Acids, Bases and Salts

2

Basic Concepts

1. **Acids:** Acids taste sour, bases taste bitter, and the compounds (salts) formed when acids react with bases taste salty. Some salts have very unpleasant taste and may be poisonous also.
2. **Organic acids:** The acids produced by plants and animals (exception hydrochloric acid) are known as organic acids.
3. **Mineral acids:** The acids prepared from minerals present in the earth's crust are known as mineral acids.
4. **Indicator:** An indicator is a special chemical that changes its colour to indicate the presence of a chemical substance. It is used to confirm the presence of an acid, a base or a neutral solution. Indicators show different colours in acidic and basic medium. These are dyes or mixtures of dyes which are used to indicate the presence of acids and bases. Some examples are litmus solution, methyl orange, phenolphthalein and universal indicator. There are some substances whose odour changes in acidic or basic medium. These are called **olfactory indicators**.
5. **Reaction with metals:** Metals react with acids to give a salt and hydrogen gas, although there are exceptions to this. When a base reacts with a metal, alongwith the evolution of hydrogen gas, a salt is formed which has its negative ion composed of the metal and oxygen.

$$Zn + H_2SO_4(dil) \longrightarrow \underset{\text{Zinc sulphate}}{ZnSO_4} + H_2$$

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

6. **Reaction with metal carbonate or metal hydrogencarbonate:** When a metal carbonate or metal hydrogencarbonate (bicarbonate) reacts with an acid, it gives out a corresponding salt, carbon dioxide and water.

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

$$NaHCO_3(s) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l) + CO_2(g)$$

When the carbon dioxide gas evolved is passed through lime water, it turns milky due to the formation of calcium carbonate.

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

On passing excess carbon dioxide the milkiness disappears and the solution becomes colourless due to the formation of soluble calcium hydrogencarbonate.

$$CaCO_3(s) + H_2O(l) + CO_2(g) \longrightarrow \underset{\text{(Soluble in water)}}{Ca(HCO_3)_2(aq)}$$

7. **Acid or a base in a water solution:** When acids dissolve in water, the hydrogen is released into the solution as $H^+(aq)$ or H_3O^+ ions. It is $H^+(aq)$ or H_3O^+ ions that make a solution acidic. Formation of $OH^-(aq)$ ions in solution is responsible for the basic nature of a substance.

Ions present in some common Acids and Bases:

Acidic solution	Formula	Ions present
Dilute hydrochloric acid	HCl	H^+ and Cl^-
Dilute nitric acid	HNO_3	H^+ and NO_3^-
Dilute sulphuric acid	H_2SO_4	H^+ and SO_4^{2-}

Alkaline solution	Formula	Ions present
Sodium hydroxide	NaOH	Na^+ and OH^-
Potassium hydroxide	KOH	K^+ and OH^-
Calcium hydroxide	$Ca(OH)_2$	Ca^{2+} and OH^-

8. Pure water is a neutral liquid. This is because water contains exactly the same numbers of H^+ and OH^- ions. Acid solution contains more hydrogen ions (H^+) than water. Alkaline solutions have a greater concentration of hydroxide ions (OH^-) than water.

Water and neutral solutions	Equal concentrations of H^+ and OH^-.
Acid solutions	Greater concentration of H^+ than water.
Alkaline solutions	Greater concentration of OH^- than water.

9. **pH Scale:** A scale for measuring hydrogen ion concentration in a solution is called pH scale. Higher the hydrogen ion concentration, lower is the pH value.

pH of a solution is defined as the negative logarithm (to the base 10) of the hydrogen ion concentration in the solution.

Role of pH in Everyday Life:

(*a*) Human blood, tears and saliva have a pH range of 7.0 to 7.8. Survival of living organisms is possible only within this range of pH.

(*b*) For gardening and farming, the best crops are usually obtained with neutral or acidic soil (pH—6.5 to 7.0). Below pH 6.5 the soil is not suitable for normal growth of plants, particularly vegetables.

(*c*) HCl produced in the stomach is important for digestion. Hyperacidity (increase in the amount of acid during indigestion) causes pain and irritation. The excess acid is neutralised by the intake of antacids such as magnesium hydoxide (milk of magnesia).

(*d*) When the pH inside the mouth becomes lower than 5.5, it causes tooth decay. Toothpastes are generally basic. They neutralise the excess acid and prevent tooth decay.

(*e*) Stings of insects such as bees, ants and wasps cause pain and irritation. They contain methanoic acid.

10. **Dilution:** The process of dissolving an acid or a base in water is an highly exothermic process. It is known as dilution.

The acid must always be added slowly to water with constant stirring. If water is added to a concentrated acid, the heat generated may cause the mixture to splash out and cause burns. The glass container may also break due to excessive local heating.

11. **Neutralisation reaction:** All bases react with acids to form salt and water. This process is known as neutralisation. During neutralisation the $H^+(aq)$ ions of an acid combine with OH^- ions of a base to form water while the negative ion of the acid and positive ion of the base combine to form a salt.

12. pH of Salts:

(*a*) The salt of a **strong acid** and a **strong base** gives a **neutral** solution (pH = 7)

(*b*) The salt of a **strong acid** and a **weak base** gives an **acidic** solution (pH < 7).

(*c*) The salt of a **weak acid** and a **strong base** gives a **basic** solution (pH > 7).

13. Water of crystallisation: The fixed number of water molecules chemically attached to each formula unit of a salt in its crystalline form is called water of crystallisation. The salt which contain water of crystallisation are called hydrated salts. *e.g.*, $CuSO_4.5H_2O$.

14. Common Salt

Chemical Name: Sodium Chloride

Chemical Formula: NaCl

Preparation: Sodium chloride can be prepared in the laboratory by combination reaction of sodium hydroxide and hydrochloric acid.

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$$

Uses: (*i*) It is used as a raw material for making a large number of useful chemicals in industry.

(*ii*) It is used in cooking food.

15. Caustic Soda

Chemical Name: Sodium Hydroxide

Chemical Formula: NaOH

Preparation: When electricity is passed through a concentrated solution of sodium chloride (brine), it decomposes to form sodium hydroxide, chlorine and hydrogen. It is also known as 'chlor-alkali' process because of the products formed, 'chlor' for Cl_2 and 'alkali' for NaOH.

$$2NaCl(aq) + 2H_2O(l) \longrightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$$

Chlorine gas is produced at the anode and hydrogen gas is produced at the cathode. Sodium hydroxide solution is formed near the cathode.

Uses: It is used

(*i*) in detergents and soaps to remove grease.

(*ii*) in paper making.

(*iii*) in rayon and acetate fibres.

(*iv*) in the manufacture of bleach (household bleaches, bleaching fabric).

(*v*) in purifying bauxite to extract aluminium.

16. Uses of Hydrogen

(*i*) It is used in making margarine: Margarines are made from vegetable oils. The oils are liquids which are too runny to spread on bread. The problem has been solved by reacting hydrogen with the natural oil molecules. This makes the oil thicker.

(*ii*) Hydrogen is used as a fuel: Hydrogen reacts explosively with the oxygen in air. When a lighted split pops in hydrogen, it reacts with oxygen to make water (steam).

$$2H_2(g) + O_2(g) \xrightarrow{\text{Catalyst}} 2H_2O(g)$$

Hydrogen has played a big part in space travel. It can be used as rocket fuel. The liquid hydrogen stored in tanks is ready to react with liquid oxygen. It has also been used inside space-craft to power fuel cells.

(*iii*) It is used in the manufacture of ammonia for fertilisers.

$$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$$

(*iv*) Hydrogen directly combines with chlorine: This reaction is used for the manufacture of hydrochloric acid (HCl).

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

Hydrochloric acid has many uses in industry. It is used for cleaning steel, preparing ammonium chloride, medicines and cosmetics.

17. Uses of Chlorine

(*i*) It is used in killing bacteria in drinking water and swimming pools.

(*ii*) It is used in the manufacture of bleach to kill bacteria and to whiten paper.

(*iii*) It forms hydrochloric acid which has many uses in industry.

(*iv*) It is used in CFCs (chloro-fluorocarbons), PVC (polyvinyl chloride), bleaching fabric.

18. Washing Soda

Chemical Name: Sodium carbonate decahydrate.

Chemical Formula: $Na_2CO_3.10H_2O$

Preparation: Washing soda is obtained by recrystallisation of sodium carbonate. Sodium carbonate is recrystallised by dissolving in water.

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

Uses: (*i*) Softening hard water.

(*ii*) Used in paper, paints and textiles industries.

(*iii*) Manufacture of glass, borax and caustic soda.

(*iv*) Used in laundry for washing clothes.

19. Baking Soda

Chemical Name: Sodium hydrogencarbonate.

Chemical Formula: $NaHCO_3$

Preparation: Sodium hydrogencarbonate is produced on a large scale by reacting a cold and concentrated solution of sodium chloride (brine) with ammonia and carbon dioxide.

