TEACHER'S HANDBOOK

STELLAR LEARNING

Chemistry

10

On Board! BOOKS

An imprint of Ratna Sagar P. Ltd.

Contents

1

Chemical Reactions and Equations

Checkpoint (Page 6)

1. Define elements. Give two examples.

Ans. Element is a basic form of matter or a pure substance that cannot be broken down into two or more simpler substances by any chemical reaction. For example, hydrogen and oxygen.

2. What are compounds?

Ans. Compounds are pure substances formed when two or more elements chemically combine with each other in a definite proportion.

3. Give two examples each of physical and chemical changes.

Ans. Conversion of ice into water and cutting of wood are physical changes.

Rusting of iron and digestion of food are chemical changes.

4. Differentiate between elements and compounds.

Ans.

Element	Compound
An element consists of the same kind of atoms.	A compound is made up of different kinds of atoms.
An element cannot be broken down into simpler substances.	A compound can be broken down into simpler substances by chemical reactions.

5. Write the formulae of following compounds: Calcium carbonate, sodium carbonate, iron (III) oxide and magnesium chloride.

Ans. Calcium carbonate: $CaCO_3$, sodium carbonate: Na_2CO_3, iron (III) oxide: Fe_2O_3 and magnesium chloride: $MgCl_2$

6. Write the symbols of following elements: Sodium, gold, calcium, potassium, copper, zinc and aluminium.

Ans. Sodium: Na

Gold: Au

Calcium: Ca

Potassium: K

Copper: Cu

Zinc: Zn

Aluminium: Al

7. Give two differences between metals and non-metals.

Ans. Metals are malleable and ductile as they can be hammered into thin sheets and drawn into wires. Metals are sonorous as they produce a ringing sound when beaten.

Non-metals are not malleable, lustrous and ductile. Non-metals generally have low melting and boiling points.

8. What is galvanisation?

Ans. The process of depositing a layer of zinc on iron to prevent it from rusting is called galvanisation.

9. Differentiate between physical and chemical changes.

Ans.

Physical changes	Chemical changes
Physical changes are reversible.	Chemical changes are irreversible.
In physical changes, no new substance is formed.	In chemical changes, one or more new substances are formed.

10. State the conditions necessary for rusting of iron.

Ans. For rusting of iron, the presence of air and moisture is essential.

Check Your Progress 1

(Page 12)

Multiple-Choice Questions

1. When you heat a magnesium ribbon on a burner, it burns with a blinding white light and some residue is left after burning. This residue appears to be like

(a) lamp black (b) charcoal ash

(c) powdered salt (d) sand **(CBSE 2010)**

Ans. (c) On heating a magnesium ribbon, a white powdered salt is formed by the reaction of magnesium and oxygen.

$$\underset{\text{Magnesium}}{2Mg} + \underset{\text{Oxygen}}{O_2} \rightarrow \underset{\text{Magnesium oxide}}{2MgO}$$

2. Which of the following are combination reactions?

(i) $Zn + FeSO_4 \rightarrow ZnSO_4 + Fe$

(ii) $4Al + 3O_2 \rightarrow 2Al_2O_3$

(iii) $MgO + H_2O \rightarrow Mg(OH)_2$

(iv) $2KClO_3 \xrightarrow{Heat} 2KCl + 3O_2$

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

(c) (i) and (ii) (d) (ii) and (iv)

Ans. (a)

3. When lead nitrate is heated, the colour of PbO and NO_2 observed is, ... respectively.

(a) yellow and colourless

(b) colourless and brown

(c) yellow and brown

(d) green and brown

Ans. (c) $\underset{\substack{\text{Lead}\\\text{nitrate}\\\text{(colourless)}}}{2Pb(NO_3)_2(s)} \xrightarrow{heat} \underset{\substack{\text{Lead(II)}\\\text{oxide}\\\text{(light yellow)}}}{2PbO(s)} + \underset{\substack{\text{Nitrogen}\\\text{dioxide}\\\text{(reddish-brown)}}}{4NO_2(g)} + O_2(g)$

4. Which of the following is a not a decomposition reaction?

(a) $2Al_2O_3(l) \xrightarrow{electricity} 4Al(l) + 3O_2(g)$

(b) $2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$

(c) $2KMnO_4(s) \rightarrow K_2MnO_4(s) + MnO_2(s) + O_2(g)$

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

Ans. (d) $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

5. Balancing of chemical equations is based on which of the following laws?

(a) Law of conservation of energy

(b) Law of conservation of mass

(c) Law of multiple proportions

(d) Law of constant proportions

Ans. (b)

6. Which of the following is a decomposition reaction?

(a) $MgCO_3 \rightarrow MgO + CO_2$

(b) $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$

(c) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

(d) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

Ans. (a) $MgCO_3 \rightarrow MgO + CO_2$

7. Select from the following a decomposition reaction in which the source of energy for decomposition is light. **(CBSE 2024)**

(a) $2FeSO_4 \rightarrow Fe_2O_3 + SO_2 + SO_3$

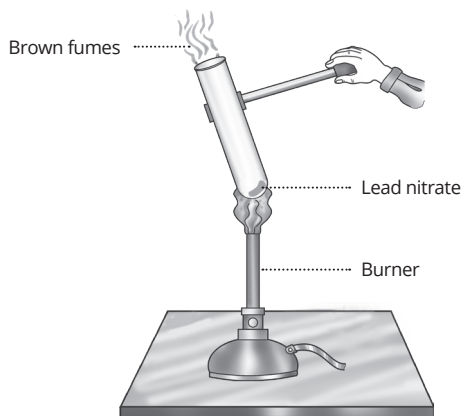
(b) $2H_2O \rightarrow 2H_2 + O_2$

(c) $2AgBr \rightarrow 2Ag + Br_2$

(d) $CaCO_3 \rightarrow CaO + CO_2$

Ans. (c) The decomposition reaction that uses light as its energy source is $2AgBr \rightarrow 2Ag + Br_2$. This reaction occurs when silver chloride is exposed to sunlight, breaking down into silver metal and chlorine gas.

8. The emission of brown fumes in the given experimental set-up is due to **(CBSE 2023)**



(a) thermal decomposition of lead nitrate which produces brown fumes of nitrogen dioxide.

(b) thermal decomposition of lead nitrate which produces brown fumes of lead oxide.

(c) oxidation of lead nitrate forming lead oxide and nitrogen dioxide.

(d) oxidation of lead nitrate forming lead oxide and oxygen.

Ans. (a) Explanation: In the given experiment, brown fumes are produced due to formation of nitrogen dioxide resulted from thermal breakdown of lead nitrate.

9. $MnO_2 + x HCl \rightarrow MnCl_2 + yH_2O + zCl_2$

In order to balance the above chemical equation, the values of *x*, *y* and *z* respectively are **(CBSE 2023)**

(a) 6, 2, 2 (b) 4, 1, 2

(c) 4, 2, 1 (d) 2, 2, 1

Ans. (c) 4, 2, 1

To balance the chemical equation:

$$MnO_2 + xHCl \rightarrow MnCl_2 + yH_2O + zCl_2$$

Step 1: Balance manganese (Mn). The left side has 1 Mn atom in MnO_2. Mn is already balanced.

Step 2: Balance chlorine (Cl). The $MnCl_2$ on the right contains 2 Cl atoms. Additionally, zCl_2 contributes Cl atoms. The total Cl atoms on the right is $2z$.

On the left, xHCl contributes x Cl atoms. Hence: $x = 2 + 2z$

Step 3: Balance oxygen (O). The left side has 2 oxygen atoms in MnO_2, and the right side has yH_2O, which contains y oxygen atoms.

Hence: $y = 2y = 2y = 2$

Step 4: Balance hydrogen (H). The left side has xHCl, which contains x H atoms. The right side has yH_2O, which contains $2y$ H atoms. Hence: $x = 2y$

Final Values: $x = 4, y = 2, z = 1$

The balanced equation is:

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

Very Short Answer Type Questions

10. Why do we need to balance a chemical equation?

Ans. In a balanced chemical equation, the number of atoms of each element in the reactants are equal to the number of atoms in the products.

11. What do you mean by aqueous solution?

Ans. An aqueous solution is a solution in which water is the solvent.

12. Why is souring of milk a chemical change?

Ans. Souring of milk involves the formation of new products with different properties. So, it is a chemical change.

13. Why do we store silver chloride in a dark coloured bottle?

Ans. Silver chloride is stored in a dark coloured bottle because it reacts with sunlight and decomposes to form silver metal and chlorine gas.

14. Why do we add a few drops of dilute sulphuric acid to water prior to electrolysis?

Ans. To increase the conductivity of water a few drops of sulphuric acid is added to it prior to electrolysis.

15. "Dil. HCl is added to Zn granules." How will you prove that chemical change has taken place here? Support your response with two arguments. **(CBSE SP 2024)**

Ans. When dilute hydrochloric acid (HCl) is added to zinc (Zn) granules, a chemical reaction occurs. The given chemical changes take place:

- New substances form: The reaction produces hydrogen gas (H_2) and zinc chloride ($ZnCl_2$), which are new substances.

The chemical equation for the reaction is:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

- Bubbles of hydrogen gas are observed in the form of effervescences, indicating a gas is being released.
- The the container become warm indicating the reaction is exothermic.

16. Name the type of chemical reaction in which calcium oxide reacts with water. Justify your answer by giving a balanced chemical equation for the chemical reaction. **(CBSE 2024)**

Ans. It is a combination reaction. The reaction in which two or more reactants (elements or compounds) combine together to form a single product is called a combination reaction. Calcium oxide (quicklime) reacts vigorously with water to form sparingly soluble calcium hydroxide (slaked lime) and a large amount of heat is released.

$$\underset{\text{Quicklime}}{CaO(s)} + \underset{\text{Water}}{H_2O(l)} \rightarrow \underset{\text{Slaked lime}}{Ca(OH)_2(aq)} + \text{Heat}$$

17. Translate the following statements into chemical equations and then balance them:

(a) Solution of barium chloride and aluminium sulphate in water react to give insoluble barium sulphate and the solution of aluminium chloride.

(b) Aluminium metal reacts with steam to give aluminium oxide and hydrogen gas. **(CBSE 2024)**

Ans. The balanced chemical equations for the given statements:

(i) Solution of barium chloride and aluminium sulphate in water react to give insoluble barium sulphate and the solution of aluminium chloride.

$$3BaCl_2 + Al_2(SO_4)_3 \rightarrow 3BaSO_4\downarrow + 2AlCl_3$$

(ii) Aluminium metal reacts with steam to give aluminium oxide and hydrogen gas.

$$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$$

Both equations are balanced to satisfy the law of conservation of mass.

18. In electrolysis of water, why is the volume of gas collected over one electrode almost double the gas collected over the other electrode? Name the gas collected on each electrode.

Ans. During electrolysis, hydrogen gas is produced at cathode and oxygen gas is produced at anode.

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

The volume of hydrogen gas produced (H_2) is double the volume of oxygen gas (O_2) as the molar ratio of hydrogen and oxygen is 2: 1 in water.

19. Translate the following into chemical equation and then balance:

(a) Aluminium hydroxide reacts with sulphuric acid to form aluminium sulphate and water.

(b) Ammonia reacts with copper oxide to give copper metal, water and nitrogen gas.

Ans. (a) $2Al(OH)_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$

(b) $2NH_3 + 3CuO \rightarrow N_2 + 3Cu + 3H_2O$

20. Why are decomposition reactions called the opposite of combination reactions? Explain with example.

Ans. In a combination reaction, two elements or compounds combine to form a new compound while in a decomposition reaction, a compound decomposes to form two or more elements or compounds. Hence, combination and decomposition reactions are opposite of each other. For example,

Combination reaction:

$$2Zn(s) + O_2(g) \rightarrow 2ZnO(s)$$

Decomposition reaction:

$$MgCO_3(s) \xrightarrow{1000\ ^\circ C} MgO(s) + CO_2(g)$$

Short Answer Type Questions

21. 2 g ferrous sulphate crystals were heated in a glass tube and observations were recorded.

(a) What type of odour is observed on heating ferrous sulphate crystal?

(b) Identify the liquid droplet collected on the cooler part of the test tube.

(c) Write a balanced chemical reaction for the observations recorded.

Ans. (a) The decomposition of ferrous sulphate produces gaseous products such as sulphur dioxide and sulphur trioxide which produce the characteristic odour of burning sulphur.

(b) Water droplets are collected on the cooler part of the test tube.

(c) $\underset{\text{Ferrous sulphate}}{2FeSO_4(s)} \xrightarrow{\text{heat}} \underset{\text{Ferric oxide}}{Fe_2O_3(s)} + SO_2(g) + SO_3(g)$

22. What happens when:

(a) Lead nitrate is heated in a boiling tube.

(b) Potassium iodide solution is added to lead nitrate solution.

(c) Water is added to quicklime.

Write balanced chemical reaction for each.

Ans. (a) On heating, lead nitrate decomposes to form lead oxide and fumes of nitrogen dioxide gas are evolved.

$$\underset{\substack{\text{Lead nitrate}\\\text{(colourless)}}}{2Pb(NO_3)_2(s)} \xrightarrow{\text{heat}} \underset{\substack{\text{Lead(II) oxide}\\\text{(light yellow)}}}{2PbO(s)} + \underset{\substack{\text{Nitrogen dioxide}\\\text{(reddish-brown)}}}{4NO_2(g)} + O_2(g)$$

(b) When lead nitrate reacts with potassium iodide a yellow precipitate of lead iodide is formed.

$$\underset{\text{Lead nitrate}}{Pb(NO_3)_2} + \underset{\text{Potassium iodide}}{2KI} \rightarrow \underset{\text{Lead iodide}}{PbI_2} + \underset{\text{Potassium nitrate}}{2KNO_3}$$

(c) Calcium oxide (quicklime) reacts vigorously with water to form sparingly soluble calcium hydroxide (slaked lime) and a large amount of heat is released.

$$\underset{\text{Quicklime}}{CaO(s)} + \underset{\text{Water}}{H_2O(l)} \rightarrow \underset{\text{Slaked lime}}{Ca(OH)_2(aq)} + \text{Heat}$$

23. (a) What do you understand by exothermic and endothermic reactions?

(b) Give one example of an exothermic reaction and one of an endothermic reaction.

(c) Write a balanced chemical equation along with state: Ethyne gas burns in oxygen to form carbon dioxide and water vapour along with evolution of heat.

Ans. (a) A chemical reaction which is accompanied by the evolution of heat is called exothermic reaction. A chemical reaction which is accompanied by the absorption of heat is called an endothermic reaction.

(b) Exothermic reaction:

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{Heat}$

Endothermic reaction:

$Ba(OH)_2 + 2NH_4Cl + \text{Heat} \rightarrow BaCl_2 + 2NH_4OH$

(c) $2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g) + \text{Heat}$

Long Answer Type Questions

24. (a) What is a chemical equation? Explain with the help of an example.

(b) Giving an example state the difference between balanced and unbalanced equation.

(c) State two characteristics of the chemical reaction which takes place when dilute sulphuric acid is poured over zinc granules.

(d) Translate the following statements into chemical equations and then balance the equations:

(i) Ammonium sulphate reacts with sodium hydroxide to form sodium sulphate, ammonia and water.

(ii) Ferric sulphate reacts with potassium hydroxide to form potassium sulphate and ferric hydroxide.

Ans. (a) The occurrence of a chemical reaction can be represented by a chemical equation. A chemical equation can be written in the form of a word equation as well as an equation involving the chemical formulae of reactants and products. For example,

$$\underset{\text{Magnesium}}{Mg} + \underset{\text{Oxygen}}{O_2} \rightarrow \underset{\text{Magnesium oxide}}{MgO}$$

(b) $$Mg + O_2 \rightarrow MgO$$

The given chemical equation is an unbalanced chemical equation, which means the number of atoms of each element on the left and right hand side of the arrow is not equal.

For balancing this chemical equation, the number of atoms of each element must be equal on both the sides of the equation, i.e.

$$2Mg + O_2 \rightarrow 2MgO$$

(c) When dilute sulphuric acid is poured over zinc granules, we can observe the following characteristics:

(i) There can be a rise in temperature as the reaction between zinc granules and sulphuric acid is exothermic in nature.

(ii) There will be an evolution of hydrogen gas.

(d) (i) $(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2NH_3 + 2H_2O$

(ii) $Fe_2(SO_4)_3 + 6KOH \rightarrow 2Fe(OH)_3 + 3K_2SO_4$

25. (a) What are the various ways by which chemical equations can be made more informative. Give examples to illustrate your answer.

(b) Balance the following equations:

(i) $AgNO_3 + K_3PO_4 \rightarrow Ag_3PO_4 + KNO_3$

(ii) $NH_3 + N_2O \rightarrow N_2 + H_2O$

(iii) $NH_3 + Cl_2 \rightarrow N_2H_4 + NH_4Cl$

Ans. (a) Chemical equations can be made more informative by expressing the following characteristics in an equation:

(i) Physical states of reactants and products: The physical states of the reactants and products are represented by the notations (*g*), (*l*), (*s*) and (*aq*) to denote gaseous, liquid, solid and aqueous state, respectively. For example,

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

(ii) Precipitation of a solid during a chemical reaction: The precipitation of a solid during a chemical reaction is indicated by placing a downward arrow (↓) or using the symbol (*s*). For example,

$$NaCl(aq) + AgNO_3(aq) \rightarrow AgCl(\downarrow) + NaNO_3(aq)$$

(iii) Evolution of a gas during a chemical reaction: The evolution of a gas during a chemical reaction is indicated by placing an upward arrow (↑) or using the symbol (*g*). For example,

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(\uparrow)$$

(iv) Reaction conditions: The specific conditions like temperature, pressure, presence of a catalyst, etc, are written above or below the arrow in a chemical equation. For example,

$$CO(g) + 2H_2(g) \xrightarrow{340\ atm} CH_3OH(l)$$

$$6CO_2(g) + 12H_2O(l) \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6(aq) + 6O_2(g) + 6H_2O(l)$$

(b) (i) $3AgNO_3 + K_3PO_4 \rightarrow Ag_3PO_4 + 3KNO_3$

(ii) $2NH_3 + 3N_2O \rightarrow 4N_2 + 3H_2O$

(iii) $4NH_3 + Cl_2 \rightarrow N_2H_4 + 2NH_4Cl$

Check Your Progress 2

(Page 18)

Multiple-Choice Questions

1. Which of the following elements will not displace copper from copper sulphate solution?

(a) Fe (b) Pb

(c) Ag (d) Al

Ans. (c) As silver(Ag) is less reactive than copper so it will not displace copper from copper sulphate solution.

2. In the given reaction, $CuO + H_2 \xrightarrow{Heat} Cu + H_2O$ the substance being reduced is

(a) CuO. (b) H_2.

(c) Cu. (d) H_2O.

Ans. (a) In the given reaction, copper oxide loses oxygen and gets reduced to copper metal and hydrogen (H_2) gains oxygen and gets oxidized.

3. Which of the following equations represent a double displacement reaction?

(a) $CaO + H_2O \rightarrow Ca(OH)_2$

(b) $CaCO_3 \xrightarrow{Heat} CaO + CO_2$

(c) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

(d) $Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$

Ans. (d)

4. Consider the following reaction:

$$Na_2SO_4 + BaCl_2 \rightarrow 2NaCl + BaSO_4$$

Which of the following statements about the given reaction is correct?

(a) Sodium is being oxidised and barium is being reduced.

(b) It is an example of combination reaction.

(c) Both of the products formed are soluble in water.

(d) The reaction is an example of double displacement reaction.

Ans. (d) The given reaction is an example of double displacement reaction in which a white precipitate of barium sulphate is formed.

5. A substance is said to be oxidised when
(a) it gains oxygen
(b) it loses hydrogen
(c) it gains an electronegative atom
(d) all of these

Ans. (d) A substance is said to be oxidised when it gains oxygen (an electronegative atom) or loses hydrogen.

6. $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$
The reaction given above is a redox reaction because in this case: **(CBSE 2024)**
(a) MnO_2 is oxidised and HCl is reduced.
(b) HCl is oxidised.
(c) MnO_2 is reduced.
(d) MnO_2 is reduced and HCl is oxidised.

Ans. (d) In this reaction, MnO_2 is reduced to $MnCl_2$, and HCl is oxidised to Cl_2. Since reduction and oxidation processes occurring together, it is a redox reaction.

Very Short Answer Type Questions

7. Define a redox reaction in terms of gain or loss of oxygen. **(CBSE 2023)**

Ans. A redox reaction is a chemical reaction in which both reduction and oxidation occur simultaneously.

In terms of oxygen

- oxidation is the process in which a substance gains oxygen.
- Reduction is the process in which a substance loses oxygen.

Consider the following reaction:

$$2Mg + O_2 \rightarrow 2MgO$$

Magnesium (Mg) gains oxygen to form magnesium oxide (MgO), so it is oxidised.

Oxygen (O_2) loses oxygen (to combine with Mg), so it is reduced.

There is simultaneous gain and loss of oxygen makes in a redox reaction.

8. In thermit welding, the following reaction occurs:

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

Identify the reducing agent and oxidising agent in the reaction.

Ans. In the given reaction, Fe_2O_3 is the oxidising agent and aluminium is the reducing agent because Al is removing oxygen from Fe_2O_3 and Fe_2O_3 is adding oxygen to Al.

9. Give an example of double displacement reaction. (Only reaction with complete balance equation).

Ans. Double displacement reaction:

$$\underset{\text{Barium chloride}}{BaCl_2(aq)} + \underset{\text{Sodium sulphate}}{Na_2SO_4(aq)} \rightarrow \underset{\text{Barium sulphate (white ppt)}}{BaSO_4(\downarrow)} + \underset{\text{Sodium chloride}}{2NaCl(aq)}$$

10. What happens when a copper rod is kept immersed in a solution of iron (II) sulphate?

Ans. Since iron is more reactive than copper, there will be no change as copper cannot displace iron from iron sulphate ($FeSO_4$) solution.

11. Can a displacement reaction be a redox reaction also?

Ans. Yes, a displacement reaction can also be a redox reaction.

12. What changes in the colour of iron nails and copper sulphate solution do you observe after keeping the iron nails dipped in copper sulphate solution for 30 minutes?

Ans. As iron is more reactive than copper, it will displace copper in copper sulphate and ferrous sulphate will be formed. The blue colour of the solution will become pale green and copper will be deposited on iron nail.

$$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$$

13. Giving one example, show that addition of hydrogen is reduction and removal of hydrogen is oxidation.

Ans. Addition of hydrogen is reduction. For example, when hydrogen gas is passed over heated copper oxide, it gets reduced to metallic copper.

$$CuO + H_2 \rightarrow Cu + H_2O$$

Removal of hydrogen is oxidation. For example, bromine water reacts with H_2S to form hydrogen bromide and sulphur. Thus, H_2S is oxidised to S.

$$H_2S + Br_2 \rightarrow 2HBr + S$$

14. Name two methods which are used for prevention of corrosion. What are the conditions necessary for corrosion?

Ans. The methods which can be used for prevention of corrosion include surface coating with oil, paint or grease and galvanisation. The conditions necessary for corrosion are

- Pressure of oxygen or air
- Pressure of moisture or water vapour

15. Solutions of lead nitrate and potassium iodide are mixed in a test tube.
(a) Write a balanced chemical equation for the reaction involved.
(b) Name the precipitate formed in the reaction.
(c) What is the colour of precipitate?

Ans. (a) $\underset{\text{Lead(II) nitrate}}{Pb(NO_3)_2\ (aq)} + \underset{\text{Potassium iodide}}{2KI(aq)} \rightarrow \underset{\text{Lead(II) iodide (yellow ppt)}}{PbI_2(s)} + \underset{\text{Potassium nitrate}}{2KNO_3(aq)}$

(b) Lead iodide

(c) Yellow

16. When a metal X is added to salt of metal Y, following reaction takes place:

Metal X + Salt solution of Y $\rightarrow$ Salt solution of X + Metal Y

Mention the inference you draw regarding the activity of metal X and Y and also about the type of reaction. **(CBSE 2011)**

Ans. Metal X is more reactive than metal Y as it is displacing metal Y from its salt solution. This is a displacement reaction.

Short Answer Type Questions

17. A, B, C are three elements which undergo chemical reactions according to the following equations:

$$A_2O_3 + 2B \rightarrow B_2O_3$$
$$CSO_4 + 2B \rightarrow B_2(SO_4)_3 + 3C$$
$$3CO + 2A \rightarrow A_2O_3 + 3C$$

Answer the following questions with reasons.

(a) Which is the most reactive element?

(b) Which is the least reactive element?

(c) What type of reactions are listed above?

(CBSE 2012)

Ans. $A_2O_3 + 2B \rightarrow B_2O_3$

$CSO_4 + 2B \rightarrow B_2(SO_4)_3 + 3C$

$3CO + 2A \rightarrow A_2O_3 + 3C$

(a) Most reactive element is B as it has displaced both A and C from their compounds.

(b) Element C is the least reactive element as it is displaced by both the elements A and B.

(c) All the given reactions are displacement reactions.

18. State the reason for the following:

(a) Potato chips manufacturer fill the packets of chips with nitrogen gas.

(b) Iron articles lose their shine gradually.

(c) Food should be kept in airtight container.

(CBSE 2015)

Ans. (a) The manufacturers of potato chips fill the packet of chips with nitrogen gas so that there is no oxygen to cause its oxidation and make it rancid.

(b) When iron articles comes in the contact of oxygen and moisture, they start rusting and gradually lose their shine.

(c) To prevent the oxidation of food, it should be kept in airtight container.

19. (a) Can we stir silver nitrate solution with copper spoon? Why or why not? Support your answer with reasons.

(b) Why a brown coating is formed on the iron rod when iron rod is dipped in copper sulphate solution for some time? What change will be observed in the colour of the solution?

(c) A green coating develops on copper vessel in rainy season. Why?

Ans. (a) Copper is more reactive than silver. When we stir silver nitrate solution with copper spoon, copper will displace silver from its solution. Reaction involved:

$$Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$$

(b) As iron is more reactive than copper, it can displace copper from copper sulphate solution and forms iron sulphate. Also, the blue colour of $CuSO_4$ solution changes to green due to the formation of $FeSO_4$.

(c) When copper vessels are exposed to air in rainy season the metal reacts with gases and moisture present in air to form a mixture of copper carbonate and copper hydroxide [$(CuCO_3).\ Cu(OH)_2$] due to corrosion. This develops a green coating on copper vessels.

Long Answer Type Questions

20. (a) Name the reducing agent, oxidising agent, substance oxidised and substance reduced in the following redox reactions:

(i) $2H_2S + SO_2 \rightarrow 3S + 2H_2O$

(ii) $Cr_2O_3 + 2Al \rightarrow 2Cr + Al_2O_3$

(iii) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

(iv) $H_2S + Br_2 \rightarrow 2HBr + S$

(b) What colour changes do you observe when:

(i) You add zinc to a solution of copper sulphate?

(ii) You add lead to a solution of cupric chloride?

Write the balanced chemical equations.

Ans. (a) (i) Reducing agent – H_2S, oxidising agent – SO_2, substance oxidised – H_2S, substance reduced – SO_2.

(ii) Reducing agent – Al, oxidising agent – Cr_2O_3, substance oxidised – Al, substance reduced – Cr_2O_3.

(iii) Reducing agent – PbS, oxidising agent – H_2O_2, substance oxidised – PbS, substance reduced – H_2O_2.

(iv) Reducing agent – H_2S, oxidising agent – Br, substance oxidised – H_2S, substance reduced – Br.

(b) (i) When zinc is added to copper sulphate solution the blue colour of the solution fades due to the formation of zinc sulphate.

$CuSO_4(aq) + Zn(s) \rightarrow Cu(s) + ZnSO_4(aq)$

(ii) On adding lead to cupric chloride solution the greenish-blue colour of the solution fades to colourless due to the formation of lead chloride.

$Pb(s) + CuCl_2(aq) \rightarrow PbCl_2(aq) + Cu(s)$

21. (a) Define rancidity. How does it occur?

(b) How will you prevent rancidity of oils and fats?

(c) What happens when an aqueous solution of sodium sulphate reacts with an aqueous solution of barium chloride? State the physical condition of the reactant in which reaction between them will not take place. Write the balanced chemical equation of the reaction and name the type of reaction. **(CBSE 2016)**

Ans. (a) The oxidation of oils and fats in the food leading to an unpleasant smell and taste is known as rancidity. It occurs due to the oxidation of fat in the presence of light and heat, wherein peroxide radicals are formed from oxidation. These radicals are highly reactive and split fats and oils into smaller organic compounds. The production of these compounds makes the food rancid.

(b) Rancidity can be prevented by adding antioxidants and by flushing the food packets with nitrogen gas.

(c) A white precipitate of barium sulphate is formed.

If the reactants are in solid state, the reaction will not take place.

The balanced chemical equation of the reaction is

$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow 2NaCl(aq) + BaSO_4(s)$

This is a double displacement reaction.

Higher Order Thinking Skills (HOTS) Questions

(Page 20)

1. No chemical reaction takes place when granules of a solid A are mixed with the powder of another solid B. However, when the mixture is heated, a reaction takes place between its compounds. One of the product C is a metal and settles down in the molten state while the other product D floats over it. It was observed that the reaction is highly exothermic.

(a) Based on the given information, make an assumption about A and B and write a chemical equation for the chemical reaction indicating the conditions of reaction, physical state of reactants and products and thermal status of reaction.

(b) Mention any two types of reactions under which above chemical reaction can be classified.

Ans. (a) Solid A is assumed to be MnO_2 and solid B to be Aluminium (Al).

When the mixture of MnO_2 and Al is heated, manganese (Mn) is produced in molten state and aluminium oxide (Al_2O_3) floats over it. Mn is produced in the molten state as a lot of heat energy is released in the process.

The balanced chemical equation involved is

$$3MnO_2(s) + 4Al(s) \xrightarrow{\text{heat}} 3Mn(l) + 2Al_2O_3(l) + \text{Heat}$$

The reaction is an exothermic reaction.

(b) The types of reaction under which the above reaction can be classified are:

(i) Redox reaction

(ii) Displacement reaction

2. Three test tubes A, B and C are taken with $CuSO_4$, $FeSO_4$ and $AgNO_3$ solutions, respectively. What will be the observations if:

(a) Fe metal is added to $CuSO_4$ solution in the test tube A?

(b) Cu turnings are added to $FeSO_4$ solution in the test tube B?

(c) Zn is added to $AgNO_3$ solution in the test tube C?

Give reasons to justify your answer.

Ans. (a) If Fe is added to $CuSO_4$ solution, the blue colour will change to pale green as Fe will replace Cu from the solution.

(b) No change will be observed as Cu is less reactive than iron and cannot replace iron form the solution.

(c) Zn will displace Ag because Zn is more reactive than Ag.

3. A shiny brown coin made up of an element turned black on heating. What was the element of the coin and what is the black compound formed?

Ans. When a shiny brown coin made of copper (Cu) is heated, it turns black and the compound formed is copper oxide (CuO).This happens because copper gets oxidised by oxygen (O_2) present in air.

$$\underset{\text{(Shiny brown)}}{2Cu(s)} + O_2(g) \xrightarrow{\text{heat}} \underset{\text{(Black)}}{2CuO(s)}$$

4. Metal A is found in the earth's crust and on exposure to moist air, it forms a reddish-brown flaky substance. When a container made up of metal A is used to store a blue coloured solution of B, the blue colour changes to pale green and

reddish-brown metal C is formed. Identify A, B, C and write a balanced equation for the reaction. Also name the type of reaction.

Ans. Metal A is iron. Blue coloured solution of B is copper sulphate. When B is stored in A, ferrous sulphate (green colour) and copper are formed. So, C is copper.

$$\underset{\text{Metal (A)}}{Fe} + \underset{\text{(B)}}{CuSO_4} \rightarrow FeSO_4 + \underset{\text{Metal (C)}}{Cu}$$

It is a displacement reaction.

5. Iron nails are taken in three test tubes – A having water, B having boiled water and a layer of oil and C having anhydrous $CaCl_2$. Nails in which test tube will undergo corrosion? Give reason.

Ans. Nails in test tube A will undergo corrosion because corrosion needs the presence of both air and moisture and both are present in test tube A. Test tube B has moisture but no air and test tube C has air but no moisture.

Self-Assessment

(Page 21)

Multiple-Choice Questions

1. The following reaction is an example of

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

(i) neutralisation reaction

(ii) redox reaction

(iii) combination reaction

(iv) displacement reaction

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

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

Ans. (b) $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

The given reaction is a redox reaction as well as a displacement reaction.

