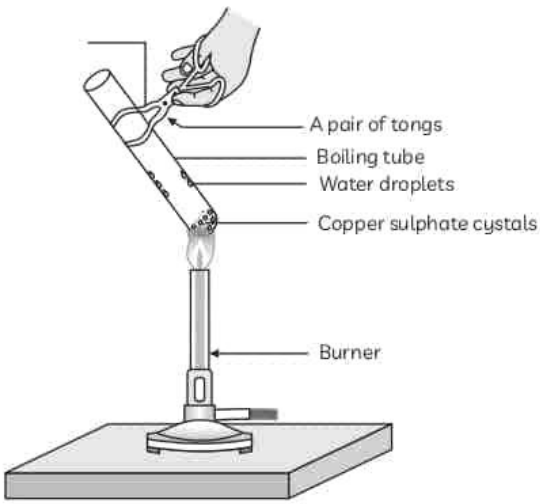
On heating, the blue copper sulphate crystals turn white and a powdery substance is formed. Tiny droplets of water are seen in the boiling tube.

$$CuSO_4.5H_2O \longrightarrow CuSO_4 + 5H_2O$$

Blue in colour, copper sulphate crystals powdery substance White in colour, powdery substance

Cool the boiling tube add 2-3 drops of water on the white copper sulphate powder. The crystals of copper sulphate become blue in colour.

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4.5H_2O$$



Removing water of crystallisation

73. **Identify the compound X on the basis of the reactions given below. Also, write the name and chemical formulae of A, B and C.**

Compound X
+ Zn → A + $H_2(g)$
+ HCl → B + H_2O
+ CH_3COOH → C + H_2O

[CBSE 2018, 16]

74. **Identify the acid and the base from which sodium chloride is obtained. Which type of salt is it? When is it called rock salt? How is rock salt formed? [CBSE 2019]**

75. **(A) Why does acidic solution conduct electricity?**

(B) Can basic solution conduct electricity?

(C) What is the role of water in the reaction that take place when HCl is added to a non-aqueous solution?

(D) While diluting an acid, why is it recommended that the acid should be addd to water and not water to the acid? [Diksha]

76. **(A) What does pH scale measure?**

(B) Write its range.

(C) State the significance of highest and lowest values of pH scale.

Ans. (A) pH scale measures the hydrogen ion concentration in a solution thus indicating acidic/basic nature of a solution.

(B) From 0 to 14

(C) Significance:

Highest value - very basic/alkaline solution.

Lowest value - very acidic solution.

77. **(A) Why is electrolysis of brine called 'Chlor-alkali process'? Write the chemical equation involved in this process.**

(B) A few crystals of hydrated copper sulphate are heated in a dry test-tube. Enlist any two observations.

78. **For making cake, baking powder is taken. If at home your mother uses baking soda instead of baking powder in cake.**

(A) How will it affect the taste of the cake and why?

(B) How can baking soda be converted into baking powder?

(C) What is the role of tartaric acid added to baking soda?

79. **Answer the following:**

(A) State the relation between hydrogen ion concentration of an aqueous solution and its pH.

(B) An aqueous solution has a pH value of 7.0. Is this solution acidic, basic and neutral?

(C) Which has a higher pH value, 1 M HCl or 1 M NaOH solution?

(D) Tooth enamel is one of the hardest substances in our body. How does it undergo damage due to eating chocolates and sweets? What should we do to prevent it?

(E) How do $[H^+]$ ions exist in nature?

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

1. What is brine? What happens when an electric current is passed through it? Write chemical equation for it.

Ans.

Brine is the cold and concentrated solution of Sodium chloride.

(1) When electricity is passed through it, NaCl breaks to give ions in the solution.

$$NaCl \xrightarrow{\text{electricity}} Na^+ + Cl^-$$

Sodium Chloride → Sodium ions + Chloride ions

(2) Then water also splits to give ions.

$$H_2O \xrightarrow[\text{decomposition}]{\text{electricity}} H^+ + OH^-$$

water → Hydrogen ions + Hydroxide ions

(3) Cl^- ions being negatively charged moves towards anode and H^+ being positively charged moves towards cathode and are collected there.

At anode

$$Cl^- - 1\bar{e} \longrightarrow Cl$$
$$Cl + Cl \longrightarrow Cl_2$$

Cl_2 → Chlorine gas

At cathode

$$H^+ + 1\bar{e} \longrightarrow H$$
$$H + H \longrightarrow H_2$$

H_2 → Hydrogen gas

The Na^+ & OH^- ions are left in solution which combine to give NaOH (Sodium Hydroxide)

$$2NaCl + 2H_2O \xrightarrow{\text{electricity}} 2NaOH + H_2\uparrow + Cl_2\uparrow$$

Sodium chloride + water (Brine) → Sodium Hydroxide + Hydrogen gas + Chlorine gas

[CBSE Topper 2019]

2. A white powder is added while baking cakes to make it soft and spongy. Name its main ingredients. Explain the function of each ingredient. Write the chemical reaction taking place when the powder is heated during baking.

Ans.

The white powder added to cakes is baking powder.

Baking powder is prepared with Baking Soda i.e. Sodium Hydrogen Carbonate along with a mild acid like Tartaric acid.

① Baking soda being a base is bitter and tartaric acid is sour.

② When their mixture is added, * neutralisation takes place nullifying the bitter and sour effects.

Baking Soda + Tartaric acid → Baking Powder.

~~Baking Soda is toxic~~

Baking soda is mainly for producing effervescence and tartaric acid is used for nullifying the bitter effect of sodium bicarbonate.

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2\uparrow + H_2O(g)$

Baking Soda in form of Baking powder. — Sodium Carbonate — Carbon dioxide — Water (vapours)

The carbon dioxide released gets trapped in the cake layers and makes it soft and spongy.

[CBSE Topper 2019]

3. 2 mL of sodium hydroxide solution is added to a few pieces of granulated zinc metal taken in a test tube. When the contents are warmed, a gas evolves which is bubbled through a soap solution before testing. Write the equation of the chemical reaction involved and the test to detect the gas. Name the gas which will be evolved when the same metal reacts with dilute solution of a strong acid.

Ans.

$NaOH\ (aq.) + Zn\ (s) \xrightarrow{\Delta} Na_2ZnO_2 + H_2(g)$

(sodium hydroxide solution) — (sodium zincate)

Thus, in this reaction, hydrogen gas is evolved

As the gas is passed through soap solution, bubbles filled with hydrogen gas come out. Bring a candle near the bubbles evolved, the bubble bursts & the gas inside it starts burning with a pop sound & extinguishes the candle. This tests the presence of H_2 gas in them.

Even if the zinc metal reacts with a solution of strong acid, hydrogen gas is produced/evolved

[Eg. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$]

[CBSE Topper 2018]