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

Uses: (*i*) Preparation of baking powder.

(*ii*) Manufacture of soda water.

(*iii*) Remove acidity of stomach.

(*iv*) Used in fire extinguishers.

20. Bleaching Powder

Chemical Name: Calcium oxychloride.

Chemical Formula: $CaOCl_2$

Preparation: It is prepared by passing chlorine gas over dry slaked lime.

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

Uses: (*i*) Used for bleaching cotton textile.

(*ii*) As disinfecting drinking water to make it germs free.

(*iii*) As an oxidising agent in chemical industries.

(*iv*) Used in manufacturing of chloroform.

21. Plaster of Paris

Chemical Name: Calcium sulphate hemihydrate

Chemical Formula: $CaSO_4.\frac{1}{2}H_2O$

Preparation: It is prepared by heating gypsum at 373K.

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

Uses: (*i*) Making statues, models, toys, etc.

(*ii*) Making chalk for writing on blackboards.

(*iii*) Making fireproof materials.

(*iv*) It is used for setting fractured bones in the right position.

NCERT Intext Questions

Q. 1. 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?

Ans. (*a*) Put the red litmus paper turn by turn in each of the three test tubes. The solution which turns the red litmus paper to blue will be a basic solution. Here, the blue litmus paper formed can now be used to test the acidic solution.

(*b*) Put this blue litmus paper in the remaining two test tubes, one by one. The solution which turns the blue litmus paper to red will be the acidic solution.

(*c*) The solution which has no effect on any litmus paper will be neutral and hence, it will be distilled water.

Q. 2. Why should curd and sour substances not be kept in brass and copper vessels?

Ans. Curd and other sour substances should not be kept in brass and copper vessels. This is because curd and other sour substances contain acids which can react with these vessels to form poisonous compounds that can cause food poisoning and damage health.

Q. 3. Which gas is usually liberated when an acid reacts with a metal? Illustrate with an example. How will you test the presence of this gas?

Ans. When a metal reacts with an acid, usually hydrogen gas is liberated. For example, zinc reacts with dilute sulphuric acid as follows:

$$\underset{\text{Zinc}}{Zn} + \underset{\text{Sulphuric acid}}{H_2SO_4} \longrightarrow \underset{\text{Zinc sulphate}}{ZnSO_4} + \underset{\text{Hydrogen}}{H_2\uparrow}$$

The hydrogen gas evolved can be tested by passing the gas through soap solution and then bringing a burning candle near the soap bubble filled with the gas. The soap bubble bursts and the hydrogen gas burns with a pop sound.

Q. 4. A 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. ***[Competency Based Question]***

Ans. The gas that extinguishes a burning candle is carbon dioxide. It is formed by the action of dilute hydrochloric acid on a metal carbonate or metal hydrogencarbonate and produces effervescence. Since one of the compounds formed is calcium chloride, this shows that the metal compound is calcium carbonate. It cannot be calcium hydrogencarbonate because calcium hydrogencarbonate is found in solution.

Thus, the metal compound A is calcium carbonate ($CaCO_3$).

Calcium carbonate reacts with dilute hydrochloric acid to form calcium chloride, carbon dioxide and water.

$$CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Q. 5. Why do HCl, HNO_3, etc., show acidic character in aqueous solutions while solutions of compounds like alcohol and glucose do not show acidic character?

Ans. HCl, HNO_3, etc., ionise in the aqueous solution to produce H_3O^+ ions. Hence, they show acidic character. Compounds like C_2H_5OH and glucose do not ionise in the aqueous solution to give H_3O^+ ions, *i.e.*, hydrogen present in them is non-ionisable. Hence, they do not show acidic character.

Q. 6. Why does an aqueous solution of an acid conduct electricity?

Ans. An acid in the aqueous solution ionises to produce H_3O^+ ions and the corresponding negative ions. For example, HCl gives H^+ and Cl^- ions. Due to the presence of ions in the solution, it conducts electricity.

Q. 7. Why does dry HCl gas not change the colour of the dry litmus paper? ***[CBSE 2019 (31/2/1)]***

Ans. Dry HCl gas does not change the colour of dry litmus paper because it does not produce H_3O^+ ion.

Q. 8. While diluting an acid, why is it recommended that the acid should be added to water and not water to the acid? ***[CBSE 2019 (31/2/1)]***

Ans. Dilution of concentrated acid with water is a highly exothermic process. If water is added into acid, the heat produced is so large that the solution may splash out and the beaker in which it is carried out may break due to excessive heating. Hence, dilution is done by adding acid into water.

Q. 9. How is the concentration of hydronium ions (H_3O^+) affected, when a solution of an acid is diluted?

Ans. When a solution of an acid is diluted, the concentration of hydronium ions (H_3O^+) per unit volume decreases.

Q. 10. How is the concentration of hydroxide ions (OH^-) affected, when excess base is dissolved in a solution of sodium hydroxide?

Ans. On dissolving excess base in a solution of sodium hydroxide, concentration of OH^- ions per unit volume in the solution increases.

Q. 11. You have two solutions A and B. The pH of solution A is 6 and pH of solution B is 8. Which solution has more hydrogen ion concentration? Which of these is acidic and which one is basic?

Ans. The pH of a solution is inversely proportional to its hydrogen ion concentration. This means that the solution having lower pH will have more hydrogen ion concentration. Thus, solution A will have more hydrogen ion concentration.

A solution with pH < 7 is acidic. Hence, solution A is acidic.

A solution with pH > 7 is basic. Hence, solution B is basic.

Q. 12. What effect does the concentration of $H^+(aq)$ ions have on the acidic nature of the solution?

Ans. Water contains exactly the same number of H^+ and OH^- ions. Acidic solution contains more hydrogen ions than water. Higher the concentration of H^+ ions in a solution, more acidic is the solution.

Q. 13. Do basic solutions also have $H^+(aq)$ ions? If yes, then why are these basic?

Ans. Basic solutions also have H^+ ions in addition to OH^- ions. They are basic because in these solutions, OH^- ion concentration is greater than H^+ ion concentration.

Q. 14. Under what soil condition do you think a farmer would treat the soil of his field with quick lime (calcium oxide) or slaked lime (calcium hydroxide) or chalk (calcium carbonate)?

Ans. Most of the plants grow best when the pH of the soil is close to 7. If the soil is too acidic or too basic, the plants grow badly or do not grow at all. As quick lime, slaked lime or chalk are all alkaline substances, these would be added to the soil by the farmer when the soil is highly acidic.

Q. 15. What is the common name of the compound $CaOCl_2$?

Ans. Bleaching powder.

Q. 16. Name the substances which on treatment with chlorine yields bleaching powder.

Ans. Dry slaked lime $Ca(OH)_2$.

Q. 17. Name the sodium compound which is used for softening hard water.

Ans. Washing soda (sodium carbonate decahydrate).

Q. 18. What will happen if a solution of sodium hydrogencarbonate is heated? Give the equation of the reaction involved.

Ans. Sodium hydrogencarbonate on heating decomposes to give sodium carbonate, carbon dioxide and water.

$$\underset{\text{Sodium hydrogencarbonate}}{2NaHCO_3} \longrightarrow \underset{\text{Sodium carbonate}}{Na_2CO_3} + \underset{\text{Carbon dioxide}}{CO_2\uparrow} + \underset{\text{Water}}{H_2O}$$

Q. 19. Write an equation to show the reaction between Plaster of Paris and water.

Ans. Plaster of Paris ($CaSO_4.1/2H_2O$) on mixing with water, changes into gypsum ($CaSO_4.2H_2O$) which sets to a hard mass in about half an hour.

$$\underset{\text{Plaster of Paris}}{CaSO_4.\frac{1}{2}H_2O} + 1\frac{1}{2}\underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Gypsum}}{CaSO_4.2H_2O}$$

NCERT Exercises

Q. 1. A solution turns red litmus blue, its pH is likely to be

(a) 1 (b) 4 (c) 5 (d) 10

Ans. The solution which turns red litmus blue is basic. Its pH should be greater than 7. Therefore, the correct answer is (*d*).

Q. 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

Ans. Egg-shells contain calcium carbonate which reacts with HCl to give out CO_2 which turns lime water milky. Hence, the correct answer is (*b*).

Q. 3. 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 of HCl solution (the same solution as before) is required to neutralise it will be

(a) 4 mL (b) 8 mL (c) 12 mL (d) 16 mL

Ans. If we take double the amount of the NaOH solution, the amount of the HCl solution required to neutralise it, is also double. Hence, the correct answer is (*d*).

Q. 4. Which one of the following type of medicines is used for treating indigestion?

(a) Antibiotic (b) Analgesic (c) Antacid (d) Antiseptic

Ans. The indigestion is due to excess of acid produced in the stomach. The medicine used to neutralise it is called antacid. Hence, the correct answer is (*c*).