2. Which of the following is a displacement reaction?

(a) $H_2 + Br_2 \rightarrow 2HBr$

(b) $CaCO_3 \rightarrow CaO + CO_2$

(c) $2K + 2H_2O \rightarrow 2KOH + H_2$

(d) $MgO + H_2O \rightarrow Mg(OH)_2$

Ans. (c) $2K + 2H_2O \rightarrow 2KOH + H_2$

3. Which of the following metals will not displace hydrogen from dilute acids?

(a) Zn (b) Ca

(c) Na (d) Sn

Ans. (d) Sn, as only highly concentrated acids can react with tin.

4. Which of the following statement(s) is/are true? Exposure of silver chloride to sunlight for long duration turns it grey due to

(i) oxidation of silver chloride.

(ii) formation of chlorine gas from silver chloride.

(iii) sublimation of silver chloride.

(iv) formation of silver by decomposition of silver chloride.

(a) (i) only (b) (ii) and (iii)

(c) (ii) and (iv) (d) (iv) only

Ans. (d)

Assertion–Reason Type Questions

For question numbers 5 to 13, two statements are given – one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

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

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

(c) A is true but R is false.

(d) A is false but R is true.

5. Assertion: Burning of magnesium ribbon in the air is a chemical reaction.

Reason: Burning of magnesium in the air results in the formation of new substances.

Ans. (a) When a piece of magnesium ribbon is burnt in air, it combines with oxygen to form magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

Since a new substance with chemical properties entirely different from that of magnesium is formed in this process, it is an example of a chemical reaction.

6. Assertion: The number of atoms of all the elements on both the sides of a chemical equation should be the same.

Reason: Mass can neither be created nor destroyed in a chemical reaction.

Ans. (a) In a balanced chemical equation, the number of atoms of all the elements is same on both the reactant and product side. This is in accordance with the law of conservation of mass, according to which the total mass of the reactants is equal to the total mass of the products in a chemical reaction.

7. Assertion: Reaction of quicklime with water is an example of decomposition reaction.

Reason: Addition of water to quicklime results in the formation of only one product.

Ans. (d) In decomposition reactions, a single reactant decomposes to form two or more products. Quicklime reacts with water to form a single product which is called as slaked lime or calcium hydroxide. Thus, the reaction

of quicklime with water is an example of combination reaction.

8. **Assertion:** Respiration is an exothermic process.

   Reason: During digestion, food is broken down into simpler substances.

Ans. (b) During respiration, the food broken down into simpler substances (during digestion) combines with oxygen in the cells of our body to produce energy. Hence, respiration is an exothermic reaction.

9. **Assertion:** The bottle of silver chloride should always be stored in a dark place.

   Reason: Silver chloride decomposes in the presence of sunlight.

Ans. (a) When silver chloride is left open in the sunlight, it decomposes to form silver and chlorine gas.

$$2AgCl(s) \xrightarrow{\text{sunlight}} 2Ag(s) + Cl_2(g)$$

Hence, to prevent the photolysis of silver chloride, it should be stored in a dark place.

10. **Assertion:** When barium hydroxide and ammonium chloride are mixed together in a test tube, the bottom of the test tube becomes hot.

    Reason: The reaction of barium hydroxide and ammonium chloride is endothermic in nature.

Ans. (d) When barium hydroxide and ammonium chloride are mixed together in a test tube, the bottom of the test tube becomes cold. Thus, this reaction is endothermic in nature.

11. **Assertion:** When an iron nail is placed in copper sulphate solution, the colour of the solution changes to pale green after some time.

    Reason: Iron displaces copper from copper sulphate solution.

Ans. (a) Iron is more reactive than copper. Hence, when an iron nail is placed in copper sulphate solution, it will displace copper from copper sulphate to form iron sulphate and copper.

$$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$$

The blue colour of the copper sulphate solution fades due to the formation of pale green solution of iron sulphate.

12. **Assertion:** The colour of aqueous solution of copper sulphate turns colourless when a piece of lead is added to it.

    Reason: Lead is more reactive than copper, and hence displaces copper from its salt solution.

(CBSE 2023)

Ans. (a) As lead is more reactive than copper it can displace copper from the solution of copper sulphate.

13. **Assertion:** When copper oxide is heated in the presence of hydrogen, its colour changes from black to brown.

    Reason: A substance is said to be oxidised if it gains oxygen during a reaction.

Ans. (b) When copper oxide (black) is heated in the presence of hydrogen, it undergoes reduction to form copper which is brown in appearance.

$$CuO + H_2 \xrightarrow{\text{heat}} Cu + H_2O$$

14. **Assertion:** Bags of potato chips are flushed with nitrogen.

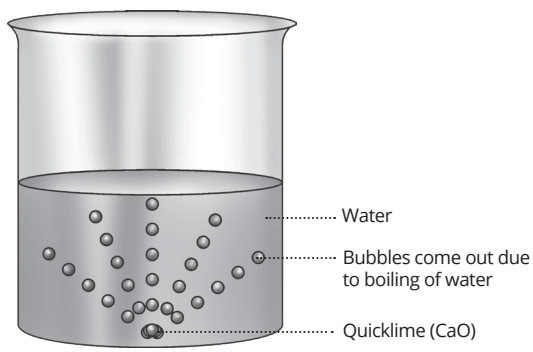
    Reason: Nitrogen is very reactive in nature.

Ans. (c) Oils and fats get oxidised after some time and develop an unpleasant taste and odour. This is known as rancidity. Hence, to prevent rancidity in potato chips, their bags are flushed with nitrogen.

Source-based/Case-based/Passage-based/ Integrated assessment questions

Answer the questions on the basis of your understanding of the following paragraphs and the related studied concepts.

15. Calcium oxide (CaO) is commonly known as quicklime. It is a very important industrial chemical, generally prepared by heating limestone ($CaCO_3$). The reaction of quicklime with water produces another chemical compound called slaked lime. The chemical name of slaked lime is calcium hydroxide. A solution of slaked lime in water is used for whitewashing.



I. (a) It is given that heating limestone gives calcium oxide. Write the balanced chemical equation for this reaction.

(b) How will you classify the chemical reaction of obtaining quicklime from limestone?

(c) (i) Addition of water to quicklime produces slaked lime. Write the chemical equation for this reaction.

OR

(ii) What is the relation between the two chemical reactions discussed in the paragraph.

Ans. (a) Heating limestone ($CaCO_3$) gives quicklime (CaO) and carbon dioxide.

$$CaCO_3(s) \xrightarrow{\text{heat}} CaO(s) + CO_2(g)$$

(b) When limestone is heated, it gives quicklime and carbon dioxide. In this reaction, two products are formed from a single reactant. Hence, it is a decomposition reaction.

(c) (i) The reaction of calcium oxide (quicklime) with water produces calcium hydroxide (slaked lime) and a large amount of heat is released. The chemical equation for the given reaction is as follows:

$$CaO + H_2O \rightarrow Ca(OH)_2$$

OR

(ii) In the paragraph, two reactions are discussed, heating of calcium carbonate to obtain calcium oxide and carbon dioxide (decomposition reaction) and the reaction of calcium oxide and water to produce calcium hydroxide (combination reaction). These two types of reactions are inverse of each other, since in combination reactions, multiple reactants give a single product, while in decomposition reactions, a single reactant gives multiple products.

II. (a) The reaction for obtaining quicklime from limestone is a

(i) combination reaction
(ii) displacement reaction
(iii) decomposition reaction
(iv) double displacement reaction

Ans. (iii) decomposition reaction

(b) Which of the following balanced chemical equations represents the reaction of obtaining slaked lime from quicklime?

(i) $CaO(s) + H_2O(l) \longrightarrow 2Ca(OH)_2(aq)$
(ii) $2CaO(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq)$
(iii) $CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq)$
(iv) $2CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2O(l)$

Ans. (iii) $CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq)$

(c) Which of the following is a correct statement?

(i) The reaction between calcium oxide and water is an endothermic reaction.
(ii) In combination reactions, a more reactive element displaces a less reactive element from its compound.
(iii) The reaction between calcium oxide and water is an exothermic reaction.
(iv) In decomposition reactions, a single reactant decomposes to form only two products.

Ans. (iii) The reaction between calcium oxide and water is an exothermic reaction.

Ans. (d) When calcium carbonate is heated, the gas formed is allowed to pass through freshly prepared lime water. What change will be observed in the lime water?

(i) Lime water will turn milky.
(ii) Lime water will turn black.
(iii) A brown ring will be formed in the lime water.
(iv) No change will be observed.

Ans. (i) The lime water will turn milky.

(e) The combination reaction between lime water and carbon dioxide leads to the formation of

(i) carbon monoxide gas
(ii) white precipitate of calcium carbonate
(iii) calcium oxide
(iv) oxygen gas

Ans. (ii) white precipitate of calcium carbonate

16. Butylated hydroxylanisole (BHA) is an organic compound used as an antioxidant. It is added to packaged food items to prevent them from rancidity. Apart from its use as a food additive, it is also used in food packaging, cosmetics and in medicines. Another organic compound used as an antioxidant in packaged food items is butylated hydroxytoluene (BHT).

I. (a) What type of food is susceptible to rancidity?

(b) What happens when food becomes rancid?

(c) (i) What are antioxidants?

OR

(ii) Suggest any two ways that can slow down the development of rancidity in food.

Ans. (a) Food containing fats and oils is susceptible to rancidity.

(b) Fats and oils are said to become rancid when they undergo oxidation. Due to rancidity, they develop an unpleasant odour and their taste also changes.

(c) (i) Antioxidants are the substances that prevent or slow down the process of oxidation.

OR

(ii) Two ways that can slow down the development of rancidity in food are as follows:

(i) By storing the food in refrigerators.
(ii) By storing the food in airtight containers.

II. (a) Food materials prepared in fats and oils become rancid due to the process of

(i) reduction

(ii) oxidation

(iii) both reduction and oxidation

(iv) corrosion

Ans. (ii) oxidation

(b) Which of the following is not a correct statement?

(i) An example of oxidation reactions in our daily life is deterioration of oils and fats.

(ii) Oxidation of oil present in food is called rancidity.

(iii) Reduction of oil present in food is called rancidity.

(iv) Light and heat start the oxidation process in fats and oils by the formation of free radicals.

Ans. (iii) Reduction of oil present in food is called rancidity.

(c) Which of the following statements is incorrect regarding antioxidants?

(i) Antioxidants are the substances that prevent or slow down the process of oxidation.

(ii) Antioxidants are the substances that control the deterioration of food quality.

(iii) Antioxidants are the substances that prevent or slow down the process of reduction.

(iv) Chilli powder acts as a natural antioxidant and prevents the oxidation process of foods.

Ans. (iii) Antioxidants are the substances that prevent or slow down the process of reduction.

(d) Bags of potato chips are filled with nitrogen gas to

(i) prevent the chips from getting oxidised

(ii) prevent the chips from absorbing moisture

(iii) enhance the flavour of chips

(iv) increase the moisture-absorbing capability of chips

Ans. (i) prevent the chips from getting oxidised

(e) Rancidity can be prevented or slowed down by

(i) adding antioxidants

(ii) storing food away from light

(iii) keeping food in refrigerator

(iv) all of the above

Ans. (iv) all of the above

17. Ferrous sulphate is a hydrated salt of iron and has the chemical formula $FeSO_4 \cdot 7H_2O$. It is blue-green in appearance and is commonly known as green vitriol. Apart from its uses in medicine, it is used as a colouring agent, for treating highly alkaline soils, and as a starting material for the synthesis of other iron compounds. It shows different characteristics when heated. On heating, it first loses its molecules of water of crystallisation and forms an anhydrous salt. On further heating, the anhydrous salt decomposes and a pungent odour is observed.

I. (a) Write the chemical reactions involved in the decomposition of ferrous sulphate on heating.

(b) It is given that ferrous sulphate decomposes on heating. What is this type of decomposition known as?

(c) (i) Give one more example of a salt which decomposes on heating. Also write the chemical equation of the reaction which takes place.

OR

(ii) What are the other types of decomposition reactions?

Ans. (a) When ferrous sulphate is heated, it loses its water of crystallisation to form anhydrous ferrous sulphate, which is white in colour.

$$FeSO_4 \cdot 7H_2O \xrightarrow{\text{heat}} FeSO_4 + 7H_2O$$

On further heating, it decomposes to give ferric oxide(reddish-brown), sulphur dioxide and sulphur trioxide.

$$2FeSO_4 \xrightarrow{\text{heat}} Fe_2O_3 + SO_2 + SO_3$$

(b) Decomposition reactions which are carried out by heating are known as thermal decomposition reactions.

(c) (i) Lead nitrate decomposes on heating. The chemical equation for the reaction is as follows:

$$2Pb(NO_3)_2 \xrightarrow{\text{heat}} 2PbO + 4NO_2 + O_2$$

OR

(ii) Decomposition reactions can also be carried out by light and electricity. Decomposition of a chemical substance in the presence of light is termed as photolysis. Decomposition of a chemical substance by the passage of electricity is termed as electrolysis.

II. (a) In decomposition reactions, for breaking down the reactants energy is required in the form of

(i) heat

(ii) light

(iii) electricity

(iv) all of these

Ans. (iv) all of these

(b) Which of the following balanced chemical equations represents the reaction involved in the decomposition of ferrous sulphate?

(i) $FeSO_4(s) \xrightarrow{heat} Fe_2O_3(s) + SO_3(g)$

(ii) $FeSO_4(s) \xrightarrow{heat} Fe_2O_3(s) + SO_2(g)$

(iii) $2FeSO_4(s) \xrightarrow{heat} Fe_2O_3(s) + SO_3(g)$

(iv) $2FeSO_4(s) \xrightarrow{heat} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

Ans. (iv) $2FeSO_4(s) \xrightarrow{heat} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

(c) When ferrous sulphate is heated strongly, it undergoes decomposition to form ferric oxide as a main product accompanied by a change in colour from

(i) blue to green.

(ii) green to blue.

(iii) green to reddish-brown.

(iv) green to yellow.

Ans. (iii) green to reddish-brown.

(d) Which of the following reactions is an example of electrolytic decomposition reaction?

(i) $2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$

(ii) $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

(iii) $2AgCl(s) \longrightarrow 2Ag(s) + Cl_2(g)$

(iv) $2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$

Ans. (iv) $2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$

(e) A reaction in which a compound is decomposed by absorbing heat is called

(i) thermal decomposition reaction

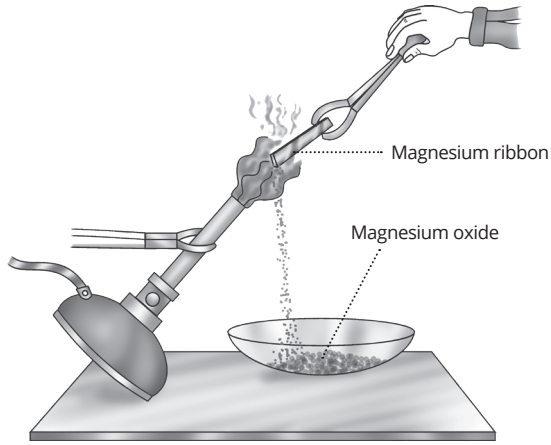
(ii) photochemical decomposition reaction

(iii) electrolytic decomposition reaction

(iv) double decomposition reaction

Ans. (i) thermal decomposition reaction

18. Magnesium is a very reactive metal. It burns in air with a dazzling flame to form a white powder, magnesium oxide. Also, it reacts with dilute sulphuric acid to form magnesium sulphate and hydrogen gas. Hydrogen is a combustible gas which burns with a popping sound. However, it itself does not support combustion. It is produced when active metals react with dilute acids. For example, the reaction of zinc with dilute hydrochloric acid produces zinc chloride and hydrogen.



I. (a) Is the burning of magnesium in air a combination reaction or a decomposition reaction?

(b) Give an example of a decomposition reaction.

(c) (i) How will you classify the reaction of zinc with dilute hydrochloric acid?

OR

(ii) Write the balanced chemical equations for the displacement reactions discussed in the given paragraph.

Ans. (a) When magnesium is burnt in air, it gives a single product, magnesium oxide. So, it is a combination reaction.

(b) $CaCO_3(s) \xrightarrow{heat} CaO(s) + CO_2(g)$

(c) (i) Zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen. Since zinc is displacing hydrogen from dilute HCl, it is an example of displacement reaction.

OR

(ii) In the given paragraph, the following displacement reactions have been discussed:

(i) $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

(ii) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

II. (a) Burning of magnesium in air is a

(i) decomposition reaction

(ii) precipitation reaction

(iii) double displacement reaction

(iv) combination reaction

Ans. (iv) combination reaction

(b) Which of the following is a correct statement?

(i) In a combination reaction, the chemical bonds between the atom of the reactants do not break.

(ii) In a combination reaction, new chemical bonds are formed.

(iii) In a combination reaction, two elements combine to form two or more compounds.

(iv) In a combination reaction, a compound breaks down to give two or more simpler substances.

Ans. (iii) In a combination reaction, two elements combine to form two or more compounds.

(c) Magnesium burns in nitrogen to give

(i) magnesium nitrate

(ii) magnesium nitrate and magnesium oxide

(iii) magnesium nitride

(iv) magnesium nitrate and magnesium nitride

Ans. (iii) magnesium nitride

(d) For the reaction between zinc and dilute sulphuric acid, the balanced chemical equation is

(i) $Zn(aq) + 2H_2SO_4(aq) \longrightarrow ZnSO_4(s) + H_2(g)$.

(ii) $2Zn(s) + 2H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$.

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

(iv) $2Zn(aq) + H_2SO_4(aq) \longrightarrow ZnSO_4(s) + H_2(g)$.

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

(e) Which of the following is a combination reaction?

(i) $NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$

(ii) $Zn + FeSO_4 \longrightarrow ZnSO_4 + Fe$

(iii) $MgO + H_2O \longrightarrow Mg(OH)_2$

(iv) $2KClO_3 \xrightarrow{\text{heat}} 2KCl + 3O_2$

Ans. (iii) $MgO + H_2O \longrightarrow Mg(OH)_2$

Very Short Answer Type Questions

19. Write a balanced chemical equation for the reaction used in black and white photography.

Ans. These two photochemical decomposition reactions are used in black and white photography.

$$\underset{\text{White}}{2AgCl(s)} \xrightarrow{\text{sunlight}} \underset{\text{Grey}}{2Ag(s)} + Cl_2(g)$$

$$\underset{\text{White}}{2AgBr(s)} \xrightarrow{\text{sunlight}} \underset{\text{Grey}}{2Ag(s)} + Br_2(g)$$

20. Why do we clean magnesium ribbon before burning in air?

Ans. Magnesium is a very reactive metal and it reacts with oxygen present in air and form a layer of magnesium oxide on magnesium ribbon. Hence, we should clean magnesium ribbon before burning to remove this oxide.

21. Identify the reducing agent and oxidising agent in the following reactions:

(a) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

(b) $Fe_2O_3 + 3CO \rightarrow 2\ Fe + 3CO_2$

Ans. (a) Substance oxidised: NH_3

Substance reduced: O_2

Oxidising agent: O_2

Reducing agent: NH_3

(b) Substance oxidised: CO

Substance reduced: Fe_2O_3

Oxidising agent: Fe_2O_3

Reducing agent: CO

22. In the refining of silver, the recovery of silver from silver nitrate solution involved displacement by copper metal. Write down the balanced chemical equation for the reaction involved.

Ans. Copper is more reactive than silver and hence it can displace silver from its solution.

Reaction involved:

$2AgNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

23. In the reaction,

$$Be_2C + xH_2O \rightarrow yBe(OH)_2 + CH_4$$

Write the values of *x* and *y*.

Ans. $Be_2C + 4H_2O \rightarrow 2Be(OH)_2 + CH_4$

So, the value of *x* is 4 and *y* is 2.

24. What is the difference between skeletal and balanced chemical equation? Give example.

Ans. A skeletal chemical equation is an unbalanced equation while a balanced chemical equation has the number of atoms of each element in the reactants is equal to the number of atoms of each element in the products.

For example:

Skeletal chemical equation:

$$Mg + O_2 \rightarrow MgO$$

Balanced chemical equation:

$$2Mg + O_2 \rightarrow 2MgO$$

25. Zinc oxide reacts with carbon, on heating to form zinc metal and carbon monoxide. Write a balanced chemical equation for the reaction. Name the

(a) oxidising agent and

(b) reducing agent in the reaction.

Ans. $\underset{\text{Zinc oxide}}{ZnO(s)} + \underset{\text{Carbon}}{C(s)} \xrightarrow{\text{heat}} \underset{\text{Zinc}}{Zn(s)} + \underset{\text{Carbon monoxide}}{CO(g)}$

(a) Oxidising agent: ZnO

(b) reducing agent: C

26. Using the suitable chemical equations, justify that some chemical reactions are determined by

(a) change in colour.

(b) change in temperature.

(c) evolution of a gas.

Ans. (a) When iron is left exposed to air for a long time, the outer surface of iron gets covered with a brown coating called rust.

$$4Fe(s) + 3O_2(g) + xH_2O \rightarrow \underset{\text{Hydrated iron oxide (rust)}}{2Fe_2O_3 \cdot xH_2O}$$

(b) Calcium oxide reacts vigorously with water to form sparingly soluble calcium hydroxide (slaked lime) and a large amount of heat is released.

$$\underset{\text{Quicklime}}{CaO(s)} + H_2O(l) \rightarrow \underset{\text{Slaked lime}}{Ca(OH)_2(aq)} + \text{Heat}$$

(c) When metallic zinc reacts with dilute sulphuric acid, hydrogen gas is evolved.

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

27. A white salt of lead on heating decomposes to give brown fumes and a residue is left behind.

(a) Name the salt.

(b) Name the metal oxide formed in the reaction.

(c) Write the equation for the decomposition reaction.

Ans. On heating, lead nitrate decomposes to form a yellow coloured compound, lead oxide and brown fumes of nitrogen dioxide gas are evolved.

(a) Lead nitrate

(b) Lead oxide

(c) $\underset{\substack{\text{Lead nitrate}\\\text{(colourless)}}}{2Pb(NO_3)_2(s)} \xrightarrow{\text{heat}} \underset{\substack{\text{Lead(II) oxide}\\\text{(light yellow)}}}{2PbO(s)} + \underset{\substack{\text{Nitrogen dioxide}\\\text{(reddish-brown)}}}{4NO_2(g)} + O_2(g)$

Short Answer Type Questions

28. On heating blue coloured powder of copper nitrate in a boiling tube, copper oxide (black), oxygen gas and a brown gas 'X' is formed.

(a) Write a balanced chemical equation for the reaction.

(b) Identify the brown gas 'X' evolved.

(c) Identify the type of reaction.

Ans. (a) $\underset{\substack{\text{Copper nitrate}\\\text{(blue)}}}{2Cu(NO_3)_2(s)} \xrightarrow{\text{heat}} \underset{\substack{\text{Copper oxide}\\\text{(black)}}}{2CuO(s)} + \underset{\substack{\text{Nitrogen dioxide}\\\text{(reddish-brown)}}}{4NO_2(g)} + O_2(g)$

(b) The brown gas 'X' evolved is nitrogen dioxide.

(c) Thermal decomposition reaction

29. Explain the term corrosion with the help of an example. Write a chemical equation to show the process of corrosion of iron. What special name is given to the corrosion of iron? What type of chemical reaction is involved in the corrosion of iron.

Ans. The process of slow destruction of metals and manufactured materials containing metals due to their exposure to the environment is called corrosion. Corrosion occurs when the surface of a metal is exposed to the atmosphere and it leads to the weakening of the strength of metals. For example,formation of a layer of oxide on aluminium leading to dullness and loss of shine.

Corrosion of iron is rusting which involves the oxidation of iron in the presence of air and moisture.

Chemical reaction for corrosion of iron:

$$4Fe(s) + 3O_2(g) + xH_2O \rightarrow \underset{\text{Hydrated iron oxide (rust)}}{2Fe_2O_3 \cdot xH_2O}$$

Long Answer Type Questions

30. Write a balanced chemical equation and identify the type of chemical reaction taking place in each of the following:

(a) Barium chloride solution is mixed with copper sulphate solution and a white precipitate is observed.

(b) On heating copper powder in air in a china dish, the surface of copper powder turns black.

(c) On heating green coloured iron sulphate crystals, reddish brown solid is left and smell of a gas having odour of burning sulphur is experienced.

(d) Iron nails when left dipped in blue copper sulphate solution become brownish in colour and the blue colour of copper sulphate fades away.

(e) Quicklime reacts vigorously with water releasing a large amount of heat.

Ans. (a) Double displacement reaction

$$BaCl_2 + CuSO_4 \rightarrow \underset{\text{(white ppt.)}}{BaSO_4} + CuCl_2$$

(b) Oxidation reaction

$$2Cu + O_2 \rightarrow \underset{\text{(black)}}{2CuO}$$

(c) Decomposition reaction

$$2FeSO_4 \xrightarrow{\text{heat}} Fe_2O_3 + SO_2 + SO_3$$

(d) Displacement reaction

$$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$$

(e) Combination reaction

$$CaO + H_2O \rightarrow Ca(OH)_2 + \text{Heat}$$

31. (a) When the powder of a common metal is heated in an open china dish, its colour turns black. However, when hydrogen is passed over the hot black substance so formed, it regains its original colour. Based on this information answer the following questions:

(i) What type of chemical reaction takes place in each of the two given steps?

(ii) Name the metal initially taken in the powder form.

Write balanced chemical equations for both the reactions.

(b) Explain the following with one example of each:
(i) Electrolytic decomposition
(ii) Thermal decomposition

Ans. (a) (i) In the first step, oxidation takes place and in the second step, redox reaction takes place.

Reactions involved:

$$\underset{\text{Brownish red}}{2Cu(s)} + O_2(g) \xrightarrow{\text{heat}} \underset{\text{Black}}{2CuO(s)}$$

$$\underset{\substack{\text{Copper(II)}\\\text{oxide}}}{CuO(s)} + \underset{\substack{\text{Hydrogen}\\\text{gas}}}{H_2(g)} \xrightarrow{\text{heat}} \underset{\text{Copper}}{Cu(s)} + \underset{\substack{\text{Water}\\\text{vapour}}}{H_2O(g)}$$

(ii) The metal initially taken in powder form was copper.

(b) (i) The process in which a compound in aqueous solution or in molten state is decomposed by passage of electricity is called electrolytic decomposition or electrolysis. For example,

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

(ii) The reaction in which a compound breaks down by heat to give two or more simpler substances is called thermal decomposition reaction. For example,

$$CaCO_3(s) \xrightarrow{\text{heat}} CaO(s) + CO_2(g)$$

Let's Compete

(Page 25)

Multiple-Choice Questions

1. The reaction, $H_2 + Br_2 \rightarrow 2HBr$ is
(a) a decomposition reaction
(b) an oxidation reaction
(c) a displacement reaction
(d) a combination reaction

Ans. (d)

2. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
The above reaction is a/an
(a) oxidation reaction.
(b) decomposition reaction.
(c) endothermic reaction.
(d) double displacement reaction.

Ans. (a)

3. $Cu + xHNO_3 \rightarrow Cu(NO_3)_2 + yNO_2 + zH_2O$
The values of *x*, *y* and *z* are
(a) 2, 1, 2 (b) 4, 4, 2
(c) 8, 4, 2 (d) 4, 2, 2

Ans. (d) $Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$
The values of *x*, *y* and *z* are 4, 2, 2 respectively.

4. The colour of $FeSO_4$ crystal before and after heating is
(a) green, reddish brown
(b) brown, green
(c) colourless, brown
(d) colourless, green

Ans. (a) green, reddish brown as on heating ferrous sulphate crystals in a boiling tube, the green colour of the crystals changes to reddish-brown due to the formation of a solid ferric oxide (Fe_2O_3).

5. In the reaction, $2FeCl_3 + H_2S \rightarrow 2FeCl_2 + 2HCl + S$
(a) $FeCl_3$ acts as an oxidising agent.
(b) both $FeCl_2$ and H_2S are oxidised.
(c) $FeCl_3$ is oxidised and H_2S is reduced.
(d) H_2S acts as an oxidising agent.

Ans. (a) $2FeCl_3 + H_2S \rightarrow 2FeCl_2 + 2HCl + S$
In this reaction, H_2S is oxidised and $FeCl_3$ acts as an oxidising agent.

6. Which of the following is not a redox reaction?
(a) $CaCO_3 \rightarrow CaO + CO_2$
(b) $2H_2 + O_2 \rightarrow 2H_2O$
(c) $2Na + 2H_2O \rightarrow 2NaOH + H_2$
(d) $ZnO + C \rightarrow Zn + CO$

Ans. (a) $CaCO_3 \rightarrow CaO + CO_2$
This reaction is a decomposition reaction.

7. A white precipitate can be formed by adding dilute sulphuric acid to
(a) copper sulphate solution
(b) sodium chloride solution
(c) barium chloride solution
(d) sodium sulphate solution

Ans. (c) When an aqueous solution of barium chloride is treated with dilute sulphuric acid a white precipitate of barium sulphate is formed.

$$\underset{\substack{\text{Barium}\\\text{chloride}}}{BaCl_2(aq)} + \underset{\text{Sulphuric acid}}{H_2SO_4(aq)} \rightarrow \underset{\substack{\text{Barium}\\\text{sulphate}\\\text{(white precipitate)}}}{BaSO_4(s)} + \underset{\substack{\text{Hydrochloric}\\\text{acid}}}{2HCl(aq)}$$

8. The chemical reaction between quicklime and water is characterised by
(a) evolution of hydrogen gas.
(b) formation of slaked lime precipitate.
(c) change in temperature of the mixture.
(d) change in colour of the product.

Ans. (c) Calcium oxide (quicklime) reacts vigorously with water to form sparingly soluble calcium hydroxide (slaked lime) and a large amount of heat is released. So it results in an increase in temperature of the mixture.

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + Heat$$
Quicklime Water Slaked lime

9. You are given the solution of lead nitrate. In order to obtain a yellow precipitate, you should mix with it a solution of

(a) potassium chloride. (b) potassium nitride.

(c) potassium iodide. (d) potassium sulphide.

Ans. (c) When lead nitrate reacts with potassium iodide a yellow precipitate of lead iodide is formed.

$$Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$$
Lead nitrate Potassium iodide Lead iodide Potassium nitrate

10. In order to prevent the spoilage of potato chips, they are packed in plastic bags in an atmosphere of

(a) chlorine. (b) oxygen.

(c) hydrogen. (d) nitrogen.

Ans. (d)

Life Skills

(Page 26)

1. Mrs Nandini had a problem of spoilage of butter. One day she discussed it with her friend Manisha. Manisha advised her to keep butter in an airtight container.

(a) Why did Manisha advise Nandini to use an airtight container for storing butter?

(b) Name the process involved in the situation.

(c) Write two characteristic features of Manisha's personality.

Ans. (a) Storing foods containing fats and oil in airtight containers slow down their oxidation and prevent rancidity.

(b) The oxidation of oils and fats in the food leading to an unpleasant smell and taste is known as rancidity.

(c) Sharing knowledge, scientific temperament, etc.

2. Students of Class X were performing the activity of decomposition of iron sulphate in the lab. The lab assistant came to Rohan and told him to keep the test tube tilted rather than straight while heating the content.

(a) Write the reaction for decomposition of iron sulphate crystals.

(b) Name the type of reaction.

(c) What are the values associated with lab assistant's instruction?

Ans. (a) $2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$
Iron sulphate iron oxide

(b) Decomposition reaction

(c) Sharing knowledge, helpfulness, etc.

3. Radheyshyam, a lab assistant demonstrated an activity of burning magnesium ribbon to Class X students. Next day Rahul, a student of the same class bought spectacles from his pocket money and gave that to Radheyshyam.

(a) Why did Rahul gave the spectacles to the lab assistant?

(b) Write the balanced chemical equation for the reaction involved.

(c) How will you describe Rahul as a person?

Ans. (a) For the safety of eyes during experiment.

(b) $2Mg + O_2 \rightarrow 2MgO$

(c) Care for others, proper use of knowledge, etc.

2

Acids, Bases and Salts

Checkpoint (Page 29)

1. What is an indicator? Name any three natural indicators.

Ans. An indicator is a substance which is used to test the presence of an acid or a base. Turmeric, litmus, china rose petals are naturally occurring indicators.

2. State two differences between acids and bases.

Ans. Acids are sour in taste and turn the colour of blue litmus paper to red. Bases are bitter in taste and turn the colour of red litmus paper to blue.

3. Why is an antacid tablet taken when you suffer from acidity?

Ans. An antacid such as milk of magnesia containing base is taken to relieve indigestion. It neutralises the effect of excessive acid.

