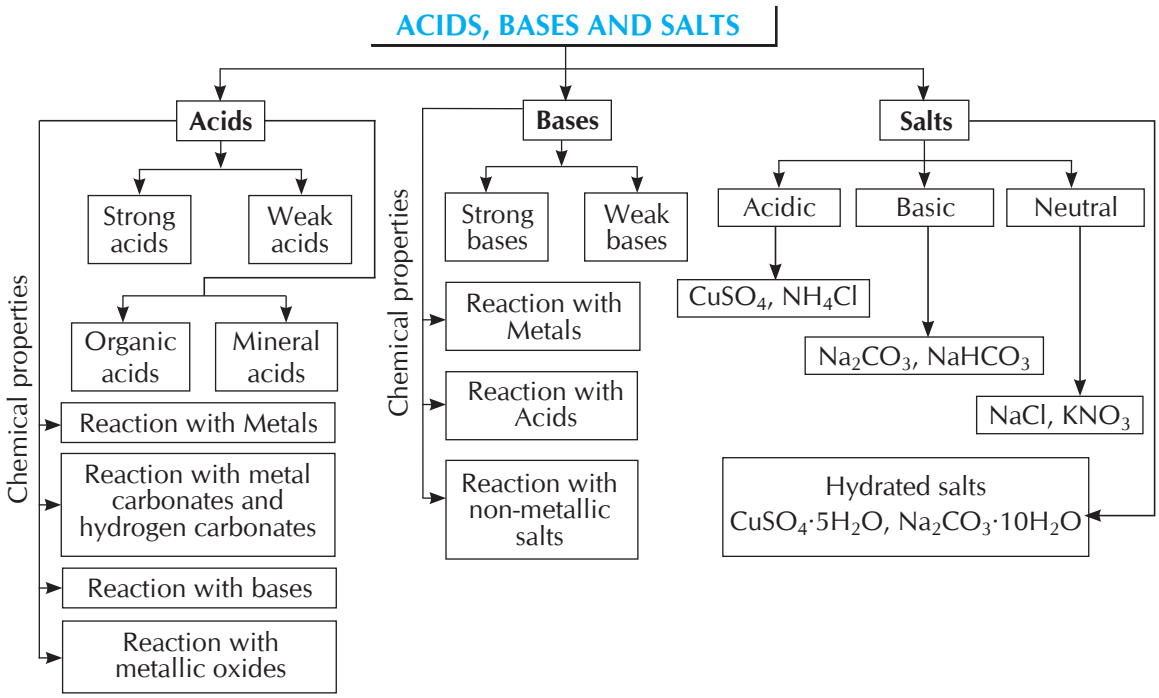
2. Acids, Bases and Salts

Topics Covered

2.1 Acids and Bases
2.2 What Do Acids and Bases Have in Common?
2.3 Salts

Chapter Map



Topic 1. Acids and Bases

Acids: Those substances which give H^+ ions in aqueous solution, *e.g.* H_2SO_4, H_2CO_3, HNO_3, HCl, CH_3COOH.

Strong Acids: Those acids which dissociate into ions completely, *e.g.* HCl, HNO_3, H_2SO_4.

Weak Acids: Those acids which do not dissociate into ions completely, *e.g.* H_2CO_3, CH_3COOH.

General Properties of Acids:

(*i*) Sour taste
(*ii*) Able to conduct electricity in aqueous solution

(*iii*) Concentrated acids are corrosive
(*iv*) Able to react with metals, metal carbonates, hydrogen carbonates, bases/alkalies
(*v*) Turn blue litmus red
(*vi*) Phenolphthalein remains colourless in acids
(*vii*) Methyl orange gives red colour in acids
(*viii*) pH is less than 7

Bases: Those substances which give OH^- ions in aqueous solution, *e.g.* NaOH, KOH, NH_4OH, $Mg(OH)_2$, $Ca(OH)_2$. $Cu(OH)_2$, $Fe(OH)_3$, $Al(OH)_3$.

Strong Bases: Those bases which dissociate into ions completely, *e.g.* NaOH, KOH, $Ca(OH)_2$.

Weak Bases: Those bases which do not dissociate into ions completely, *e.g.* NH_4OH, $Mg(OH)_2$.

General Properties of Bases:

(*i*) Bitter taste
(*ii*) Able to conduct electricity in aqueous solution
(*iii*) Corrosive when concentrated and strong
(*iv*) Able to react with some metals, acids, acidic oxides, acidic salts
(*v*) Turn red litmus blue
(*vi*) Turn phenolphthalein pink
(*vii*) Turn methyl orange yellow
(*viii*) pH is more than 7

Indicators: Those substances which change their colour in acids and bases.

Synthetic indicators: Those indicators which are prepared in the lab from chemicals, *e.g.* phenolphthalein, methyl orange.

Natural indicators: Those substances which occur in nature and show different colour in acids and bases, *e.g.* turmeric, litmus.

Neutralisation Reaction: Those reactions in which an acid react with a base to form salt and water; *e.g.* $\underset{\text{Base}}{NaOH} + \underset{\text{Acid}}{HCl} \longrightarrow \underset{\text{Salt}}{NaCl} + \underset{\text{Water}}{H_2O}$

Olfactory Indicators: Those substances which change their odour (smell) in acidic or basic mediums; *e.g.* onion, clove. They can be used by visually impaired people.

Reaction of Acids with Metals: Metals react with dilute acids to form salt and hydrogen gas.

$$\boxed{\text{Metal}} + \boxed{\text{Acid}} \rightarrow \boxed{\text{Salt}} + \boxed{\text{Hydrogen gas}}$$
$$Zn(s) + 2HCl(dil) \rightarrow ZnCl_2(aq) + H_2(g)$$

Reaction of Bases with Metals: Some metals react with bases to form salt and hydrogen gas, which burns with a 'pop' sound.

$$\boxed{\text{Metal}} + \boxed{\text{Base}} \rightarrow \boxed{\text{Salt}} + \boxed{\text{Hydrogen gas}}$$
$$Zn(s) + 2NaOH(aq) \rightarrow \underset{\text{(Sodium zincate)}}{Na_2ZnO_2(aq)} + H_2(g)$$

Reaction of Acid with Metal carbonates and Metal hydrogen carbonates: They form salts, carbon dioxide gas, which turns lime water milky.