Q. 5. Write word–equations and then balanced equations for the reactions taking place when

(a) dilute sulphuric acid reacts with zinc granules.

(b) dilute hydrochloric acid reacts with magnesium ribbon.

(c) dilute sulphuric acid reacts with aluminium powder.

(d) dilute hydrochloric acid reacts with iron filings.

Ans. (*a*) Sulphuric acid(*aq*) + Zinc(*s*) ⟶ Zinc sulphate(*aq*) + Hydrogen(*g*)

$H_2SO_4(aq) + Zn(s) \longrightarrow ZnSO_4(aq) + H_2(g)$

(*b*) Hydrochloric acid(*aq*) + Magnesium(*s*) ⟶ Magnesium chloride(*aq*) + Hydrogen(*g*)

$2HCl(aq) + Mg(s) \longrightarrow MgCl_2(aq) + H_2(g)$

(*c*) Sulphuric acid(*aq*) + Aluminium(*s*) ⟶ Aluminium sulphate(*aq*) + Hydrogen(*g*)

$3H_2SO_4(aq) + 2Al(s) \longrightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

(*d*) Hydrochloric acid(*aq*) + Iron(*s*) ⟶ Iron(II) chloride(*aq*) + Hydrogen(*g*)

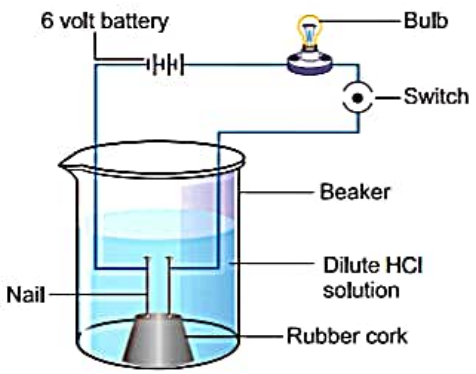
$2HCl(aq) + Fe(s) \longrightarrow FeCl_2(aq) + H_2(g)$

Q. 6. Compounds such as alcohols and glucose also contain hydrogen but are not categorised as acids. Describe an activity to prove it.

Ans. Although alcohols and glucose contain hydrogen, they are not ionised to give H^+ ions in solution. So, they are not considered as acid.

Activity:

- Collect solutions of hydrochloric acid, sulphuric acid, glucose and alcohol.
- Take a beaker of 100 mL.
- Now, take a cork and fix two nails on it as shown in figure.
- Place this cork in the beaker.



- Connect the nails to the two terminals of a 6 volt battery through a bulb and a switch.
- Now, pour dilute H_2SO_4 in the beaker so that the nails are immersed in the acid. Switch on the current.
- Repeat the experiment with dilute hydrochloric acid, glucose and alcohol solutions.
- Does the cases?

It is observed that the bulb will glow in case of hydrochloric acid and sulphuric acid, but not in the case of alcohol and glucose.

Q. 7. Why does distilled water not conduct electricity, whereas rain water does?

Ans. Distilled water does not conduct electricity because it does not contain any ionic compounds like acids, bases or salts, dissolved in it. Rain water, while falling to the earth through the atmosphere, dissolves acidic gases like CO_2, SO_2, etc., from the air and form acids like carbonic acid (H_2CO_3), sulphurous acid (H_2SO_3), etc. These acids provide hydrogen ions (H^+) to rain water. So, due to the presence of these acids, the rain water conducts electricity.

Q. 8. Why do acids not show acidic behaviour in the absence of water?

Ans. Acidic nature of a substance is due to the formation of $H^+(aq)$ ions in solution. Hydrogen ions are produced in the presence of water. The separation of H^+ ions from acid like HCl molecule cannot occur in the absence of water. So, acids do not show acidic behaviour in the absence of water.

Q. 9. 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.

Ans.

	Nature	pH	Solution
(*a*)	Neutral	7	D
(*b*)	Strongly alkaline	11	C
(*c*)	Strongly acidic	1	B
(*d*)	Weakly acidic	4	A
(*e*)	Weakly alkaline	9	E

Arrangement of the pH in increasing order of hydrogen ion concentration is as follows:

$$11 < 9 < 7 < 4 < 1$$

Q. 10. 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. Amount and concentration taken for both the acids are same. In which test tube, will the fizzing occur more vigorously and why?

Ans. We know that hydrochloric acid (HCl) is a strong acid and acetic acid (CH_3COOH) is a weak acid. Being a strong acid, HCl solution contains a much greater amount of hydrogen ions in it. Due to this, the fizzing will occur more vigorously in test tube A. The fizzing is due to the evolution of H_2 gas which is formed by the action of acid on the magnesium ribbon.

Q. 11. Fresh milk has a pH of 6. How do you think the pH will change as it turns into curd? Explain your answer.

Ans. The pH will fall below 6. This is because lactic acid is produced when milk sets into curd.

Q. 12. 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?

Ans. (*a*) Milk is made slightly alkaline so that it may not get sour easily due to the formation of lactic acid in it.

(*b*) The alkaline milk takes a longer time to set into curd because the lactic acid formed has to first neutralise the alkali present in it.

Q. 13. Plaster of Paris should be stored in a moisture-proof container. Explain why.

Ans. Plaster of Paris is a white powder and on mixing with water, it changes to gypsum giving a hard solid mass.

$$\underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + 1\frac{1}{2}H_2O \longrightarrow \underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O}$$

Hence, it should be stored in a moisture-proof container.

Q. 14. What is a neutralisation reaction? Give two examples.

Ans. All bases react with acids to form salt and water. Such type of reactions are called neutralisation reactions.

$$\underset{\substack{\text{Sodium hydroxide}\\\text{(Base)}}}{NaOH} + \underset{\substack{\text{Hydrochloric acid}\\\text{(Acid)}}}{HCl} \longrightarrow \underset{\substack{\text{Sodium chloride}\\\text{(Salt)}}}{NaCl} + \underset{\text{Water}}{H_2O}$$

$$\underset{\substack{\text{Potassium hydroxide}\\\text{(Base)}}}{KOH} + \underset{\substack{\text{Nitric acid}\\\text{(Acid)}}}{HNO_3} \longrightarrow \underset{\substack{\text{Potassium nitrate}\\\text{(Salt)}}}{KNO_3} + \underset{\text{Water}}{H_2O}$$

Q. 15. Give two important uses of washing soda and baking soda.

Ans. (*i*) Washing soda ($Na_2CO_3.10H_2O$)

Uses: (*a*) Softening hard water.

(*b*) In paper, paints and textile industries.

(*ii*) Baking soda ($NaHCO_3$)

Uses: (*a*) Preparation of baking powder and soda water.

(*b*) In fire extinguishers.

Multiple Choice Questions

Each question has 4 choices (a), (b), (c) and (d). Choose and write the correct option.

1. **Calcium carbonate is the chemical formula of**

   (*a*) limestone (*b*) chalk (*c*) marble (*d*) all (*a*), (*b*) and (*c*)

2. **On adding dilute HCl to copper oxide in a beaker, the solution turns blue-green due to formation of**

   (*a*) copper(II) hydroxide (*b*) copper nitrate

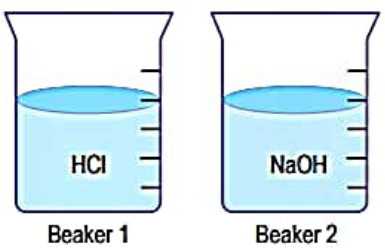
   (*c*) copper (II) chloride (*d*) copper sulphate

3. **Human body works within the pH range of**

   (*a*) 7.0 to 7.8 (*b*) 4.5 to 5.6 (*c*) 13.0 to 14.0 (*d*) 1.2 to 2.2

4. **A student placed 10 mL HCl and NaOH in two separate beakers as shown.**

   [*CBSE Question Bank*]



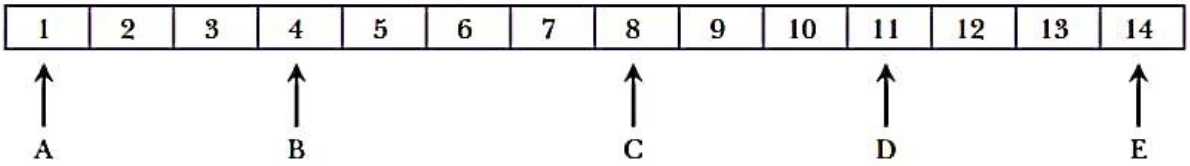
In beaker 1, 4 mL of NaOH is added whereas in beaker 2, 4 mL of HCl is added. The student notes the possible changes in pH in both solutions.

	Change in pH (Beaker 1)	Change in pH (Beaker 2)
A	increase	increase
B	reduce	increase
C	increase	reduce
D	reduce	reduce

Which change in pH is correct?