4. What is a salt? Name any two salts.

Ans. Salt is a substance formed when an acid reacts with a base. For example, sodium chloride(NaCl) and calcium chloride($CaCl_2$).

5. What happens when an ant stings? How can we treat ant stings?

Ans. When an ant stings, it injects formic acid into the skin. The effect of the sting can be neutralised by rubbing moist baking soda on the effective area.

6. Define salts.

Ans. Salts are the substances which are formed when acids react with bases. Salts can be acidic, basic and neutral in nature.

7. Give one characteristic property of all bases.

Ans. Bases turn red litmus blue.

8. Name the acids which are present in curd and spinach.

Ans. Lactic acid is present in curd and oxalic acid is present in spinach.

9. What is a neutralisation reaction? Explain with the help of an example?

Ans. The reaction between an acid and a base is known as neutralisation. In this reaction, salt and water are produced. For example,

$$\underset{\text{Base}}{NaOH} + \underset{\text{Acid}}{HCl} \rightarrow \underset{\text{Salt}}{NaCl} + \underset{\text{Water}}{H_2O}$$

10. Give one characteristic property of acids.

Ans. Acids turn blue litmus red.

Check Your Progress 1

(Page 36)

Multiple-Choice Questions

1. Acetic acid is a weak acid because

(a) its aqueous solution is acidic.
(b) it is highly ionised.
(c) it is weakly ionised.
(d) it contains –COOH group.

Ans. (c) it is weakly ionised because it is weakly ionised.

2. A solution reacts with marble chips to produce a gas which turns lime water milky. The solution contains

(a) sodium sulphate (b) calcium sulphate
(c) sulphuric acid (d) potassium sulphate

Ans. (c) Marble chips contain calcium carbonate which reacts with sulphuric acid to form cabon dioxide gas. When CO_2 gas is passed through lime water, it turns milky.

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$$

$$\underset{\text{Lime water}}{Ca(OH)_2(aq)} + CO_2(g) \rightarrow \underset{\substack{\text{Calcium}\\ \text{carbonate}\\ \text{(white ppt)}}}{CaCO_3(s)} + H_2O(l)$$

3. The indicators which turn red in acidic solution are

(a) turmeric and litmus

(b) phenolphthalein and methyl orange
(c) litmus and methyl orange
(d) phenolphthalein and litmus

Ans. (c)

4. A solution reacts with zinc granules to give a gas which burns with a pop sound. The solution contains this agent.
(a) Magnesium hydroxide
(b) Sodium carbonate
(c) Sodium chloride
(d) Sodium hydroxide

Ans. (d) Sodium hydroxide reacts with zinc granules to produce hydrogen gas which burns with a pop sound.

$$2NaOH + Zn \rightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + H_2(\uparrow)$$

5. On adding concentrated NaOH solution to a test tube containing phenolphthalein, the colour change observed by a student would be
(a) pink to colourless (b) pink to blue
(c) colourless to pink (d) red to blue

Ans. (c)

6. Which of the following is a strong acid?
(a) Lactic acid (b) Ascorbic acid
(c) Formic acid (d) Sulphuric acid

Ans. (d)

Very Short Answer Type Questions

7. On adding dilute HCl to copper oxide powder, the solution formed is blue-green. Predict the new compound formed that imparts a blue-green colour to the solution.

Ans. When hydrochloric acid reacts with copper oxide powder, copper chloride ($CuCl_2$) is formed which imparts blue-green colour to the solution.

$$\underset{\substack{\text{Copper oxide}\\\text{(black)}}}{CuO(s)} + 2HCl(aq) \rightarrow \underset{\substack{\text{Copper chloride}\\\text{(bluish-green)}}}{CuCl_2(aq)} + H_2O(l)$$

8. Dry ammonia gas has no action on litmus paper, but a solution of ammonia in water turns red litmus paper blue. Why is it so?

Ans. Dry ammonia does not contain hydroxide (OH^-) ions. On dissolving in water, it forms NH_4OH (base) which dissociates to give NH_4^+ and OH^- ions. Hence, the solution becomes basic and turns red litmus paper blue.

9. What colour do the following indicators give when added to a base?
(a) methyl orange
(b) red cabbage extract

Ans. (a) Methyl orange turns yellow in a basic medium.
(b) Red cabbage extracts show green colour in basic medium.

10. What is meant by strong acids and weak acids? Give two examples of each.

Ans. Acids which undergo ionisation to a large extent in a solution are called strong acids. For example, hydrochloric acid (HCl), nitric acid (HNO_3), etc.
Acids which undergo ionisation to a small extent only are called weak acids. For example, acetic acid (CH_3COOH), formic acid (HCOOH), etc.

11. What happens when an acid reacts with a metal oxide? Explain with the help of an example. Write a balanced equation for the reaction involved.

Ans. Acids react with metal oxides to form salt and water. This shows that metallic oxides are basic in nature. For example,

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

12. What is an indicator? Name two common indicators. What colour does turmeric paper turn when put in an alkaline solution?

Ans. An indicator is a substance which shows a characteristic colour or odour in the presence of an acidic or a basic solution. The two common indicators are litmus paper and phenolphthalein. Turmeric paper turns dark red when put in an alkaline solution.

Short Answer Type Questions

13. A compound X reacts with Zn and forms 'A' and liberates H_2 gas. It reacts with HCl to form salt 'B' and H_2O. It reacts with acetic acid to form 'C' and H_2O. Identify X, A, B and C. Write the balanced chemical reactions involved.

Ans.

$$\underset{\text{(X)}}{2NaOH} + Zn \rightarrow \underset{\substack{\text{sodium zincate}\\\text{(A)}}}{Na_2ZnO_2} + H_2$$

$$\underset{\text{(X)}}{NaOH} + HCl \rightarrow \underset{\text{(B)}}{NaCl} + H_2O$$

$$\underset{\text{(X)}}{NaOH} + \underset{\text{acetic acid}}{CH_3COOH} \rightarrow \underset{\text{(C)}}{CH_3COONa} + H_2O$$

14. A student dropped few pieces of marble in dil. HCl contained in a test tube. The gas evolved passed through lime water. What changes would be observed in lime water? Write balanced chemical equation for the reaction when
(a) gas was evolved
(b) gas was passed through lime water
(c) excess of gas was passed through lime water

Ans. Marble is chemically calcium carbonate. On reacting with HCl, it will form $CaCl_2$, H_2O and CO_2. CO_2 gas evolved turns lime water milky due to the formation of $CaCO_3$.
If excess of CO_2 gas is passed through lime water, the white precipitate of $CaCO_3$ dissolves and the solution becomes clear due to the formation of

soluble calcium hydrogen carbonate. The required equations are as follows:

(a) $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

(b) $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$
(Lime water)

(c) $CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$

15. (a) While diluting an acid, why is it recommended that acid should be added to water not water to acid ?

(b) Name two synthetic indicators. What are its effects in acidic and basic solutions?

(c) Write the equation for ionisation of hydrochloric acid in water.

Ans. (a) Dilution of an acid is a highly exothermic process. When water is added to acid during dilution, the heat evolved is so large that it will instantly turn water into steam resulting in splashing of acid and may cause severe acid burns. Hence, dilution of concentrated acid is always done by adding the acid gradually to water.

(b) The two common synthetic indicators are phenolphthalein and methyl orange. Phenolphthalein turns pink in a basic solution and remains colourless in an acidic solution while methyl orange turns yellow in a basic solution and red in acidic solution.

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

Long Answer Type Questions

16. (a) What happens when carbon dioxide gas is passed through sodium hydroxide solution? Explain with the help of a balanced chemical reaction.

(b) Why do the copper vessels get tarnished? How will you regain the shine of copper vessels? Name the types of reactions involved in both the processes.

Ans. (a) When carbon dioxide gas is passed through sodium hydroxide solution, sodium carbonate is formed. The balanced chemical equation for the reaction is as follows:

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

(b) Copper vessels get tarnished when kept in open due to the formation of a black layer of copper oxide which is basic in nature. The shine can be regained by rubbing the utensils with pieces of lemon which is acidic in nature. The reaction between copper and oxygen is an oxidation reaction whereas the second reaction is a neutralisation reaction between copper oxide and lemon.

17. (a) Acetic acid is a weak acid and milk of magnesia is a weak base. Discuss the term weak.

(b) Ammonia is a base but does not contain a hydroxide ion. Explain.

Ans. (a) The term 'weak' with reference to acids and bases means that the given acid or base ionizes only partially in solution. This means it produces very less number of H^+ ions (in case of acids) or OH^- ions (in case of bases). Since both acetic acid and milk of magnesia ionize to a very small extent in water, they are considered to be weak acid and weak base respectively.

(b) Ammonia does not contain hydroxide ion but it is alkaline(basic) in nature because it dissolves in water to form ammonium hydroxide which dissociates to give hydroxide ions (OH^-).

$$\underset{\text{Ammonia}}{NH_3} + H_2O \rightarrow \underset{\text{Ammonium hydroxide}}{NH_4OH}$$

$$NH_4OH + H_2O \rightarrow NH_4^+ + OH^-$$

Check Your Progress 2

(Page 44)

Multiple-Choice Questions

1. The number of water molecules present in one formula unit of washing soda is

(a) 0 (b) 10

(c) 2 (d) 7

Ans. (b) The number of water molecules present in one formula unit of washing soda ($Na_2CO_3.10H_2O$) is 10.

2. What is the chemical formula of milk of magnesia?

(a) $Ca(OH)_2$ (b) $NaHCO_3$

(c) $Mg(OH)_2$ (d) $Al(OH)_3$

Ans. (c)

3. Common salt, besides being used in kitchen, can also be used as a raw material for making

(i) washing soda. (ii) bleaching powder.

(iii) baking soda. (iv) slaked lime.

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

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

Ans. (b)

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

(i) Lower the *p*H, weaker is the base.

(ii) Lower the *p*H, stronger is the base.

(iii) Higher the *p*H, stronger is the acid.

(iv) Higher the *p*H, stronger is the base.

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

(c) (ii) and (iii) (d) (ii) and (iv)

Ans. (b) Strength of acid increases with decrease in the value of *p*H while strength of base increases with increase in the value of *p*H.

5. The acid present in ant's sting is

(a) acetic acid (b) lactic acid

(c) citric acid (d) formic acid

Ans. (d)

6. Which of the following is the correct chemical formula of plaster of Paris?

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

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

Ans. (c) The chemical formula of plaster of Paris is $CaSO_4 \cdot 1/2H_2O$.

7. The table below has information regarding *p*H and the nature (acidic/basic) of four different solutions. Which one of the options in the table is correct? **(CBSE 2023)**

Option	Solution	Colour of pH paper	Approximate pH value	Nature of solution
(a)	Lemon juice	Orange	3	Basic
(b)	Milk of magnesia	Blue	10	Basic
(c)	Gastric juice	Red	6	Acidic
(d)	Pure water	Yellow	7	Neutral

Ans. (b) Milk of magnesia

Milk of magnesia is a basic substance. Its approximate pH value is around 9–10. The colour of pH paper would be blue for a basic solution.

Lemon juice and Gastric juice are acidic. Pure water is neutral.

8. Select washing soda from the following: **(CBSE 2023)**

(a) $NaHCO_3$ (b) $NaHCO_3 \cdot 5H_2O$

(c) $NaHCO_3 \cdot 10H_2O$ (d) NaOH

Ans. (c) $NaHCO_3 \cdot 5H_2O$.

Washing soda is the common name for sodium carbonate decahydrate ($Na_2CO_3 \cdot 10H_2O$).

9. Consider the following compounds:

$FeSO_4$; $CuSO_4$; $CaSO_4$; Na_2CO_3

The compound having maximum number of water of crystallisation in its crystalline form in one molecule is: **(CBSE 2024)**

(a) $FeSO_4$ (b) $CuSO_4$

(c) $CaSO_4$ (d) Na_2CO_3

Ans. (d) Na_2CO_3

$FeSO_4$ (Iron(II) sulphate) in its hydrated form is $FeSO_4 \cdot 7H_2O$ (iron(II) sulphate heptahydrate), contains 7 water molecules of crystallisation.

$CuSO_4$ (Copper(II) sulphate) in its hydrated form, is $CuSO_4 \cdot 5H_2O$ (copper(II) sulphate pentahydrate), contains 5 water molecules of crystallisation.

$CaSO_4$ (Calcium sulphate) in its hydrated form, is $CaSO_4 \cdot 2H_2O$ (calcium sulphate dihydrate, also known as gypsum) contains 2 water molecules of crystallisation.

Na_2CO_3 (Sodium carbonate) in its hydrated form, it is $Na_2CO_3 \cdot 10H_2O$ (sodium carbonate decahydrate, also known as washing soda) contains 10 water molecules of crystallisation.

10. Mild non-corrosive basic salt is **(CBSE SP 2024)**

(a) $Ca(OH)_2$ (b) NaCl

(c) NaOH (d) $NaHCO_3$

Ans. (d) $NaHCO_3$ (sodium bicarbonate), commonly known as baking soda, is a mild and non-corrosive basic salt. It is used in cooking, as an antacid, and for cleaning purposes. It is not strongly alkaline and hence non-corrosive.

Analysis of other options: (a) $Ca(OH)_2$ (calcium hydroxide) is a strong base (slaked lime) and can be corrosive in concentrated form.

(b) NaCl (sodium chloride) is neutral salt, not basic.

(c) NaOH (sodium hydroxide) is a strong base and highly corrosive.

Very Short Answer Type Questions

11. What happens when electricity is passed through brine? Also, write the balanced equation.

Ans. When electric current is passed through brine, sodium chloride decomposes to give sodium hydroxide, chlorine gas and hydrogen gas.

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

12. What happens when water is added to plaster of Paris? Also, write the balanced equation.

Ans. Plaster of Paris reacts with water to form gypsum which sets to form a hard mass.

$$\underset{\text{Plaster of Paris}}{CaSO_4 \cdot 1/2\ H_2O(s)} + 3/2\ H_2O(l) \rightarrow \underset{\text{Gypsum (hard mass)}}{CaSO_4 \cdot 2H_2O(s)}$$

13. Name the basic salt used in soda acid fire extinguishers. How does this work?

Ans. Sodium hydrogencarbonate ($NaHCO_3$) is used in soda acid fire extinguishers. When activated, it reacts with sulfuric acid to produce carbon dioxide gas, which displaces oxygen around the fire, smothering it and stopping combustion.

14. Write the names of two salts belonging to sodium family. Write their chemical formula too.

Ans. Two examples of salts of sodium family are sodium sulphate and sodium chloride. Na_2SO_4 is chemical formula of sodium sulphate and NaCl is the chemical formula of sodium chloride.

15. How will you distinguish between baking soda and washing soda by heating?

Ans. On heating, baking soda produces carbon dioxide gas which turns lime water milky.

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

When washing soda is heated it does not produce any gas, it only loses the water of crystallisation molecules.

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

16. Write balanced chemical equation for the reaction that occurs when **(CBSE 2023)**

(a) blue coloured copper sulphate crystals are heated and

(b) sodium hydrogen carbonate is heated during cooking.

Ans. (i) When copper sulphate pentahydrate ($CuSO_4 \cdot 5H_2O$) is heated, it loses water of crystallisation and forms anhydrous copper sulphate, which is white. Further heating can decompose it to form other products.

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

(ii) When sodium hydrogen carbonate ($NaHCO_3$) which is also known as baking soda is heated during cooking, it decomposes to form sodium carbonate (Na_2CO_3), water, and carbon dioxide.

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

17. A compound 'X' which is prepared from gypsum has the property of hardening when mixed with proper quantity of water.

Identify 'X' and write its chemical formula.

(CBSE 2023)

Ans. The compound 'X' is Plaster of Paris (POP). It is prepared by heating gypsum at around 373 K (100°C) to remove part of its water content. When mixed with a proper quantity of water, Plaster of Paris hardens due to the rehydration process, forming gypsum.

$$CaSO_4 \cdot 2H_2O \xrightarrow{\text{heat (373 K)}} CaSO_4 \cdot \frac{1}{2}H_2O + \frac{3}{2}H_2O$$

Gypsum Plaster of Paris:

When Plaster of Paris is mixed with water, it rehydrates to form gypsum:

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

This rehydration causes the hardening of Plaster of Paris.

18. State the difference in chemical composition between baking soda and baking powder.

(CBSE 2023)

Ans. Baking Soda is Sodium bicarbonate ($NaHCO_3$) or sodium hydrogen carbonate.

It is a base and requires an acidic ingredient (like lemon juice, vinegar, or yogurt) and moisture to activate and produce carbon dioxide gas, which causes the batter to rise.

Baking powder is a mixture of sodium hydrogen carbonate and a mild edible acid such as tartaric acid or citric acid.

It contains both an acid and a base, so it can activate with just moisture. Some baking powders are "double-acting," meaning they release gas both when mixed with liquid and when exposed to heat.

19. Explain why an aqueous solution of sodium chloride is neutral but an aqueous solution of sodium carbonate is basic.

Ans. Sodium chloride is a salt of a strong acid and a strong base and it is neutral with *p*H value of 7. Sodium carbonate is a salt of a weak acid and a strong base so, it is basic in nature with *p*H value more than 7.

20. Define *p*H. Explain the importance of *p*H in tooth decay.

Ans. *p*H is the measure of hydrogen ion concentration. It is inversely proportional to the hydrogen ion concentration in a solution.

Food particles present in our mouth after eating sweet tasting foods undergo bacterial decomposition and acid is produced as one of the products. Tooth enamel contains calcium phosphate. The acid reacts with calcium phosphate present in tooth enamel to form soluble calcium salt and cavities are formed. When the *p*H of mouth falls below 5.5, the tooth decay starts.

21. Write the chemical name and formula of

(a) baking soda. (b) bleaching powder.

(c) Plaster of Paris

Ans.

Compound	Chemical Name	Formula
(a) Baking Soda	Sodium hydrogencarbonate	$NaHCO_3$
(b) Bleaching Powder	Calcium oxychloride	$CaOCl_2$
(c) Plaster of Paris	Calcium sulphate hemihydrate	$CaSO_4 \cdot 1/2H_2O$

22. A compound X of sodium is commonly used in kitchen for making crispy *pakora*. It is also used for curing acidity in stomach. What is its chemical formula? State the reaction which takes place when it is heated during cooking. What will be the reaction of compound X with dil. HCl?

Ans. Compound 'X' is sodium hydrogencarbonate (baking soda) and its chemical formula is $NaHCO_3$.

Reactions involved:

$$2NaHCO_3(s) \xrightarrow{\text{heat}} Na_2CO_3(s) + H_2O + CO_2(g)$$

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

23. Tap water conducts electricity whereas distilled water does not. Explain.

Ans. Tap water contain dissolved salts which ionise in water and hence tap water conducts electricity. But distilled water does not contain any salt and hence it does not conduct electricity.

24. Chlorine gas was prepared using electrolysis of brine solution. Write the chemical equation to represent the change. Identify the other products formed in the process and give one application of each. **(CBSE SP 2024)**

Ans. The electrolysis of brine (a) concentrated solution of sodium chloride, NaCl) produces chlorine gas along with two other products: hydrogen gas and sodium hydroxide. The chemical equation for the reaction is:

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

Other products formed are hydrogen gas (H_2) and sodium hydroxide (NaOH).

Applications:

- Chlorine gas (Cl_2): Used for water purification and disinfection, as it kills bacteria and other pathogens.
- Hydrogen gas (H_2): Used as a fuel in hydrogen fuel cells and for producing ammonia in the Haber process.
- Sodium hydroxide (NaOH): Used in the manufacture of soap, paper, and detergents. It is also used in chemical industries as a strong alkali.

Short Answer Type Questions

25. Write the chemical composition of tooth enamel. Under what conditions of pH it starts corroding? Explain the reason of tooth decay and suggest one method to prevent it. **(CBSE 2023)**

Ans. Tooth enamel is composed of calcium hydroxyapatite, which has the chemical formula: $Ca_{10}(PO_4)_6(OH)_2$. It starts corroding when the pH of the mouth falls below 5.5. This acidic condition leads to the demineralisation of enamel.

Tooth decay occurs due to the production of acids by bacteria in the mouth.

These bacteria feed on sugars and carbohydrates from food, producing acids as a byproduct.

Demineralisation:

The acids lower the pH in the mouth, dissolving the calcium and phosphate ions from the enamel, leading to decay.

- Brush teeth twice a day using fluoride toothpaste. Fluoride strengthens enamel and helps resist acid attacks.
- Reduce the intake of sugary and acidic foods to limit acid production by bacteria.
- Antibacterial mouthwash reduces bacterial growth and maintain a neutral pH.

26. For making cake, baking powder is taken. If at home, your mother uses baking soda instead of baking powder in cake, then:

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

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

(c) What is the role of this compound added to baking soda?

Ans. (a) The cake will taste bitter due to the formation of sodium carbonate.

(b) Tartaric acid should be added to baking soda for converting it into baking powder.

(c) Tartaric acid neutralises the sodium carbonate formed and this will not make the taste of the cake bitter.

27. (a) What is meant by water of crystallisation? How will you show that copper sulphate crystals contain water of crystallisation? **(CBSE 2016)**

(b) Write the names and formulae for two acidic salts and two basic salts.

Ans. (a) The fixed number of water molecules which are present in one formula unit of a crystalline salt are called water of crystallisation.

The chemical formula of copper sulphate is $CuSO_4.5H_2O$ in which five molecules of water are attached to each formula unit of $CuSO_4$. This salt is blue in colour. When heated, it becomes colourless because it loses its water of crystallisation molecules to form anhydrous $CuSO_4$. This shows that copper sulphate crystals contain water of crystallisation.

(b) Acidic salts: NH_4Cl, $ZnSO_4$

Basic salts: Na_2CO_3, CH_3COONa

28. (a) What happens when crystals of washing soda are exposed to air?

(b) How is Plaster of Paris chemically different from gypsum? How can these be inter converted? Write one use of Plaster of Paris. **(CBSE 2016)**

Ans. (a) When washing soda is exposed to air, it loses the molecules of water of crystallisation to form sodium carbonate monohydrate.

$$Na_2CO_3 \cdot 10H_2O \xrightarrow{\text{air}} Na_2CO_3 \cdot H_2O + 9H_2O$$

(b) Plaster of paris (POP) has chemical formula $CaSO_4.1/2\ H_2O$ which is produced by heating gypsum having chemical formula $CaSO_4.2H_2O$. When POP is mixed with water, it convert back to gypsum.

Plaster of Paris is used for making toys and for making smooth surfaces.

29. (a) The pH of a sample of tomato juice is 4.6. How is this juice likely to be in taste? Give reason to justify your answer.

(b) How do we differentiate between a strong acid and a weak base in terms of ion-formation in aqueous solutions?

(c) The acid rain can make the survival of aquatic animals difficult. How? **(CBSE 2024)**

Ans. (i) Tomato juice is likely to taste slightly sour since pH of 4.6 indicates that the juice is acidic.

(ii) Strong Acid completely ionises in water, releasing a high concentration of hydrogen ions (H^+).

Example: Hydrochloric acid (HCl) dissociates fully into H^+ and Cl^- ions.

Weak Base partially ionises in water, producing a relatively low concentration of hydroxide ions (OH^-).

Example: Ammonia (NH_3) reacts with water to form a small amount of NH_4^+ and OH^- ions.

(iii) Acid rain water, if mixed with river water, lowers its pH below 5.6 and makes it acidic. But the living bodies in the river works normally within a pH range of 7–7.8. This is why the flow of acid rain water into river makes the survival of aquatic life in the river difficult.

Example: Fish eggs often fail to hatch in highly acidic water, leading to population decline.

Long Answer Type Questions

30. (a) What is the chemical name and chemical formula of the compound washing soda? Starting from NaCl, how will you prepare washing soda? Give the relevant equations. Give any two uses of washing soda.

(b) What are the three products of chlor-alkali process? Write one commercially or industrially important material that can be prepared from each of these products.

Ans. (a) Chemical name and formula: sodium carbonate decahydrate ($Na_2CO_3.10H_2O$).

Reactions involved for the preparation of washing soda:

$$NaCl(aq) + NH_3(g) + H_2O(l) + CO_2(g) \rightarrow \underset{\text{Sodium hydrogen carbonate}}{NaHCO_3(s)} + \underset{\text{Ammonium chloride}}{NH_4Cl(aq)}$$

$$2NaHCO_3(s) \xrightarrow{\text{heat}} \underset{\text{Sodium carbonate}}{Na_2CO_3(s)} + H_2O(g) + CO_2(g)$$

Recrystallisation of sodium carbonate produces washing soda.

$$Na_2CO_3 + 10H_2O \rightarrow \underset{\text{Washing soda}}{Na_2CO_3 \cdot 10H_2O}$$

Washing soda is used in paper industries and as a cleansing agent in the household.

(b) The three products of chlor-alkali process are sodium hydroxide (NaOH), chlorine gas (Cl_2) and hydrogen gas (H_2).

NaOH: It is used in industries such as soaps and detergents.

Cl_2 gas: It is used in the manufacture of PVC, pesticides and CFCs.

H_2 gas: It is used as a fuel and in hydrogenation of unsaturated oils.

31. (a) What is brine? What happens when electricity is passed through it? Name the process and the product evolved.

(b) What happens when the gas evolved at anode is passed through dry slaked lime. Write the chemical equation involved. Write two uses of the product formed.

Ans. (a) Concentrated aqueous solution of sodium chloride is known as brine. When electric current(electricity) is passed through brine, it decomposes to give sodium hydroxide which is formed near the cathode. The other products formed are chlorine gas and hydrogen gas. Chlorine gas is evolved at the anode and hydrogen gas is given off at the cathode.This process of production of sodium hydroxide from sodium chloride is called chlor-alkali process.

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

(b) When chlorine gas is passed through dry slaked lime at 313 K, it forms bleaching powder. The chemical equation for the reaction is as follows:

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

The uses of bleaching powder are:

(i) It is used for bleaching cotton fabrics in textile industry and wood pulp in paper industry.

(ii) It is used for disinfecting drinking water.

Higher Order Thinking Skills (HOTS) Questions

(Page 47)

1. A student working in the laboratory added some water to a syrupy liquid taken in a tube. The tube immediately cracked and the liquid which escaped out of it produced blisters on the skin of the student. What actually happened?

Ans. The syrupy liquid in the tube was concentrated sulphuric acid. When water is added to the acid, a

large amount of heat is released. This is why, the tube cracked and the vapours of the escaping acid produced blisters on the skin of the student.

2. A substance 'X' is used as a building material and is insoluble in water. When reacted with dilute HCl it produces a gas which turns lime water milky. Predict the substance. Write the chemical equations involved.

Ans. The substance 'X' is calcium carbonate which is used as a building material and is insoluble in water. The reactions involved between $CaCO_3$ and dil. HCl is:

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

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

3. A small amount of hydrochloric acid is always produced in the stomach. Is it useful or harmful and in what ways? If excess of acid is produced in the stomach, what do we do?

Ans. A small amount of HCl produced in the stomach is useful in digesting food as some foods can only be digested in acidic medium. If it is produced in excess we can neutralise it by using an antacid which is a mild base like milk of magnesia.

4. An element 'P' does not react with dilute sulphuric acid. It forms an oxide PO which turns red litmus blue. Will you call 'P' a metal or a non-metal? Give reasons for your answer.

Ans. The element P is a metal and it does not react with dilute sulphuric acid. The red litmus paper turns blue when it comes in a contact with an oxide PO which indicates that P is a metal because metallic oxides are basic in nature.

5. A baker found that the cake prepared by him is hard and small in size. Which ingredient has he forgotten to add that would have made the cake fluffy? Give reason.

Ans. The baker must have forgotten to add baking powder while making the dough of cake. While baking, sodium hydrogencarbonate present in baking powder releases CO_2 gas. The bubbles of the gas evolved leave behind pores which make the cake soft and fluffy.

$$2NaHCO_3(s) \xrightarrow{\text{heat}} Na_2CO_3(s) + H_2O(g) + CO_2(g)$$

Self-Assessment

(Page 47)

Multiple-Choice Questions

1. Which of the following gases is evolved when a zinc granule is added to dilute hydrochloric acid?

(a) Hydrogen
(b) Carbon dioxide
(c) Nitrogen
(d) Oxygen

Ans. (a) $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

2. When excess of carbon dioxide is passed through lime water, the white precipitate formed initially dissolves due to the formation of

(a) $Ca(HCO_3)_2$. (b) $CaCO_3$.
(c) $CaCl_2$. (d) $Ca(OH)_2$.

Ans. (a) $CaCO_3\ (s) + H_2O\ (l) + CO_2\ (g) \rightarrow Ca(HCO_3)_2\ (aq)$
Calcium Carbonate; Water; Carbon dioxide; Calcium hydrogen carbonate

3. Which of the following is not an olfactory indicator?

(a) Onion (b) Vanilla
(c) Clove (d) Red cabbage juice

Ans. (d) Red cabbage juice is a natural indicator.

4. A drop of liquid sample was put on *p*H paper. The paper turned blue. The liquid must be

(a) lemon juice (b) HCl
(c) sodium carbonate (d) ethanoic acid

Ans. (c)

5. Plaster of Paris hardens by

(a) giving off carbon dioxide
(b) changing into $CaCO_3$
(c) combining with water
(d) losing water

Ans. (c) $CaSO_4 \cdot 1/2\ H_2O(s) + 3/2\ H_2O(l) \rightarrow CaSO_4 \cdot 2H_2O$
Plaster of Paris; Gypsum (hard mass)

Assertion–Reason Type Questions

For question numbers 6 to 15, two statements are given – one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

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

6. **Assertion:** While preparing plaster of Paris from gypsum, the temperature should not be allowed to go beyond 100 °C.
Reason: Gypsum polymerises when heated above 100 °C.

Ans. (c) When gypsum is heated above 100 °C, it loses its water of crystallisation and forms anhydrous calcium sulphate, also known as dead burnt plaster. This is why, while preparing plaster of Paris from gypsum, the temperature should not be allowed to go beyond 100°C.

7. **Assertion:** When a few drops of dilute hydrochloric acid are added to vanilla essence, the smell of vanilla essence is not observed.

Reason: Vanilla essence is an olfactory indicator and loses its smell in basic solutions.

Ans. (d) Vanilla essence can be used as an olfactory indicator. It exhibits different odours in acidic and basic solutions. It retains its characteristic odour in acidic solutions but loses it in basic solutions. Thus, when a few drops of vanilla extract are added to dilute hydrochloric acid, its odour will be observed.

8. Assertion: Lime water becomes turbid after carbon dioxide is passed through it.

Reason: Lime water is an aqueous solution of calcium hydroxide.

Ans. (b) Lime water is an aqueous solution of calcium hydroxide. Lime water becomes turbid when carbon dioxide is passed through it due to the formation of calcium carbonate.

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

9. Assertion: When moist blue litmus paper is placed in a jar containing sulphur dioxide, its colour changes to red.

Reason: Sulphur dioxide is basic in nature.

Ans. (c) Oxides of non-metals (SO_2) are acidic in nature. Hence, they turn moist blue litmus paper red. Basic solutions have no effect on blue litmus paper. They turn red litmus paper blue.

10. Assertion: The *p*H of an acid increases on dilution.

Reason: Addition of water to an acid results in increase in the concentration of hydronium ions per unit volume.

Ans. (c) On dilution, the number of hydronium ions per unit volume decreases. Thus, the *p*H of an acid increases on dilution.

11. Assertion: When a drop of lemon juice is placed on a strip of universal indicator, the colour of the strip changes to green.

Reason: Lemon juice is acidic in nature.

Ans. (d) Lemon juice is acidic in nature and its *p*H is about 2.2. Thus, when a drop of lemon juice is placed on a strip of *p*H paper, it will turn orange-red. Neutral substances change the colour of *p*H paper to green.

12. Assertion: The *p*H of an aqueous solution of sodium bicarbonate is greater than 7.

Reason: Sodium bicarbonate is obtained by the action of a strong base and a weak acid.

Ans. (a) Sodium bicarbonate is a basic salt. It is produced by the action of a strong base (NaOH) and a weak acid (H_2CO_3). Hence, the *p*H of its solution would be more than 7.

13. Assertion: Calcium oxychloride is used as a bleaching agent in the textile industry.

Reason: Action of dilute acids on calcium oxychloride produces chlorine, which is oxidising in nature.

Ans. (a) When calcium oxychloride is treated with dilute acids, chlorine is produced.

$$CaOCl_2 + H_2SO_4 \rightarrow CaSO_4 + Cl_2 + H_2O$$

Chlorine is oxidising in nature. This imparts bleaching property to chlorine. Due to its bleaching action, calcium oxychloride is used as a bleaching agent in cotton and textile industries.