Metal Carbonate/Hydrogen Carbonate + Acid → Salt + Carbon dioxide + Water

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$
$$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$$

To test the presence of CO_2 gas, pass the gas through lime water. If it turns milky it shows CO_2 gas

$$\underset{\text{(lime water)}}{Ca(OH)_2} + CO_2(g) \longrightarrow \underset{\text{(white ppt)}}{CaCO_3(s)} + H_2O(l)$$

On passing excess of CO_2 gas, milkiness disappears, due to the formation of soluble calcium hydrogen carbonate. $\underset{\text{Calcium carbonate}}{CaCO_3(s)} + \underset{\text{Carbon dioxide}}{CO_2(g)} + \underset{\text{Water}}{H_2O(l)} \longrightarrow \underset{\text{Calcium hydrogen carbonate}}{Ca(HCO_3)_2(aq)}$

Reaction of Metallic oxides with Acids: Metallic oxides (basic) react with acids to form salt and water.

$$\text{Metal oxide} + \text{Acid} \rightarrow \text{Salt} + \text{Water}$$

$$\underset{\text{Black}}{CuO(s)} + H_2SO_4(dil) \longrightarrow \underset{\text{Blue}}{CuSO_4(aq)} + H_2O(l)$$

Reaction of Non-metallic oxides with bases: Non-metallic oxides (acidic) react with a base to form salt and water.

$$2NaOH(aq) + SO_2(g) \rightarrow Na_2SO_3(aq) + H_2O(l)$$

$$\boxed{\text{Base}} + \boxed{\text{Non-metallic oxide}} \rightarrow \boxed{\text{Salt}} + \boxed{\text{Water}}$$

EXERCISE 2.1

I. Multiple Choice Questions (1 Mark)

Choose the correct answer from the given options.

1. Which of the following will turn red litmus blue
(*a*) $Mg(OH)_2$ (*b*) Citric acid (*c*) Carbonic acid (*d*) Acetic acid

2. Which of the following will conduct electricity?
(*a*) Glucose solution (*b*) Ethanol solution (*c*) Acetic acid solution (*d*) Dry HCl(*g*)

3. What happens when a solution of an acid is mixed with a 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*) (I) only (*b*) (I) and (III) (*c*) (II) and (III) (*d*) (I) and (IV)

4. An aqueous solution turns red litmus solution blue. Excess addition of which of the following solution would reverse the change?
(*a*) Baking powder (*b*) Lime
(*c*) Ammonium hydroxide solution (*d*) Hydrochloric acid

5. 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]

6. Which of the following acid is present in sour milk?
(*a*) glycolic acid (*b*) lactic acid
(*c*) citrus acid (*d*) tartaric acid

7. Incorrect statement about acids is/are
(*a*) they have sour taste
(*b*) they may change the colour of indicator
(*c*) they change the colour of blue litmus to red
(*d*) they change the colour of red litmus to blue

8. The acid used in making of vinegar is
(*a*) formic acid (*b*) acetic acid
(*c*) sulphuric acid (*d*) nitric acid

9. $CuO + (X) \longrightarrow CuSO_4 + H_2O$. Here (X) is
(*a*) $CuSO_4$ (*b*) HCl
(*c*) H_2SO_4 (*d*) HNO_3

10. Acetic acid was added to a solid X kept in a test tube. A colourless and odourless gas was evolved. The gas was passed through lime water which turned milky. It was concluded that.
(*a*) Solid X is sodium hydroxide and the gas evolved is CO_2
(*b*) Solid X is sodium bicarbonate and the gas evolved is CO_2
(*c*) Solid X is sodium acetate and the gas evolved is CO_2
(*d*) Solid X is sodium chloride and the gas evolved is CO_2

11. 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

II. Assertion-Reason Type Questions (1 Mark)

For question number 1 to 5, two statements are given-one labeled as **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 correct explanation of the assertion.
(*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
(*c*) 'A' is true but 'R' is false.
(*d*) 'A' is false and 'R' is true.

1. Assertion: Tomato contains oxalic acid, vinegar contains acetic acid.
Reason: Tamarind contains tartaric acid.

2. Assertion: Conc H_2SO_4 should be added slowly into water to get dilute acid with constant cooling.
Reason: Dilution of conc. H_2SO_4 is highly exothermic reaction.

3. Assertion: H_2CO_3 is a strong acid.
Reason: A strong acid dissociates completely or almost completely in water.

4. Assertion: Sodium hydroxide reacts with zinc to produce hydrogen gas
Reason: Acids reacts with active metals to produce hydrogen gas.

5. Assertion: Ammonia solution is an alkali.
Reason: Ammonia solution turns blue litmus paper red.

Answers 2.1

I. 1. (*a*) $Mg(OH)_2$ will turn red litmus blue because it is a base.
2. (*c*) Acetic acid form ions in aqueous solution, therefore, it conducts electricity.
3. (*d*) It is a neutralization reaction which is exothermic and forms salt. For example, $NaOH + HCl \rightarrow NaCl + H_2O$
4. (*d*) HCl will neutralize the base and will turn blue litmus red when present in excess.
5. (*b*) Clove oil gives different odour in acidic and basic medium which can be detected by visually impaired student.
6. (*b*) Lactic acid is present in sour milk or curd.
7. (*d*) Acids change the colour of blue litmus to red.
8. (*b*) Vinegar is 5-8% solution of acetic acid
9. (*c*) H_2SO_4
10. (*b*) Solid X is sodium bicarbonate and the gas evolved is CO_2.
11. (*b*) Egg-shells contain $CaCO_3$ which reacts with HCl to give $CaCl_2$, H_2O and CO_2.

II. 1. (*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of 'A'.

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

3. (*d*) 'A' is false and 'R' is true.

H_2CO_3 carbonic acid is a weak acid.

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

Sodium hydroxide is a strong base which reacts with zinc metal to produce H_2 gas. The reaction is given as follows:

$$Zn(s) + 2NaOH(aq) \longrightarrow Na_2ZnO_2(aq) + H_2(g)$$

5. (*c*) 'A' is true but 'R' is false.

Ammonia gas, which is alkaline, turn the red litmus paper blue.

TOPIC 2. What Do All Acids and All Bases Have in Common? Strength of Acids and Bases

- All acids genterate hydrogen gas on reaction with active metals.
- All acids conduct electricity in aqueous solution only.
- Glucose, alcohol contain hydrogen, but do not ionise in aqueous solution. Therefore they do not conduct electricity.
- All acids ionise only in presence of water. *e.g.*

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

- H^+ ions cannot exist alone, it combines with H_2O to form H_3O^+ ions.
- When a base is dissolved in water, it forms OH^- ions in aqueous solution:

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

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

Alkalies: Those bases which dissolve in water are called alkalies, *e.g.* NaOH, KOH, $Ca(OH)_2$.

Neutralisation reaction: When H^+ ions from acid combines with OH^- ions from base, they form H_2O.

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

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

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l) \text{ (Ionic equation)}$$

- When water is added to base (solid), heat is evolved, *i.e.* the process is exothermic.
- When concentrated acid is added to water, lot of heat is evolved. Therefore, we must add acid to water and not water to acid.

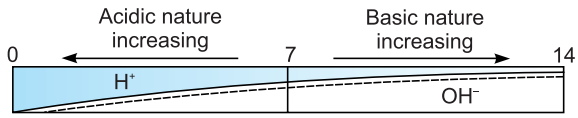
Strength of Acid and Base: The strength of an acid or a base can be measured with the help of pH. It depends upon the number of H^+ ions produced by an acid and OH^- ions produced by a base.

pH: A scale for measuring hydrogen ion concentration in a solution. 'p' stands for 'power' and 'H' stands for H^+, *i.e.* pH means power of hydrogen ion concentration.