(*a*) A (*b*) B (*c*) C (*d*) D

5. **Five solutions are labelled on a pH scale.** **[*CBSE Question Bank*]**



Which classification is correct?

(*a*)

Strongest Acid	Strongest Base
A	E

(*b*)

Strongest Acid	Strongest Base
B	E

(*c*)

Strongest Acid	Strongest Base
A	C

(*d*)

Strongest Acid	Strongest Base
B	C

6. **A basic solution could have a pH of**

(*a*) 1 (*b*) 11 (*c*) 7 (*d*) 2

7. **Which of the following gives the correct increasing order of acidic strength?** **[*NCERT Exemplar*]**

(*a*) Water < Acetic acid < Hydrochloric acid (*b*) Water < Hydrochloric acid < Acetic acid

(*c*) Acetic acid < Water < Hydrochloric acid (*d*) Hydrochloric acid < Water < Acetic acid

8. **Which of the following reactions is a neutralisation reaction?** **[*CBSE Question Bank*]**

(*a*) $4Na + O_2 \longrightarrow 2Na_2O$ (*b*) $Fe + 2HCl \longrightarrow FeCl_2 + H_2$

(*c*) $MgO + H_2O \longrightarrow Mg(OH)_2$ (*d*) $HNO_3 + NaOH \longrightarrow NaNO_3 + H_2O$

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** **[*NCERT Exemplar*]**

(*a*) (*i*) and (*ii*) (*b*) (*i*), (*ii*) and (*iv*)

(*c*) (*i*) and (*iii*) (*d*) (*i*), (*iii*) and (*iv*)

10. **Which of the following salts does not contain water of crystallisation?** **[*NCERT Exemplar*]**

(*a*) Blue vitriol (*b*) Baking soda

(*c*) Washing soda (*d*) Gypsum

11. A scientist in a chemistry lab wants to make salt of pH 5.5 using acid and base. The table shows the acid and base present in the lab.

1	HCl
2	NaOH
3	H_2CO_3
4	NH_4OH
5	CH_3COOH

Which of the acid and base he should use for the reaction? ***[HOTS]***

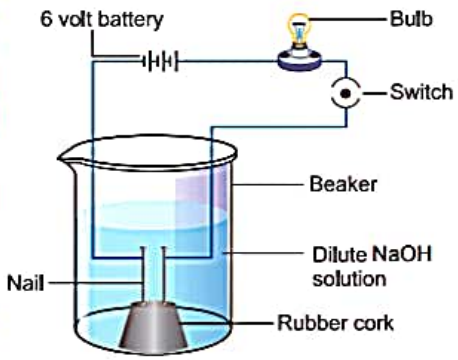
(*a*) CH_3COOH and NaOH (*b*) HCl and NaOH

(*c*) HCl and NH_4OH (*d*) H_2CO_3 and NaOH

12. 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? ***[NCERT Exemplar]***

(*a*) Lemon juice (*b*) Vinegar (*c*) Common salt (*d*) An antacid

13. In an attempt to demonstrate electrical conductivity through an electrolyte, the alongside apparatus was set up. Which among the following statement(s) is(are) correct? ***[NCERT Exemplar]***



(*i*) **Bulb will not glow because electrolyte is not acidic.**

(*ii*) **Bulb will glow because NaOH is a strong base and furnishes ions for conduction.**

(*iii*) **Bulb will not glow because circuit is incomplete.**

(*iv*) **Bulb will not glow because it depends upon the type of electrolytic solution.**

(*a*) (*i*) and (*iii*) (*b*) (*ii*) and (*iv*)

(*c*) (*ii*) only (*d*) (*iv*) only

14. 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: ***[CBSE 2020 (31/5/1)]*** ***[HOTS]***

(*a*) Red (*b*) Yellow (*c*) Green (*d*) Blue

15. Which of the following solutions will turn phenolphthalein pink?

(*a*) HCl(*aq*) (*b*) $CO_2(aq)$ (*c*) KOH(*aq*) (*d*) $H_2SO_4(aq)$

16. When a small amount of acid is added to water, the phenomena which occur are: ***[CBSE 2020 (31/1/3)]***

(A) Dilution **(B) Neutralisation**

(C) Formation of H_3O^+ ions **(D) Salt formation**

The correct statements are:

(*a*) (A) and (C) (*b*) (B) and (D) (*c*) (A) and (B) (*d*) (C) and (D)

17. Which of the following statements is true for acids? ***[NCERT Exemplar]***

(*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

18. The acid having highest hydrogen ion concentration is one with

(*a*) pH = 2.5 (*b*) pH = 1.8

(*c*) pH = 7 (*d*) pH = 10

19. The pH of the gastric juices released during digestion is: ***[NCERT Exemplar]***

(*a*) less than 7 (*b*) more than 7

(*c*) equal to 7 (*d*) equal to 0

20. If a few drops of a concentrated acid accidentally spills over the hand of a student, what should be done? ***[NCERT Exemplar]***

(*a*) Wash the hand with saline solution.

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

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

(*d*) Neutralise the acid with a strong alkali.

21. When dilute sulphuric acid is added to a solid X, a gas Y is formed along with the formation of the salt of the solid. What could be X and Y? ***[HOTS]***

(*a*) X: carbon; Y: hydrogen (*b*) X: zinc; Y: hydrogen

(*c*) X: zinc; Y: oxygen (*d*) X: copper; Y: oxygen

22. Sodium hydrogencarbonate when added to acetic acid evolves a gas. Which of the following statements is 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. ***[NCERT Exemplar]***

(*a*) (*i*) and (*ii*) (*b*) (*i*), (*ii*) and (*iii*)

(*c*) (*ii*), (*iii*) and (*iv*) (*d*) (*i*) and (*iv*)

23. Which solution will change blue litmus to red?

(*a*) NaOH(*aq*) (*b*) H_2SO_4(*aq*)

(*c*) KCl(*aq*) (*d*) NH_4OH(*aq*)

24. 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: ***[CBSE 2020 (31/2/1)]***

(*a*) Blue litmus (*b*) Clove oil

(*c*) Red cabbage extract (*d*) Hibiscus extract

25. Identify the basic salt from the following salts: ***[CBSE Sample Paper 2020]***

(*a*) Na_2CO_3 (*b*) NH_4Cl

(*c*) $NaNO_3$ (*d*) KCl

26. In general, salts

(*a*) are ionic compounds. (*b*) contain hydrogen ions.

(*c*) contain hydroxide ions. (*d*) turn blue litmus red.

27. Baking soda is a mixture of: ***[CBSE 2020 (31/1/1)]***

(*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

28. 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.

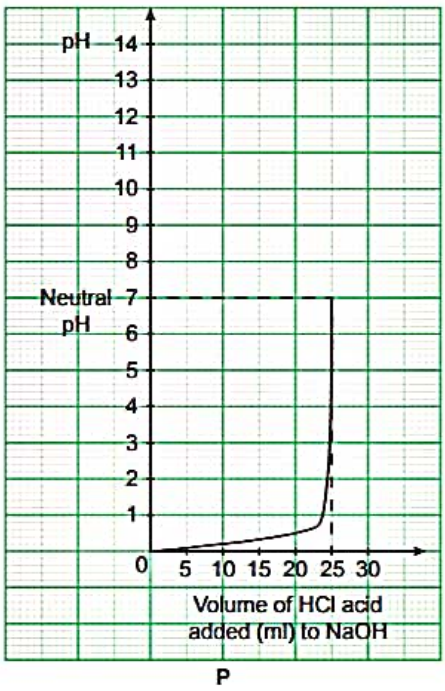
(*iii*) It gives both hydrogen and hydroxyl ion in the solution.

(*iv*) It forms hydronium ion in the solution due to the combination of hydrogen ion with water molecule. ***[NCERT Exemplar]***

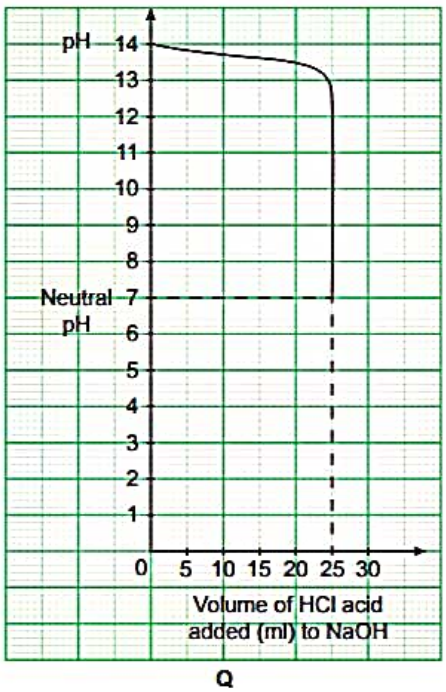
(*a*) (*i*) only (*b*) (*iii*) only (*c*) (*ii*) and (*iv*) (*d*) (*iii*) and (*iv*)

29. Aditi adds dropwise 25 ml of concentrated HCl to 25 ml of concentrated NaOH and continuously monitors the pH in the mixture. She finds that the pH of the mixture at the end of the experiment is 7.