14. Assertion: Applying a paste of baking soda on a bee-sting provides relief from the pain.

Reason: Baking soda is the common name for sodium bicarbonate.

Ans. (b) A bee injects formic acid into the skin when it stings. This causes pain and irritation in the stung area. Applying a paste of baking soda (basic salt) on the stung area neutralises the acid and provides relief from the pain.

15. Assertion: A piece of cloth stained with curry becomes reddish-brown after being washed with soap.

Reason: Turmeric turns red in basic solutions.

Ans. (a) Turmeric is used as an indicator and it shows reddish-brown colour in basic solutions. Soaps are basic in nature. Thus, when a piece of cloth stained with curry is washed with soap, it becomes reddish-brown.

Source-based/Case-based/Passage-based/ Integrated assessment questions

Answer the questions on the basis of your understanding of the following paragraphs and the related studied concepts.

16. Vinegar is an aqueous solution of ethanoic acid, commonly known as acetic acid. Acetic acid is an organic acid with the chemical formula CH_3COOH. Pure acetic acid, when cooled below its melting point, solidifies to form ice like crystals. This is why, it is also known as glacial acetic acid. It is used as a solvent in the purification of many organic compounds and in the synthesis of some polymers.

I. (a) What will happen when a few drops of phenolphthalein are added to an aqueous solution of acetic acid?

(b) How will dilute acetic acid react with sodium? Give the chemical equation for the reaction.

(c) (i) Will you classify acetic acid as a strong acid or a weak acid?

OR

(ii) How will the hydrogen ion concentration be affected when acetic acid is diluted?

Ans. (a) Phenolphthalein is an indicator. It turns pink in basic solutions and remains colourless in acidic solutions. Thus, when a few drops of phenolphthalein are added to a solution of acetic acid in water, the solution will remain colourless.

(b) Dilute acetic acid reacts with sodium to form sodium acetate and hydrogen. The chemical equation for the reaction is as follows:

$2CH_3COOH + 2Na \rightarrow 2CH_3COONa + H_2$

(c) (i) Acetic acid is a weak acid. This is because it dissociates only partially in water. Thus, the number of H^+ ions produced by its dissociation is less.

OR

(ii) When acetic acid is diluted, the number of hydrogen ions per unit volume will decrease. Hence, the concentration of H^+ ions will reduce on its dilution.

II. (a) When a few drops of phenolphthalein are added to a solution of acetic acid in water, the solution

(i) turns pink
(ii) turns orange
(iii) will remain colourless
(iv) turns yellow

Ans. (iii) will remain colourless

(b) Which of the following balanced chemical equations represents the reaction between dilute acetic acid and sodium?

(i) $CH_3COOH + 2Na \longrightarrow Na_2CO_3$
(ii) $2CH_3COOH + Na \longrightarrow NaHCO_3 + H_2$
(iii) $2CH_3COOH + 2Na \longrightarrow 2CH_3COONa + H_2$
(iv) $CH_3COOH + 2Na \longrightarrow 2CH_3COONa + H_2$

Ans. (iii) $2CH_3COOH + 2Na \longrightarrow 2CH_3COONa + H_2$

(c) When acetic acid is diluted, the number of hydrogen ions per unit volume will

(i) increase
(ii) decrease
(iii) not change
(iv) increase and then decrease

Ans. (ii) decrease

(d) The basicity of acetic acid is

(i) 1. (ii) 2.
(iii) 3. (iv) 4.

Ans. (i) 1.

(e) Which of the following is an incorrect statement?

(i) Ethanoic acid turns blue litmus red.
(ii) Ethanoic acid is a monobasic acid.
(iii) Ethanoic acid is highly ionised.
(iv) Ethanoic acid is a colourless liquid.

Ans. (iii) Ethanoic acid is highly ionised.

17. A device used for putting out fire is known as a fire extinguisher. It works by cutting off the supply of air, or bringing down the temperature of the burning fuel, or both. A soda-acid fire extinguisher is a type of fire extinguisher that uses the chemical reaction between an acid and a base to produce a stream of water which can put out a fire. The acid used is sulphuric acid while the base used is sodium bicarbonate. Sodium bicarbonate solution is present in the body of the fire extinguisher while sulphuric acid is present in a small bottle inside the fire extinguisher. When the fire extinguisher is inverted and its plunger is hit on the ground, the bottle of acid breaks. This causes a chemical reaction between the acid and the base.

I. (a) Write the chemical reaction between the acid and the base used in soda-acid fire extinguishers.

(b) The reaction in a soda-acid fire extinguisher occurs between an acid and a base. What are these reactions known as? How would you categorise these type of reactions?

(c) (i) What happens when the base used in a soda-acid fire extinguisher is heated?

OR

(ii) State any two uses of the base used in a soda-acid fire extinguisher.

Ans. (a) The acid used in soda-acid fire extinguisher is sulphuric acid and the base used is sodium bicarbonate. The chemical equation for the reaction between these two reactants is written as follows:

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

(b) The reactions between an acid and a base are known as neutralisation reactions. They result in the formation of salt and water. Neutralisation reactions are a type of double displacement reactions. This is because the acid and the base exchange their respective ions to form salt and water.

(c) (i) Sodium bicarbonate on heating forms sodium carbonate, water and carbon dioxide.

$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

OR

(ii) The base used in soda-acid fire extinguisher is sodium bicarbonate. Its uses are as follows:

(a) It is used in the preparation of baking powder.
(b) It is used as an ingredient in antacids.

II. (a) The reaction occurs in a soda-acid fire extinguisher is a

(i) combination reaction

(ii) neutralisation reaction

(iii) decomposition reaction

(iv) oxidation reaction

Ans. (ii) neutralisation reaction

(b) Identify the correct chemical reaction between the acid and the base used in soda-acid fire extinguishers.

(i) $H_2SO_4 + 2NaHCO_3 \rightarrow NaOH + 2H_2O$

(ii) $H_2SO_4 + NaHCO_3 \rightarrow Na_2SO_4 + 2CO_2$

(iii) $H_2SO_4 + 2NaHCO_3 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2$

(iv) $H_2SO_4 + NaHCO_3 \rightarrow Na_2SO_4 + 2H_2O$

Ans. (iii) $H_2SO_4 + 2NaHCO_3 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2$

(c) When the base used in a soda-acid fire extinguisher is heated, it forms

(i) sodium bicarbonate and carbon dioxide

(ii) sodium hydroxide and water

(iii) sodium carbonate, water and carbon dioxide

(iv) sodium bicarbonate and water

Ans. (iii) sodium carbonate, water and carbon dioxide

(d) When the acid used in a soda-acid fire extinguisher reacts with zinc, it forms

(i) oxygen gas

(ii) hydrogen gas

(iii) sulphur dioxide gas

(iv) carbon dioxide gas

Ans. (ii) hydrogen gas

(e) The acid used in a soda-acid fire extinguisher

(i) completely gets ionised in water.

(ii) partially gets ionised in water.

(iii) do not get ionised in water.

(iv) is a weak acid.

Ans. (i) completely gets ionised in water.

18. Plaster of Paris is chemically known as calcium sulphate hemihydrate ($CaSO_4 \cdot \frac{1}{2}H_2O$). It is a hydrated salt of calcium obtained by heating gypsum. Fine-quality gypsum was found in huge deposits around Paris. This was mined extensively for the manufacture of plaster of Paris. This is how plaster of Paris got its name. It is extensively used in the building and construction industry.

I. (a) Why is the chemical formula of plaster of Paris written as $CaSO_4 \cdot \frac{1}{2}H_2O$?

(b) Write the chemical equation for obtaining plaster of Paris from gypsum.

(c) (i) Why is it advised to store plaster of Paris in moisture-proof container?

OR

(ii) List any two uses of plaster of Paris.

Ans. (a) The chemical formula of plaster of Paris is written as $CaSO_4 \cdot \frac{1}{2}H_2O$ because two units of calcium sulphate share one unit of water.

(b) Plaster of Paris is obtained by heating gypsum. The chemical equation for the reaction is as follows:

$$CaSO_4 \cdot 2H_2O \xrightarrow{100\ ^\circ C} CaSO_4 \cdot \tfrac{1}{2}H_2O + 3/2H_2O$$

(c) (i) It is advised to store plaster of Paris in a moisture-proof container because it can absorb water to form gypsum again, setting into a hard solid mass.

OR

(ii) The uses of plaster of Paris are as follows:

a. It is used by doctors for supporting fractured bones in the right position.

b. It is used for making toys and materials for decoration.

II. (a) The chemical formula of gypsum is written as

(i) $CaSO_4 \cdot 4H_2O$ (ii) $CaSO_4 \cdot 2H_2O$

(iii) $CaSO_4 \cdot \frac{1}{2}H_2O$ (iv) $CaSO_4 \cdot 3H_2O$

Ans. (ii) $CaSO_4 \cdot 2H_2O$

(b) It is advised to store plaster of Paris in a moisture-proof container because

(i) it mixes with water to form gypsum again, setting into a hard solid mass.

(ii) it mixes with water and produce sulphur dioxide gas.

(iii) it mixes with water to form sulphur trioxide gas.

(iv) it mixes with water to produce different hazardous gases.

Ans. (i) it mixes with water to form gypsum again, setting into a hard solid mass.

(c) In plaster of Paris, two formula units of $CaSO_4$ share

(i) five molecules of water

(ii) two molecules of water

(iii) three molecules of water

(iv) one molecule of water

Ans. (iv) one molecule of water

(d) Which of the following statements is correct?

(i) Gypsum contains one molecule of water of crystallisation.

(ii) Gypsum contains two molecules of water of crystallisation.

(iii) Gypsum contains three molecules of water of crystallisation.

(iv) Gypsum contains four molecules of water of crystallisation.

Ans. (ii) Gypsum contains two molecules of water of crystallisation.

(e) At what temperature is gypsum heated to form plaster of Paris?

(i) 90 °C (ii) 100 °C

(iii) 110 °C (iv) 120 °C

Ans. (ii) 100 °C

19. In a swimming pool, the *p*H of the water should ideally be 7.2. A *p*H range of 7.0–7.6 is workable, however, any *p*H value above or below this range is undesirable. If the swimming pool water is too acidic, it causes burning sensation in the eyes and makes the skin dry and itchy. It also causes the corrosion of metal parts in the pool. In highly alkaline water, the swimmer experiences a similar discomfort. Thus, it is important to maintain the *p*H of swimming pool water.

I. (a) What is meant by a *p*H scale?

(b) How does the *p*H of acidic, basic and neutral solutions vary on the *p*H scale?

(c) (i) How does change in *p*H in our mouth cause tooth decay?

OR

(ii) The *p*H of a sample of water was found to be 5. What colour will it show when tested with a strip of *p*H paper?

Ans. (a) The scale which measures the acidity or basicity of a solution in terms of its hydrogen ion concentration is known as *p*H scale.

(b) The *p*H value on a *p*H scale varies from 0 to 14. The *p*H of acidic solutions is less than 7, while the *p*H of basic solutions is more than 7. The *p*H of neutral solutions is equal to 7.

(c) (i) Food particles that remain in our mouth after eating are degraded by the bacteria to produce acids. These acids corrode tooth enamel when the *p*H of the mouth falls below 5.5. Cleaning mouth after eating can prevent tooth decay.

OR

(ii) If the *p*H of the sample of water was found to be 5, it means that the water is acidic in nature. The strip of *p*H paper will show orange-yellow colour when tested with this sample of water.

II. (a) *p*H refers to the

(i) logarithm of the hydrogen ion concentration of a solution.

(ii) negative logarithm of the hydrogen ion concentration of a solution.

(iii) logarithm of the hydroxyl ion concentration of a solution.

(iv) negative logarithm of the hydroxyl ion concentration of a solution.

Ans. (ii) negative logarithm of the hydrogen ion concentration of a solution.

(b) The *p*H of acidic, basic and neutral solutions vary on the *p*H scale from

(i) 0 to 7. (ii) 0 to 10.

(iii) 0 to 14. (iv) 0 to 5.

Ans. (iii) 0 to 14.

(c) When a strip of *p*H paper was dipped in the aqueous solution of a substance X, the colour of the *p*H paper changed to orange yellow. This substance is most likely to be

(i) lemon juice (ii) baking soda

(iii) rainwater (iv) milk of magnesia

Ans. (i) lemon juice.

(d) In acid rain, the *p*H of rainwater is less than

(i) 12.5. (ii) 10.5.

(iii) 8.3. (iv) 5.6.

Ans. (iv) 5.6.

(e) What will be the *p*H of a solution which has equal concentrations of H^+ and OH^- ions?

(i) 5.6 (ii) 6.3

(iii) 7.0 (iv) 9.0

Ans. (iii) 7.0

20. On a commercial scale, sodium carbonate is mainly produced by the Solvay process. In this process, carbon dioxide is allowed to pass through a concentrated aqueous solution of sodium chloride saturated with ammonia. This causes the precipitation of sodium bicarbonate from the solution.

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

The sodium bicarbonate crystals are heated to obtain sodium carbonate. The ammonia used in the process is recovered by treating the solution containing ammonium chloride with calcium hydroxide.

I. (a) The chemical formula of sodium carbonate decahydrate is $Na_2CO_3 \cdot 10H_2O$. What is this substance commonly known as? Write the chemical equation for the preparation of this compound from sodium carbonate.

(b) How does sodium carbonate react with dilute HCl?

(c) (i) When a few drops of phenolphthalein are added to aqueous solution of sodium carbonate, what colour change will be observed?

OR

(ii) Write any two uses of sodium carbonate.

Ans. (a) Sodium carbonate decahydrate is commonly known as washing soda. It is prepared from sodium carbonate by recrystallisation. The chemical equation for the reaction is as follows:

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

(b) Sodium carbonate is basic in nature. It reacts with dilute HCl to form salt, water, and carbon dioxide.

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

(c) (i) When a few drops of phenolphthalein are added to aqueous solution of sodium carbonate (basic salt), the colour of the solution will turn light pink.

OR

(ii) The uses of sodium carbonate are:

(a) It is used in glass, soap and paper industries.

(b) It is used in removing permanent hardness of water.

II. (a) Sodium carbonate is a salt of a

(i) strong acid and strong base

(ii) weak acid and weak base

(iii) strong acid and weak base

(iv) weak acid and strong base

Ans. (iv) weak acid and strong base

(b) Which of the following is an incorrect statement?

(i) Sodium carbonate is an acidic salt.

(ii) Sodium carbonate can be obtained from sodium chloride.

(iii) Sodium carbonate can be obtained by heating baking soda.

(iv) Sodium carbonate can be used to remove permanent hardness of water.

Ans. (i) Sodium carbonate is an acidic salt.

(c) Sodium carbonate reacts with dilute hydrochloric acid to form

(i) oxygen gas.

(ii) hydrogen gas.

(iii) chlorine gas.

(iv) salt, water, and carbon dioxide.

Ans. (iv) salt, water, and carbon dioxide.

(d) When a few drops of phenolphthalein are added to an aqueous solution of sodium carbonate, the colour of the solution turns

(i) orange (ii) blue

(iii) light pink (iv) yellow

Ans. (iii) light pink

(e) Sodium carbonate decahydrate is commonly known as

(i) baking soda

(ii) washing soda

(iii) caustic potash

(iv) caustic soda

Ans. (ii) washing soda

Very Short Answer Type Questions

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

Ans. The sodium compound used for softening hard water is sodium carbonate (Na_2CO_3), commonly known as washing soda. It helps in precipitating calcium and magnesium ions, which are responsible for water hardness, thereby softening the water.

22. Which is more acidic, a solution of *p*H = 6.0 or a solution with *p*H 2.0?

Ans. A solution with pH 2.0 is more acidic than one with pH 6.0. Each decrease of 1 in pH represents a tenfold increase in hydrogen ion concentration. Therefore, pH 2.0 significantly more acidic.

23. During summer season, a milkman usually adds very small amount of baking soda to fresh milk. Give reason.

Ans. During summers temperature is high and hence the milkman adds baking soda to the milk to increase the *p*H of the solution as it is a base and neutralises the milk in summers.

24. What is the role of tartaric acid in baking powder?

Ans. The function of tartaric acid in baking powder is to neutralize sodium carbonate formed during heating. It helps to overcome the bitter taste of sodium carbonate.

25. Oxides of metals are basic while those of non-metals are acidic. Explain. **(CBSE 2010)**

Ans. Metallic oxides react with acids while non-metallic oxides react with bases to produce salt and water. This is why, non-metallic oxides are acidic and metallic oxides are basic in nature.

26. (a) A student has four samples A, B, C, D containing dil HCl, aqueous KCl, dil. NaOH and distilled water. Which two samples will show equal value of *p*H?

(b) How does the flow of acid rainwater into river makes the survival of aquatic life in the river difficult?

Ans. (a) Sample B and D will show equal value of *p*H because both are neutral.

(b) Acid rain water, if mixed with river water, lowers its *p*H below 5.6 and makes it acidic. But the living bodies in the river works

normally within a *p*H range of 7-7.8. This is why the flow of acid rain water into river makes the survival of aquatic life in the river difficult.

27. (a) Why is acetic acid (CH_3COOH) a weak acid even though it has four H-atoms in one molecule?

(b) The oxide of a metal M was water soluble. When a blue litmus strip was dipped in this solution, it did not undergo any change in colour. Predict the nature of the oxide.

Ans. (a) Acetic acid is a weak acid because only one of the four H-atoms of the acid is released as H^+ ion in solution.

(b) The metal oxide is basic in nature. It reacts with water to form metal hydroxide.

$$MO + H_2O \rightarrow M(OH)_2$$

Also, blue litmus does not change the colour in the basic medium.

28. While eating food, you spill some curry on your white shirt. You immediately scrub it with soap. What happens to its yellow colour on scrubbing with soap? Why? What happens to this stain if the shirt is washed with plenty of water?

Ans. The yellow stain of curry turns reddish-brown when soap is scrubbed on it because soap solution is basic in nature which changes the colour of turmeric in the curry stain to red-brown. This stain turns yellow again when the shirt is rinsed with plenty of water because then the basic soap gets removed with water.

29. Write the chemical formula of bleaching powder. How is bleaching powder prepared? For what purpose is it used in drinking water? **(CBSE 2016)**

Ans. Chemical formula of bleaching powder is $CaOCl_2$.

Preparation of bleaching powder:

$$Ca(OH)_2(s) + Cl_2(g) \rightarrow CaOCl_2(s) + H_2O(l)$$

Bleaching powder is used in water treatment for disinfecting drinking water to make it free of germs.

Short Answer Type Question

30. (a) Three acidic solutions A,B and C have *p*H = 0, 3 and 5 respectively.

(i) Which solution has highest concentration of H^+ ions?

(ii) Which solution has lowest concentration of H^+ ions?

(b) How can concentrated sulphuric acid be diluted? Describe the process.

Ans. (a) (i) Solution A has the highest concentration of H^+ ions with *p*H=0

(ii) Solution C has the lowest concentration of H^+ ions with *p*H=5

(b) Concentrated sulphuric acid can be diluted by adding the acid gradually into water. If water is added to the acid, It will be a highly reactive exothermic reaction and the vapour of the escaping acid can cause severe acid burns.

Long Answer Type Questions

31. (a) A compound X on heating at 373 K gives Y which is used for making chalk and for plastering fractured bones. 'Y' on mixing with water changes to X. Identify X and Y and write chemical reaction involved.

(b) State reasons for the following:

(i) Acidic solution has OH^- (aq) ions, but they are not basic.

(ii) Sodium chloride is a neutral salt.

(iii) A solution of sulphuric acid conducts electricity while that of alcohol does not.

Ans. (a) Gypsum ($CaSO_4 \cdot 2H_2O$) on heating gives plaster of paris which is used for making chalk and plastering fractured bones. Hence, compound X is gypsum and compound Y is plaster of Paris ($CaSO_4.1/2\ H_2O$).

$$\underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O(s)} \xrightarrow{373K} \underset{\text{Plaster of Paris}}{CaSO_4 \cdot 1/2H_2O(s)} + 3/2H_2O(g)$$

$$\underset{\text{Plaster of Paris}}{CaSO_4 \cdot 1/2\ H_2O(s)} + 3/2\ H_2O(l) \rightarrow \underset{\text{Gypsum (hard mass)}}{CaSO_4 \cdot 2H_2O}$$

(b) (i) Acidic solutions also contain hydroxide ions which come from dissociation of water. However, the concentration of hydroxide ions in acidic solutions is much less than that of H^+ ions.

(ii) Sodium chloride is a salt of strong acid and strong base so, it is neutral in nature.

(iii) When sulphuric acid is dissolved in water it dissociates to produce ions thus it conducts electricity while alcohol is weakly ionized in water and does not produce ions or H^+ ions. Hence, alcohol does not conduct electricity.

32. (a) What happens when magnesium carbonate reacts with dil. HCl? Give a balanced chemical reaction.

(b) 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 slaked Y, it gives the compound Z, used for disinfecting drinking water. Identify X, Y G and Z. Write balanced equation for each.

Ans. (a) $MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$

(b) X is calcium carbonate ($CaCO_3$).

Y is slaked lime [$Ca(OH)_2$].

G is chlorine gas.

Z is bleaching powder ($CaOCl_2$).

The reactions involved are:

$CaCO_3(s) + H_2SO_4(aq) \rightarrow CaSO_4(aq) + H_2O(l) + CO_2(\uparrow)$
(X)

$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O\ (l)$
(Y)

$Ca(OH)_2(s) + Cl_2(g) \rightarrow CaOCl_2(s) + H_2O(l)$
Slaked lime (Y) Chlorine (G) Bleaching powder (Z)

Let's Compete

(Page 51)

Multiple-Choice Questions

1. 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 remains the same.

(ii) The temperature of the solution decreases.

(iii) The temperature of the solution increases.

(iv) Salt formation takes place.

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

(c) i and iv (d) iv only

Ans. (a) The temperature of the solution increases and salt formation takes place.

2. Four test tubes were labelled as A, B, C and D. Dilute H_2SO_4 was taken in the test tube A. Dilute NaCl solution was taken in the test tube B. Dilute HCl was taken in the test tube C. Dilute NaOH solution was taken in the test tube D. A few pieces of granulated zinc were added to each of the test tubes A and B. A small amount of sodium carbonate crystals were added to each of the test tubes C and D. In which of the following test tubes, there would be rapid evolution of gas?

(a) C and D (b) A and B

(c) B and D (d) A and C

Ans. (d) In test tubes A and C there will be rapid evolution of gas.

3. Identify the false statement.

(a) Na_2O is an Arrhenius base.

(b) An aqueous solution of CH_3COONa is basic.

(c) An aqueous solution of NH_4Cl is acidic.

(d) An aqueous solution of $FeCl_3$ is acidic.

Ans. (a) Na_2O is an Arrhenius base.

4. Which of the following is not a natural indicator?

(a) Litmus (b) Phenolphthalein

(c) Turmeric (d) Red cabbage juice

Ans. (b) Phenolphthalein is a synthethic indicator.

5. Three test tubes were taken and they were labelled as I, II and III. Ethanoic acid was taken in the test tube I, an aqueous solution of sodium carbonate was taken in the test tube II, and an aqueous solution of sodium hydrogencarbonate was taken in the test tube III. On dipping a *p*H paper in each of the solution, the colour of the *p*H paper in the test tubes I, II and III, respectively becomes

(a) orange, green, green. (b) green, blue, blue.

(c) blue, orange, orange. (d) orange, blue, blue.

Ans. (d)

6. Which of the following is an Arrhenius acid?

(a) HBr (b) SO_2

(c) CO_2 (d) $CaCO_3$

Ans. (a)

7. In which of the following reactions does water behave as an acid?

(a) $H_2O + NH_3 \rightarrow NH_4^+ + OH^-$

(b) $H_2O + HNO_3 \rightarrow H_3O^+ + NO_3^-$

(c) $H_2O + H_2S \rightarrow H_3O^+ + HS^-$

(d) $H_2O + HCl \rightarrow H_3O^+ + Cl^-$

Ans. (a)

8. Which of the following occurs when a small amount of acid is added to water?

(i) Ionisation (ii) Neutralisation

(iii) Dilution (iv) Salt formation

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

(c) i and iii (d) i and ii

Ans. (c)

9. An aqueous solution with *p*H zero is

(a) acidic. (b) alkaline.

(c) neutral. (d) amphoteric.

Ans. (a) An aqueous solution with *p*H zero is acidic.

10. Which of the following is not a base?

(a) KOH (b) $Ca(OH)_2$

(c) K_2SO_4 (d) ZnO

Ans. (c) Potassium sulphate (K_2SO_4) is a salt.

Life Skills

(Page 52)

1. A student found that bad odours were coming out of his younger brother's mouth. He advised his younger brother not to eat sweet-tasting foods and chocolates. He also told him to brush his teeth two times everyday, in the morning and at night after having dinner, using a fluoride toothpaste.

(a) Why is bad odour produced in our mouth after eating sweet-tasting foods and chocolates?

(b) How are cavities formed in our teeth?

(c) How can the formation of cavities in our teeth be prevented?

(d) What values did the student display by telling his brother not to eat sweet-tasting foods and to brush his teeth twice everyday using a fluoride toothpaste?

Ans. (a) Carbohydrates and food particles which remain in our mouth after eating sweet-tasting food are degraded by bacteria to produce acids. These acids react with calcium phosphate present in our tooth enamel which results in cavities and bad odour in our mouth.

(b) Cavities are formed when the *p*H of the mouth falls below 5.5. The carbohydrate and food particles which remain in our mouth after eating are degraded by bacteria to produce acids. These acids corrode the tooth enamel which results in cavities.

(c) Formation of cavities can be prevented by cleaning the mouth after eating, avoiding eating excessive sweet-tasting foods and brushing the teeth two times preferably using a fluoride toothpaste.

(d) The student displayed care for his younger brother and also scientific awareness by telling his brother not to eat sweet-tasting foods and brushing his teeth twice everyday.

2. Sodium chloride was used as an important symbol in our freedom struggle. Mahatma Gandhi and his followers did *Dandi March* in order to stop the British Government from increasing the price of common salt used daily by Indian people.

(a) What is rock salt? How is it formed?

(b) How is sodium chloride prepared and purified?

(c) What are the uses of common salt?

(d) What values did Mahatma Gandhi and his followers display by doing *Dandi March*?

Ans. (a) Sodium chloride occurs in nature as large brown crystals due to the presence of various impurities. This natural brown salt is known as rock salt. It occurs as beds under the earth, which are believed to be formed due to the drying of seas in prehistoric times.

(b) The main source of sodium chloride is sea water. It is prepared by evaporation of sea water followed by fractional crystallisation when it is separated from impurities such as KCl, $MgCl_2$, $MgSO_4$, etc.

(c) Common salt is used

(i) for cooking food

(ii) as a raw material in the manufacture of variety of chemicals such as sodium hydroxide, sodium hydrogen carbonate, sodium carbonate, etc.

(d) By doing the *Dandi March*, Mahatma Gandhi and his followers displayed the qualities of courage, truthfulness and devotion to his motherland and the people.

3. Kamla was playing in the garden. She was stung by a wasp and started crying. Her mother immediately applied a coating of toothpaste on the affected area and then took her to the doctor.

(a) Why did Kamla cry?

(b) What does wasp-sting contain?

(c) Why did her mother apply toothpaste on the affected area?

(d) What values are displayed in this episode?

Ans. (a) Kamla cried because she was stung by the wasp.

(b) Wasp sting contains formic acid.

(c) By applying toothpaste, the effect of formic acid can be neutralised.

(d) Scientific temperament, alertness, care for others, etc.

3

Metals and Non-metals

Checkpoint (Page 56)

1. Define elements and compounds.

Ans. An element is defined as the basic form of matter which cannot be broken down further into simpler substances by chemical reactions. It is made up of only one type of particles. Carbon, hydrogen, gold and silver are some examples of elements.

A compound, on the other hand, is a pure substance formed when two or more elements combine with each other in a fixed proportion. Carbon dioxide, water, ammonia and sulphur dioxide are some examples of compounds.

2. What is the difference between the physical state of metals and non-metals at room temperature?

Ans. All metals (except mercury) exist as solids at room temperature. On the other hand, non-metals exist as solids, liquids, and gases at room temperature.

3. What are noble metals?

Ans. Noble metals are the metals which are inert in nature. They do not react easily. Gold, silver and platinum are examples of inert metals.

4. What do you mean by malleability and ductility?

Ans. The property of materials by which they can be beaten into thin sheets is known as malleability. On the other hand, the property of materials by which they can be drawn into wires is known as ductility.

Metals are malleable as well as ductile in nature.

5. What do you understand by corrosion?

Ans. The deterioration of metals caused as a result of their chemical reactions with moisture, gases and chemicals is known as corrosion. For example, when iron objects are left in the open for some time, they get covered with a reddish-brown flaky layer known as rust.

6. Name the non-metal which is used in antiseptic solutions.

Ans. Iodine is the non-metal used in antiseptic solutions.

7. What are metalloids?

Ans. The elements that exhibit the properties of both metals and non-metals are known as metalloids. Boron, silicon, and arsenic are some examples of metalloids.

8. Name a metal which is liquid at room temperature.

Ans. Mercury is the metal that exists as a liquid at room temperature.

9. Name a non-metal which is liquid at room temperature.

Ans. Bromine is the non-metal that exists as a liquid at room temperature.

10. Give the names of the most abundant and the rarest elements in the earth's crust.

Ans. The most abundant element in the earth's crust is oxygen and the rarest element is astatine.

Check Your Progress 1

(Page 64)

Multiple-Choice Questions

1. The colour of the solution observed after 30 minutes of placing zinc metal to copper sulphate solution is **(CBSE SP 2024)**

(a) Blue (b) Colourless

(c) Dirty green (d) Reddish Brown

Ans. (b) When zinc metal is placed in a copper sulphate ($CuSO_4$) solution, a displacement reaction occurs. Zinc displaces copper from the solution, forming zinc sulphate and copper metal. The solution will turn colourless.

2. Oxides of aluminium and zinc are **(CBSE 2024)**

(a) acidic (b) basic

(c) amphoteric (d) neutral

Ans. (c) Both aluminum oxide (Al_2O_3) and zinc oxide (ZnO) are amphoteric, meaning they can react with both acids and bases. This characteristic allows them to exhibit acidic and basic properties depending on the conditions.

3. On adding dilute sulphuric acid to a test tube containing a metal 'X', a colourless gas is produced when a burning match stick is brought near it. Which of the following correctly represents metal 'X'? **(CBSE SP 2024)**

(a) Sodium (b) Sulphur

(c) Copper (d) Silver

Ans. (a) Sodium. When dilute sulphuric acid is added to sodium metal, hydrogen gas is released, which is colourless. If a burning matchstick is brought near the gas, it will produce a popping sound, indicating the presence of hydrogen gas. This reaction is characteristic of sodium.

4. Which of the following elements will not displace hydrogen from dilute HCl?

(a) Calcium (b) Magnesium

(c) Lead (d) Copper

Ans. (d) Copper

5. Identify the incorrect statement about metals.

(a) Metals are reducing agents.

(b) Metals are electropositive.

(c) Metals form basic or amphoteric oxides.

(d) Metals do not lose electrons easily.

Ans. (d) Metals do not lose electrons easily.

6. Which of the following metals does not liberate hydrogen from dilute acids?

(a) Copper (b) Tin

(c) Iron (d) Aluminium

Ans. (a) Copper

7. Copper is used for making cooking utensils. Which of the following physical properties of copper is NOT responsible for the same? **(CBSE 2023)**

(a) Malleability (b) High melting point

(c) Thermal conductivity (d) High reactivity

Ans. (d) Copper is used for making cooking utensils due to its malleability, high melting point, and excellent thermal conductivity. However, high reactivity is not a desirable property for cooking utensils, as it would lead to unwanted chemical reactions with food or other substances.

8. A metal and a non-metal that exists in a liquid state at room temperature are respectively **(CBSE 2024)**

(a) Bromine and Mercury

(b) Mercury and Iodine

(c) Mercury and Bromine

(d) Iodine and Mercury

Ans. (c)

- Mercury is the only metal that exists in a liquid state at room temperature.
- Bromine is a non-metal that also exists as a liquid at room temperature.

Thus, Mercury and Bromine are the correct pair of metal and non-metal that are liquid at room temperature.

Very Short Answer Type Questions

9. Arrange the following in decreasing order of reactivity: Na, Ag, Cu, Mn, Fe, Al

Ans. The arrangement of the given metals in the decreasing order of reactivity is as follows:

Na > Al > Mn > Fe > Cu > Ag

10. Name two most malleable metals.

Ans. Gold and silver are the most malleable metals.