(*i*) pH scale ranges from 0 to 14. For any substance, pH = 0 is strongly acidic, pH = 14 is strongly basic and pH = 7 represents a neutral solution.

(*ii*) Higher the H_3O^+ concentration, lower will be the pH.

pH Paper: The paper coated with universal indicator is used to determine the pH of solution. It has a colour chart having red colour at the top, bluish violet colour at the bottom and green colour in the centre.



Universal Indicator: It is a mixture of indicators and is used to measure the strength of acids and bases like pH paper by matching colour produced with it in the form of chart as given on the bottle.

Importance of pH in daily life:

(*i*) All plants and animals are pH sensitive.
(*ii*) Acid rain can spoil the growth of plants.
(*iii*) Our body works in the pH range of 7.0 to 7.8, except stomach which has a pH of 2.
(*iv*) The survival of aquatic species become difficult in acidic pH of the river water, due to acid rain.
(*v*) The atmosphere of Venus is made of thick white and yellowish clouds of sulphuric acid. Therefore, life cannot exist on Venus.
(*vi*) pH of soil is very important for healthy growth of plants. Different crops need different types of soil with different pH.
(*vii*) Our stomach produces HCl, which helps in digestion of proteins.
(*viii*) Decrease in pH of our stomach leads to hyper-acidity.

Antacids: Those chemicals which help to neutralise excess amount of acid in our body are called antacids, *e.g.* Baking soda ($NaHCO_3$) present in ENO.

- Acidic pH can cause tooth decay. Enamel is made up of $Ca_3(PO_4)_2$, which reacts with acid produced in mouth after eating sweets and due to this tooth decay can take place.
- Honeybee, nettle and red ants sting leaves formic acid, which causes irritation and pain.
- Baking soda can give relief to the pain by neutralising the acid.
- Dock plant produces base which can neutralise formic acid produced by nettle's sting.

EXERCISE 2.2

I. Multiple Choice Questions (1 Mark)

Choose the correct answer from the given options.

1. The pH of the gastric juices released during digestion is
(*a*) less than 7 (*b*) more than 7 (*c*) equal to 7 (*d*) equal to 0

2. 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)

3. Which of the following statements is correct about an aqueous solution of an acid and of a base?
(I) Higher the pH, stronger the acid (II) Higher the pH, weaker the acid
(III) Lower the pH, stronger the base (IV) Lower the pH, weaker the base
(*a*) (I) and (III) (*b*) (II) and (III) (*c*) (I) and (IV) (*d*) (II) and (IV)

4. Which of the following is not a mineral acid?
(*a*) Hydrochloric acid (*b*) Citric acid
(*c*) Sulphuric acid (*d*) Nitric acid

5. A solution turns red litmus blue, its pH is likely to be:
(*a*) 1 (*b*) 4 (*c*) 5 (*d*) 10. [*NCERT*]

6. A solution 'X' reacts with crushed egg shells to give a gas which turns lime water milky. The solution contains:
(*a*) NaCl (*b*) HCl (*c*) LiCl (*d*) KCl.
[*NCERT*] [**HOTS**]

7. 10 mL of a solution of NaOH found to be completely neutralised by 8 mL of given solution of HCl. If we take 20 mL of same solution of NaOH, the amount of 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*]

8. Which one of the following types of medicines is used for treating indigestion?
(*a*) Antibiotic (*b*) Analgesic (*c*) Antacid (*d*) Antiseptic
[*NCERT*]

9. When small amount of acid is added to water, the phenomenon which occur are
(A) Dilution (B) Neutralisation
(C) Formation of H_3O^+ (D) Salt formation
The correct statements are
(*a*) (A) and (C) (*b*) (B) and (D) (*c*) (A) and (B) (*d*) (C) and (D)
[*CBSE* 2020]

10. Antacids contain
(*a*) weak base (*b*) weak acid (*c*) strong base (*d*) strong acid

11. You are having five solutions A, B, C, D and E with *p*H values as follows:
A = 1.8, B = 7, C = 8.5, D = 8 and E = 5
Which solution would be most likely to liberate hydrogen with magnesium powder?
(*a*) Solution A and B (*b*) Solution A (*c*) Solution C (*d*) All of the above

12. The correct statement regarding universal indicator is
(*a*) it is an indicator having pH = 7 (*b*) it gives blue colour at pH = 3
(*c*) it becomes colourless at pH = 7 (*d*) it gives orange colour at pH = 3

13. The pH of a solution is 4.0. What should be the change in the hydrogen ion concentration of the solution, if its pH is to increased to 5.0.
(*a*) decreases to 1/10 of its original concentration
(*b*) halved (*c*) doubled
(*d*) increases by 10 times

14. The pH of a solution is 5.0. Its hydrogen ion concentration is decreased by 100 times, the solution will be:
(*a*) more acidic (*b*) basic (*c*) neutral (*d*) unaffected

II. Assertion-Reason Type Questions (1 Mark)

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(*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
(*c*) 'A' is true but 'R' is false.
(*d*) 'A' is false but 'R' is true.

1. Assertion: pH = 11 is strongly basic, pH=7 is neutral.
Reason: pH = 5 is weak acid and pH= 2 is strong acid.

2. Assertion: Higher the pH, less will be H_3O^+ concentration in the solution.
Reason: pH of blood is 9.36 to 9.42.

3. Assertion: pH of HCl solution in our stomach is about 2.
Reason: HCl in our stomach helps in digestion.

4. Assertion: If the pH inside the mouth decreases below 5.5, the decay of tooth enamel begins.
Reason: The bacteria present in mouth degrades the sugar and left over food particles and produce acids that remains in the mouth after eating.

5. Assertion: pH = 7 signifies pure water.
Reason: At this pH, $[H^+] = [OH^-] = 10^{-7}$.

Answers 2.2

I. 1. (*a*) pH = 2, i.e. less than 7 **2.** (*b*) Ionisation and dilution **3.** (*d*) (*ii*) and (*iv*)
4. (*b*) Citric acid is organic acid, others are mineral acids.
5. (*d*) 10 ∵ Bases have pH > 7 and turn red litmus blue.
6. (*b*) HCl, $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$. Egg shell is made up of $CaCO_3$.
7. (*d*) 16 mL.
10 mL of a solution of NaOH neutralises 8 mL of HCl.

$\therefore$ 20 mL of a solution of NaOH neutralises = $\frac{8}{10} \times 20 = 16$ mL of HCl.