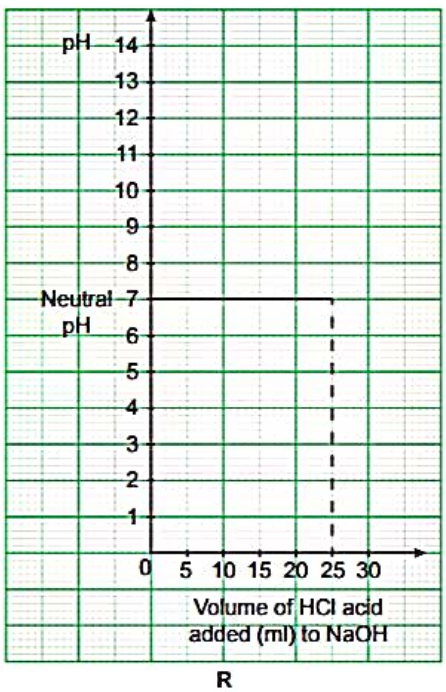
Which of the following graph correctly demonstrates the change in pH in the mixture during the experiment? ***[Competency Based Question]*** ***[CBSE Question Bank]***



P



Q



R

(*a*) Only P

(*b*) Only Q

(*c*) Either P or Q

(*d*) Any of them - P, Q or R

30. An aqueous solution 'A' turns phenolphthalein solution pink. On addition of an aqueous solution 'B' to 'A', the pink colour disappears. Which of the following statement is true for solution 'A' and 'B'? ***[CBSE 2020 (31/3/1)]***

(*a*) A is strongly basic and B is a weak base.

(*b*) A is strongly acidic and B is a weak acid.

(*c*) A has pH greater than 7 and B has pH less than 7.

(*d*) A has pH less than 7 and B has pH greater than 7.

31. A metal carbonate reacts with a solution X which forms a salt, water, and a gas Y. What are X and Y? ***[CBSE Question Bank]***

(*a*) X: sodium hydroxide; Y: carbon dioxide (*b*) X: sodium hydroxide; Y: hydrogen

(*c*) X: hydrochloric acid; Y: carbon dioxide (*d*) X: hydrochloric acid; Y: hydrogen

32. Anand took four colourless solutions P, Q, R and S, and performed the following tests. What is the definite conclusion that Anand can reach? ***[CBSE Question Bank]***

	Solution P	Solution Q	Solution R	Solution S
With methyl orange	No change in colour	Turns red	No change in colour	No change in colour
With phenolphthalein	No change in colour	No change in colour	No change in colour	Turns pink
With red litmus	No change in colour	No change in colour	No change in colour	Turns litmus blue
With blue litmus	No change in colour	Turns litmus red	No change in colour	No change in colour

(*a*) Both P and S are salt solutions. (*b*) Both Q and S are basic solutions.

(*c*) Both Q and R are salt solutions. (*d*) Both P and R are neutral solutions.

Answers

1. (*d*)	**2.** (*c*)	**3.** (*a*)	**4.** (*c*)	**5.** (*a*)	**6.** (*b*)	**7.** (*a*)
8. (*d*)	**9.** (*c*)	**10.** (*b*)	**11.** (*c*)	**12.** (*d*)	**13.** (*c*)	**14.** (*c*)
15. (*c*)	**16.** (*a*)	**17.** (*c*)	**18.** (*b*)	**19.** (*a*)	**20.** (*b*)	**21.** (*b*)
22. (*b*)	**23.** (*b*)	**24.** (*b*)	**25.** (*a*)	**26.** (*a*)	**27.** (*c*)	**28.** (*c*)
29. (*b*)	**30.** (*c*)	**31.** (*c*)	**32.** (*d*)			

Explanations of selected Multiple Choice Questions

4. (*c*) Addition of a base to an acid increases the pH and addition of an acid to a base reduces the pH.

11. (*c*) The salt having pH 5.5 is acidic. So, to prepare an acidic salt, a strong acid (HCl) and a weak base (NH_4OH) is required.

12. (*d*) Greenish-blue colour on the pH paper indicates basic solution. So, an antacid (base) is added.

21. (*b*) $\underset{X}{Zn} + H_2SO_4 \longrightarrow ZnSO_4 + \underset{Y}{H_2}$

25. (*a*) Na_2CO_3 is a salt of weak acid (H_2CO_3) and strong base (NaOH).

29. (*b*) Initially the pH of NaOH (strong base) is 14. When acid is added dropwise, the pH will keep decreasing till base gets neutralised by acid. At neutralisation point, the pH is 7.

30. (*c*) Phenolphthalein gives pink colour in basic medium so pH of A is greater than 7. It is colourless in acidic medium so pH of B is less than 7.

32. (*d*) Since there is no change in the colour of solution P and R with any of the indicators so they are neutral solutions.

Assertion-Reason Questions

The following questions consist of two statements — Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

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

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

(c) A is true but R is false.

(d) A is false but R is true.

1. **Assertion (*A*) :** The acid must always be added to water with constant stirring.
   Reason (*R*) : Mixing of an acid with water decreases the concentration of H^+ ions per unit volume.
2. **Assertion (*A*) :** Copper sulphate crystals are wet because it contains water of crystallisation.
   Reason (*R*) : Water of crystallisation is the fixed number of molecules of water present in one formula unit of salt.
3. **Assertion (*A*) :** The aqueous solutions of glucose and alcohol do not show acidic character.
   Reason (*R*) : Aqueous solutions of glucose and alcohol do not give H^+ ions.
4. **Assertion (*A*) :** HCl gas does not change the colour of dry blue litmus paper.
   Reason (*R*) : HCl gas dissolves in the water present in wet litmus paper to form H^+ ions.
5. **Assertion (*A*) :** Weak acids have low electrical conductivity.
   Reason (*R*) : Strong acids and weak acids have equal concentration of hydrogen ions in their solutions.
6. **Assertion (*A*) :** Pure water is neither acidic nor basic. **[*HOTS*]**
   Reason (*R*) : The pH of a solution is inversely proportional to the concentration of hydrogen ions in it.
7. **Assertion (*A*) :** During electrolysis of concentrated aqueous solution of sodium chloride, hydrogen is produced at anode and chlorine gas is produced at cathode.
   Reason (*R*) : Ions get attracted to oppositely charged electrodes.

Answers

1. (*b*) **2.** (*d*) **3.** (*a*) **4.** (*a*) **5.** (*c*) **6.** (*b*) **7.** (*d*)

Explanations of selected Assertion-Reason Questions

1. (*b*) The acid must always be added to water with constant stirring because if water is added to acid, the heat produced is so large that the solution may splash out and the beaker may break due to excessive heating.

2. (*d*) Copper sulphate crystals are dry.

5. (*c*) Strong acids have more concentration of H^+ ions than weak acids.

6. (*b*) Pure water is neither acidic nor basic because it contains equal number of H^+ and OH^- ions.

7. (*d*) During electrolysis of concentrated aqueous solution of sodium chloride, hydrogen is produced at cathode and chlorine gas is produced at anode.

Passage-based/Case-based/Source-based Questions

Read the following passages and answer the questions that follow.

PASSAGE-1

The pH values of many common liquids are given in the table below. ***[CBSE Question Bank]***

Substance	pH
Battery acid	< 1.0
Lemon juice	2.4
Apple juice	3.5
Black tea	5.5
Milk	6.5
Human saliva	7.5
Soap	9.0–10.0
Ammonia	11.5

Substance	pH
Stomach acid	2.0
Cola	2.5
Black coffee	5.0
Acid rain	5.6
Distilled water	7.0
Sea water	8.0
Milk of magnesia	10.5
Bleach	12.5

Study the table and answer the questions that follow:

(*i*) Which of these is a neutralisation reaction? **1**

(*a*) Mixing sea water and bleach (*b*) Mixing lemon juice and soap

(*c*) Mixing milk and black tea (*d*) Mixing cola and distilled water

(*ii*) Which of these is a valid conclusion that can be drawn from the table? **1**

(*a*) Many common food items are quite acidic in nature.

(*b*) Our stomach contains a liquid which is a weak acid.

(*c*) Sea water is neither acidic nor basic - it is neutral.

(*d*) Acid rain, in spite of its name, is basic in nature.

(*iii*) Amit has black coffee with milk.

Which of the following is most likely to be true about the pH of the mixture? **1**

(*a*) It will be less than that of black coffee.

(*b*) It will be more than that of distilled water.