11. Give an example of a metal which (a) can be easily cut with a knife (b) is a liquid at room temperature.

Ans. (a) Potassium is a soft metal that can be cut easily with a knife.

(b) Mercury is the metal that exists as a liquid at room temperature.

12. A non-metal X exists in two different forms, Y and Z. Y is the hardest natural substance, whereas Z is a good conductor of electricity. Identify X, Y and Z. **(CBSE 2011)**

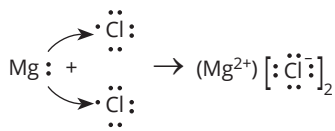
Ans. The non-metal X is carbon. Diamond, a form of carbon, is the hardest natural substance. On the other hand, graphite, another form of carbon, is a good conductor of electricity. So, Y is diamond and Z is graphite.

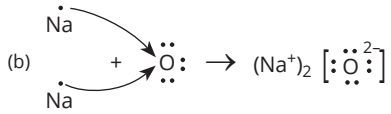
13. In nature, aluminium is found in combined state, while silver/gold is found in free state. Give reason. **(CBSE 2011)**

Ans. Aluminium is a very reactive metal. It reacts with different elements such as oxygen, chlorine and phosphorus to form compounds. On the other hand, gold and silver are non-reactive metals. They do not react easily with other elements. This is why aluminium is found in combined state in nature while gold and silver are found in free state in nature.

14. Show the formation of (a) Magnesium chloride (b) Sodium oxide by drawing electron-dot structure of Na, O, Cl, Mg and transfer of electrons.

Ans. (a)



(b) 

15. What are amphoteric oxides? Give two examples of amphoteric oxides with balanced chemical reactions. **(CBSE 2012)**

Ans. Oxides that show the properties of both acidic and basic oxides are known as amphoteric oxides. Zinc oxide (ZnO) and aluminium oxide (Al_2O_3) are examples of amphoteric oxides. The reactions of zinc oxide and aluminium oxide with acids and bases are as follows:

$$ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$$

$$ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$$

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

$$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$$

16. You are provided two containers made of copper and aluminium. You are provided solutions of dil. HCl, dil. HNO_3, $ZnCl_2$, and H_2O. In which of the above containers these solutions can be kept? Give reasons.

Ans. Aluminium is more reactive than both zinc and hydrogen. Hence if zinc chloride solution is stored in an aluminium container, aluminium will displace zinc from zinc chloride. Aluminium will also displace hydrogen from dilute hydrochloric acid, nitric acid and water.

On the other hand, copper is less reactive than both hydrogen and zinc. It will not be able to displace either of them from the solutions of their compounds. Hence dilute HCl, dil. HNO_3, $ZnCl_2$, and H_2O should be kept in copper containers.

17. You have two beakers 'A' and 'B' containing copper sulphate solution. What would you observe after about 2 hours if you dip a strip of zinc in beaker 'A' and a strip of silver in beaker 'B'? Give reason for your observations in each case. **(CBSE 2024)**

Ans. In beaker A, the zinc strip will gradually dissolve, and copper metal will begin to deposit on the surface of the zinc strip. Reason: Zinc is more reactive than copper.

In beaker B, no noticeable change occurs. The silver strip will not dissolve, and no copper will deposit on the silver. Reason: Silver is less reactive than copper.

Short Answer Type Questions

18. What happens when

(a) aluminium oxide reacts with sodium hydroxide?

(b) steam is passed over red hot iron?

(c) magnesium reacts with very dilute nitric acid?

Write balanced chemical equation for each.

Ans. (a) Aluminium oxide is an amphoteric oxide. It reacts with sodium hydroxide to form sodium aluminate and water.

$$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$$

(b) When steam is passed over red hot iron, iron oxide and hydrogen gas are formed.

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

(c) Magnesium reacts with very dilute nitric acid to form magnesium nitrate and hydrogen gas.

$$Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$$

19. Explain the reactions of different metals with hot water, cold water and steam. Give one example with a proper balanced chemical equation. Name two metals which do not react with any form of water.

Ans. Sodium and potassium are very reactive metals. They react violently with cold water to form the respective metal hydroxide and hydrogen gas.

$$2K + 2H_2O \rightarrow 2KOH + H_2$$

Magnesium does not react with cold water. It reacts with hot water to form magnesium hydroxide and hydrogen gas.

$$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$$

Metals such as aluminium, iron, and zinc neither react with cold water nor with hot water. They react with steam to form the respective metal oxide and hydrogen gas.

$$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$$

Copper and silver do not react with any form of water.

20. P, Q and R are three elements which undergo chemical reactions according to the following equations:

(a) $P_2O_3 + 2Q \rightarrow Q_2O_3 + 2P$

(b) $3RSO_4 + 2Q \rightarrow Q_2(SO_4)_3 + 3R$

(c) $3RO + 2P \rightarrow P_2O_3 + 3R$

Answer the following questions:

(i) Which element is most reactive?

(ii) Which element is least reactive?

(iii) State the type of reaction listed above.

(CBSE 2016)

Ans. (i) Equations (a) and (b) suggest that element Q can replace element P and element R from their respective compounds. Hence element Q is the most reactive.

(ii) Equations (a) and (b) suggest that out of elements P, Q, and R, element Q is the most reactive. Equation (c) suggests that element P can replace element R from its oxide. This will only be possible when element P will be more reactive than element R. Hence, element R is least reactive.

(iii) In the given chemical equations, one element is replacing the other element from its compound. Hence the type of reactions given is displacement reactions.

21. An element 'M' with electronic configuration 2, 8, 3 combines separately with Cl^-, SO_4^{-2} anions. Write the chemical formulae of the compounds formed. Predict with the suitable reason the nature of the bond formed by element 'M' in general. How will the electrical conductivity of the compounds formed vary with respect to 'M'? **(CBSE 2023)**

Ans. The electronic configuration of the element 'M' is 2, 8, 3. The element is Aluminum (Al). Aluminum typically forms a +3 ion (Al^{3+}) by losing its three valence electrons to achieve a stable electronic configuration like that of a noble gas.

Combination with Chloride ion (Cl^-): The chloride ion (Cl^-) has a charge of −1. Chemical formula of the compound is $AlCl_3$.

Combination with Sulphate ion (SO_4^{2-}): The sulphate ion (SO_4^{2-}) has a charge of –2. Two Al^{3+} ions will combine with three sulphate ions to form $Al_2(SO_4)_3$.

The bonds formed are ionic bonds. Aluminum donates its electrons, while chlorine and sulphate ions accept electrons, and there is electrostatic attractions between them.

Electrical conductivity: In the solid state, neither $AlCl_3$ nor $Al_2(SO_4)_3$ conducts electricity. In the molten state or in aqueous solution, both compounds will conduct electricity due to the free movement of ions.

Long Answer Type Questions

22. Account for the following:

(a) Metal oxides are amphoteric in nature.

(b) Hydrogen gas is not evolved when Zn metal reacts with dilute nitric acid.

(c) NaCl is not a conductor of electricity in solid state whereas it does conduct electricity in molten state.

(d) Metals replace hydrogen from acids but non-metals do not.

(e) Sodium metal is stored under kerosene.

Ans. (a) Some metal oxides show the properties of acidic as well as basic oxides. Such oxides are known as amphoteric oxides. Zinc oxide and aluminium oxide are examples of amphoteric oxides.

(b) Nitric acid is a strong oxidising agent. On reaction with metals, it oxidises the hydrogen produced to water and itself gets reduced to any of the nitrogen oxides. This is why hydrogen gas is not evolved when zinc reacts with dilute nitric acid.

(c) NaCl does not conduct electricity in the solid state because the movement of ions is not possible in the solid state due to the rigid structure of solids. In the liquid state, the electrostatic forces of attraction between the oppositely charged ions are overcome due to heat. Thus the ions can move freely and conduct electricity.

(d) Metals which are above hydrogen in the activity series displace hydrogen from acids but non-metals do not displace hydrogen from acids because they do not have a tendency to lose electrons to the hydrogen ions to reduce them to hydrogen gas.

(e) Sodium is a very reactive metal. It reacts vigorously with oxygen and moisture. A lot of heat is generated in the reaction and sodium may even catch fire when left in the open. Hence to protect sodium and to prevent accidental fires, sodium is stored under kerosene.

23. Sample pieces of five metals A, B, C, D, and E are added to the tabulated solutions separately. The results observed are shown in the table:

Metal	$FeSO_4$	$CuSO_4$	$ZnSO_4$	$AgNO_3$	$Al_2(SO_4)_3$
A	No change	No change	No change	A coating on the metal	No change
B	A grey deposit on the metal	A brown coating on the metal	No change	A coating on the metal	No change
C	No change	No change	No change	No change	No change
D	No change	-	No change	A coating on the metal	No change
E	-	Brown coating	New coating	New coating	No change

Based on the observation recorded in the table, answer the following:

(a) Which is the most reactive metal?

(b) Which is the least reactive metal?

(c) What would you observe if metal D were added to solution of copper (II) sulphate?

(d) What would you observe if metal E were added to a solution of iron(II) sulphate?

(e) Arrange the metals A, B, C, D and E in order of decreasing reactivity?

Ans. (a) Out of the given metals, only in case of metal E, a new coating was formed when it reacted with zinc sulphate. This suggests that metal E

has displaced zinc from zinc sulphate, and is the most reactive among metals A, B, C, D and E.

(b) The least reactive metal is metal C, because it could not displace any metal from their salt solutions.

(c) Metal D could only displace silver from silver nitrate solution. This suggests that metal D is less reactive than aluminium and zinc. The activity series suggests that metal D could be iron. So, when iron is added to copper sulphate solution, it will displace copper to form iron sulphate and copper metal. The colour of the solution will change from blue to pale green and the displaced copper will be deposited on the iron.

(d) The data given in the table suggests that metal E is more reactive than copper, zinc, and silver. If it is more reactive than zinc, then it must also be more reactive than iron. This suggests that element E is aluminium. So, when element E will be added to ferrous sulphate solution, it will displace iron and form aluminium sulphate. The colour of the solution will also change from pale green to colourless.

$$3FeSO_4 + 2Al \rightarrow Al_2(SO_4)_3 + 3Fe$$

(e) The order of reactivity of metals A to E is E > B > D > A > C.

Check Your Progress 2

(Page 73)

Multiple-Choice Questions

1. The process of heating an ore in the absence of air below its melting point is called

(a) calcination. (b) roasting.

(c) pyrolysis. (d) ore dressing.

Ans. (a) calcination.

2. Sodium is obtained by

(a) heating its oxide

(b) reduction of its oxide with carbon

(c) electrolysis of molten NaCl

(d) none of these

Ans. (c) electrolysis of molten NaCl

3. Galvanisation is a method of protecting iron from rusting by coating with a thin layer of

(a) zinc (b) gallium

(c) silver (d) aluminium

Ans. (a) zinc.

4. Roasting is done generally in the case of

(a) carbonate ore (b) sulphide ore

(c) oxide ore (d) silicate ore

Ans. (b) sulphide ore

5. In the thermite process, the reducing agent used is

(a) calcium (b) sodium

(c) coke (d) aluminium powder

Ans. (d) aluminium powder

6. Electrolytic reduction is used in the extraction of

(a) highly electropositive elements

(b) highly electronegative elements

(c) noble metals

(d) transition metals

Ans. (a) highly electropositive elements

7. A metal 'X' is used in thermite process. When X is burnt in air it gives an amphoteric oxide 'Y'. 'X' and 'Y' are respectively: **(CBSE 2023)**

(a) Fe and Fe_2O_3 (b) Al and Al_2O_3

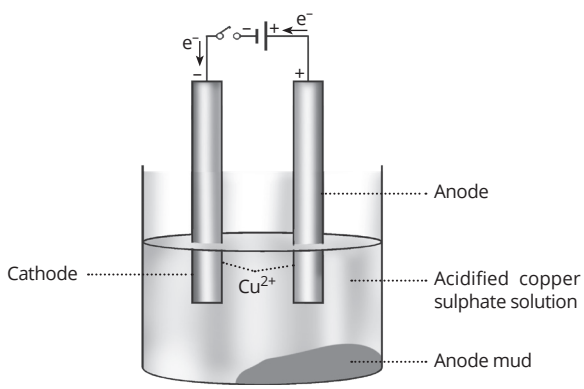
(c) Fe and Fe_3O_4 (d) Al and Al_3O_4

Ans. (b) Al and Al_2O_3. Reason: Aluminium is used in thermite process. When aluminium is heated in oxygen it forms aluminium oxide which is amphoteric in nature.

$4Al + 3O_2 \rightarrow 2Al_2O_3$

8. The following diagram shows the electrolytic refining of copper:

Which of the following statements is **incorrect** description of the process? **(CBSE 2023)**



(a) The impure metal from the anode dissolves into the electrolyte.

(b) The pure metal from the electrolyte is deposited on the cathode.

(c) Insoluble impurities settle down at the bottom of the anode.

(d) On passing the current through the electrolyte, the pure metal from the anode dissolves into electrolyte.

Ans. (d) In the process of electrolytic refining of copper, the impure metal (not pure metal) dissolves from

the anode into the electrolyte. The pure metal then gets deposited on the cathode.

Explanation: (a) is correct: The impure metal dissolves from the anode into the electrolyte. (b) is correct: The pure metal gets deposited on the cathode. (c) is correct: Insoluble impurities settle at the bottom of the anode as sludge.

So, the incorrect statement is (d) because it implies that pure metal dissolves, which is not the case.

9. Which of the following metals do not corrode in moist air? **(CBSE 2023)**

(a) Copper (b) Iron

(c) Gold (d) Silver

Ans. (c) Gold is a noble metal and does not corrode or tarnish in moist air, unlike metals like iron, which rust, or silver, which tarnishes. Copper may develop a patina over time due to oxidation but does not corrode in the same way as iron.

Very Short Answer Type Questions

10. A galvanised article is protected against rusting even if zinc coating is broken. Comment.

Ans. A galvanised article is protected against rusting even if the zinc coating is broken. When the zinc coating gets a crack, zinc continues to get corroded in preference to iron since zinc is more reactive than iron.

11. What is gangue?

Ans. Ores mined from the earth are generally contaminated with many impurities such as sand and soil. These impurities are known as gangue.

12. Write a chemical reaction to show that aluminium can be used as a reducing agent. **(CBSE 2001)**

Ans. When aluminium is made to react with manganese dioxide, aluminium oxide and manganese are obtained. Aluminum acts as a reducing agent in this reaction.

$$3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3 + Heat$$

13. Which property makes solder suitable for welding electrical wires? **(CBSE 2010)**

Ans. Solder is an alloy of tin and lead. It has a low melting point. This property of solder is useful for welding electrical wires.

14. Generally alloys are used in electrical engineering devices instead of pure metals. Why is it so?

Ans. Alloys generally have higher melting and boiling points and are more stable towards oxidation than pure metals. This is why generally alloys are used in electrical devices instead of pure metals.

15. What is an alloy? Give the composition and one use of each of the following:

(a) Brass (b) Solder

Ans. An alloy is a homogeneous mixture of two or more metals or a metal and a non-metal.

(a) Brass is an alloy of copper and zinc. It is used in making castings, sheets, tubes and decoration items.

(b) Solder is an alloy of tin and lead. It is used for welding electrical wires together.

16. Give reasons for the following:

(a) Carbon is not used for reducing Al from aluminium oxide.

(b) In nature, aluminium is found in combined state whereas gold is found in free state.

Ans. (a) Aluminium is a highly reactive metal. It has more affinity for oxygen than carbon. This is why carbon is not used for reducing aluminium oxide to aluminium.

(b) Aluminium is a very reactive metal. It reacts with different elements to form compounds. On the other hand, gold is an inert metal. It does not react with other elements easily. This is why aluminium is found in combined state in nature while gold is found in free state in nature.

17. Differentiate between roasting and calcination process giving an example of each.

Ans. Roasting is the process in which the concentrated ore is strongly heated below its melting point in the presence of excess of air. It is done for sulphide ores such as zinc blende (ZnS) and cinnabar (HgS).

Calcination is the process in which the concentrated ore is heated strongly below its melting point in the absence or limited supply of air. It is used for carbonate ores such as limestone ($CaCO_3$) and zinc carbonate ($ZnCO_3$).

18. How do properties of iron change when:

(a) a small quantity of carbon is mixed with it?

(b) nickel and chromium are mixed with it?

Ans. (a) When iron is mixed with a small quantity of carbon, it becomes hard and strong.

(b) When a small amount of nickel and chromium are added to iron, it becomes very hard and does not rust.

Short Answer Type Questions

19. Give reasons for the following:

(a) Platinum, gold and silver are used to make jewellery.

(b) Aluminium is more reactive than iron but its corrosion is less than iron.

(c) Silver metal does not easily react with oxygen but silver jewellery tarnishes after some time.

Ans. (a) Platinum, gold and silver are used to make jewellery because these are very lustrous metals. They are rare, highly malleable and ductile. They are also inert metals and do not corrode easily.

(b) Aluminium, when exposed to air for some time, develops a thin layer of aluminium oxide (Al_2O_3) on its surface. This layer prevents its further corrosion. This is why aluminium, though more reactive than iron, corrodes slower than iron.

(c) Silver is an inert metal. This is why it does not react with oxygen easily. However, when silver articles are left open in the air, they react with sulphur to form a coating of silver sulphide. This coating imparts them a black colour.

20. A student was given Mn, Zn, Fe and Cu metals. Identify which of them

(a) will not displace hydrogen from dil. HCl.

(b) will react only with steam to give hydrogen.

(c) will give hydrogen with 5% nitric acid.

Write the chemical reactions involved in each case.

Ans. (a) Out of the given metals, copper will not displace hydrogen from dilute HCl because it is less reactive than hydrogen.

(b) Out of the given metals, zinc and iron will react with steam to form hydrogen.

$$Zn + H_2O \rightarrow ZnO + H_2$$

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

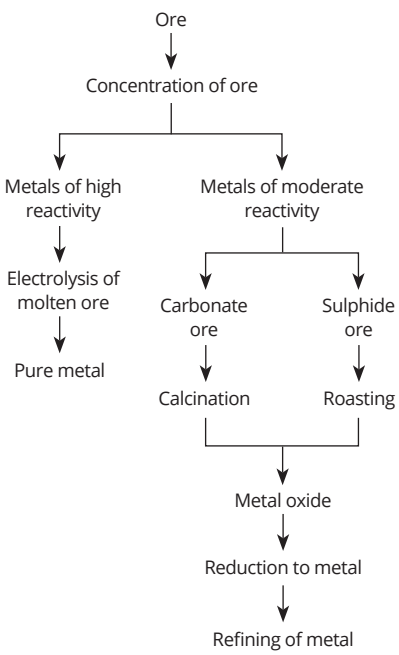
(c) Out of the given metals, only manganese will give hydrogen gas on reaction with 5% nitric acid.

$$Mn + 2HNO_3 \rightarrow Mn(NO_3)_2 + H_2$$

Long Answer Type Questions

21. Draw a flow chart to show extraction of metals of medium and high reactivity from their ores.

Ans.



22. (a) What is an alloy? How does it differ from an amalgam?

(b) A metal M found in nature as sulphide ore (M_2S), is one of the good conductors of heat and electricity and used in making electrical wires.

(i) Identify the metal M.

(ii) Write the balanced chemical reaction involved in the process of extraction of the metal.

(iii) Draw a labelled diagram to show the refining of this metal.

Ans. (a) An alloy is a homogeneous mixture of two or more metals or a metal and a non-metal. Amalgam is an alloy in which one of the metals is mercury.

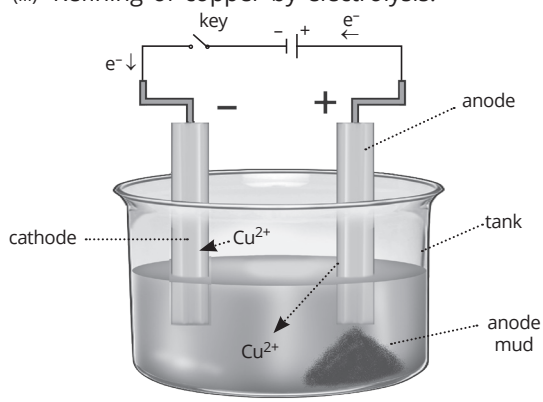
(b) (i) The metal M is copper and its ore is Cu_2S.

(ii) Copper is obtained from its ore by heating the ore in air. The equations involved are as follows:

$$2Cu_2S + 3O_2 \xrightarrow{Heat} 2Cu_2O + 2SO_2$$

$$2Cu_2O + Cu_2S \xrightarrow{Heat} 6Cu + SO_2$$

(iii) Refining of copper by electrolysis:



Higher Order Thinking Skills (HOTS) Questions

(Page 76)

1. Native metals like gold and platinum are insoluble in mineral acids but they are soluble in a solution. Name the solution and give its composition.

Ans. The solution in which native metals are soluble is aqua regia. It is a mixture of concentrated nitric acid and concentrated hydrochloric acid in the ratio 1:3.

2. A metal 'A' does not react with dil. HCl and dil. H_2SO_4. It forms a black coating of oxide 'B' on heating. It reacts with conc. H_2SO_4 to produce a gas which smells like burning sulphur. Identify 'A' and 'B'.

Ans. Since the metal does not react with either dilute HCl or dilute H_2SO_4, it suggests that the metal

A is less reactive than hydrogen. The oxide of copper is black in colour. Hence, metal A is copper. It reacts with concentrated H_2SO_4 to form sulphur dioxide gas, which smells like burning sulphur. Thus, A is copper and B is copper oxide. The equation for the reaction of copper with concentrated H_2SO_4 is as follows:

$$Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$$

3. An element 'A' forms an oxide having formula AO_2, which when dissolved in water turns blue litmus red. Predict whether 'A' is a metal or non-metal. Give reason for your answer.

Ans. Since the oxide turns blue litmus red, it means that the oxide is acidic in nature. Acidic oxides are formed by non-metals. Therefore, element 'A' is a non-metal.

Self-Assessment

(Page 76)

Multiple-Choice Questions

1. Which of the following metals does not react with cold as well as hot water?

(a) Iron (b) Sodium
(c) Calcium (d) Magnesium

Ans. (a) Iron

2. Bauxite is the important ore of

(a) aluminium (b) iron
(c) copper (d) lead

Ans. (a) aluminium

3. A mineral is known as an ore of a metal if the metal

(a) can be produced from it.
(b) cannot be produced from it.
(c) is very costly.
(d) can be produced from it profitably.

Ans. (d) can be produced from it profitably.

4. Which of the following reactions is an example of calcination process?

(a) $CaCO_3 \rightarrow CaO + CO_2$
(b) $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$
(c) $2Zn + O_2 \rightarrow 2ZnO$
(d) $FeO + CO \rightarrow Fe + CO_2$

Ans. (a) $CaCO_3 \rightarrow CaO + CO_2$

Assertion–Reason Type Questions

For question numbers 5 to 14, two statements are given – one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

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

5. **Assertion:** Iron is generally not used in its pure state.

Reason: Pure iron is very hard and strong.

Ans. (c) Iron is generally not used in the pure state because pure iron is very soft and stretches easily when hot. Mixing it with a small percentage of carbon makes it hard and strong.

6. **Assertion:** Aqueous solution of sodium oxide turns red litmus blue.

Reason: Metal oxides are acidic in nature.

Ans. (c) Oxides of metals are generally basic in nature. Since sodium is a metal, its oxide will be basic in nature and aqueous solution of sodium oxide will turn red litmus blue.

7. **Assertion:** Hydrogen is not evolved when a metal (except Mg and Mn) reacts with dilute nitric acid.

Reason: Nitric acid is a strong oxidising agent.

Ans. (a) Nitric acid is a strong oxidising agent and oxidizes the hydrogen produced in its reaction with a metal to water and itself gets reduced to any of the oxides of nitrogen. However, magnesium and manganese react with very dilute nitric acid to produce hydrogen.

8. **Assertion:** Aluminium oxide forms a salt with dilute HCl but not with NaOH.

Reason: Aluminium oxide is an amphoteric oxide.

Ans. (d) Aluminium oxide is amphoteric in nature and it shows the properties of both acidic and basic oxides. Hence, it will react with both dilute HCl and NaOH to form salt and water.

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

$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

9. **Assertion:** Sodium metal is stored in kerosene oil.

Reason: Sodium is a very reactive metal.

Ans. (a) Sodium is a very reactive metal. It reacts vigorously with oxygen and may even catch fire when left open in the air. Thus, to prevent accidental fires, sodium is stored in kerosene oil.

10. **Assertion:** When a piece of clean copper wire is placed in aqueous zinc sulphate solution, the colour of zinc sulphate solution will turn blue after some time.

Reason: Copper is less reactive than zinc.

Ans. (d) Copper is less reactive than zinc, so, it cannot displace zinc from zinc sulphate solution. Thus, when a piece of copper wire is placed in aqueous zinc sulphate solution, no reaction will occur.

11. Assertion: Sodium chloride has a very high melting point.

Reason: Sodium chloride is an ionic compound.

Ans. (a) In ionic compounds, oppositely-charged ions are held together by strong electrostatic forces of attraction. This is why, ionic compounds have very high melting points.

12. Assertion: The reaction of aluminium and iron(III) oxide is used to join railway tracks.

Reason: Aluminium reacts with iron(III) oxide to form aluminium oxide and iron.

Ans. (b) Aluminium is more reactive than iron. On reaction with iron oxide, it reduces iron oxide to iron and itself gets oxidized to aluminium oxide.

$Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s) + Heat$

This reaction is exothermic in nature and the amount of heat evolved is so large that the iron produced is obtained in the molten state. This is why, the reaction between aluminium and iron oxide is used to join cracked railway tracks.

13. Assertion: Metals placed towards the top of the reactivity series cannot be obtained from their oxides by heating with carbon.

Reason: Highly reactive metals are volatile in nature.

Ans. (c) Metals placed towards the top of the reactivity series are very reactive in nature. They cannot be obtained from their oxides by heating with carbon because they have more affinity for oxygen than carbon. They are obtained by electrolytic reduction.

14. Assertion: An alloy of copper and tin is used for making bells.

Reason: Metals are malleable and ductile.

Ans. (b) Metals are sonorous, that is, they produce a ringing sound when struck with a hard substance. An alloy of copper and tin, which contains tin in the higher amount, is used for making bells.

15. Assertion: Hydrogen gas is not evolved when zinc reacts with nitric acid. **(CBSE 2023)**

Reason: Nitric acid oxidises the hydrogen gas produced to water and itself gets reduced.

Ans. (a) Hydrogen gas is not evolved when zinc reacts with concentrated nitric acid.

Zinc displaces hydrogen ions from the acid and produce H_2. Nitric acid is a strong oxidising agent and oxidises the hydrogen gas (H_2) to water (H_2O). At the same time, nitric acid is reduced to nitrogen oxides.

16. Assertion: Rusting of Iron is endothermic in nature. **(CBSE SP 2024)**

Reason: As the reaction is slow, the release of heat is barely evident.

Ans. (d) Assertion is false but reason is correct.

Rusting of iron is an exothermic reaction, meaning it releases energy (heat) as iron reacts with oxygen and water. Since it is a slow reaction the release of heat is barely evident.

The reason is correct, but it does not justify the assertion because the assertion itself is incorrect.

Source-based/Case-based/Passage-based/ Integrated assessment questions

Answer the questions on the basis of your understanding of the following paragraphs and the related studied concepts.

17. Aluminium is the most abundant metal in the earth's crust. It is a light-weight metal and is an excellent conductor of heat and electricity. At extremely low temperatures, it shows superconductivity. It has many desirable properties such as high malleability, ductility and mechanical strength. It also becomes passive on corrosion, which protects it from further corrosion. Anodising of aluminium is also done to make it resistant to corrosion. It is mainly used for making bodies of aircrafts and automobiles, in packaging material, for building and construction purposes and in making electrical wires.

I. (a) It is given that aluminium shows high malleability and ductility. What is the meaning of malleability and ductility?

(b) How is the oxide of aluminium different from other metal oxides?

(c) (i) Why does aluminium become passive on corrosion?

OR

(ii) What is anodising?

Ans. (a) The property by virtue of which materials can be beaten into thin sheets is known as malleability. The property which allows materials to be drawn into thin wires is known as ductility.

(b) Oxides of metals are generally basic in nature. However, aluminium oxide is amphoteric in nature, that is, it shows both acidic and basic properties. Hence, it reacts with both acids and bases to form salt and water.

(c) (i) When aluminium is left open in the air, it reacts with oxygen to form a thin layer of aluminium oxide on its surface. This layer of oxide prevents the further corrosion of aluminium.

OR

(ii) The process by which a thick layer of aluminium oxide is deposited on the

surface of aluminium objects is known as anodising. This layer makes the aluminium objects more resistant to corrosion.

II. (a) Name the property of aluminium by which it can be beaten into thin sheets.

(i) Malleability (ii) Ductility
(iii) Sonority (iv) Metallic lustre

Ans. (i) Malleability

(b) Aluminium is used for making cooking utensils because of its

(i) low melting point
(ii) mechanical strength
(iii) high malleability
(iv) high melting point

Ans. (iv) high melting point

(c) The process by which a thick layer of aluminium oxide is deposited on the surface of aluminium objects is known as

(i) corrosion (ii) metallurgy
(iii) anodising (iv) refining

Ans. (iii) anodising

(d) Which of the following chemical equations explains the basic character of aluminium oxide?

(i) $Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$
(ii) $2Al + 3H_2O \longrightarrow Al_2O_3 + 3H_2$
(iii) $Al_2O_3 + 6HCl \longrightarrow 2AlCl_3 + 3H_2O$
(iv) $4Al + 3O_2 \longrightarrow 2Al_2O_3$

Ans. (iii) $Al_2O_3 + 6HCl \longrightarrow 2AlCl_3 + 3H_2O$

(e) Which of the following statements is true?

(i) Aluminium oxide is only acidic in nature.
(ii) Aluminium oxide is only basic in nature.
(iii) Aluminium oxide is amphoteric in nature.
(iv) Aluminium oxide do not react with acids.

Ans. (iii) Aluminium oxide is amphoteric in nature.

18. Sulphur dioxide is a colourless and pungent gas. It is released into the air mainly by the combustion of coal in thermal power plants. Volcanic eruptions, extraction of metals from ores, small-scale industries and vehicles and locomotives which run on high-sulphur fuel also release sulphur dioxide into the air. It causes breathing problems and respiratory disorders in humans. It also reduces visibility by forming fine particles with other compounds which remain suspended in the air. It makes rain water acidic (acid rain) which destroys the vegetation cover and also harms aquatic life.

I. (a) Write the chemical equation for the formation of sulphur dioxide from sulphur and oxygen.

(b) How does sulphur dioxide react with water?

(c) (i) What will happen when a piece of dry blue litmus paper is placed in a gas jar containing only sulphur dioxide?

OR

(ii) How will sulphur dioxide react with sodium hydroxide solution?

Ans. (a) Sulphur burns in oxygen to form sulphur dioxide. The chemical equation for the reaction is as follows:

$S_8 + 8O_2 \rightarrow 8SO_2$

(b) Sulphur dioxide reacts with water to form sulphurous acid. The chemical equation for the reaction is as follows:

$SO_2 + H_2O \rightarrow H_2SO_3$

(c) (i) When a piece of dry blue litmus paper is placed in a gas jar containing sulphur dioxide, the colour of litmus paper will not change. This is because in the absence of water, sulphurous acid will not be formed.

OR

(ii) Sulphur dioxide is acidic in nature. It reacts with sodium hydroxide to form sodium sulphite and water.

$2NaOH + SO_2 \rightarrow Na_2SO_3 + H_2O$

II. (a) Sulphur burns in oxygen to form

(i) sulphur dioxide. (ii) sulphurous acid.
(iii) sulphur trioxide. (iv) sulphuric acid.

Ans. (i) sulphur dioxide.

(b) When a piece of dry blue litmus paper is placed in a gas jar containing sulphur dioxide, the colour of litmus paper

(i) turns red. (ii) will not change.
(iii) turns light pink. (iv) turns light brown.

Ans. (ii) will not change.

(c) Which of the following balanced chemical equations represents the reaction between sulphur dioxide and water?

(i) $2SO_2 + H_2O \longrightarrow H_2SO_4$
(ii) $SO_2 + H_2O \longrightarrow H_2SO_3$
(iii) $2SO_2 + H_2O \longrightarrow H_2SO_3$
(iv) $SO_2 + H_2O \longrightarrow H_2SO_4$

Ans. (iii) $2SO_2 + H_2O \longrightarrow H_2SO_3$

(d) Sulphur dioxide reacts with the solution of sodium hydroxide to form

(i) sodium sulphide and water.
(ii) hydrogen sulphide and water.
(iii) sodium sulphite and water.
(iv) sulphur trioxide and water.