8. (*c*) Antacid **9.** (*a*) Dilution and formation of H_3O^+
10. (*a*) Weak base **11.** (*b*) Solution A, as it is strongly acidic.
12. (*d*) It gives orange colour at pH = 3
13. (*a*) Decreases to 1/10 of its original concentration as pH = $-\log[H^+]$
14. (*c*) Neutral

II. 1. (*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
2. (*c*) 'A' is true but 'R' is false. pH of blood is slightly basic of about 7.35 to 7.45.
3. (*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
4. (*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.
5. (*d*) 'A' is false but 'R' is true.
pH = 7, signifies neutral solution

TOPIC 3. Salts

Salts: Those compounds which are formed by the reaction of acids (or acidic oxides) with bases (or basic oxides) are called salts.

Family of Salts: Salts having same positive or negative radicals are said to belong to a family. For example,

Sodium Salts: NaCl, $NaHCO_3$, Na_2SO_4, Na_2CO_3, $NaNO_3$

Chloride Salts: NaCl, KCl, $CaCl_2$, $MgCl_2$, $BaCl_2$, $AlCl_3$, $FeCl_3$

Carbonate Salts: Na_2CO_3, K_2CO_3, $CaCO_3$, $ZnCO_3$, $FeCO_3$, $MgCO_3$

Potassium Salts: KCl, $KHCO_3$, K_2SO_4, KNO_3, K_2CO_3, CH_3COOK, KNO_2

Sulphate Salts: Na_2SO_4, K_2SO_4, $CaSO_4$, $MgSO_4$, $CuSO_4$, $FeSO_4$

pH of Salts:

(*i*) Salts can be acidic, basic or neutral.
(*ii*) Acidic salt solution will have pH < 7, basic salt solution will have pH > 7. Neutral salt solution will have pH = 7.
(*iii*) Salts of strong acids and strong bases are neutral, *i.e.* pH = 7.
(*iv*) Salts of weak acids and strong bases are basic, *i.e.* pH > 7.
(*v*) Salts of strong acids and weak bases are acidic, *i.e.* pH < 7.

Sodium Chloride:

(*i*) It is also called rock salt.
(*ii*) It is obtained from sea water.
(*iii*) This salt is used at home, in food items.

(*iv*) It is a salt of strong acid (HCl) and a strong base (NaOH), ∴ It is neutral, *i.e.* its pH = 7

(*v*) Common salt is used for making baking soda ($NaHCO_3$), caustic soda (NaOH), washing soda ($Na_2CO_3.10H_2O$), bleaching powder ($CaOCl_2$).

Sodium hydroxide: It is obtained by electrolysis of aqueous solution of sodium chloride, called brine. The process is commercially called chlor-alkali process, because products formed are chlor for chlorine and alkali for sodium hydroxide.

$$2NaCl(aq) + 2H_2O(l) \xrightarrow{\text{electrolysis}} 2NaOH(aq) + Cl_2(g) + H_2(g)$$

Cl_2 gas is formed at anode (+), H_2 gas is formed at cathode (–).

Sodium hydroxide is a strong base used in lab in the manufacture of soaps, paper, etc.

Bleaching powder:

(*i*) The chlorine gas obtained as a by-product of chlor-alkali process can be used in the manufacture of bleaching powder.

(*ii*) Bleaching powder is obtained by the reaction of Cl_2 gas with dry slaked lime.

$$Ca(OH)_2(s) + Cl_2(g) \xrightarrow{\text{Electrolysis}} CaOCl_2(s) + H_2O$$

Uses:

(*i*) It is used as a bleaching agent in textile industry.

(*ii*) It is used as a disinfectant to make water free from germs.

(*iii*) It is used as an oxidising agent.

(*iv*) It is used as a chlorinating agent.

Baking Soda ($NaHCO_3$): It is obtained by the reaction of carbon dioxide with saturated solution of ammoniacal brine.

(*i*) pH of $NaHCO_3$ is 8.4, *i.e.* it is weakly basic, acts as an antacid.

(*ii*) It is a non-corrosive base.

(*iii*) It is used in making bread, biscuits, cake, crispy fritters. The following reaction takes place when it is heated, during cooking:

$$2NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3 + CO_2 + H_2O$$

Uses:

(*i*) It is used for making baking powder ($NaHCO_3$ + tartaric acid).

(*ii*) Its solution in water is basic (alkaline in nature). It liberates CO_2 with acid.

$$NaHCO_3 + \underset{\text{(from acid)}}{H^+} \rightarrow CO_2 + H_2O + Na^+$$

(*iii*) CO_2 liberated makes the cake and bread fluffy, soft and spongy.

(*iv*) It is used as an antacid.

(*v*) It is used in soda-acid fire extinguishers.

Washing Soda ($Na_2CO_3.10H_2O$)

(*i*) Recrystallisation of sodium carbonate obtained by heating $NaHCO_3$, gives washing soda.

$$Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3 \cdot 10H_2O$$

(*ii*) 10 H_2O molecules are called water of crystallisation.

(*iii*) It is used as washing powder.

(*iv*) It is used for softening both temporary as well as permanent hard water.

(*v*) It is used in the manufacturing of glass and cement.

(*vi*) It is used as a laboratory reagent.

Water of crystallisation: The number of water molecules bonded to a crystalline salt is called water of crystallisation. *e.g.* $CuSO_4 \cdot 5H_2O$, has 5 molecules of H_2O as water of crystallisation.

Hydrated Salts: Those salts which contain fixed number of molecules of H_2O are called hydrated salts. *e.g.* $CuSO_4 \cdot 5H_2O$, $FeSO_4 \cdot 7H_2O$, $Na_2CO_3 \cdot 10H_2O$, $CaSO_4 \cdot 2H_2O$.

Anhydrous Salts: Crystalline hydrated salts, when heated to lose water of crystallisation and their colour changes and become amorphous (powdery). Such powdery salts are called anhydrous salts.

$$\underset{\text{Blue}}{CuSO_4 \cdot 5H_2O} \xrightarrow{\text{Heat}} \underset{\text{White}}{CuSO_4} + 5H_2O$$

Plaster of Paris: It is obtained by heating gypsum ($CaSO_4 \cdot 2H_2O$), at 373 K.

$$\underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow{373\ K} \underset{\text{Plaster of Paris}}{CaSO_4 \cdot \tfrac{1}{2}H_2O} + \tfrac{3}{2}H_2O$$

When mixed with water, it forms gypsum, a hard solid mass

$$\underset{\text{Plaster of Paris}}{CaSO_4 \cdot \tfrac{1}{2}H_2O} + \tfrac{3}{2}H_2O \rightarrow \underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O}$$

Uses:

(*i*) It is used for making chalk.
(*ii*) It is used for making toys, statues, moulds for jewellery, etc.
(*iii*) It is used for plastering fractured bones.
(*iv*) It is used for making the surface smooth before white washing.

EXERCISE 2.3

I. Multiple Choice Questions (1 Mark)

Choose the correct answer from the given options.