(*c*) It will be more than that of acid rain.

(*d*) It will be less than that of apple juice.

(*iv*) Which of the following would be the best for a person suffering from acidity? **1**

(*a*) Cola (*b*) Milk

(*c*) Black tea (*d*) Milk of magnesia

Ans. (*i*) (*b*); lemon juice is acidic and soap is basic so, neutralisation reaction occurs.

(*ii*) (*a*); many food items have pH less than 7.

(*iii*) (*c*)

(*iv*) (*d*); milk of magnesia is basic so it would be best to treat acidity.

PASSAGE-2

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* 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.

[Competency Based Question] ***[CBSE Question Bank]***

(i) Predict the pH value of the water of river Yamuna if the reason for froth is high content of detergents dissolved in it. **1**

(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? **1**

(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? **1**

(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: **1**

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

(b) decreased level of dissolved oxygen and no effect on 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

Ans. (i) (a); Detergents being basic increase the pH of water above 7.

(ii) (b); Detergents are basic in nature. So, it has high concentration of hydroxide ion (OH^-) and low concentration of hydronium ion (H_3O^+)

(iii) (c); Higher the pH, lower is the hydronium ion concentration.

(iv) (a); Phosphate ion increases the growth of algae which ultimately decrease the level of dissolved oxygen.

PASSAGE-3

The pH of a solution is a measure of its hydrogen ion (H^+) concentration. It is measured generally using pH scale. The values on pH scale ranges from 0 to 14.

A pH of 1 is very acidic and corresponds to a high concentration of H^+ ions. A pH of 14 is very basic and corresponds to a low concentration of H^+ ions. The pH of a neutral solution is 7. The table given below shows the pH and H^+ ion concentration of some common aqueous solutions. The leftmost column shows the number of moles of H^+ ions in 1 mole of liquid.

The pH and Hydrogen ion (H^+) Concentration of Some Solutions

H^+ Concentration (moles)	pH	Solution
10^{-1}	1	
10^{-2}	2	Gastric (stomach) juice, cola, lemon juice
10^{-3}	3	Vinegar
10^{-4}	4	Tomato juice
10^{-5}	5	Black coffee, rain water
10^{-6}	6	Urine
10^{-7}	7	Pure water
10^{-8}	8	Sea water
10^{-9}	9	Baking soda
10^{-10}	10	
10^{-11}	11	Milk of magnesia
10^{-12}	12	Household bleach
10^{-13}	13	Oven cleaner
10^{-14}	14	

(*i*) How is the hydrogen ion concentration and pH related to each other? 1

(*ii*) On the basis of above table, arrange the following in the decreasing order of H^+ concentration. 1

Pure water, tomato juice, milk of magnesia, sea water

(*iii*) A solution of pH 2 is filled in two separate beakers. A few drops of methyl orange and phenolphthalein are added into separate solutions. How will the colour of the indicators change? 2

Ans. (*i*) pH is inversely proportional to the hydrogen ion concentration.

(*ii*) The decreasing order of H^+ concentration is

Tomato juice > Pure water > Sea water > Milk of magnesia

(*iii*) The solution of pH 2 is acidic in nature. So, the colour change is

Methyl orange: red; phenolphthalein: colourless

Very Short Answer Questions

Each of the following questions are of 1 mark and have to be answered in one word or one sentence.

Q. 1. Which acid is injected by the stinging hair of nettle leaf?

Ans. Methanoic acid.

Q. 2. Show that non-metallic oxides are acidic in nature with the help of a chemical equation.

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

Calcium hydroxide is a base. So, to form salt and water it must react with an acid. It means CO_2 is acidic in nature.

Q. 3. Two solutions A and B have pH values of 5 and 8 respectively. Which solution will be basic in nature?

Ans. Solution B

Q. 4. Why is acetic acid called a weak acid though there are four hydrogen atoms in the molecule? [*HOTS*]

Ans. Though acetic acid has four hydrogen atoms, only one of the four hydrogen atoms is released as H^+ ion in solution. So, it is a weak acid.

Q. 5. If someone is suffering from the problem of acidity after overeating; which of the following would you suggest as a remedy?

Lemon juice, Baking soda solution or Vinegar.

Ans. Baking soda solution because it is basic in nature and hence neutralises the excess acid present in the stomach.

Q. 6. Arrange the following in the increasing order of acidic strength.

Gastric juice, milk, lemon juice.

Ans. Milk < Lemon juice < Gastric juice.

Q. 7. Why does tooth decay start when the pH of mouth is lower than 5.5?

Ans. Tooth starts decaying when the pH of our mouth is lower than 5.5. This is because below this pH value, the medium of the mouth becomes more acidic due to which tooth enamel corrodes at a faster rate.

Q. 8. Two solutions X and Y have pH values of 3.0 and 9.5 respectively. Which of these will turn litmus solution from blue to red and which will turn phenolphthalein from colourless to pink?

Ans. X will turn blue litmus to red because it is acidic in nature having pH value less than 7. Y will turn phenolphthalein from colourless to pink because it is basic in nature having pH value greater than 7.

Q. 9. Why aqueous ammonia solution considered a base although ammonia does not contain hydroxyl (OH^-) ion?

Ans. Ammonia dissolves in water as follows:

$$NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$$

The hydroxyl ions produced in the solution are responsible for basic character of ammonia.

Q. 10. A knife, which is used to cut a fruit, was immediately dipped into water containing drops of blue litmus solution. The colour of the solution changes to red, what is the nature of the fruit?

Ans. The fruit is acidic as it turns blue litmus solution to red.

Q. 11. Explain why an aqueous solution of ammonium chloride is acidic in nature.

Ans. Ammonium chloride (NH_4Cl) is the salt of a strong acid, hydrochloric acid (HCl), and a weak base ammonium hydroxide (NH_4OH), so an aqueous solution of ammonium chloride is acidic in nature.

Q. 12. Write the chemical name and chemical formula of the salt used to remove permanent hardness of water. ***[CBSE Sample Paper 2021]***

Ans. **Chemical name:** Sodium Carbonate decahydrate

Chemical formula: $Na_2CO_3.10H_2O$

Q. 13. Which one of these has a higher concentration of H^+ ions?

1M HCl or 1M CH_3COOH

Ans. 1 M HCl has a higher concentration of H^+ ions because it is a stronger acid than CH_3COOH.

Q. 14. In addition to sodium hydrogencarbonate, baking powder contains a substance 'X'. Name the substance 'X'.

Ans. Tartaric acid.

Q. 15. What is the commercial name of calcium sulphate hemihydrate?

Ans. Plaster of Paris.

Q. 16. Name the substance obtained by the action of chlorine on dry slaked lime.

Ans. Bleaching powder.

Q. 17. How many molecules of water of crystallisation are there in

(*i*) Plaster of Paris **(*ii*) washing soda crystals?**

Ans. (*i*) $\frac{1}{2}$ (*ii*) 10.

Q. 18. An aqueous solution turns red litmus solution blue. Excess addition of which solution would reverse the change—ammonium hydroxide solution or hydrochloric acid?

Ans. Hydrochloric acid because adding excess acid to the base would turn blue litmus solution red.

Q. 19. (*i*) What do you think will be the pH in the stomach of a person suffering from indigestion?
(*ii*) What do you think will be the pH of an antacid solution?