Ans. (iii) sodium sulphite and water.

(e) A non-metal oxide like SO_2

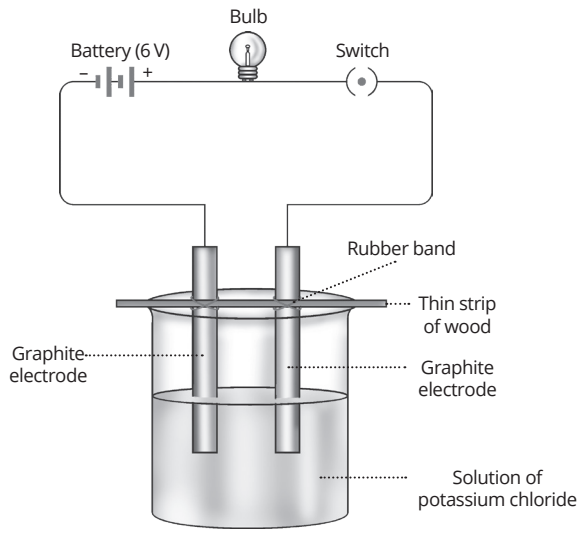
(i) turns blue litmus red.
(ii) is amphoteric in nature.

(iii) is basic in nature.

(iv) turns red litmus blue.

Ans. (i) turns blue litmus red.

19. Potassium chloride is a white crystalline ionic compound. It is highly soluble in water and has high melting and boiling points. It is mainly used for making fertilizers. It is also used in the manufacture of potassium hydroxide and potassium metal. Though potassium chloride is a poor conductor of electricity in the solid state, an aqueous solution of potassium chloride can conduct electricity.



I. (a) It is given that potassium chloride is an ionic compound. What are ionic compounds?

(b) Why does potassium chloride have high melting and boiling points?

(c) (i) Why does potassium chloride conduct electricity in the aqueous and molten state but not in the solid state?

OR

(ii) Give an example of a polar solvent in which ionic compounds are soluble.

Ans. (a) The compounds which are formed by the complete transfer of electrons from the metal atom to the non-metal atom are known as ionic compounds.

(b) Potassium chloride is an ionic compound. In ionic compounds, oppositely-charged ions are held together by strong electrostatic forces of attraction. A large amount of energy is required to break these forces. This is why, potassium chloride has high melting and boiling points.

(c) (i) Ionic solids have a rigid structure. However, in the molten and aqueous state, the ions are free to move. This is why, potassium chloride conducts electricity in the molten and aqueous state but not in the solid state.

OR

(ii) Ionic compounds are soluble in water which is a polar solvent.

II. (a) Identify the correct statement from the following.

(i) Ionic compounds are formed by the transfer of electrons between metals and non-metals.

(ii) Ionic compounds are generally soft.

(iii) Ionic compounds have low melting and boiling points.

(iv) Ionic compounds are generally soluble in kerosene oil.

Ans. (i) Ionic compounds are formed by the transfer of electrons between metals and non-metals.

(b) Potassium chloride has high melting and boiling points because

(i) it is a covalent compound.

(ii) its ions are held together by strong electrostatic forces of attraction.

(iii) its ions are held together by weak electrostatic forces of attraction.

(iv) it is highly soluble in water.

Ans. (ii) its ions are held together by strong electrostatic forces of attraction.

(c) A solid compound, which has high melting and boiling points, is highly soluble in water but shows poor solubility in non-polar solvents. This compound is formed by the transfer of electrons between the constituent atoms. Which of the following characteristics will be shown by this compound?

(i) The compound will conduct electricity in the solid state.

(ii) The compound will conduct electricity in the aqueous state.

(iii) The compound will not conduct electricity in the molten form.

(iv) The compound will conduct electricity due to the presence of free electrons.

Ans. (ii) The compound will conduct electricity in the aqueous state.

(d) Potassium chloride conducts electricity in the molten and aqueous state because

(i) the ions are held fixed in their positions.

(ii) the ions are able to move freely.

(iii) of its low solubility in water.

(iv) of its low melting point.

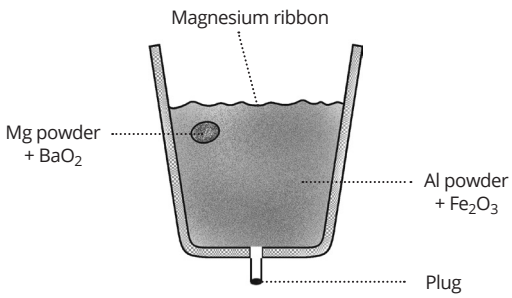
Ans. (ii) the ions are able to move freely.

(e) Which of the following is an example of polar solvent in which ionic compounds are highly soluble?

(i) Benzene
(ii) Chloroform
(iii) H_2O
(iv) CCl_4

Ans. (iii) H_2O

20. The reaction of iron oxide and aluminium is a highly exothermic reaction. The amount of heat produced in this reaction is so large that iron is obtained in the molten state. This reaction is known as thermit reaction and it is used for welding railway tracks. This reaction was discovered by Hans Goldschmidt, a German chemist.



I. (a) In thermit reaction, iron oxide is reduced to iron by aluminium. Give another example of a reaction where a highly reactive metal is used as a reducing agent.

(b) How can you classify thermit reaction other than redox reaction?

(c) (i) What do you mean by aluminothermy?

OR

(ii) What will happen if instead of iron oxide and aluminium, aluminium oxide and iron are used?

Ans. (a) An example of a reaction in which a more reactive metal is used as a reducing agent is as follows:

$3MnO_2 + 4Al \rightarrow 3Mn + Al_2O_3 + Heat$

(b) Other than redox reaction, the thermit reaction can be classified as displacement reaction.

(c) (i) The reduction of a metal oxide using aluminium as the reducing agent is known as aluminothermy.

OR

(ii) If in place of aluminium and iron oxide, aluminium oxide and iron are used, then no reaction will occur. This is because iron is a weaker reducing agent than aluminium.

II. (a) The thermit reaction can be classified as
(i) decomposition reaction
(ii) combination reaction
(iii) displacement reaction
(iv) double displacement reaction

Ans. (iii) displacement reaction

(b) Which of the following is an example of a reaction in which a more reactive metal is used as a reducing agent?
(i) $2H_2 + O_2 \longrightarrow 2H_2O$
(ii) $CaCO_3 \xrightarrow{heat} CaO + CO_2$
(iii) $3MnO_2 + 4Al \longrightarrow 3Mn + Al_2O_3 + Heat$
(iv) $2Cu + O_2 \xrightarrow{heat} 2CuO$

Ans. (iii) $3MnO_2 + 4Al \longrightarrow 3Mn + Al_2O_3 + Heat$

(c) In aluminothermic reduction process, aluminium is used as a/an
(i) oxidising agent
(ii) reducing agent
(iii) both oxidising as well as reducing agent
(iv) none of the above

Ans. (ii) reducing agent

(d) If in place of aluminium and iron oxide, aluminium oxide and iron are used, then
(i) FeO will be formed
(ii) Fe_2O_3 will be formed
(iii) Fe_3O_4 will be formed
(iv) no reaction will occur

Ans. (iv) no reaction will occur

(e) Aluminium is used in thermit welding because
(i) it is a light metal.
(ii) it has more affinity for oxygen.
(iii) it is a strong oxidising agent.
(iv) it is least reactive metal.

Ans. (ii) it has more affinity for oxygen.

21. Galvanisation is the process of coating iron and steel articles with a thin layer of zinc to protect them from rusting. There are different methods of galvanising iron articles such as electrogalvanising and thermal spraying. However, the most common method is hot-dip galvanising. In this method, the iron or steel object is cleaned and dipped in molten zinc. It is a fairly economical process and results in the formation of a strong layer of zinc on iron articles.

I. (a) What is rusting of iron?

(b) What are the conditions necessary for rusting to occur?

(c) (i) How does zinc prevent rusting of iron?

OR

(ii) Suggest any two ways, other than galvanisation, to protect iron from rusting.

Ans. (a) When iron objects are left in the open for some time, they get covered with a reddish-brown, flaky coating. This coating is known as rust and the process is known as rusting.

(b) The conditions necessary for rusting to occur are presence of air and presence of moisture.

(c) (i) Zinc reacts with oxygen to form zinc oxide. This layer prevents further corrosion of zinc. Thus, in galvanised iron, zinc oxide prevents air to come in contact with iron. Even if the zinc coating is broken, zinc corrodes in preference to iron (since it is more reactive than iron) and hence protects the underlying iron.

OR

(ii) Apart from galvanisation, the following methods can be used to prevent rusting of iron:
(i) Electroplating
(ii) Alloying with metals

II. (a) Rusting of iron involves
(i) physical reaction
(ii) chemical reaction
(iii) both physical and chemical reaction
(iv) none of the above

Ans. (ii) chemical reaction

(b) Which of the following represents a balanced chemical equation showing the rusting of iron?
(i) $2Fe + 3O_2 + xH_2O \longrightarrow 2Fe_2O_3{\cdot}xH_2O$
(ii) $2Fe + 3O_2 + xH_2O \longrightarrow Fe_2O_3{\cdot}xH_2O$
(iii) $4Fe + 3O_2 + xH_2O \longrightarrow 2Fe_2O_3{\cdot}xH_2O$
(iv) $4Fe + O_2 + xH_2O \longrightarrow 2Fe_2O_3{\cdot}xH_2O$

Ans. (iii) $4Fe + 3O_2 + xH_2O \longrightarrow 2Fe_2O_3{\cdot}xH_2O$

(c) In the process of rusting, the iron objects get covered with a
(i) black coating
(ii) reddish-grey coating
(iii) reddish-brown coating
(iv) green coating

Ans. (iii) reddish-brown coating

(d) The condition necessary for rusting to occur is the
(i) presence of air
(ii) presence of nitrogen dioxide
(iii) presence of sulphur dioxide
(iv) presence of carbon dioxide

Ans. (i) presence of air

(e) Rusting of iron can take place in
(i) ordinary water
(ii) distilled water
(iii) both ordinary and distilled water
(iv) none of the above

Ans. (iii) both ordinary and distilled water

Very Short Answer Type Questions

22. From amongst the metals sodium, calcium, aluminium, copper and magnesium, name the following.
(a) A metal which reacts with water only on boiling.
(b) A metal which does not react even with steam.

Ans. (a) Water on boiling forms steam. Out of sodium, calcium, aluminium, copper and magnesium, aluminium reacts with steam.
(b) Copper is the metal which will not react even with steam. This is because copper is less reactive than hydrogen.

23. Name one metal and one non-metal which are liquid at room temperature.

Ans. Mercury is the metal that exists as a liquid at room temperature, while bromine is the non-metal that exists as a liquid at room temperature.

24. Which one of the metal in the following group is (a) least reactive? (b) most reactive?

Au, Na, Cu, Ca

Ans. (a) Gold is the least reactive metal out of the given metals.
(b) Sodium is the most reactive metal out of the given metals.

25. Which element is alloyed with copper to make bronze?

Ans. Tin and zinc are alloyed with copper to make bronze.

26. Why does aluminium not react with water under ordinary conditions?

Ans. Under ordinary conditions, a thin layer of oxide is formed on the surface of aluminium. This layer renders the metal passive and prevents its further reaction. This is why aluminium does not react with water under ordinary conditions.

27. Why does the reactivity of aluminium decrease if it is dipped in nitric acid solution?

Ans. Nitric acid is a strong oxidising agent. When aluminium is dipped in dilute nitric acid solution, a thin layer of aluminium oxide is formed on the surface of the metal. This layer renders the metal passive and prevents its further reaction. This is why the reactivity of aluminium decreases when it is dipped in dilute nitric acid solution.

28. Give reasons for the following:
(a) Metals can be given different shapes according to our needs.
(b) Carbonates and sulphide ores are usually converted into oxides prior to reduction during the process of extraction.

Ans. (a) Metals are highly malleable and ductile materials. They can be beaten into thin sheets and also drawn into wires. This is why metals can be given different shapes according to our needs.
(b) Carbonates and sulphide ores are usually converted into oxides prior to reduction during the process of extraction because it is easier to

obtain a metal from its oxide as compared to its sulphides and carbonates.

29. (a) What is galvanisation?

(b) Why is gold alloyed with copper? Explain.

Ans. (a) The process of coating iron and steel objects with a thin layer of zinc to protect them from rusting is known as galvanisation.

(b) Pure gold is very soft and not suitable for making jewellery. It is therefore alloyed with copper for making it hard.

30. State three general properties of ionic compounds.

Ans. The general properties of ionic compounds are as follows:

(a) **Melting and boiling points:** Ionic compounds exhibit high melting and boiling points since a large amount of energy is needed to break the strong electrostatic forces of attraction.

(b) **Solubility:** Ionic compounds are highly soluble in polar solvents such as water and insoluble in non-polar solvents such as benzene, chloroform, carbon tetrachloride, petrol, kerosene, etc.

(c) **Electrical conductivity:** Ionic compounds conduct electricity in aqueous solution and in molten state. This is because in both these forms, ions can move freely and conduct electricity.

31. Why is that sodium when reacts with water forms sodium hydroxide whereas aluminium forms only aluminium oxide? Give reasons for your answer.

Ans. Sodium reacts with water to form sodium oxide and hydrogen gas. Sodium oxide is soluble in water. It further dissolves in water to form sodium hydroxide. The overall equation for the reaction of sodium and water is as follows:

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

On the other hand, aluminium oxide is insoluble in water. This is why aluminium reacts with water to form aluminium oxide and hydrogen gas.

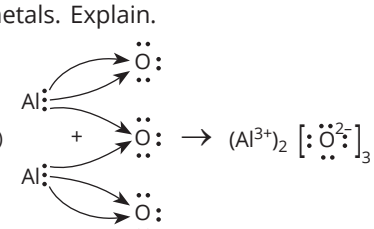
$$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$$

Short Answer Type Questions

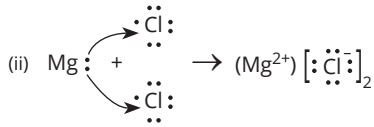
32. (a) Show the electron transfer in the formation of (i) Aluminium oxide (ii) Magnesium chloride.

(b) Hydrogen is not a metal but it has been assigned a place in the reactivity series of metals. Explain.

Ans. (a) (i)



(ii)



(b) Even though hydrogen is not a metal, yet it is placed in the activity series of metals because like metals, hydrogen has a tendency to lose electrons. Metals placed below hydrogen are less reactive than hydrogen, while metals placed above hydrogen are more reactive than hydrogen.

33. (a) Define corrosion. What name is given to the corrosion of iron? Name the colour of coating formed on silver and copper articles when exposed to air.

(b) List two damages caused by corrosion and suggest how corrosion can be prevented.

Ans. (a) The deterioration of metals caused as a result of their chemical reactions with moisture, gases and chemicals is known as corrosion. The corrosion of iron is known as rusting. When silver articles are left in the open for some time, they get covered with a black coating of silver sulphide. When copper articles are left in the open for some time, they get covered with a green coating of basic copper carbonate.

(b) The effects of corrosion are as follows:

(i) Due to corrosion, most iron and steel structures get damaged. A large amount of money is spent for the replacement of these structures.

(ii) Articles made of copper get deteriorated due to corrosion. Utensils made of copper also become unfit for use after corrosion.

Corrosion can be prevented by the following methods:

(i) Protection by coating with oil or grease: Objects made of iron and steel can be protected by coating them with oil and grease.

(ii) Protection by galvanisation: Galvanisation is the method of protecting iron and steel articles by coating them with a thin layer of zinc.

34. The given reaction shows one of the processes to extract the metals like iron and manganese. **(CBSE SP 2024)**

$$MnO_2(s) + Al(s) \rightarrow Mn(l) + Al_2O_3(s) + Heat$$

(a) Give reason why the above reaction is known as a thermite reaction.

(b) Identify the substance oxidised and reduced in the above reaction.

(c) Give a reason why aluminium is preferably used in thermite reactions.

Ans. (a) The given reaction is between a metal oxide (MnO_2) and aluminium (Al) powder. A large amount of heat is released in this process, which is characteristic of thermite reactions.

(b) Aluminum (Al) is oxidised in this reaction. It loses electrons and is converted into aluminum oxide (Al_2O_3). The oxidation half-reaction is $2Al(s) \rightarrow Al_2O_3(s) + 6e^-$.

Manganese dioxide (MnO_2) is reduced. It gains electrons and is converted to liquid manganese (Mn). The reduction half-reaction is $MnO_2(s) + 2e- \rightarrow Mn(l) + O_2$.

Long Answer Type Questions

35. A metal E is stored under kerosene. When a small piece of it is left open in air, it catches fire. When the product formed is dissolved in water, it turns red litmus to blue:

(a) Name the metal E.

(b) Write the chemical equation for the reaction when it is exposed to air and when the product is dissolved in water.

(c) Explain the process by which the metal E is obtained from its molten chloride.

(CBSE 2010, 2012)

Ans. (a) The metal E is sodium.

(b) When sodium is exposed to air, it reacts with oxygen to form sodium oxide. The sodium oxide dissolves in water to form sodium hydroxide.

$$4Na + O_2 \rightarrow 2Na_2O$$

$$Na_2O + H_2O \rightarrow 2NaOH$$

(c) Sodium is obtained from molten sodium chloride by electrolytic reduction. When molten sodium chloride is electrolysed, sodium is deposited at the cathode while chlorine is formed at the anode. The equations for the reactions are as follows:

At cathode: $Na^+ + e^- \rightarrow Na$

At anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

36. Define an alloy. How is an alloy prepared? State one advantage of making alloys. Write the composition of stainless steel. Why is it preferred over iron? State two reasons.

Ans. An alloy is a homogeneous mixture of two or more metals or a metal and a non-metal. It is prepared by melting the primary metal and dissolving the other elements in it in the required amount. Alloying helps in improving the properties of the metals. For example, pure iron is soft in nature and stretches easily when hot. Alloying it with small amount of carbon makes it hard.

Stainless steel is an alloy of iron, nickel and chromium. It is preferred over iron because it is harder than iron and does not rust.

37. Almost all metals combine with oxygen to form metal oxides. Metal oxides are generally basic in nature. But some metal oxides show both basic as well as acidic behavior. Different metals show different reactivities towards oxygen. Some react vigorously while some do not react at all.

(CBSE 2023)

(a) What happens when copper is heated in air? (Give the equation of the reaction involved).

(b) Why are some metal oxides categorized as amphoteric? Give one example.

(c) Complete the following equations:

(i) $Na_2O(s) + H_2O(l) \rightarrow$

(ii) $Al_2O_3 + 2NaOH \rightarrow$

Ans. (a) When copper (Cu) is heated in the air, it reacts with oxygen (O_2) to form copper(II) oxide (CuO). The equation for this reaction is $2Cu\ (s) + O_2(g) \rightarrow 2CuO\ (s)$

This copper oxide is basic in nature, and if heated further, copper(II) oxide can decompose at higher temperatures to form copper(I) oxide (Cu_2O), which is red in color.

(b) Some metal oxides are amphoteric because they can act both as acids and bases, depending on the nature of the substances they react with. Amphoteric oxides can react with both acids and bases to form salts and water. Example: Aluminum oxide (Al_2O_3).

(c) (i) $Na_2O\ (s) + H_2O\ (l) \rightarrow 2NaOH\ (aq)$

(ii) $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

38. The metals produced by various reduction processes are not very pure.

They contain impurities, which must be removed to obtain pure metals. The most widely used method for refining impure metals is electrolytic refining. **(CBSE 2024)**

(a) What is the cathode and anode made of in the refining of copper by this process?

(b) Name the solution used in the above process and write its formula.

(c) How copper gets refined when an electric current is passed in the electrolytic cell?

Ans. (a) In electrolytic refining of copper, the anode is made of impure copper. The cathode is made of pure copper where the refined copper will deposit.

(b) Copper(II) sulphate solution is used in electrolytic refining of copper and its formula is $CuSO_4$ (aq).

(c) When an electric current is passed through the electrolytic cell, the following occurs:

At the anode (impure copper): The impure copper (Cu) at the anode dissolves into the solution as copper ions (Cu^{2+}). The other impurities (like iron, silver, etc.) do not dissolve in the electrolyte and either fall to the bottom of the cell or remain as sludge, known as anode mud.

$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

At the cathode (pure copper): Copper ions (Cu^{2+}) from the solution are reduced by gaining electrons at the cathode and deposit as pure copper metal:

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

Let's Compete

(Page 81)

Multiple-Choice Questions

1. Metals are refined by using different methods. Which of the following metals are refined by electrolytic refining?

i. K ii. Na
iii. Cu iv. Au

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

Ans. (d) iii and iv

2. Aluminium is used for making cooking utensils. Which of the following properties of aluminium are responsible for the same?

i. High melting point
ii. Ductility
iii. Good electrical conductivity
iv. Good thermal conductivity

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

Ans. (a) i and iv

3. An element A reacts with another element B to form a compound C. In this reaction, A loses electron and B gains electron. Which of the following properties is not shown by the compound C?

(a) The physical state of C is solid
(b) C conducts electricity in the molten state
(c) C has low melting point
(d) C has high melting point.

Ans. (c) C has low melting point.

4. Four test tubes were taken and they were labelled as A, B, C and D. About 5 mL solution of iron(II) sulphate was added to each test tube. Strips of aluminium, copper, iron and zinc were put in the test tubes A, B, C and D, respectively. A black deposit is formed in two test tubes only. Identify the test tubes in which black deposit is formed.

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

Ans. (a) A and D

5. The impurities associated with ore used in metallurgy are called

(a) mud (b) slag
(c) gangue (d) none of these

Ans. (c) gangue

6. Alloys are homogeneous mixtures of a metal with a metal or non-metal. Which of the following alloys contain a non-metal as one of the constituents?

(a) Steel (b) Amalgam
(c) Bronze (d) Brass

Ans. (a) Steel

7. Which of the following metals is found native in nature?

(a) Magnesium (b) Iron
(c) Copper (d) Aluminium

Ans. (c) Copper

8. An element E reacts with water to form a solution which turns phenolphthalein solution pink. The element E is most likely to be

(a) Sulphur (b) Calcium
(c) Carbon (d) Silver

Ans. (b) Calcium

9. The atomic number of four elements A, B, C and D is 6, 8, 10 and 12, respectively. The two elements which can react to form ionic bond/ionic compound are

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

Ans. (d) B and D

10. Zinc blende ore can be converted into zinc oxide by the process of

(a) roasting. (b) hydrogenation.
(c) chlorination. (d) calcination.

Ans. (a) roasting.

11. Which one of the following correctly represents Sodium oxide? **(CBSE SP 2024)**

(a) $Na^{+2}\ 2\left[\times\!\!\times\ \underset{\times\times}{\overset{\times\times}{O}}\ \times\!\!\times\right]^{-2}$ (b) $2Na^{+}\left[\times\!\!\times\ \underset{\times\times}{\overset{\times\times}{O}}\ \times\!\!\times\right]^{-2}$

(c) $2Na^{+}\ 2\left[\times\!\!\times\ \underset{\times\times}{\overset{\times\times}{O}}\ \times\!\!\times\right]^{-1}$ (d) $Na^{+1}\left[\times\!\!\times\ \underset{\times\times}{\overset{\times\times}{O}}\ \times\!\!\times\right]^{-2}$

Ans. (b) Reason: The valency of sodium is 1 and that of oxygen is −2. Two sodium cations and one oxygen anion form an ionic bond and the chemical formula of sodium oxide is Na_2O.

12. An element with atomic number ..... will form a basic oxide. **(CBSE SP 2024)**

(a) 7 (2,5) (b) 17 (2,8,7)

(c) 14 (2,8,4) (d) 11 (2,8,1)

Ans. (d) 11 (2,8,1). This element is Sodium (Na), a Group 1 metal. Sodium forms basic oxides like sodium oxide (Na_2O). So, this will form a basic oxide.

13. An element 'M' has 50% of the electrons filled in the 3rd shell as in the 2nd shell. The atomic number of 'M' is **(CBSE SP 2024)**

(a) 10 (b) 12

(c) 14 (d) 18

Ans. (c) The element with atomic number 16 is Sulphur (S).

Life Skills

(Page 81)

1. One of the important applications of the activity series is the extraction of metals. For the purpose of extraction, the metals are grouped in the activity series in terms of their position in the activity series. The metals (Cu, Ag, Au, and Pt) lying at the bottom of the activity series are the least reactive. The metals (Na, K, Ca, Mg and Al) occurring at the top of activity series are very reactive and they are not found in the nature in the free state. The metals (Zn, Fe, Pb, etc.) appearing at the middle of the activity series are moderately active. Sudhir wrote a new mnemonic to help the students to remember the activity series.

(a) Name the methods which you will use for the extraction of these three categories of metals.

(b) Which methods of prevention of corrosion will you suggest for the prevention of moderately active metals appearing at the middle of the activity series?

(c) What values can we learn from Sudhir's writing a new mnemonic for remembering the activity series?

Ans. (a) Metals occurring at the top of the activity series are highly reactive. They are extracted by electrolytic reduction. Metals in the middle of the series are extracted by the reduction of their oxides. Metals lying low in the series can be obtained by heating their oxides alone.

(b) Metals that appear in the middle of the activity series include zinc, iron, copper and lead. Rusting of iron can be prevented by painting, oiling, greasing, galvanisation and making alloys. Corrosion of other elements can also be prevented by alloying.

(c) We learn helpfulness, creativity and application of knowledge from Sudhir's writing a new mnemonic for remembering the activity series.

2. A rich lady went to a goldsmith and selected a design for her necklace. She wanted 24 carat pure gold jewellery but the goldsmith suggested her to go for 22 carat gold jewellery.

(a) What is 22 carat gold?

(b) Was the advice of the goldsmith valuable? If yes, why?

Ans. (a) 22 carat gold is an alloy of gold that consists of 22 parts of gold and 2 parts of copper or silver.

(b) The advice given by the goldsmith was valuable because 24 carat gold is very soft and not suitable for making jewellery. Alloying it with copper or silver makes it hard.

3. To prevent electric shock, metal wires are coated with a material called PVC. Rajat found some wires at his home with broken PVC coating. He told his father to call an electrician to replace those wires immediately.

(a) Write full form of PVC.

(b) Is PVC an insulator or a semiconductor?

(c) What value do you learn from Rajat's behaviour?

Ans. (a) The full form of PVC is polyvinyl chloride.

(b) PVC is an insulator.

(c) We learn carefulness and awareness from Rajat's behaviour.

4

Carbon and its Compounds

Checkpoint (Page 85)

1. Write the symbol and atomic number of carbon.

Ans. The symbol of carbon is C and its atomic number is 6.

2. State the valency of carbon. Is it a metal or a non-metal?

Ans. The valency of carbon is 4. It is a non-metal.

3. What are fossil fuels?

Ans. Fuels that are formed from remains of dead plants and animals that lived millions of years ago are known as fossil fuels. Coal, petroleum and natural gas are fossil fuels.

4. Write any two characteristics of a good fuel.

Ans. The characteristics of a good fuel are as follows:

(i) It should have a high calorific value.

(ii) It should not produce any harmful residue on combustion.

5. Define combustion.

Ans. The chemical process in which a substance reacts with oxygen to produce heat is known as combustion.

6. Why does wood burn with a flame initially and then it glows?

Ans. Flame is produced by those substances which vaporise during burning. Initially wood burns with a flame because it contains many volatile substances. When these volatile substances get completely consumed, the wood burns with a glow.

7. What are combustible substances?

Ans. The substances which can undergo combustion are known as combustible substances.

8. Define ignition temperature.

Ans. The lowest temperature at which a substance starts burning is known as its ignition temperature.

9. Write the reaction for combustion of coal.

Ans. Coal mainly contains carbon. On combustion, carbon combines with oxygen to form carbon dioxide. The chemical equation for the combustion of coal is

$$C + O_2 \rightarrow CO_2$$

10. Write two uses of natural gas.

Ans. The uses of natural gas are as follows:

(i) It is used for the generation of electricity.

(ii) It is used as a fuel in vehicles.

Check Your Progress 1

(Page 96)

Multiple-Choice Questions

1. Which of the following does not belong to the same homologous series?

(a) CH_4 (b) C_4H_8

(c) C_2H_6 (d) C_3H_8

Ans. (b) C_4H_8

2. In ethane, each carbon atom is bonded to

(a) two atoms (b) three atoms

(c) four atoms (d) six atoms

Ans. (c) four atoms

3. How many isomers are there in the organic compound pentane?

(a) 2 (b) 3

(c) 4 (d) 5

Ans. (b) 3

4. The compounds containing –CHO functional group are known as

(a) ketones (b) aldehydes

(c) alcohols (d) carboxylic acids

Ans. (b) aldehydes

5. The first member of alkyne homologous series is

(a) ethene. (b) ethyne.

(c) propyne. (d) methane.

Ans. (b) ethyne.

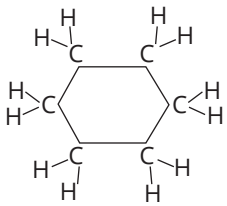
6. The organic compounds containing —COOH group are called

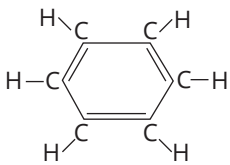
(a) esters (b) carboxylic acids

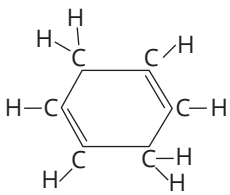
(c) alcohols (d) aldehydes

Ans. (b) carboxylic acids

7. Consider the structures of the three cyclic carbon compounds A, B and C given below and select the correct option from the following: **(CBSE 2023)**

(A) 

(B) 

(C) 

(a) A and C are isomers of hexane and B is benzene.

(b) A is an isomer of hexane, B is benzene and C is isomer of hexene.

(c) A is saturated cyclic hydrocarbon and B and C are unsaturated cyclic hydrocarbons.

(d) A is cyclohexane and B and C are the isomers of benzene.

Ans. (c) A is a saturated cyclic hydrocarbon and B and C are unsaturated cyclic hydrocarbons.

Reason: All bonds of A are single bonds hence it is a saturated hydrocarbon whereas B and C have double bonds so they are unsaturated cyclic hydrocarbons.

8. Carbon compounds: **(CBSE 2024)**

(i) are good conductors of electricity.

(ii) are bad conductors of electricity.

(iii) have strong forces of attraction between their molecules.

(iv) have weak forces of attraction between their molecules.

The correct statements are:

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

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

Ans. (c) The correct statements are: (ii) carbon compounds are bad conductors of electricity and (iv) carbon compounds have weak forces of attraction between their molecules.

9. The name and formula of third member of homologous series of alkyne is **(CBSE 2024)**

(a) Propyne C_3H_6 (b) Propyne C_3H_4

(c) Butyne C_4H_8 (d) Butyne C_4H_6

Ans. (d) The third member of the alkyne homologous series is butyne (C_4H_6).

Very Short Answer Type Questions

10. Write the molecular formulae of the third and fifth members of homologous series of carbon compounds represented by the general formula C_nH_{2n-2}.

Ans. The compounds with the general formula C_nH_{2n-2} are known as alkynes. The third member of this series is butyne. Its chemical formula is C_4H_6. The fifth member of this series is hexyne. Its chemical formula is C_6H_{10}.

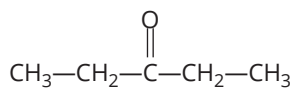
11. Draw the structure of:

(a) Butanol (b) Pentanone

Ans. (a) Butanol

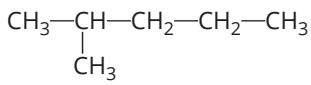
$CH_3—CH_2—CH_2—CH_2—OH$

(b) Pentanone



12. Write the structural formula of one isomer of *n*-hexane.

Ans. Isohexane is an isomer of *n*-hexane. Its structural formula is



13. Write the names of the following:

(a) $CH_3CH_2COCH_2CH_3$

(b) HCOOH

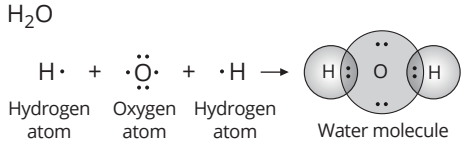
Ans. (a) Pentan-3-one

(b) Methanoic acid

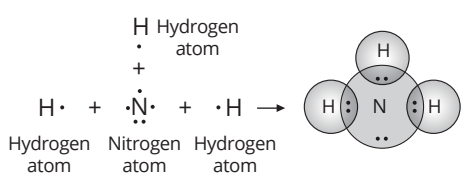
14. Draw the electron-dot structures for

(a) H_2O (b) NH_3.