1. During the preparation of hydrogen chloride gas on a humid day, the gas is usually passed through the guard tube containing calcium chloride. The role of calcium chloride taken in the guard tube is to

(*a*) absorb the evolved gas (*b*) moisten the gas
(*c*) absorb moisture from the gas (*d*) absorb Cl^- ions from the evolved gas

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

(*a*) Blue vitriol (*b*) Baking soda
(*c*) Washing soda (*d*) Gypsum

3. Sodium carbonate is a basic salt because it is a salt of

(*a*) strong acid and strong base (*b*) weak acid and weak base
(*c*) strong acid and weak base (*d*) weak acid and strong base

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

(*a*) basic (*b*) acidic (*c*) neutral (*d*) amphoteric

5. 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)

6. You have four test tubes, A, B, C and D containing sodium carbonate, sodium chloride, lime water and blue litmus solutions respectively. Out of these the material of which

test tube/test tubes would be suitable for the correct test of acetic/ethanoic acid?
(*a*) only A (*b*) A and B (*c*) B and C (*d*) A and D
[*Delhi* 2017]

7. Identify the basic salt from the following salts:
(*a*) Na_2CO_3 (*b*) NH_4Cl
(*c*) $NaNO_3$ (*d*) KCl [*CBSE Sample Paper* 2019-2020]

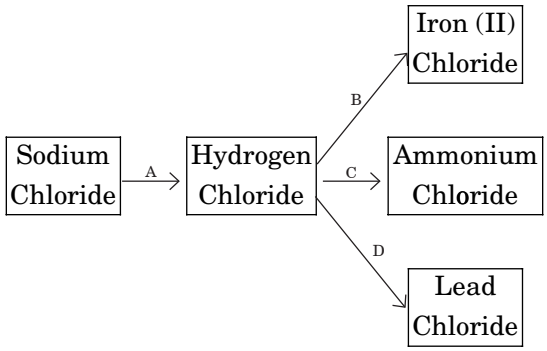
8. Baking soda is a mixture of:
(*a*) Sodium carbonate and acetic acid (*b*) Sodium carbonate and tartaric acid
(*c*) Sodium hydrogen carbonate and tartaric acid
(*d*) Sodium hydrogen carbonate and acetic acid [*CBSE* 2020]

9. 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*) $2CaSO_4 \cdot H_2O$

10. An acid (A) with sodium hydrogen carbonate is used in making the cakes fluffy and spongy. It is due to the release of (B) gas in the reaction. Here, A and B are
(*a*) A : Oxalic acid : B : CO_2 (*b*) A : Tartaric acid : B : O_2
(*c*) A : Succinic acid : B : H_2 (*d*) A : Tartaric acid : B : CO_2

11. Chemical formula of baking soda is
(*a*) $MgSO_4$ (*b*) Na_2CO_3
(*c*) $NaHCO_3$ (*d*) $MgCO_3$

12.



Here, A, B, C and D respectively are:
(*a*) A = Conc. HCl; B = Fe; C = NH_4OH; D = PbO
(*b*) A = Conc. H_2SO_4; B = Fe; C = NH_4OH; D = $Pb(NO_3)_2$
(*c*) A = Conc. H_2SO_4; B = Fe; C = NH_3; D = $Pb(NO_3)_2$
(*d*) A = Conc. HCl; B = Fe; C = NH_3; D = PbO

13. Bleaching powder is soluble in cold water giving a milky solution due to:
(*a*) available chlorine (*b*) lime present in it
(*c*) calcium carbonate formation
(*d*) The absorption of carbon dioxide from atmosphere

14. Bleaching powder gives smell of chlorine because it
(*a*) is unstable.
(*b*) gives chlorine on exposure to atmosphere.
(*c*) is a mixture of chlorine and slaked lime.
(*d*) contains excess of chlorine.

15. Washing soda has the formula
(*a*) $Na_2CO_3 \cdot 7H_2O$ (*b*) $Na_2CO_3 \cdot 10H_2O$
(*c*) $Na_2CO_3 \cdot H_2O$ (*d*) Na_2CO_3

II. Assertion-Reason Type Questions (1 Mark)

For question numbers 1 to 5, two statements are given-one labeled as **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 correct explanation of the assertion.
(*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
(*c*) 'A' is true but 'R' is false.
(*d*) 'A' is false but 'R' is true.

1. **Assertion:** $NaHCO_3$ is a basic salt
   Reason: It is a salt of strong base NaOH and weak acid H_2CO_3
2. **Assertion:** Copper sulphate solution turns blue litmus red.
   Reason: Copper sulphate is salt of strong acid H_2SO_4, weak base $Cu(OH)_2$, therefore, acidic in nature.
3. **Assertion:** Salts are the products of an acid-base reaction.
   Reason: Salt may be acidic or basic.
4. **Assertion:** Baking soda creates acidity in the stomach.
   Reason: Baking soda is alkaline.
5. **Assertion:** Plaster of Paris is used by doctors by setting fractured bones.
   Reason: When Plaster of Paris is mixed with water and applied around the fractured limbs, it sets into a hard mass.

Answers 2.3

I.

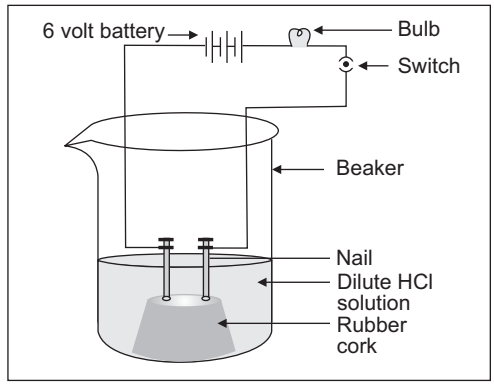
1. (*c*) absorb moisture from the gas
2. Baking soda ($NaHCO_3$) does not contain water of crystalliation. Blue vitriol $CuSO_4.5H_2O$, washing soda $Na_2CO_3.10H_2O$, Gypsum $CaSO_4.2H_2O$, all contains it.
3. (*d*) Na_2CO_3 is a basic salt because it is made up of H_2CO_3, a weak acid and NaOH a strong base
4. (*a*) basic because $Ca(OH)_2$ is a strong base, H_3PO_4 is a weak acid
5. (*c*) Baking soda and washing soda can be prepared from NaCl
6. (*d*) A and D
7. (*a*) Na_2CO_3 is basic salt because it is a salt of strong base NaOH and weak acid H_2CO_3.
8. (*c*) It consist of sodium hydrogen carbonate and tartaric acid.
9. (*c*) $CaSO_4 \cdot \frac{1}{2}H_2O$
10. (*d*) A : Tartaric acid : B : CO_2
11. (*c*) $NaHCO_3$
12. (*c*) A = Conc. H_2SO_4; B = Fe; C = NH_3; D = $Pb(NO_3)_2$
13. (*b*) Lime present in it
14. (*b*) Gives chlorine on exposure to atmosphere.
15. (*b*) $Na_2CO_3.10H_2O$

II.