Ans. (*i*) Less than 7 (*ii*) More than 7

Q. 20. Why is the electrolysis of a concentrated solution of sodium chloride known as chlor-alkali process?

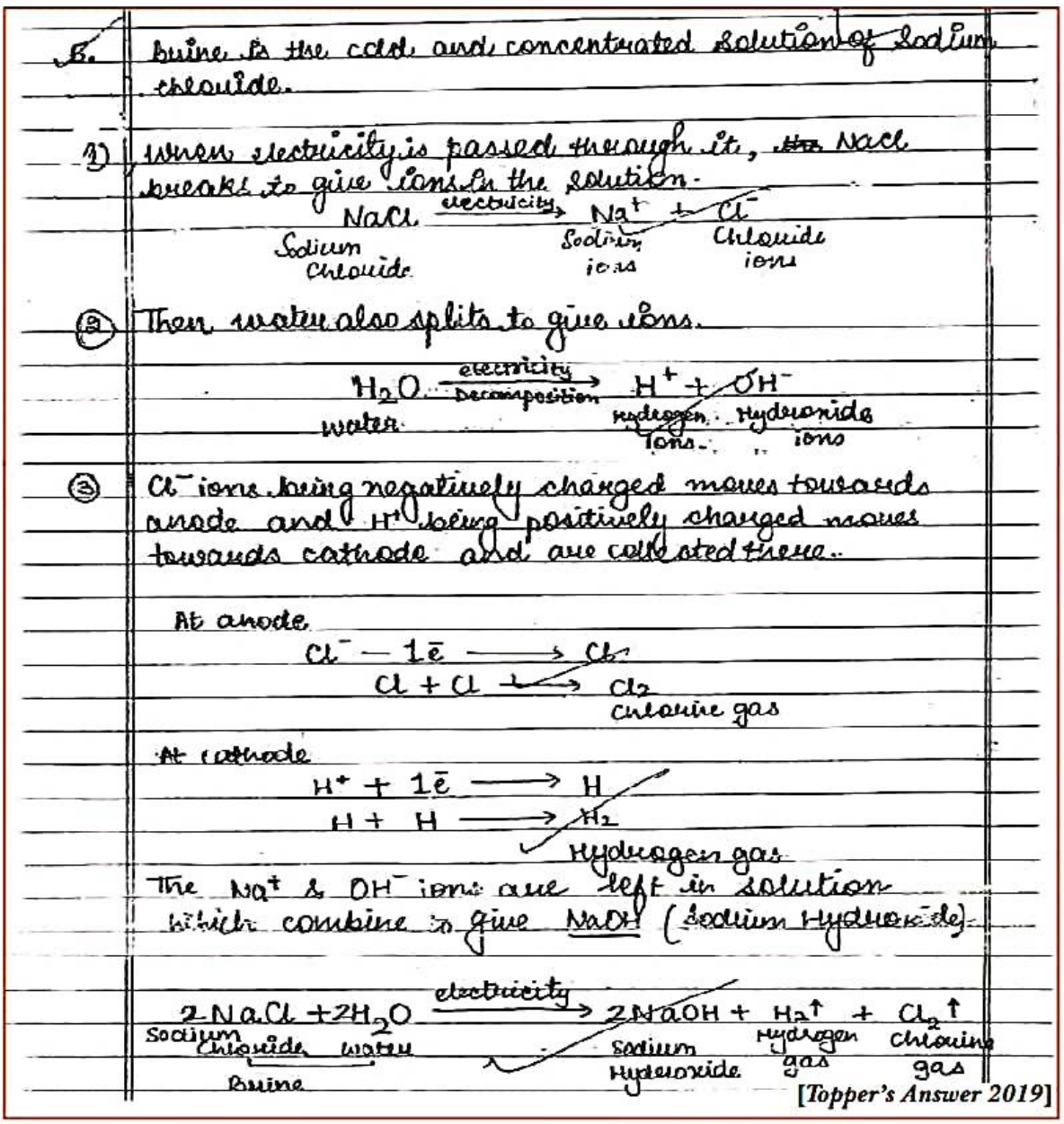
Ans. It is because of the products formed: chlor for chlorine and alkali for sodium hydroxide.

Short Answer Questions–I

Each of the following questions are of 2 marks and have to be answered in about 30–50 words.

Q. 1. What is brine? What happens when an electric current is passed through it? Write chemical equation for it. ***[CBSE 2019 (31/5/2)]***

Ans.



B. 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,

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

$Cl + Cl \longrightarrow Cl_2$

Chlorine gas

At cathode

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

$H + H \longrightarrow H_2$

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

[Topper's Answer 2019]

Q. 3. Name the acid present in the following: **[CBSE Delhi 2015]**

(i) Tomato **(ii) Vinegar** **(iii) Tamarind**

Ans. (i) Citric acid (ii) Acetic acid (iii) Tartaric acid

Q. 4. 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. **[CBSE 2019 (31/5/1)]**

Ans.

10. 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 used~~

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

$$\underset{\text{Baking Soda in form of Baking powder.}}{2NaHCO_3} \xrightarrow{\Delta} \underset{\text{Sodium Carbonate}}{Na_2CO_3} + \underset{\text{Carbon dioxide}}{CO_2\uparrow} + \underset{\text{Water (vapours)}}{H_2O(g)}$$

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

[Topper's Answer 2019]

Q. 5. What will be the action of the following substances on litmus paper?

Dry HCl gas, Moistened NH_3 gas, Lemon juice, Carbonated soft drink, Curd, Soap solution.

[NCERT Exemplar]

Ans.

Substance	Action on Litmus Paper
Dry HCl gas	No change
Moistened NH_3 gas	Turns red to blue as it is basic.
Lemon juice	Turns blue to red because it contains citric acid.
Carbonated soft drink	Turns blue to red because it contains carbonic acid.
Curd	Turns blue to red because it contains lactic acid.
Soap solution	Turns red to blue as it is basic.

Q. 6. 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? **[NCERT Exemplar]**

Ans. In the absence of litmus paper, any indicator like methyl orange, phenolphthalein can be used. Natural indicator like turmeric can also be used.

Indicator	Colour in acidic solution	Colour in basic solution
Methyl Orange	Pinkish red	Yellow
Phenolphthalein	Colourless	Pink
Turmeric	Yellow	Reddish brown

Q. 7. When zinc metal is treated with a dilute solution of a strong acid, a gas is evolved, which is utilised in the hydrogenation of oil. Name the gas evolved. Write the chemical equation of the reaction and also write a test to detect the gas formed. ***[NCERT Exemplar]***

Ans. When zinc reacts with dilute solution of strong acid, it forms salt and hydrogen gas is evolved.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

When a burning splinter is brought near the mouth of the test tube, the gas burns with a pop sound.

Q. 8. 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. ***[CBSE 2018]***

Ans.

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

(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. $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$] ***[Topper's Answer 2018]***

Q. 9. To the three solutions listed below, a few drops of phenolphthalein and blue litmus were added separately. Specify the colour change in each case, if any:

Name of the solution	Colour change with phenolphthalein	Colour change with blue litmus
(*a*) Sodium carbonate		
(*b*) Hydrochloric acid		
(*c*) Sodium chloride		

Q. 14. With the help of a chemical equation, explain how a soda–acid fire extinguisher helps in putting out a fire.

Ans. Soda-acid fire extinguisher contains sodium bicarbonate and sulphuric acid, which are in separate containers. When knob of the fire extinguisher is pressed, then sulphuric acid mixes with sodium bicarbonate solution and produces a lot of CO_2 gas, which forms a blanket over the fire and cuts it off from the supply of the air to the burning substance and the fire stops.

$$\underset{\text{Sodium hydrogencarbonate}}{2NaHCO_3} + \underset{\text{Sulphuric acid}}{H_2SO_4} \longrightarrow \underset{\text{Sodium sulphate}}{Na_2SO_4} + \underset{\text{Water}}{2H_2O} + \underset{\text{Carbon dioxide}}{2CO_2}$$

Q. 15. (*i*) Write the formula and chemical name of bleaching powder.

(*ii*) Write the chemical equation to represent the action of atmospheric CO_2 gas on bleaching powder when left exposed in open.

(*iii*) State for what purpose is bleaching powder used in water treatment plants.

Ans. (*i*) Chemical formula: $CaOCl_2$

Chemical name: Calcium oxychloride

(*ii*) $$\underset{\text{Bleaching powder}}{CaOCl_2(s)} + \underset{\text{Carbon dioxide}}{CO_2(g)} \longrightarrow \underset{\text{Calcium carbonate}}{CaCO_3(s)} + \underset{\text{Chlorine}}{Cl_2(g)}$$

(*iii*) Bleaching powder is used in water treatment plants for disinfecting drinking water to make it free of germs.

Q. 16. How would you distinguish between baking powder and washing soda by heating?

[*NCERT Exemplar*]

Ans. The chemical formula of baking powder is sodium hydrogencarbonate ($NaHCO_3$); whereas, that of washing soda is sodium carbonate ($Na_2CO_3.10H_2O$).

Sodium hydrogencarbonate on heating gives CO_2 gas which will turn lime water milky whereas no such gas is obtained from sodium carbonate.

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

$$Na_2CO_3.10H_2O \xrightarrow{\text{Heat}} Na_2CO_3 + 10H_2O$$

Q. 17. A compound 'X' of sodium is used as an antacid and it decomposes on strong heating.

(*i*) Name the compound 'X' and give its chemical formula.

(*ii*) Write a balanced chemical equation to represent the decomposition of 'X'.

(*iii*) Give one use of compound 'X' besides an antacid. **[*CBSE Sample Paper 2020*]**

Ans. (*i*) Sodium bicarbonate or Sodium hydrogencarbonate or baking soda and its chemical formula is $NaHCO_3$. **½+½**

(*ii*) $$\underset{\text{Sodium hydrogen carbonate}}{2NaHCO_3(s)} \xrightarrow{\text{Heat}} \underset{\text{Sodium carbonate}}{Na_2CO_3(s)} + \underset{\text{Carbon dioxide}}{CO_2(g)} + \underset{\text{Water}}{H_2O(s)}$$ **1**

(*iii*) It is used in fire extinguisher and for baking. (*Any one*) **1**

[*CBSE Sample Paper Marking Scheme 2020*]

Q. 18. Salt A commonly used in bakery products on heating gets converted into another salt B which itself is used for removal of hardness of water and a gas C is evolved. The gas C when passed through lime water, turns it milky. Identify A, B and C. [*NCERT Exemplar, CBSE 2019 (31/4/2)*]

Ans. Baking powder ($NaHCO_3$), salt A is commonly used in bakery products. On heating, it forms sodium carbonate (Na_2CO_3), B and CO_2 gas, C is evolved. When CO_2 gas is passed through lime water it forms calcium carbonate ($CaCO_3$), which is slightly soluble in water making it milky.