Ans. (a) H_2O



(b) NH_3



15. Catenation is exhibited by both carbon and silicon. Compare the ability of catenation of the two elements. Give reasons.

Ans. Both carbon and silicon exhibit catenation. However, the ability of catenation is shown more by carbon than silicon because carbon is smaller in size. Therefore, bonds formed between carbon atoms are smaller and stronger than the bonds formed between silicon atoms.

16. Give reasons:

(a) Covalent compounds are non-conductors of electricity.

(b) Covalent compounds have low melting point and boiling point.

(c) Covalent compounds are soluble in non-polar solvents.

Ans. (a) Covalent compounds are formed by sharing of electrons. Since the formation of these compounds does not involve transfer of electrons, they do not contain ions. The conduction of electricity occurs as a result of movement of ions. As covalent compounds do not dissociate into ions, they do not conduct electricity.

(b) Covalent compounds have low melting and boiling points. This is because the forces of attraction between the molecules are very weak. Only a small amount of energy is needed to overcome these forces.

(c) Covalent compounds are soluble in non-polar solvents like alcohol, benzene, etc. and are insoluble in polar solvents.

17. (a) Which of the following compounds belong to the same homologous series?

C_2H_6, C_2H_6O, $C_2H_6O_2$, CH_4O

(b) What is a homologous series of substances? Mention any two characteristics of compounds of a homologous series.

Ans. (a) Out of the given compounds, CH_4O and C_2H_6O belong to the same homologous series. CH_4O is the chemical formula for methanol and C_2H_6O is the chemical formula for ethanol.

(b) A group of organic compounds which possess the same functional group and exhibit similar chemical properties is known as homologous series of compounds. The characteristics of a homologous series are as follows:

(i) All the members of a homologous series are represented by the same general formula.

(ii) Each successive member of a homologous series differs in the molecular formula by a $–CH_2–$ unit.

Short Answer Type Questions

18. (a) Give the structural differences between saturated and unsaturated hydrocarbons with two examples each.

(b) What is a functional group? Write two examples of any three functional groups.

Ans. (a) Saturated hydrocarbons are the hydrocarbons that contain only single bonds between the carbon atoms. Unsaturated hydrocarbons are the hydrocarbons in which the carbon atoms are linked by double and triple bonds. Ethane, propane and butane are some examples of saturated hydrocarbons. Ethene, ethyne and propene are some examples of unsaturated hydrocarbons.

(b) A functional group is an atom or a group of atoms which determines the characteristic functions or chemical properties of a particular organic compound. Examples of functional groups are aldehydic group (–CHO), ketonic group (–C=O) and carboxylic acid group (–COOH). Some examples of compounds containing these functional groups are:

Functional group	Organic compounds
Aldehyde	Ethanal, propanal
Ketone	Propanone, butanone
Carboxylic acid	Methanoic acid, ethanoic acid

19. What are covalent compounds? Why are they different from ionic compounds? List their three characteristic properties. **(CBSE 2016)**

Ans. Covalent compounds are the compounds that are formed by sharing of electrons between atoms. They are different from ionic compounds because ionic compounds are formed by transfer of electrons. The three characteristic properties of covalent compounds are:

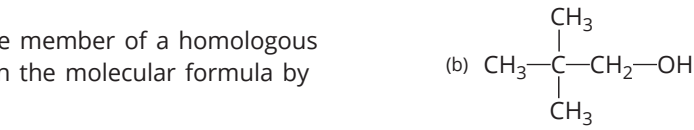
(i) Covalent compounds have low melting and boiling points.

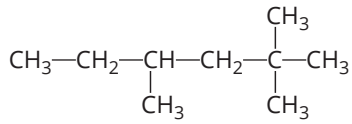
(ii) They are poor conductors of electricity.

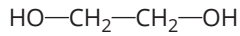
(iii) Covalent compounds are soluble in non-polar solvents such as chloroform but insoluble in polar solvents such as water.

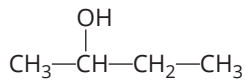
20. Give the chemical names of the following compounds:

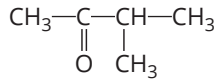
(a) 

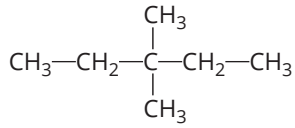
(b) 

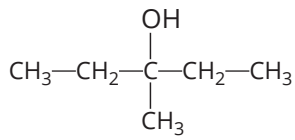
(c) 

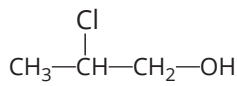
(d) 

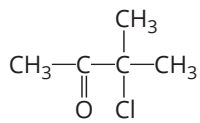
(e) 

(f) 

(g) 

(h) 

(i) 

(j) 

Ans. (a) 3-Methylbutan-1-ol

(b) 2,2-Dimethylpropan-1-ol

(c) 2,2,4-Trimethylhexane

(d) Ethane-1,2-diol

(e) Butan-2-ol

(f) 3-Methylbutan-2-one

(g) 3,3-Dimethylpentane

(h) 3-Methylpentan-3-ol

(i) 2-Chloropropan-1-ol

(j) 3-Chloro-3-methylbutan-2-one

Long Answer Type Questions

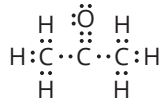
21. (a) Define the term 'isomers'.

(b) Draw two possible isomers of the compound with molecular formula C_3H_6O and write their names. Also give their electron dot structures.

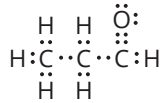
Ans. (a) The compounds having the same chemical formula but different structures are known as isomers.

(b) The two possible isomers of the compound with the molecular formula C_3H_6O are propanone (CH_3COCH_3) and propanal (CH_3CH_2CHO). The electron dot structures of these compounds are as follows:

Electron dot structure of propanone



Electron dot structure of propanal



22. A saturated organic compound 'A' belongs to homologous series of alcohols.

On heating 'A' with concentrated sulphuric acid at 443 K, it forms an unsaturated compound 'B' with molecular mass 28 u.

The compound 'B' on addition of one mole of hydrogen in the presence of nickel, changes to a saturated hydrocarbon 'C'. **(CBSE 2023)**

(a) Identify A, B and C.

(b) Write the chemical equations showing the conversion of A into B.

(c) What happens when compound C undergoes combustion?

(d) State one industrial application of hydrogenation reaction.

(e) Name the products formed when compound A reacts with sodium.

Ans. (a) Compound A is a saturated organic compound belonging to the alcohols homologous series. A saturated alcohol that can undergo dehydration (removal of water) to form an unsaturated compound likely corresponds to ethanol (C_2H_5OH).

The unsaturated compound B must be ethene (C_2H_4). Ethene is formed by the dehydration of ethanol in the presence of concentrated sulfuric acid at 443 K.

Compound C is formed when B (ethene) reacts with one mole of hydrogen in the presence of nickel. This process is called hydrogenation, which adds hydrogen to the carbon–carbon double bond, converting ethene (C_2H_4) into ethane (C_2H_4), a saturated hydrocarbon.

So, the compounds are: A – Ethanol (C_2H_4OH), B – Ethene (C_2H_4), C – Ethane (C_2H_4)

(b) The reaction of ethanol (A) to form ethene (B) involves dehydration in the presence of concentrated sulfuric acid at 443 K. The chemical equation is:

$$C_2H_5OH \xrightarrow[\text{conc. } H_2SO_4,\ 443\ K]{\text{heat}} C_2H_4 + H_2O$$

This is a dehydration reaction where ethanol loses a molecule of water to form ethene.

(c) When ethane (C_2H_4), a saturated hydrocarbon, undergoes combustion, it reacts with oxygen to

produce carbon dioxide and water. The chemical equation for the complete combustion of ethane is:

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

This is an exothermic reaction, producing heat and light.

(iv) Hydrogenation reactions are commonly used to convert unsaturated fats and oils (such as vegetable oils) into saturated fats, resulting in the production of solid fats like margarine and shortening. In this process, unsaturated vegetable oils are hydrogenated to convert their double bonds into single bonds.

(v) When ethanol (C_2H_5OH) reacts with sodium (Na), it forms sodium ethoxide (C_2H_5ONa) and hydrogen gas (H_2). The chemical equation for this reaction is

$$2\ C_2H_5OH + 2\ Na \rightarrow 2C_2H_5ONa + H_2$$

So, the products are sodium ethoxide and hydrogen gas.

23. State the reason why carbon can neither form C^{4+} cation nor C^{4-} anion but forms covalent compounds. Also state the reasons to explain why covalent compounds

(a) are bad conductor of electricity?

(b) have low melting and boiling points?

Ans. Carbon neither forms C^{4+} cation or C^{4-} anion because:

(i) Formation of C^{4+} cation would require the removal of four electrons. A lot of energy would be needed for this process, as it would leave behind a carbon cation with six protons in the nucleus holding on to just two electrons.

(ii) Formation of C^{4-} anion would require the addition of four electrons to the carbon atom. In this case, it would be difficult for nucleus with six protons to hold on to ten electrons.

(a) Covalent compounds are bad conductors of electricity because they are formed by sharing of electrons and not transfer of electrons. Hence they do not contain ions. Conduction of electricity in compounds occurs as a result of movement of ions. This is why covalent compounds do not conduct electricity.

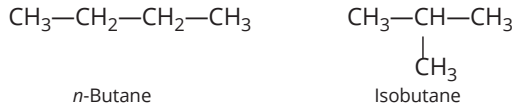
(b) Covalent compounds have low melting and boiling point because of weak forces of attraction between the molecules. Only a small amount of energy is needed to overcome these forces.

24. (a) Define structural isomer and draw the isomeric structures of butane. Compare the structure of benzene and cyclohexane by drawing them.

(b) Why is graphite a good conductor of electricity but diamond is a non-conductor of electricity?

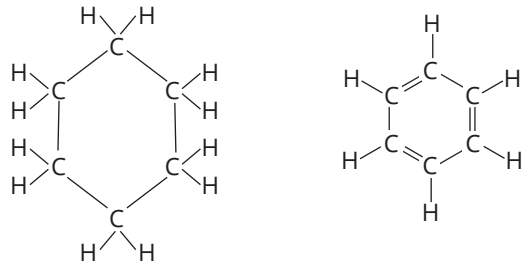
(c) Draw the structure of butanoic acid.

Ans. (a) Compounds having the same molecular formula but different structures are known as structural isomers. The structural isomers of butane are as follows:



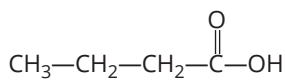
n-Butane Isobutane

Benzene is a compound that possesses three double bonds. On the other hand, cyclohexane does not possess any double bonds. It contains only single bonds. The structures of benzene and cyclohexane are as follows:



Cyclohexane Benzene

(b) In graphite, each carbon atom is bonded to three other carbon atoms. One of the carbon-carbon bonds is a double bond. The electron in the double bond is free to move. Thus, the movement of this electron causes the flow of electricity. On the other hand, in diamond, each carbon atom is bonded to four other carbon atoms with single bonds. Hence, no electrons are free to move in diamond which makes diamond a poor conductor of electricity.

(c) 

Check Your Progress 2

(Page 108)

Multiple-Choice Questions

1. Which of the following fuels burns without a flame?

(a) LPG (b) Kerosene oil

(c) Wood (d) Coal

Ans. (d) Coal

2. Soap molecule has

(a) a hydrophilic head and a hydrophilic tail.

(b) a hydrophobic head and a hydrophobic tail.

(c) a hydrophobic head and a hydrophilic tail.

(d) a hydrophilic head and a hydrophobic tail.

Ans. (d) a hydrophilic head and a hydrophobic tail.

3. Oils on treating with hydrogen in the presence of nickel catalyst form fats. This is an example of

(a) oxidation reaction

(b) displacement reaction

(c) substitution reaction

(d) addition reaction.

Ans. (d) addition reaction.

4. Ethanoic acid was added to four test tubes containing the following chemicals

(i) Sodium carbonate

(ii) Blue litmus solution

(iii) Lime water

(iv) Distilled water.

Which among these is/are the correct option(s) for carrying out a characteristic test for identification of a carboxylic acid (ethanoic acid) in the laboratory?

(a) i only (b) iii only

(c) i and ii only (d) iii and iv

Ans. (c) i and ii only

5. Which of the following will not undergo addition reaction?

(a) Acetylene (b) Ethylene

(c) Ethane (d) Propyne

Ans. (c) Ethane

6. Presence of which of the following salts causes hardness of water?

(a) Sodium carbonate

(b) Magnesium sulphate

(c) Potassium chloride

(d) Sodium chloride

Ans. (b) Magnesium sulphate

Very Short Answer Type Questions

7. The formula of an ester is $CH_3COOCH_2CH_3$. Write the formula of the acid and the alcohol from which it is formed.

Ans. If the formula of the ester is $CH_3COOCH_2CH_3$, then the formulae of the acid and alcohol from which it will be obtained are CH_3COOH and CH_3CH_2OH.

8. A mixture of ethyne and oxygen is burnt for welding. Explain why a mixture of ethyne and air is not used?

Ans. Ethyne is an unsaturated hydrocarbon. It burns in air giving a yellow flame with black smoke due to the presence of unburnt carbon. Thus, there occurs incomplete combustion and as a result, the heat produced is less and the high temperature required for welding of metals and alloys cannot be achieved. This is why a mixture of ethyne and air is not used for welding.

9. What happens when soap solution in a test tube is shaken with

(a) soft water? (b) hard water?

Ans. (a) When soap solution is shaken with soft water, it will form lather.

(b) When soap solution is shaken with hard water, the insoluble substances called scum will be formed. These are formed as a result of the reaction of soap with calcium and magnesium salts, which cause the hardness of water.

10. How would you convert propanol into propanoic acid?

Ans. Propanol can be converted to propanoic acid by adding alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$ to propanol and heating it. The chemical equation for the reaction is as follows:

$$CH_3CH_2CH_2OH \xrightarrow[\text{or Acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alk. } KMnO_4 + \text{Heat}} CH_3CH_2COOH$$

11. What happens when ethanol reacts with sodium metal?

Ans. When ethanol reacts with sodium metal, it forms sodium ethoxide and hydrogen gas. The chemical equation for the reaction is as follows:

$$2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2$$

12. "Carbon tetrachloride is not a good conductor of electricity." Give reason to justify this statement.

(CBSE 2013)

Ans. Carbon tetrachloride does not conduct electricity because it is a covalent compound. Covalent compounds are formed by sharing of electrons and not by transfer of electrons. Hence, they do not dissociate into ions either in the molten form or in the aqueous form. As a result, covalent compounds do not conduct electricity.

13. Explain the terms with examples.

(a) Esterification (b) Dehydration

Ans. (a) The reaction of a carboxylic acid and an alcohol that produces an ester and water is known as esterification reaction. For example, ethanoic acid reacts with ethanol in the presence of an acid catalyst to give ethyl ethanoate and water. The chemical equation for the reaction is as follows:

$$\underset{\text{Ethanoic acid}}{CH_3-COOH} + \underset{\text{Ethanol}}{CH_3-CH_2-OH} \overset{\text{Acid}}{\rightleftharpoons} \underset{\text{Ethyl ethanoate}}{CH_3-\overset{\overset{O}{\|}}{C}-O-CH_2CH_3} + H_2O$$

(b) The chemical reaction in which a compound loses water molecule is known as dehydration reaction. For example, when ethanol is heated with concentrated sulphuric acid at 443 K, it loses a molecule of water to form ethene. The chemical equation for the reaction is as follows:

$$CH_3—CH_2—OH \xrightarrow[443\ K]{\text{conc. } H_2SO_4} CH_2=CH_2 + H_2O$$

14. Why does methane burn in the presence of excess air? What happens when methane reacts with chlorine?

Ans. Methane is a compound of carbon. Its chemical formula is CH_4. It is widely used as a fuel and is a major component of natural gas. In the presence of excess of air, it burns to form carbon dioxide and water vapour.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Methane reacts with chlorine in the presence of sunlight to form methyl chloride. Methyl chloride undergoes further reaction with chlorine to form dichloromethane, trichloromethane and tetrachloromethane.

$$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$$

15. What happens when a molecule of hydrogen is added to ethyne? Explain.

Ans. Ethyne is a compound of carbon containing a triple bond between the carbon atoms. When a hydrogen molecule is added to an ethyne molecule, it will undergo addition reaction to form ethene. The chemical equation for the reaction is as follows:

$$HC{\equiv}CH + H_2 \rightarrow H_2C{=}CH_2$$

16. Write a chemical test to distinguish between ethanol and ethanoic acid.

Ans. Ethanoic acid can be distinguished from ethanol with the help of sodium bicarbonate. Ethanoic acid will react with sodium bicarbonate to give sodium ethanoate, carbon dioxide and water.

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

On the other hand, no such reaction occurs with ethanol.

17. Rehmat classified the reaction between methane and chlorine in presence of sunlight as a substitution reaction. Support Rehmat's view with suitable justification and illustrate the reaction with the help of a balanced chemical equation.

(CBSE SP 2024)

Ans. Rehmat's observation is correct as the hydrogen atoms are substituted by hetero atom i.e., Cl. Rehmat is correct in classifying the reaction between methane (CH_4) and chlorine (Cl_2) in the presence of sunlight as a substitution reaction.

$$\underset{\text{Methane}}{CH_4} + Cl_2 \xrightarrow{\text{Sunlight}} \underset{\text{Chloromethane}}{CH_3Cl} + HCl$$

$$CH_3Cl + Cl_2 \xrightarrow{\text{Sunlight}} \underset{\text{Dichloromethane}}{CH_2Cl_2} + HCl$$

$$CH_2Cl_2 + Cl_2 \xrightarrow{\text{Sunlight}} \underset{\text{Chloroform}}{CHCl_3} + HCl$$

$$CHCl_3 + Cl_2 \xrightarrow{\text{Sunlight}} \underset{\text{Carbon tetrachloride}}{CCl_4} + HCl$$

Short Answer Type Questions

18. Give reasons:

(a) Methane burns with blue flame.

(b) Vegetable oils decolourize bromine water.

(c) Air holes of a gas burner has to be adjusted when heated vessels get blackened by the flame.

Ans. (a) Methane is a saturated hydrocarbon. This is why it burns with a clean blue flame.

(b) Decolourisation of bromine water is used as a test for the detection of unsaturated hydrocarbons. Vegetable oils generally have long unsaturated hydrocarbon chains. Hence they decolourize bromine water.

(c) LPG is the fuel used in gas burners. It burns with a clean flame. When vessels are blackened by the flame, it indicates that the air holes are blocked and fuel is getting wasted. This is why air holes of a gas burner have to be adjusted when heated vessels get blackened by the flame.

19. What is the difference between molecules of soap and detergents chemically? Explain the cleansing action of soap.

Ans. Soaps are sodium and potassium salts of long chain carboxylic acids. They are represented by the general formulae $RCOO^-Na^+$ and $RCOO^-K^+$ respectively. Detergents are sodium salts of sulphonic acids or ammonium salts with chlorides or bromide ions.

Let us understand the cleansing action of soap with the help of an example. The most common soap is sodium stearate, $C_{17}H_{35}COONa$. In aqueous solution, this soap ionizes as follows:

$$C_{17}H_{35}COONa \rightarrow C_{17}H_{35}COO^- + Na^+$$

The stearate ion has two parts—the long hydrocarbon chain (R) which is hydrophobic (water repelling) and the negatively charged anionic part which is hydrophilic (water loving).

When a cloth with oily (or greasy) dirt is dipped into a soap solution, the hydrocarbon chain of the stearate ion attaches itself to oils and fats and the polar end ($—COO^-$) is directed towards water. When shaken with water, the stearate ions form micelles containing oily dirt in the centre of micelles. The micelles stay in the solution as a colloid.

When the cloth is washed with water, the micelles containing the oily dirt are washed away and the cloth gets cleaned. Due to electrostatic repulsion, the negatively charged micelles repel each other. Consequently, the oily dirt particles do not come together but are rinsed away in water. Thus, the soap micelles help in dissolving the dirt and the clothes are washed clean.

20. (a) In a tabular form, differentiate between ethanol and ethanoic acid under the following heads:

(i) Physical state (ii) Taste

(iii) $NaHCO_3$ test (iv) Ester test

(b) Write a chemical reaction to show the dehydration of ethanol.

Ans. (a)

Parameter	Ethanol	Ethanoic acid
Physical state	Liquid	Liquid
Taste	Bitter	Sour
$NaHCO_3$ test	Does not give $NaHCO_3$ test	Gives $NaHCO_3$ test to form sodium ethanoate, carbon dioxide and water
Ester test	Reacts with carboxylic acids in the presence of acid catalyst to give esters	Reacts with alcohols in the presence of acid catalyst to give esters

(b) Ethanol undergoes dehydration in the presence of sulphuric acid as a catalyst at 443 K to form ethene. The chemical equation for the reaction is as follows:

$$CH_3—CH_2—OH \xrightarrow[443\ K]{\text{conc. } H_2SO_4} CH_2=CH_2 + H_2O$$

Long Answer Type Questions

21. An organic compound A is widely used as a preservative in pickles and has a molecular formula $C_2H_4O_2$. This compound reacts with ethanol to form a sweet-smelling compound B.

(a) Identify the compound A.

(b) Write the chemical equation for its reaction with ethanol to form the compound B.

(c) How can you get compound A from compound B?

(d) Name the process and write the corresponding chemical equation.

(e) Which gas is produced when compound A reacts with washing soda? Write the chemical equation.

Ans. (a) The compound A is ethanoic acid (CH_3COOH).

(b) Ethanoic acid reacts with ethanol to form ethyl ethanoate, an ester. Thus compound B is ethyl ethanoate. The chemical equation for the reaction is as follows:

$$CH_3COOH + CH_3CH_2OH \underset{}{\overset{\text{Acid}}{\rightleftharpoons}} CH_3COOCH_2CH_3 + H_2O$$

(c) We can get ethanoic acid from ethyl ethanoate by carrying out alkaline hydrolysis of ethyl ethanoate with sodium hydroxide. This will give sodium ethanoate and ethanol and treating sodium ethanoate with an acid will give back ethanoic acid.

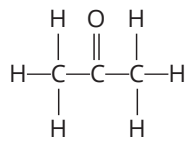
(d) Alkaline hydrolysis of esters is known as saponification. Saponification of ethyl ethanoate will give sodium ethanoate and ethanol. The chemical equation for the reaction is as follows:

$$CH_3COOC_2H_5 \xrightarrow{NaOH} CH_3COONa + C_2H_5OH$$

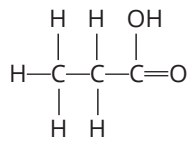
(e) When ethanoic acid reacts with washing soda, carbon dioxide gas is produced. The chemical equation for the reaction is as follows:

$$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + H_2O + CO_2$$

22. (a) Define the term functional group. Identify the functional groups present in the following carbon compounds:



(i)



(ii)

(b) What happens when ethanol reacts with acidified potassium dichromate solution? Write chemical equation for the reaction. Why is this reaction considered an oxidation reaction?

(c) Write chemical equation for the reaction of ethanoic acid with sodium hydroxide.

(CBSE 2024)

Ans. (a) A functional group is a specific group of atoms or bonds within a molecule that is responsible for the characteristic chemical reactions of that molecule. The functional group determines the chemical behavior of the compound to a great extent.

The functional groups present in (I) carbonyl group (C=O) of ketones and in (II) is carboxyl group (−COOH) in carboxylic acids.

(b) Ethanol undergoes oxidation in the presence of acidified potassium dichromate or alkaline potassium permanganate to form ethanal. Ethanal is further oxidised to ethanoic acid.

Ethanol undergoes oxidation in the presence of acidified potassium dichromate or alkaline potassium permanganate to form ethanal. Ethanal is further oxidised to ethanoic acid.

$$C_2H_5OH \xrightarrow[K_2Cr_2O_7/H_2SO_4]{[O]} CH_3CHO$$

Ethanol — Ethanal

$$CH_3CHO \xrightarrow[K_2Cr_2O_7/H_2SO_4]{[O]} CH_3COOH$$

Ethanoic acid

(c) The chemical equation for the reaction is:

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

Ethanoic acid — Sodium hydroxide — Sodium ethnoate

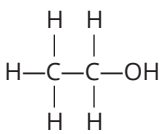
23. (a) Write the name and structure of an organic compound 'X' having two carbon atoms in its molecule and its name is suffixed with '-ol'.

(b) What happens when 'X' is heated with excess concentrated sulphuric acid at 443 K? Write chemical equation for the reaction stating the conditions for the reaction. Also, state the role played by concentrated sulphuric acid in the reaction.

(c) Name and draw the electron dot structure of hydrocarbon produced in the above reaction.

(CBSE 2024)

Ans. (a) The compound 'X' is ethanol (C_2H_4OH), which is a two-carbon alcohol. Its structure is



(b) Ethanol undergoes dehydration when heated with conc. H_2SO_4 at 170°C or 443 K to form ethene.

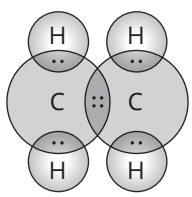
The chemical equation for the reaction is:

$$C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4,\ 170^\circ C} CH_2 = CH_2 + H_2O$$

Ethanol — Ethene

In this reaction conc. H_2SO_4 acts as a dehydrating agent which removes water from ethanol.

(c) Name of the hydrocarbon produced in the above reaction is ethene (C_2H_4) and its electron dot structure is given below.



Electron-dot structure of ethene

24. Raina while doing certain reactions observed that heating of substance 'X' with vinegar-like smell with a substance 'Y' (which is used as an industrial solvent) in presence of conc. sulphuric acid on a water bath gives a sweet-smelling liquid 'Z' having molecular formula $C_4H_8O_2$. When heated with caustic soda (NaOH), 'Z' gives back the sodium salt of and the compound 'Y'.

Identify 'X', 'Y', and 'Z'. Illustrate the changes with the help of suitable chemical equations.

(CBSE SP 2024)

Ans.

- Substance X has a "vinegar-like" smell, which suggests it is acetic acid (CH_3COOH).
- Substance Y is used as an industrial solvent, which could likely be ethanol (C_2H_5OH), as it is a common solvent and reacts with acetic acid in the presence of sulfuric acid.
- The product Z has a molecular formula of $C_4H_8O_2$ and is sweet-smelling. Given this molecular formula and the reaction described, the product is likely ethyl acetate ($CH_3COOC_2H_5$), an ester with a sweet smell. The reaction is as follows:

$$CH_3COOH + C_2H_5OH \xrightarrow[\text{heat}]{\text{conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

Ethanoic acid — Ethanol — Ethyl ethanoate (ester)

The above reaction is called Fischer esterification.

When ethyl acetate (Z) is heated with caustic soda (NaOH), it undergoes hydrolysis to produce acetic acid and ethanol.

$$CH_3COOC_2H_5 \xrightarrow{NaOH} C_2H_5OH + CH_3COONa$$

Ethyl ethanoate — Ethanol — Sodium ethanoate

This reaction is known as saponification as it is used in the manufacture of soap. Saponification is the reverse of esterification.

25. The table given below shows the hints given by the quiz master in a quiz. **(CBSE SP 2024)**

S. NO.	HINT
(i)	Substance 'C' is used as a preservative.
(ii)	'C' has two carbon atoms; 'C' is obtained by the reaction of 'A' in presence of alkaline potassium permanganate followed by acidification.
(iii)	Misuse of 'A' in industries is prevented by adding methanol, benzene, and pyridine to 'A'.
(iv)	'F' is formed on heating 'A' in presence of conc sulphuric acid.
(v)	'F' reacts with hydrogen gas in presence of nickel and palladium catalyst.

Based on the above hints answer the following questions:

(a) Give the IUPAC names of 'A' and 'F'

(b) Illustrate with the help of chemical equations the changes taking place.
($A \rightarrow C$ and $A \rightarrow F$)

(c) Name the chemical reactions which occur in steps 2 and 5. Identify the compounds formed in these steps if 'A' is replaced with its next homologue.

Ans. The substance C is likely acetic acid (CH_3COOH), which is used as a preservative called vinegar.

C has two carbon atoms as in acetic acid (CH_3COOH), and it is produced by the oxidation of a substance A. This suggests that A is ethanol (C_2H_5OH), as ethanol can be oxidised to acetic acid using alkaline potassium permanganate.

The substance A should be ethanol (C_2H_5OH). Methanol, benzene, and pyridine are added to prevent its misuse. This mixture is known as denatured alcohol.

Ethanol (A) in the presence of concentrated sulfuric acid (H_2SO_4) forms ethylene (F), an alkene. This is a dehydration reaction.

$$\underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow{\text{conc. } H_2SO_4,\ 170^\circ C} \underset{\text{Ethene}}{CH_2{=}CH_2} + H_2O$$

F is ethylene (C_2H_4), and it reacts with hydrogen gas in the presence of a Nickel (Ni) or Palladium (Pd) catalyst in a hydrogenation reaction, forming ethane (C_2H_6).

(a) IUPAC name of A is ethanol, and F is ethene.

(b) Chemical equation of $A \rightarrow C$ (Oxidation of ethanol to acetic acid):

$$\underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow[K_2Cr_2O_7/H_2SO_4]{[O]} \underset{\text{Ethanal}}{CH_3CHO} \xrightarrow[K_2Cr_2O_7/H_2SO_4]{[O]} \underset{\text{Ethanoic acid}}{CH_3COOH}$$

Chemical equation of $A \rightarrow F$ (Dehydration of ethanol to ethene):

$$\underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow{\text{conc. } H_2SO_4,\ 170^\circ C} \underset{\text{Ethene}}{CH_2{=}CH_2} + H_2O$$

(c) The chemical reactions which occur in step 2 is oxidation, and in step 5 is Addition/ Hydrogenation.

The compounds formed in these steps if 'A' is replaced with its next homologue are Propanol and Propene.

26. (a) Give a chemical test to distinguish between saturated and unsaturated hydrocarbon.

(b) Name the products formed when ethane burns in air. Write the balanced chemical equation for the reaction showing the types of energies liberated.

(c) Why is the reaction between chlorine and methane in the presence of sunlight considered a substitution reaction?

Ans. (a) We can distinguish between saturated and unsaturated hydrocarbons with the help of bromine water. Unsaturated hydrocarbons will decolourize bromine water but saturated hydrocarbons will not do so.

(b) Ethane undergoes combustion to form carbon dioxide and water vapour. A lot of heat energy is produced in this reaction. The chemical equation for the reaction is as follows:

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O + \text{Heat} + \text{Light}$$

(c) The reaction between methane and chlorine in the presence of sunlight is regarded as a substitution reaction because the hydrogen atoms of methane are replaced by chlorine atoms.

$$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$$

(in the presence of sunlight)

Higher Order Thinking Skills (HOTS) Questions

(Page 110)

1. A carbon compound P on heating with concentrated H_2SO_4 forms a compound Q which on addition of one mole of hydrogen in presence of Ni forms a compound R. One mole of compound R on combustion forms two moles of CO_2 and 3 moles of H_2O. Identify compounds P, Q and R and write the chemical equation of the reactions involved. **(CBSE 2016)**

Ans. We are given that the compound Q on addition of hydrogen in the presence of nickel catalyst forms compound R, and one mole of compound R forms two moles of CO_2 and 3 moles of H_2O on combustion. This indicates that compound R is an alkane containing two carbon atoms, or ethane. Compound Q is ethene. The compound P from which compound Q is formed is ethanol, as alcohols on being heated with concentrated sulphuric acid at 443 K give alkenes. The chemical equations involved in the reactions are as follows:

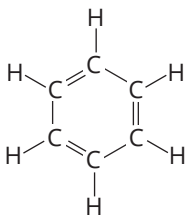
$$\underset{\substack{\text{Ethanol}\\\text{(Compound P)}}}{CH_3CH_2OH} \xrightarrow[443\ K]{\text{conc. } H_2SO_4} \underset{\substack{\text{Ethene}\\\text{(Compound Q)}}}{CH_2{=}CH_2} + H_2O$$

$$\underset{\substack{\text{Ethene}\\\text{(Compound Q)}}}{CH_2{=}CH_2} + H_2 \xrightarrow{\text{Ni catalyst}} \underset{\substack{\text{Ethane}\\\text{(Compound R)}}}{CH_3{-}CH_3}$$

$$2CH_3{-}CH_3 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$$

2. A cyclic compound 'X' has a molecular formula C_6H_6. It is unsaturated and burns with sooty flame. Identify 'X' and write its structural formula. Will it decolourize bromine water or not and why?