1. (*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.
2. (*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.
3. (*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
4. (*d*) 'A' is false and 'R' is true. Baking soda is alkaline so it is used to neutralise excess acid in stomach.
5. (*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.

CASE STUDY QUESTIONS

1. The electrolysis is a process in which the solution or molten liquid allows electricity to pass through it. The electrolysis of acid and water conducts electricity and the bulb glows as the circuit is complete.



(*i*) What are the possible results if alcohol is used instead of acid?
- (*a*) The solution of alcohol can conduct electricity, hence the bulb will glow
- (*b*) The alcohol do not dissociate hydronium ion in the water hence the bulb will not glow
- (*c*) The bulb will not glow as the solution of alcohol do not conduct electricity
- (*d*) Both (*b*) &(*c*)

(*ii*) If the acid is replaced by glucose will the bulb glow.
- (*a*) Glucose will not dissociate into ions and the bulb will not glow.
- (*b*) The glucose can conduct electricity, hence the bulb will glow
- (*c*) Glucose will dissociate into ions and the bulb will glow
- (*d*) Both (*b*) & (*c*)

(*iii*) Name the ions produced during the electrolysis of HCl.
- (*a*) The chloride ions
- (*b*) The hydrogen ions and chloride ions.
- (*c*) The hydrogen ions
- (*d*) The calcium ions and sulphide ions

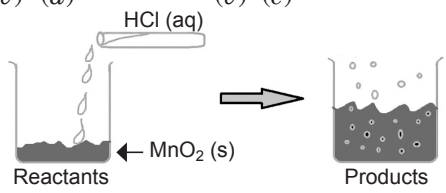
(*iv*) What will happen if you replace the above solution in the beaker with molten sodium chloride?
- (*a*) The bulb will glow as molten sodium chloride can conduct electricity
- (*b*) Sodium chloride is a salt and salts do not conducting electricity, the bulb will not glow
- (*c*) The bulb will melt in molten sodium chloride
- (*d*) None of the above

(*v*) Which of the following statement(s) is (are) correct?
- I. Bulb will not glow if an electrolyte solution is taken in the beaker because electrolyte is not acidic.
- II. Bulb will glow if HCl is taken in the beaker as it is a strong acid and furnishes ions for conduction.
- III. Bulb will glow if solid NaCl is taken in the beaker.
- IV. Bulb will not glow if solution of NaOH is taken in the beaker because it is basic.

(*a*) (I) and (III) (*b*) (II) and (IV) (c) (II) only (d) (IV) only

Ans. (*i*) (*d*) (*ii*) (*a*) (*iii*) (*b*) (*iv*) (*a*) (*v*) (*c*)

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



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

(*a*) displacement reaction (*b*) combination reaction
(*c*) redox reaction (*d*) decomposition reaction.

(*ii*) 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

(*iii*) Identify the correct statement from the 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.

(*iv*) In the above discussed reaction, what is the nature of MnO_2?
(*a*) Acidic oxide (*b*) Basic oxide (*c*) Neutral oxide (*d*) Amphoteric oxide

(*v*) 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

Ans. (*i*) (*c*) (*ii*) (*a*) (*iii*) (*a*) (*iv*) (*b*) (*v*) (*b*)

3. 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 ghat 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.

(*i*) 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

(*ii*) 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^+).

(*iii*) The table provides the pH value of four solutions P, Q, R and S

Solution	pH value
P	2
Q	9
R	5
S	11

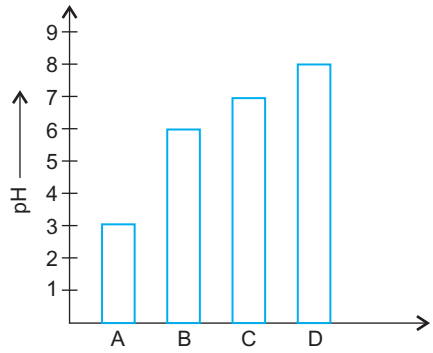
Which of the following correctly represents the solutions in increasing order of their hydronium ion concentration?
(*a*) P > Q > R > S (*b*) P > S > Q > R (*c*) S < Q < R < P (*d*) S < P < Q < R

(*iv*) 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

(*v*) 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

Ans. (*i*) (*a*) (*ii*) (*b*) (*iii*) (*c*) (*iv*) (*a*) (*v*) (*b*)

4. Orchids grow best if the soil has pH between 5.5 to 6.8. An orchid grower tested various soils. The chart shows the results.



Farmers who wish to increase the nitrogen content of soil can add ammonium salts as fertilizer.

(*i*) Which soil is best for orchid?
(*a*) A (*b*) B
(*c*) C (*d*) D

(*ii*) Why calcium hydroxide should not be added along with ammonium salts?
(*a*) It makes soil extremely acidic
(*b*) It makes soil extremely basic
(*c*) It decreases nitrogen content in soil as $Ca(OH)_2$ reacts with NH_3 to form salt
(*d*) None of these.

(*iii*) The pH of NH_4NO_3 in aqueous solution will be
(*a*) 7 (*b*) 10 (*c*) 5 (*d*) 11

(*iv*) What is colour of phenolphthalein in ammonium hydroxide?
(*a*) Colourless (*b*) Orange (*c*) Yellow (*d*) Pink

(*v*) Approximate *p*H of ammonium hydroxide is
(*a*) 7 (*b*) 10 (*c*) 1 (*d*) 4

Ans. (*i*) (*b*) (*ii*) (*c*) (*iii*) (*c*) (*iv*) (*d*) (*v*) (*b*)

QUICK REVISION NOTES

- Acids are sour in taste. They give H^+ ions in aqueous solution. If you take large amount of sour and spicy food, you will suffer from hyper-acidity. Acids turn blue litmus red.
- Baking soda helps in curing hyper-acidity. It acts as antacid, because it is basic in nature.
- Bases are bitter in taste, give OH^- ions in aqueous solution. They turn red litmus to blue, phenolphthalein to pink and methyl orange to yellow.
- Litmus solution is a purple dye that acts as a natural acid-base indicator. Red cabbage leaves, turmeric, coloured petals of hydrangea, petunia and geranium are also used as natural acid-base indicators.
- Phenolphthalein, methyl orange, universal indicator (mixture of indicators) are synthetic indicators.
- Acid and base react to form salt and water. It is called neutralisation reaction.
- When dilute acid reacts with reactive metal, salt is formed and hydrogen gas is evolved, except with nitric acid.