A — $NaHCO_3$; B — Na_2CO_3; C — CO_2 gas

Ans. (*i*) (*a*) Hydrogen gas will evolve with greater speed.

(*b*) Almost same amount of gas is evolved.

(*c*) If sodium hydroxide is taken, hydrogen gas will be evolved.

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

(*ii*) All metal carbonates and hydrogencarbonates react with acids to form a corresponding salt, carbon dioxide and water.

Metal carbonate + Acid ⟶ Salt + Carbon dioxide + Water

Metal hydrogencarbonate + Acid ⟶ Salt + Carbon dioxide + Water

For example, sodium carbonate reacts with dilute hydrochloric acid as follows:

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

Sodium hydrogencarbonate reacts with dilute hydrochloric acid as follows:

$$NaHCO_3(s) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l) + CO_2(g)$$

Q. 3. A metal carbonate X on reacting with an acid gives a gas which when passed through a solution Y gives the carbonate back. On the other hand, a gas G that is obtained at anode during electrolysis of brine is passed on dry Y, it gives a compound Z, used for disinfecting drinking water. Identify X, Y, G and Z. ***[NCERT Exemplar]***

Ans. The gas evolved at anode during electrolysis of brine is chlorine (G).

When chlorine gas is passed through dry $Ca(OH)_2$ (Y) produces bleaching powder (Z) used for disinfecting drinking water.

$$\underset{\substack{\text{Slaked lime}\\(Y)}}{Ca(OH)_2} + Cl_2 \longrightarrow \underset{\substack{\text{Bleaching powder}\\(Z)}}{CaOCl_2} + H_2O$$

Since Y and Z are calcium salts, therefore X is also a calcium salt and is calcium carbonate.

$$\underset{\substack{\text{Calcium carbonate}\\(X)}}{CaCO_3} + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$$

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

Q. 4. Match the following pH values 1, 7, 10, 13 to the solutions given below:

- **Milk of magnesia**
- **Gastric juices**
- **Brine**
- **Aqueous Sodium hydroxide.**

Amit and Rita decided to bake a cake and added baking soda to the cake batter. Explain with a balanced reaction, the role of the baking soda. Mention any other use of baking soda.

[CBSE Sample Paper 2021]

Ans.

- Milk of magnesia — 10
- Gastric juices — 1
- Brine — 7
- Aqueous Sodium hydroxide — 13

Baking soda undergoes thermal decomposition to form Na_2CO_3, CO_2 and H_2O; CO_2 makes the cake fluffy & soft.

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

Uses

(*a*) Used in fire extinguishers.

(*b*) Act as antacid to neutralize excess acid in stomach.

(*c*) Used to neutralize the effect of acid in insect sting. (*Any two*)

Q. 5. 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 (31/4/1)*]**

Ans.
- Water of crystallization is the fixed number of water molecules present in one formula unit of a salt. **1**
- **Examples:** $CuSO_4 .5H_2O$ **½**

  $Na_2CO_3 . 10H_2O$ (*or Any other*) **½**
- Heat a few crystals of hydrated copper sulphate (blue colour) in a dry boiling tube. **½**

  Water droplets are seen in the boiling tube. **½**

  Colour : The colour of copper sulphate changes to white. **1**

  State : The blue crystal changes to white powder. **1**

[*CBSE Marking Scheme 2020 (31/4/1)*]

Q. 6. A sulphate salt of Group 2 element of the Periodic Table is a white, soft substance, which can be moulded into different shapes by making its dough. When this compound is left in open for some time, it becomes a solid mass and cannot be used for moulding purposes. Identify the sulphate salt and state why does it show such a behaviour. Give the reaction involved.

[*NCERT Exemplar*]

Ans. The substance which is used for making different shapes is Plaster of Paris. Its chemical name is calcium sulphate hemihydrate ($CaSO_4.\frac{1}{2}H_2O$). The two formula unit of $CaSO_4$ share one molecule of water. As a result, it is soft.

When it is left open for some time, it absorbs moisture from the atmosphere and forms gypsum, which is a hard solid mass.

$$\underset{\text{Plaster of Paris (Soft)}}{CaSO_4.\frac{1}{2}H_2O} + 1\frac{1}{2}H_2O \longrightarrow \underset{\text{Gypsum (Hard mass)}}{CaSO_4.2H_2O}$$

Q. 7. (*a*) Four samples A, B, C and D change the colour of pH paper or solution to Green, Reddish-pink, Blue and Orange. Their pH was recorded as 7, 2, 10.5 & 6 respectively. Which of the samples has the highest amount of Hydrogen ion concentration? Arrange the four samples in the decreasing order of their pH.

(*b*) Rahul found that the Plaster of Paris, which he stored in a container, has become very hard and lost its binding nature. What is the reason for this? Also, write a chemical equation to represent the reaction taking place.

(*c*) Give any one use of Plaster of Paris other than for plastering or smoothening of walls.

[*CBSE Sample Paper 2021*]

Ans. (*a*) (*i*) B as lower the pH value, higher is the hydrogen ion concentration.

(*ii*) C > A > D > B

(*b*) It reacted with the moisture in the atmosphere and converted into Gypsum, a hard solid mass.

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

(*c*) (*i*) Making toys. (*ii*) Dolls or statues.

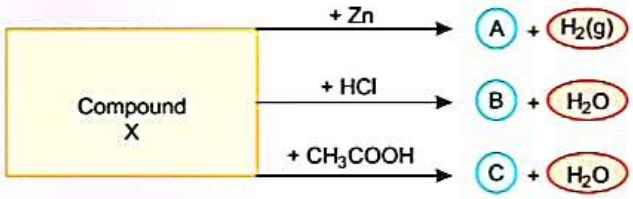
(*iii*) Making decorative materials. (*Any one*)

11. A student prepared solutions of (*i*) an acid and (*ii*) a base in two separate beakers but forgot to label the solutions and litmus paper is not available in the laboratory. Since both the solutions are colourless, how will he distinguish between the two using
(*a*) phenolphthalein and (*b*) methyl orange? **[*CBSE 2019 (31/5/3)*]**

SECTION–C

Answer the following questions in about 50-80 words each. **(4 × 3 = 12)**

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



[*NCERT Exemplar*]

13. You are provided with 90 mL of distilled water and 10 mL of concentrated sulphuric acid to prepare dilute sulphuric acid. **[*CBSE Sample Paper 2020*]**
(*i*) What is the correct way of preparing dilute sulphuric acid? Give reason.
(*ii*) How will the concentration of H_3O^+ ions change on dilution?
14. Identify the acid and base which form sodium hydrogen carbonate. Write chemical equation in support of your answer. State whether this compound is acidic, basic or neutral. Also write its pH value. **[*CBSE 2019 (31/1/2)*]**
15. State the effect of concentration of $H^+(aq)$ ions on the nature of the solution. Do basic solution also have $H^+(aq)$ ions? If yes, then why are these basic? **[*CBSE 2019 (31/3/1)*]**

SECTION–D

Answer the following questions in about 80–120 words each. **(3 × 5 = 15)**

16. A compound 'X' is bitter to taste. It is a compound of washing powder and reacts with dilute HCl to produce brisk effervescence due to a colourless and odourless gas 'Y' which turns lime water milky due to the formation of 'Z' when excess of CO_2 is passed, milkiness disappears due to formation of 'P'. Identify 'X', 'Y', 'Z' and 'P'. Write the equations involved in the formation of Y, Z and P.
17. For making cake, baking powder is taken. If at home your mother uses baking soda instead of baking powder in cake.
(*i*) How will it affect the taste of the cake and why?
(*ii*) How can baking soda be converted into baking powder?
(*iii*) What is the role of tartaric acid added to baking soda? **[*NCERT Exemplar*]**
18. What happens when:
(*i*) gypsum is heated at 373 K?
(*ii*) electricity is passed through an aqueous solution of sodium chloride?
(*iii*) dry chlorine gas is passed over slaked lime?
(*iv*) excess of CO_2 is passed through lime water?
(*v*) marble is treated with hydrochloric acid?

Answers

1. (*d*) 2. (*d*) 3. (*c*) 4. (*c*) 5. (*a*) 6. (*c*)
7. Phenolphthalein and methyl orange
8. pH is the negative logarithm of hydrogen ion concentration in moles/litre.
9. NH_4Cl