- Some metals like Zn, Al react with bases to form salt and hydrogen gas is evolved.
- HCl, H_2SO_4, HNO_3 are strong acids; CH_3COOH, H_2CO_3, citric acid are weak acids.
- NaOH, KOH, $Ca(OH)_2$ are strong bases; NH_4OH, $Cu(OH)_2$, $Fe(OH)_3$, $Mg(OH)_2$ are weak bases.
- Universal indicator helps in deciding the strength of acids and bases.
- Acids have pH less than 7, bases have pH more than 7. For neutral substances, pH = 7.
- Lower the pH, more will be the $[H^+]$ concentration, stronger will be the acid. Higher the pH, more will be the $[OH^-]$ concentration, stronger will be the base.
- When acid reacts with metal carbonate and metal hydrogen carbonate, it gives brisk effervescence, due to the formation of carbon dioxide and water.
- Acidic and basic solutions conduct electricity, because they produce H^+ and OH^- ions in aqueous solution, but not in non-polar solvents like benzene.
- Living organisms carry out all the metabolic activities at optimum pH, *e.g.* pH of our stomach is 2. Blood has pH = 7.42.
- Mixing acid with water is an exothermic process and should be done with constant stirring. Water should never be added to concentrated acid.
- Mixing base with water is also an exothermic process.
- Conc. acid should not be touched.
- Salts are formed by reaction of acids and bases. Salts can be acidic, basic or neutral.
- Salts of strong acid and strong bases are neutral, *i.e.* pH = 7. e.g. NaCl, KNO_3.
- Salts of strong acid and weak bases are acidic. *e.g.* $CuSO_4$, $FeSO_4$, $FeCl_3$, pH < 7.
- Salts of weak acid and strong bases are basic. *e.g.* CH_3COONa, Na_2CO_3, $NaHCO_3$, $CaCO_3$, pH > 7.
- Salts have many uses in everyday life, e.g. common salt is used in daily meals. Baking soda is used in cooking and baking.
- Common salt is used in food and also as a preservative.
- Water of crystallisation is fixed number of water molecules chemically combined with the formula of salt in crystalline form; *e.g.* $CuSO_4 \cdot 5H_2O$ (Blue vitriol).
- Hydrated salts on heating lose water of crystallisation. Their colour changes and they become powdery (amorphous).
- Plaster of Paris, $CaSO_4 \cdot \frac{1}{2}H_2O$ is used for making chalk, statues, plastering fractured bones, etc.
- Bleaching powder, $CaOCl_2$ is used as a disinfectant in drinking water, chlorinating agent and as a bleaching agent.
- $Na_2CO_3 \cdot 10H_2O$ is washing soda.
- Antacids are used to cure indigestion.
- Eggshell is made up of calcium carbonate.
- Toothpastes contain sodium lauryl sulphate, which is a part of anionic detergents.
- Toothpastes are basic in nature due to the presence of calcium carbonate.
- Alcohol and glucose are not acidic as they do not form H^+ ions in aqueous solution.
- Distilled water does not conduct electricity, because it does not contain ions.
- Curd is sour in taste, due to the presence of lactic acid.
- Tamarind contains tartaric acid, lemon contains citric acid, vinegar contains acetic acid.
- Red ants sting contains formic acid. Thus, applying basic baking soda provides relief.
- $CaSO_4 \cdot 2H_2O$ is called gypsum.
- Sodium hydroxide (Caustic soda) is manufactured by electrolysis of brine solution (sodium chloride).
- Sodium hydroxide is used in the manufacture of soap.

IMPORTANT FORMULAE

1.	Sulphuric Acid	H_2SO_4	
2.	Nitric Acid	HNO_3	
3.	Carbonic Acid	H_2CO_3	
4.	Acetic Acid	CH_3COOH	
5.	Boric Acid	H_3BO_3	
6.	Calcium Hydroxide	$Ca(OH)_2$ [Slaked lime]	
7.	Magnesium Hydroxide	$Mg(OH)_2$ [Milk of Magnesia]	
8.	Aluminium Hydroxide	$Al(OH)_3$	
9.	Sodium Meta Aluminate	$NaAlO_2$	
10.	Sodium Zincate	Na_2ZnO_2	
11.	Aqua Regia	3 HCl (conc.) + 1 HNO_3 (conc.)	
12.	Calcium Carbonate	$CaCO_3$ [limestone]	
13.	Sodium Carbonate	Na_2CO_3	
14.	Potassium Carbonate	K_2CO_3	
15.	Sodium Hydrogen Carbonate	$NaHCO_3$	
16.	Calcium Hydrogen Carbonate	$Ca(HCO_3)_2$	
17.	Magnesium Hydrogen Carbonate	$Mg(HCO_3)_2$	
18.	Sodium Chloride	$NaCl$	
19.	Sodium Sulphate	Na_2SO_4	
20.	Calcium Chloride	$CaCl_2$	
21.	Sodium Nitrate	$NaNO_3$	
22.	Potassium Nitrate	KNO_3	
23.	Calcium Nitrate	$Ca(NO_3)_2$	
24.	Copper Nitrate	$Cu(NO_3)_2$	
25.	Lead Nitrate	$Pb(NO_3)_2$	
26.	Copper Oxide	CuO	
27.	Sodium Oxide	Na_2O	
28.	Phosphorus Pentoxide	P_2O_5	
29.	Sulphur Dioxide	SO_2	
30.	Nitrogen Dioxide	NO_2	
31.	Sulphur Trioxide	SO_3	
32.	Nitrogen Pentoxide	N_2O_5	
33.	Glucose	$C_6H_{12}O_6$	
34.	Ethyl Alcohol	C_2H_5OH	
35.	Gypsum	$CaSO_4.2H_2O$	
36.	Washing Soda	$Na_2CO_3.10H_2O$	
37.	Baking Soda	$NaHCO_3$	
38.	Sodium Acetate	CH_3COONa	
39.	Bleaching Powder [Calcium Oxychloride]	$CaOCl_2$	
40.	Potassium Acetate	CH_3COOK	
41.	Sodium Sulphate	Na_2SO_4	
42.	Sodium Sulphide	Na_2S	
43.	Barium Sulphite	$BaSO_3$	
44.	Barium Sulphate	$BaSO_4$	
45.	Sulphurous Acid	H_2SO_3	
46.	Nitrous Acid	HNO_2	
47.	Sodium Nitrite	$NaNO_2$	
48.	Sodium Nitride	Na_3N	
49.	Magnesium Nitride	Mg_3N_2	
50.	Zinc Carbonate	$ZnCO_3$	
51.	Zinc Sulphate	$ZnSO_4$	
52.	Magnesium Chloride	$MgCl_2$	
53.	Mercury (II) Chloride	$HgCl_2$	

COMMON ERRORS

Errors	Corrections
• Students do mistake in identifying the colours of pH paper or universal indicator.	☞ Change of colours in weak and strong acid and base with pH paper or universal indicator need to be remembered after performing experiment in the lab.
• Students write incorrect formulae.	☞ Correct formulae of compounds must be remembered. It can be derived by using valency.
• Students forget to balance the reaction which may result in wrong interpretation of products.	☞ Correct balanced equation must be written.

IMPORTANT REACTIONS

1. $NaOH + HCl \longrightarrow NaCl + H_2O$
2. $HCl + H_2O \longrightarrow H_3O^+ + Cl^-$
3. $H_2SO_4 + H_2O \longrightarrow H_3O^+ + HSO_4^-$
4. $H_2SO_4 + 2H_2O \longrightarrow 2H_3O^+ + SO_4^{2-}$
5. $NaOH(aq) \longrightarrow Na^+(aq) + OH^-(aq)$
6. $Ca(OH)_2(aq) \longrightarrow Ca^{2+}(aq) + 2OH^-(aq)$
7. $CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$
8. $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$
9. $CaCO_3 \xrightarrow{\text{heat}} CaO + CO_2$
10. $Ca(OH)_2 + SO_2 \longrightarrow CaSO_3 + H_2O$
11. $2NaOH + H_2S \longrightarrow Na_2S + 2H_2O$
12. $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$
13. $2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$
14. $Na_2CO_3 + CO_2 + H_2O \longrightarrow 2NaHCO_3$
15. $K_2CO_3 + CO_2 + H_2O \longrightarrow 2KHCO_3$
16. $Ca(HCO_3)_2 \xrightarrow{\text{heat}} CaCO_3 + CO_2 + H_2O$
17. $Mg(HCO_3)_2 \xrightarrow{\text{heat}} MgCO_3 + CO_2 + H_2O$
18. $2NaHCO_3 \xrightarrow{\text{heat}} Na_2CO_3 + CO_2 + H_2O$
19. $KOH + HNO_3 \longrightarrow KNO_3 + H_2O$
20. $Ca(OH)_2 + 2HNO_3 \longrightarrow Ca(NO_3)_2 + 2H_2O$
21. $Mg(OH)_2 + 2HNO_3 \longrightarrow Mg(NO_3)_2 + 2H_2O$
22. $ZnO + H_2SO_4 \longrightarrow ZnSO_4 + H_2O$
23. $ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O$
24. $CuO + H_2SO_4 \longrightarrow CuSO_4 + H_2O$
25. $FeO + 2HCl \longrightarrow FeCl_2 + H_2O$
26. $CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$
27. $Zn + 2HCl\ (dil.) \longrightarrow ZnCl_2(aq) + H_2(g)$
28. $2Al + 6HCl\ (dil.) \longrightarrow 2AlCl_3 + 3H_2$
29. $2Al + 3H_2SO_4\ (dil.) \longrightarrow Al_2(SO_4)_3 + 3H_2$
30. $Mg + H_2SO_4\ (dil.) \longrightarrow MgSO_4 + H_2$
31. $Mg + 2HNO_3(5\%) \longrightarrow Mg(NO_3)_2 + H_2$
32. $Mn + 2HNO_3(5\%) \longrightarrow Mn(NO_3)_2 + H_2$
33. $Na_2CO_3 + 2HCl\ (dil.) \longrightarrow 2NaCl + H_2O + CO_2$
34. $CaCO_3 + 2HCl\ (dil.) \longrightarrow CaCl_2 + CO_2 + H_2O$
35. $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2$
36. $Na_2SO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + SO_2$
37. $Ca(OH)_2 + SO_2 \longrightarrow CaSO_3 + H_2O$
38. $Ca(OH)_2 + Cl_2 \longrightarrow CaOCl_2 + H_2O$
39. $Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3.10H_2O$
40. $CaSO_4.2H_2O \xrightarrow{373\ K} CaSO_4.1/2H_2O + 3/2H_2O$
41. $CaO + SiO_2 \longrightarrow CaSiO_3$
42. $FeO + SiO_2 \longrightarrow FeSiO_3$
43. $ZnCO_3 + 2HCl \longrightarrow ZnCl_2 + H_2O + CO_2$
44. $FeS + H_2SO_4\ (dil.) \longrightarrow FeSO_4 + H_2S$
45. $SO_2 + H_2O \longrightarrow H_2SO_3$
46. $SO_3 + H_2O \longrightarrow H_2SO_4$
47. $P_2O_5 + 3H_2O \longrightarrow 2H_3PO_4$
48. $N_2O_5 + H_2O \longrightarrow 2HNO_3$
49. $CO_2 + H_2O \longrightarrow H_2CO_3$
50. $SO_2 + H_2O \longrightarrow H_2SO_3$
51. $Na_2O + H_2O \longrightarrow 2NaOH$
52. $K_2O + H_2O \longrightarrow 2KOH$
53. $CaO + H_2O \longrightarrow Ca(OH)_2$
54. $2NaOH + SO_2 \longrightarrow Na_2SO_3 + H_2O$
55. $Na_2SO_3 + SO_2 + H_2O \longrightarrow 2NaHSO_3$
56. $Fe(OH)_2 + 2HCl \longrightarrow FeCl_2 + 2H_2O$
57. $Cu(OH)_2 + H_2SO_4 \longrightarrow CuSO_4 + 2H_2O$
58. $2Al(OH)_3 + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 6H_2O$
59. $Al(OH)_3 + NaOH \longrightarrow NaAlO_2 + 2H_2O$
60. $Zn(OH)_2 + 2NaOH \longrightarrow Na_2ZnO_2 + 2H_2O$
61. $NaOH + H_2CO_3 \longrightarrow NaHCO_3 + H_2O$
62. $2NaOH + H_2CO_3 \longrightarrow Na_2CO_3 + H_2O$

ASSIGNMENT

Total Marks : 10

I. Multiple Choice Questions (8 × 1 = 8)

Choose the correct answer from the given options.

1. Which of the following statements is correct about an aqueous solution of an acid and of a base

(I) Higher the pH, strong the base (II) Higher the pH, weaker the base

(III) Lower the pH, weaker the base (IV) Lower the pH, weaker the acid

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

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]

3. Zinc granules on treating with an acid X, form the 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 the 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

4. 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)

5. Dilute acid does not produce carbon dioxide on being treated with:

(*a*) Marble (*b*) Lime (*c*) Baking soda (*d*) Limestone

6. An ant's sting can be treated with .....which will neutralise the effect of the chemical injected by the ant's sting into our skin.

Choose the correct option from the following to be filled in the blank space:

(*a*) Methanoic acid (*b*) Formic acid (*c*) Baking soda (*d*) Caustic soda

7. Which of the following salt will give acidic solution when dissolved in water?

(*a*) NH_4Cl (*b*) NaCl (*c*) Na_2CO_3 (*d*) CH_3COONa

8. Brine is an

(*a*) aqueous solution of sodium hydroxide

(*b*) aqueous solution of sodium carbonate

(*c*) aqueous solution of sodium chloride

(*d*) aqueous solution of sodium bicarbonate

II. Assertion-Reason Type Questions (2 × 1 = 2)

Note: Use instructions as given in topical exercises of the chapter.

1. **Assertion:** pH of our stomach is nearly 2.0.
Reason: It is due to secretion of HCl in gastric juice which helps in digestion of proteins.

2. **Assertion:** Sodium hydrogen carbonate is acidic salt.
Reason: The pH of aqueous solution of $NaHCO_3$ is 8.4