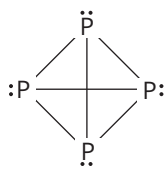
Ans. The compound X is benzene. Its structure is as follows:



Benzene will not decolourize bromine water because even though it is unsaturated and contains three double bonds, it acts like a saturated compound. The electrons of the three double bonds are said to be delocalised, because of which benzene acts like saturated hydrocarbons.

3. The molecule of phosphorus consists of four atoms. Write its electron dot structure.

Ans. The structure of phosphorus is as follows:



4. A sweet-smelling compound A with molecular formula $C_4H_8O_2$ on hydrolysis with dilute sulphuric acid gives compounds B and C. B on oxidation with acidified potassium dichromate gives C. Identify A, B and C.

Ans. Since the compound A is sweet smelling with chemical formula $C_4H_8O_2$ and undergoes hydrolysis to form two compounds, it suggests that compound A is ethyl ethanoate. Ethyl ethanoate on hydrolysis forms ethanoic acid and ethanol. Ethanol on oxidation with acidified potassium dichromate forms ethanoic acid. So, compound B is ethanol and compound C is ethanoic acid. The chemical equations for the reactions are as follows:

$$\underset{\text{Ethyl ethanoate (Compound A)}}{CH_3COOCH_2CH_3} \xrightarrow[\text{catalyst}]{\text{acid}} \underset{\text{Ethanoic acid (Compound C)}}{CH_3COOH} + \underset{\text{Ethanol (Compound B)}}{CH_3CH_2OH}$$

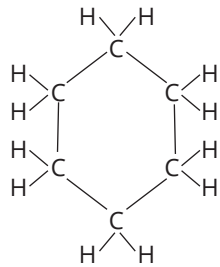
$$\underset{\text{(Compound B)}}{CH_3CH_2OH} \xrightarrow[K_2Cr_2O_7]{\text{acidified}} \underset{\text{Ethanoic acid (Compound C)}}{CH_3COOH}$$

5. If the *p*H of water is 2, out of soap and detergent, which one would you use for cleaning clothes.

Ans. If the *p*H of water is 2, it suggests that the water is too acidic. This condition might not be suitable for washing clothes with soap. In this case, detergent will be used for washing clothes because it can form lather in soft water, hard water and highly acidic water.

6. Two compounds X and Y have the same molecular formula, $C_6H_{12.}$ Compound X is saturated while compound Y is unsaturated. Draw their structures. What type of reaction, compound X and Y are expected to undergo?

Ans. The compound X is cyclohexane, and compound Y is hexene. The structures of both the compounds are as follows:



Compound X

$CH_3—CH=CH—CH_2—CH_2—CH_3$

Compound Y

(Note: The compound Y is hex-2-ene. Other isomers of the compound are also possible.)

Cyclohexane will undergo substitution reactions while hexene will undergo addition reactions.

Self-Assessment

(Page 110)

Multiple-Choice Questions

1. Pentane having the molecular formula C_5H_{12} has

(a) 5 covalent bonds
(b) 16 covalent bonds
(c) 12 covalent bonds
(d) 17 covalent bonds

Ans. (b) 16 covalent bonds

2. Soaps are prepared by the alkaline hydrolysis of

(a) alcohols
(b) carboxylic acid
(c) esters
(d) none of these

Ans. (c) esters

3. Which of the following is/are formed when methane reacts with chlorine in the presence of sunlight?

(a) CH_3Cl (b) CH_2Cl_2
(c) $CHCl_3$ (d) All of these

Ans. (d) All of these

4. Carboxylic acids are obtained from alcohols by

(a) pyrolysis (b) hydrolysis
(c) reduction (d) oxidation

Ans. (d) oxidation

Assertion–Reason Type Questions

For question numbers 5 to 14, two statements are given – one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

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

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

(c) A is true but R is false.

(d) A is false but R is true.

5. Assertion: Covalent compounds are poor conductors of electricity.

Reason: Covalent compounds are formed by transfer of electrons between the atoms.

Ans. (c) Covalent compounds are formed by sharing of electrons and not transfer of electrons. Thus, they consist of molecules and not ions. Since they do not contain ions, covalent compounds are poor conductors of electricity.

6. Assertion: Graphite is smooth and slippery in nature.

Reason: Graphite is an allotrope of carbon.

Ans. (b) Graphite is an allotrope of carbon and has a layered structure. The layers of carbon atoms in graphite are held together by weak forces of attraction and can slide over one another. This makes graphite smooth and slippery in nature.

7. Assertion: Ethene cannot undergo addition reaction.

Reason: Ethene is an unsaturated hydrocarbon.

Ans. (d) Ethene is an unsaturated hydrocarbon, so it can undergo addition reaction.

8. Assertion: Propanal and pentanal are homologues.

Reason: The successive members of a homologous series differ from each other in molecular formula by a —CH_2— unit and in molecular mass by 14 u.

Ans. (d) Homologues differ from each other in molecular formula by a —CH_2— unit and in molecular mass by 14 u. Propanal and pentanal are not homologues because they differ from each other by two —CH_2— units. The next homologue of propanal is butanal.

9. Assertion: Alkaline hydrolysis of esters is known as saponification.

Reason: Esters are sweet-smelling substances.

Ans. (b) Esters are sweet-smelling compounds prepared by the reaction of alcohols and carboxylic acids. When esters are treated with alkalis, the ester is converted back into alcohol and sodium salt of carboxylic acid. This reaction is known as saponification.

10. Assertion: Heating ethanol with alkaline potassium permanganate results in the formation of ethanoic acid.

Reason: Alkaline potassium permanganate is a strong oxidising agent.

Ans. (a) Alkaline potassium permanganate and acidified potassium dichromate are strong oxidising agents and they can oxidise alcohols to carboxylic acids.

11. Assertion: Unlike mineral acids, carboxylic acids are weak acids.

Reason: Carboxylic acids are insoluble in water.

Ans. (c) Carboxylic acids ionise only partially in water. Hence, they furnish lesser number of H+ ions in water as compared to mineral acids. This is why they are weak acids.

12. Assertion: When a pinch of sodium carbonate is added to acetic acid, effervescence is observed.

Reason: Reaction of sodium carbonate and acetic acid produces sodium acetate, water vapour and hydrogen.

Ans. (c) Sodium carbonate reacts with acetic acid to form sodium acetate, water vapour and carbon dioxide. Thus, when a pinch of sodium carbonate is added to acetic acid solution, effervescence is observed due to the formation of carbon dioxide.

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$$

13. Assertion: Soaps do not form lather with hard water.

Reason: Soaps form micelles in water.

Ans. (b) Soaps do not form lather with hard water. When soaps are used with hard water, the calcium and magnesium ions in hard water react with soap to form insoluble substances called scum.

14. Assertion: Compounds of carbon generally have low melting points.

Reason: Compounds of carbon are mostly covalent in nature.

Ans. (a) Carbon forms compounds by sharing of electrons, that is, covalent compounds. The forces of attraction between the molecules of covalent compounds are quite weak. This is why they generally have low melting points.

Source-based/Case-based/Passage-based/ Integrated assessment questions

Answer the questions on the basis of your understanding of the following paragraphs and the related studied concepts.

15. Chloroform is a colourless, sweet-smelling organic liquid with the chemical formula $CHCl_3$. Its boiling point is 61.2 °C. It is mainly produced by heating

chlorine with either chloromethane or methane. Methane undergoes substitution reaction with chlorine to form a mixture of products which are separated by distillation. Chloroform is mainly used as a solvent and reagent for the preparation of other commercially important organic compounds. It is also a powerful anaesthetic. Inhalation of small quantities of chloroform causes temporary loss of consciousness.

I. (a) What is the type of bonding present in chloroform?

(b) Why does chloroform have a low boiling point?

(c) Would you classify chloroform as a saturated or unsaturated compound?

(d) Why the reaction between chlorine and methane is called a substitution reaction?

Ans. (a) Chloroform is formed by the sharing of electrons. Thus, covalent bonding is present in chloroform.

(b) Chloroform has a low boiling point because it is a covalent compound. In covalent compounds, the intermolecular forces of attraction are weak. Hence, the amount of energy required to break the bonds is less.

(c) Chloroform is a saturated compound because it consists of single bonds between carbon and chlorine atoms.

(d) In the reaction between chlorine and methane, chlorine replaces the hydrogen atoms of methane one by one. Thus, it is called a substitution reaction.

II. (a) Which of the following is a correct statement?

(i) Chloroform is a saturated compound.

(ii) Chloroform is an unsaturated compound.

(iii) Chloroform consists of double bond between carbon and chlorine atoms.

(iv) Chloroform does not have any single bond between carbon and chlorine atoms.

Ans. (i) Chloroform is a saturated compound.

(b) Chloroform has a low boiling point because

(i) it is an ionic compound.

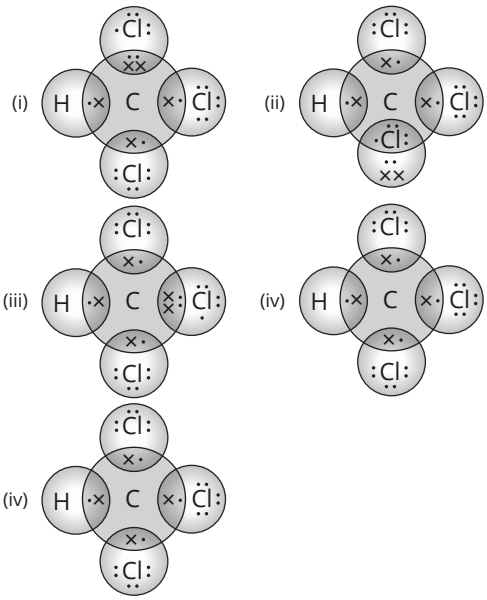
(ii) it exhibits strong intermolecular forces of attraction.

(iii) it exhibits weak intermolecular forces of attraction.

(iv) it is an unsaturated compound.

Ans. (iii) it exhibits weak intermolecular forces of attraction.

(c) Which of the following correctly represents the electron-dot structure of chloroform?



Ans. (iv)

(d) Methane undergoes substitution reaction with chlorine in the

(i) absence of sunlight

(ii) presence of sunlight

(iii) absence of water

(iv) presence of water

Ans. (ii) presence of sunlight

(e) The type of bonding present in chloroform is

(i) ionic

(ii) covalent

(iii) coordinate

(iv) both ionic and covalent

Ans. (ii) covalent

16. Esters are the sweet-smelling organic compounds prepared by the reaction of a carboxylic acid and an alcohol. This reaction is known as esterification. One of the most commonly used esters is ethyl acetate. It is a sweet-smelling, colourless liquid used for the decaffeination of tea leaves and coffee beans. It is also used as a solvent and diluting agent in laboratories.

I. (a) Write the chemical equation for the formation of ethyl acetate by esterification.

(b) Why is concentrated sulphuric acid added during esterification?

(c) What happens when ethyl acetate is hydrolysed with sodium hydroxide? What is this reaction known as?

(d) How will you prepare ethyl propanoate by esterification?

Ans. (a) The chemical equation for the formation of ethyl acetate by esterification is as follows:

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

(b) Concentrated sulphuric acid acts as a catalyst during esterification reaction.

(c) Ethyl acetate on hydrolysis with sodium hydroxide will give ethanol and sodium salt of ethanoic acid. Alkaline hydrolysis of esters is known as saponification reaction.

$$CH_3COOC_2H_5 \xrightarrow{NaOH} C_2H_5OH + CH_3COONa$$

(d) $C_2H_5OH + CH_3CH_2COOH \xrightarrow{acid} CH_3CH_2COOC_2H_5 + H_2O$

II. (a) Which of the following will give a pleasant smell of ester when heated with ethanol and a small quantity of sulphuric acid?

(i) CH_3COOH (ii) CH_3CH_2OH

(iii) CH_3OH (iv) CH_3CHO

Ans. (i) CH_3COOH

(b) Ethyl propanoate can be prepared by the esterification reaction using

(i) propanol and propanoic acid

(ii) ethanol and ethanoic acid

(iii) propanol and ethanoic acid

(iv) ethanol and propanoic acid

Ans. (iv) ethanol and propanoic acid

(c) Ethyl acetate on hydrolysis with sodium hydroxide will form

(i) ethanol and sodium salt of ethanoic acid.

(ii) methanol and sodium salt of ethanoic acid.

(iii) ethane and sodium salt of ethanoic acid.

(iv) methane and sodium salt of ethanoic acid.

Ans. (i) ethanol and sodium salt of ethanoic acid.

(d) Which of the following correctly represents the chemical equation for the formation of ethyl acetate?

(i) $CH_3COOH + CH_3OH \xrightarrow{conc.\ H_2SO_4} CH_3COOC_2H_5 + H_2O$

(ii) $C_2H_5OH + HCOOH \xrightarrow{conc.\ H_2SO_4} CH_3COOC_2H_5 + H_2O$

(iii) $CH_3OH + HCOOH \xrightarrow{conc.\ H_2SO_4} CH_3COOC_2H_5 + H_2O$

(iv) $C_2H_5OH + CH_3COOH \xrightarrow{conc.\ H_2SO_4} CH_3COOC_2H_5 + H_2O$

Ans. (iv) $C_2H_5OH + CH_3COOH \xrightarrow{conc.\ H_2SO_4} CH_3COOC_2H_5 + H_2O$

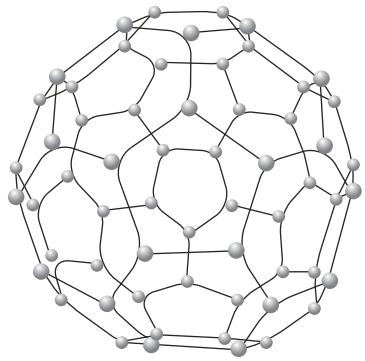
(e) When ethyl alcohol and acetic acid are mixed, the resulting ester has a chemical formula

(i) $CH_3COOC_2H_5$ (ii) $C_2H_5COOC_2H_6$

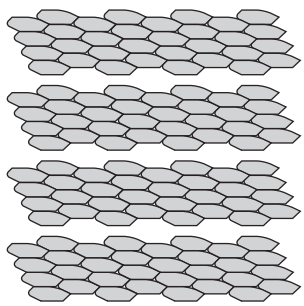
(iii) $C_2H_5COOC_2H_5$ (iv) CH_3COOCH_3

Ans. (i) $CH_3COOC_2H_5$

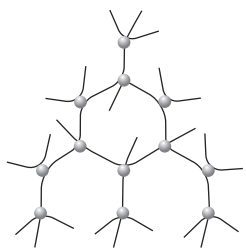
17. Fullerenes were first discovered in 1985 by H.W. Kroto, R.E. Smalley and R.F. Curl. They received the Nobel Prize in chemistry in 1996 for their work. Fullerenes are a class of carbon allotropes (other being diamond and graphite) consisting of molecules of carbon atoms. These molecules may be in the form of a hollow tube, sphere or other shapes. They are denoted by the general chemical formula C_n, where n denotes the number of carbon atoms in a fullerene molecule.



Structure of fullerene



Structure of graphite



Structure of diamond

I. (a) What are allotropes?

(b) What is the arrangement of carbon atoms in diamond?

(c) Write any two important properties of graphite.

(d) Apart from carbon, name any two elements which exhibit allotropy.

Ans. (a) The different physical forms of an element in which it can exist are known as its allotropes. For example, diamond and fullerene are the allotropes of carbon.

(b) In diamond, each carbon atom is bonded to four other carbon atoms by single bonds in a tetrahedral manner. Thus, diamond has a rigid three-dimensional structure. It has no free electrons, since all the electrons are involved in bonding.

(c) Graphite has a layered structure and has free electrons. Hence, it is soft and slippery and is a good conductor of electricity.

(d) Apart from carbon, elements such as sulphur and phosphorus also show allotropy.

II. (a) In diamond, each carbon atom is bonded to

(i) two other carbon atoms by single bonds in a tetrahedral manner

(ii) three other carbon atoms by single bonds in a tetrahedral manner

(iii) four other carbon atoms by single bonds in a tetrahedral manner

(iv) six other carbon atoms by single bonds in a tetrahedral manner

Ans. (iii) four other carbon atoms by single bonds in a tetrahedral manner

(b) Which of the following statements is incorrect?

(i) The carbon atoms of graphite form hexagonal rings.

(ii) The layers of carbon atoms in graphite are held by weak forces.

(iii) Graphite has a layered structure and has free electrons.

(iv) Graphite is a bad conductor of electricity.

Ans. (iv) Graphite is a bad conductor of electricity.

(c) Which of the following elements do not exhibit allotropy?

(i) Oxygen (ii) Magnesium

(iii) Sulphur (iv) Phosphorus

Ans. (ii) Magnesium

(d) Which of the following statements is incorrect?

(i) Diamond has a rigid three-dimensional structure.

(ii) Diamond has a layered structure and has free electrons.

(iii) Diamond has no free electrons since all the electrons are involved in bonding.

(iv) Diamond is a poor conductor of electricity.

Ans. (i) Diamond has a rigid three-dimensional structure.

(e) Which of the following statements about graphite and diamond is true?

(i) They have the same crystal structure.

(ii) They have the same degree of hardness.

(iii) They have the same electrical conductivity.

(iv) They can undergo the same chemical reactions.

Ans. (i) They have the same crystal structure.

18. Liquefied petroleum gas (LPG) is obtained by the fractional distillation of petroleum. It is a mixture of propane and butane. LPG is colourless, odourless and highly inflammable in nature. It is also heavier than air. This is why, it has a tendency to settle down and collect in low-lying areas. To detect its leakage, a foul-smelling compound, called ethyl mercaptan is added to it.

I. (a) Write the chemical formulae of propane and butane.

(b) Out of propane and butane, which compound will show isomerism?

(c) Propane and butane belong to which family of organic compounds? What is the next homologue of butane?

(d) Which type of reactions are the principal components of LPG more likely to undergo – addition or substitution?

Ans. (a) The chemical formulae of propane and butane are as follows:

Propane: C_3H_8

Butane: C_4H_{10}

(b) Out of propane and butane, butane will show isomerism.

(c) Propane and butane are saturated hydrocarbons. They belong to the family of alkanes. The next homologue of butane is pentane.

(d) The principal components of LPG are propane and butane. They are more likely to undergo substitution reactions.

II. (a) The chemical formulae of propane and butane are

(i) C_2H_2 and C_4H_8 respectively

(ii) C_2H_4 and C_3H_6 respectively

(iii) C_3H_6 and C_4H_8 respectively

(iv) C_3H_8 and C_4H_{10} respectively

Ans. (iv) C_3H_8 and C_4H_{10} respectively

(b) How many structural isomers can you draw for butane?

(i) 2 (ii) 3

(iii) 4 (iv) 5

Ans. (i) 2

(c) The next homologue of butane is

(i) methane (ii) pentane

(iii) hexane (iv) propane

Ans. (ii) pentane

(d) Saturated hydrocarbons like propane and butane are likely to undergo
(i) substitution reaction
(ii) addition reaction
(iii) oxidation reaction
(iv) no reaction because they are unreactive

Ans. (i) substitution reaction

(e) The principal component(s) of liquefied petroleum gas is\are
(i) propane and butane.
(ii) methane and ethane.
(iii) only methane.
(iv) only butane.

Ans. (i) propane and butane.

19. Hard water contains the bicarbonate, chloride and sulphate salts of calcium and magnesium. Hardness of water is of two types – temporary and permanent. Temporary hardness is due to the presence of calcium and magnesium bicarbonates. It can be removed by boiling and treating the hard water with slaked lime. Permanent hardness is due to the presence of calcium and magnesium chlorides and sulphates. It can be removed by treating hard water with sodium carbonate and using chemicals such as calgon and zeolite. Hard water does not give lather with soap. However, detergents function both with hard water as well as with soft water.

I. (a) What happens when soap is used with hard water?
(b) How are soaps chemically different from detergents?
(c) State any one disadvantage of detergents over soaps?
(d) How will you determine whether a given sample of water is hard or soft?

Ans. (a) When soap is used with hard water, it reacts with the calcium and magnesium ions in hard water to form insoluble precipitates called scum.
(b) Soaps are the sodium or potassium salts of long-chain carboxylic acids. Detergents are the sodium salts of sulphonic acids or ammonium salts with chloride or bromide ions.
(c) Detergents in which the hydrocarbon chain is highly branched are non-biodegradable, that is, they cannot be decomposed by the action of microorganisms. Thus, they accumulate in water bodies and cause water pollution.
(d) We can determine whether a given sample of water is hard or soft by testing it with soap solution. Soap forms lather with soft water and scum with hard water.

II. (a) When soap is used with hard water, it forms
(i) soluble precipitate called scum
(ii) insoluble precipitate called scum
(iii) lather
(iv) both lather and scum

Ans. (ii) insoluble precipitate called scum

(b) The substance not responsible for the hardness of water is
(i) sodium nitrate
(ii) magnesium carbonate
(iii) calcium carbonate
(iv) calcium hydrogen carbonate

Ans. (i) sodium nitrate

(c) The soap molecule has a
(i) hydrophilic head and a hydrophobic tail.
(ii) hydrophobic head and a hydrophilic tail.
(iii) hydrophobic head and a hydrophobic tail.
(iv) hydrophilic head and a hydrophilic tail.

Ans. (i) hydrophilic head and a hydrophobic tail.

(d) Which of the following statements is incorrect?
(i) Soaps are sodium salts of long-chain carboxylic acids.
(ii) Detergents are sodium salts of long-chain carboxylic acids.
(iii) Detergents are sodium salts of sulphonic acids or ammonium salts with chloride or bromide ions.
(iv) Detergents in which the hydrocarbon chain is highly branched are non-biodegradable.

Ans. (ii) Detergents are sodium salts of long-chain carboxylic acids.

(e) Which of the following statements is incorrect?
(i) If a given sample of water forms lather with soap, it is soft.
(ii) If a given sample of water forms lather with soap, it is hard.
(iii) We can determine whether a given sample of water is hard or soft by testing it with soap solution.
(iv) Detergent can be used even in acidic water.

Ans. (ii) If a given sample of water forms lather with soap, it is hard.

Very Short Answer Type Questions

20. How would you name the following compound?

(a) $(CH_3)_2CHCH(CH_3)_2$

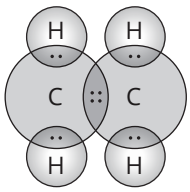
(b) $CH_3CHCH_3CH_2CH_3$

Ans. (a) 2,3-Dimethylbutane

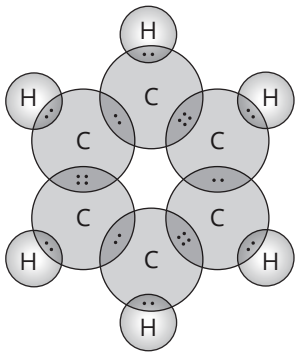
(b) 2-Methylbutane

21. Draw the electron-dot structures for
(a) benzene. (b) ethene.

Ans. The electron-dot structures of benzene and ethene are as follows:



Electron-dot structure of ethene



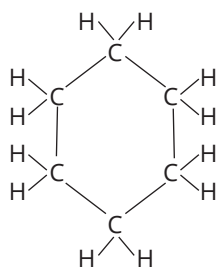
Electron-dot structure of benzene

22. Saturated hydrocarbons are very good fuel. Give reason.

Ans. Saturated hydrocarbons contain more hydrogen atoms per molecule than unsaturated hydrocarbons. In other words, the percentage of hydrogen in saturated hydrocarbons is more than that in unsaturated hydrocarbons. Hence saturated hydrocarbons get completely oxidised by the oxygen present in air. They release a lot of energy and do not produce any black smoke on combustion. This is why saturated hydrocarbons are very good fuels.

23. Draw the structures of the following compounds: (i) Cyclohexane (ii) Pentyne.

Ans. (i) Cyclohexane



(ii) Pentyne

$HC{\equiv}C{-}CH_2{-}CH_2{-}CH_3$ (Pent-1-yne) $H_3C{-}C{\equiv}C{-}CH_2{-}CH_3$ (Pent-2-yne)

24. A compound 'A' with molecular formula C_3H_8O reacts with sodium metal to evolve hydrogen gas. Draw the structure of the compound 'A'?

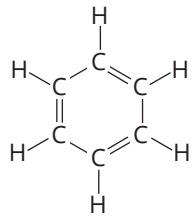
Ans. The molecular formula of compound A suggests that it does not contain any double or triple bond. Hence it is an alcohol. The structure of compound A could be $CH_3{-}CH_2{-}CH_2{-}OH$ or $CH_3{-}CH(OH){-}CH_3$.

25. Give reasons for the following:
(a) Ethanol is used in the preparation of tincture iodine.
(b) Ethanoic acid is used in the preparation of pickles.

Ans. (a) Ethanol is a good solvent. This is why it is used in making tincture of iodine.
(b) Ethanoic acid is a mild acid. It has a sour taste. Also, it prevents the growth of microorganisms. This is why ethanoic acid is used in the preparation of pickles.

26. A cyclic compound X has molecular formula C_6H_6. It is an unsaturated compound and burns with sooty flame. Identify X and its structural formula.

Ans. The compound X is benzene. Its structure is as follows:



27. (a) When is flame produced?
(b) Why does combustion of fossil fuel forms oxides of nitrogen and sulphur?

Ans. (a) Flame is produced when a substance vaporises during burning.
(b) Fossil fuels mainly contain carbon but also contain impurities such as sulphur and nitrogen. This is why combustion of fossil fuels forms oxides of nitrogen and sulphur.

28. Diamond and graphite show different physical properties although they are made up of carbon. Name this relationship between diamond and graphite. Give the basis of this relationship also.

Ans. The relationship between diamond and graphite is allotropy. The basis of allotropy is the difference in the arrangement of carbon atoms in the two allotropes. In diamond, each carbon atom is bonded to four other carbon atoms forming a rigid three-dimensional structure. In graphite, each carbon atom is bonded to three other carbon atoms in the same plane giving a hexagonal array. One of these bonds is a double bond.

Short Answer Type Questions

29. (a) Give the IUPAC name of HCOOH.
(b) Give one advantage of soaps over detergents.
(c) How is scum formed?

Ans. (a) The IUPAC name of HCOOH is methanoic acid.
(b) The advantage of soaps over detergents is that detergents can form lather even with hard water. Soap, on the other hand, cannot form lather with hard water.
(c) Scum is an insoluble substance formed when soap is used with hard water. It is formed by the

reaction of calcium and magnesium salts present in hard water with salts of long-chain carboxylic acids present in soap.

30. A compound X is formed by reaction of a carboxylic acid $C_2H_4O_2$ and an alcohol Y in presence of few drops of conc. sulphuric acid. The intake of alcohol even in small amount is lethal. The alcohol on oxidation with alkaline $KMnO_4$ followed by acidification gives carboxylic acid Z. Give the names of X, Y and Z. Write the chemical reactions involved.

Ans. The chemical formula of carboxylic acid ($C_2H_4O_2$) suggests that it is acetic acid. We are given that compound Y is alcohol and its consumption in even small amount is lethal. Thus compound Y is methanol. On oxidation with alkaline $KMnO_4$, methanol will form methanoic acid. Thus

$X = CH_3COOCH_3$

$Y = CH_3OH$

$Z = HCOOH$

The reactions involved are as follows:

$$CH_3COOH + CH_3OH \underset{}{\overset{\text{Acid catalyst}}{\rightleftharpoons}} CH_3COOCH_3 + H_2O$$

$$CH_3OH \xrightarrow[KMnO_4]{\text{Alkaline}} HCOOH$$

Long Answer Type Questions

31. (a) Explain the given reactions with examples:

(i) Hydrogenation reaction

(ii) Dehydration reaction

(iii) Combustion reaction

(b) A test tube contains a brown liquid in it. The colour of the liquid remains the same when methane is passed through it but becomes colourless when ethene is passed. Suggest the name of the liquid brown in colour. Give the chemical reaction involved.

Ans. (a) (i) Addition of hydrogen to unsaturated hydrocarbons in the presence of catalysts such as nickel or palladium to give saturated hydrocarbons is known as hydrogenation.

(ii) The chemical reaction in which a compound loses water molecule is known as dehydration reaction.

(iii) The chemical process in which a substance reacts with oxygen to produce heat is known as combustion.

(b) The liquid in the test tube is bromine water. Alkenes and alkynes are unsaturated hydrocarbons. They undergo addition reaction with bromine. Saturated hydrocarbons, on the other hand, do not undergo this reaction.

$$CH_2{=}CH_2 + Br_2 \rightarrow CH_2Br{-}CH_2Br$$

32. (a) What is a detergent? Would you be able to check if water is hard by using a detergent? Justify your answer?

(b) What is saponification? Explain the cleansing action of soap.

(c) What would be the disadvantage of detergents over soaps?

Ans. (a) Detergents are sulphonate, sulphate or ammonium salts of long chain hydrocarbons. We will not be able to check hardness of water using a detergent because detergent works with both hard water and soft water.

(b) The alkaline hydrolysis of fats or oils to give glycerol and sodium salts of fatty acids is called saponification.

Let us understand the cleansing action of soap with the help of an example. The most common soap is sodium stearate, $C_{17}H_{35}COONa$. In aqueous solution, this soap ionizes as follows:

$$C_{17}H_{35}COONa \rightarrow C_{17}H_{35}COO^- + Na^+$$

The stearate ion has two parts—the long hydrocarbon chain (R) which is hydrophobic (water repelling) and the negatively charged anionic part which is hydrophilic (water loving). Hence, the R group stays away from water and the $—COO^-$ group dips into the water. Thus, the hydrocarbon chain of soap dissolves in oil while the ionic end of soap dissolves in water. When a large number of $RCOO^-$ groups orient themselves, the $—COO^-$ groups stay away from each other due to the electrostatic repulsion and the R groups form a bunch in the interior. Thus, an emulsion of soap in water is formed. Such a cluster of about 100 soap molecules is known as a micelle. It is spherical in shape.

When a cloth with oily (or greasy) dirt is dipped into a soap solution, the hydrocarbon chain of the stearate ion attaches itself to oils and fats and the polar end ($—COO^-$) is directed towards water. When shaken with water, the stearate ions form micelles containing oily dirt in the centre of micelles. The micelles stay in solution as a colloid.

When the cloth is washed with water, the micelles containing the oily dirt are washed away and the cloth gets cleaned. Due to electrostatic repulsion, the negatively charged micelles repel each other. Consequently, the oily dirt particles do not come together but are rinsed away in water. Thus, the soap micelles help in dissolving the dirt and the clothes are washed clean.

(c) The disadvantage of detergents over soaps is that if the hydrocarbon chain in detergents

is highly branched, the bacteria cannot decompose them. Thus, they get accumulated in water bodies and cause water pollution.

Let's Compete

(Page 115)

Multiple-Choice Questions

1. In the soap micelles

(a) both ionic end and carbon chain are on the exterior of the cluster.

(b) both ionic end and carbon chain are in the interior of the cluster.

(c) ionic end of soap is in the interior of the cluster and the carbon chain is out of the cluster.

(d) ionic end of soap is on the surface of the cluster while the carbon chain is in the interior of the cluster.

Ans. (d) ionic end of soap is on the surface of the cluster while the carbon chain is in the interior of the cluster.

2. The next higher homologue of C_6H_{14} is

(a) C_7H_{14}. (b) C_7H_{16}.

(c) C_7H_{12}. (d) C_8H_{18}.

Ans. (b) C_7H_{16}.

3. The formation of ethene from ethanol by heating with conc. H_2SO_4 is a/an

(a) addition reaction

(b) substitution reaction

(c) dehydration reaction

(d) none of these

Ans. (c) dehydration reaction

4. Ethanoic acid was added to solid sodium carbonate taken in a test tube. Which of the following would be observed?

(a) Evolution of colourless gas having smell of rotten egg.

(b) Evolution of colourless gas having pungent smell.

(c) Evolution of colourless and odourless gas.

(d) Evolution of greenish-yellow gas with a pungent smell.

Ans. (c) Evolution of colourless and odourless gas.

5. Synthetic detergents are suitable for washing of clothes

(a) in soft water only

(b) in hard water only

(c) in both soft as well as hard water

(d) none of these

Ans. (c) in both soft as well as hard water

6. Vinegar is

(a) 5–8% acetic acid

(b) 50% acetic acid

(c) 25% acetic acid

(d) acetic acid of any concentration

Ans. (a) 5–8% acetic acid

7. Open chain saturated hydrocarbons are called

(a) paraffins. (b) alkenes.

(c) alkynes. (d) cycloalkanes.

Ans. (a) paraffins.

8. A student took four test tubes P, Q, R and S and filled about 8 mL of distilled water in each. After that he dissolved an equal amount of Na_2SO_4 in P, K_2SO_4 in Q, $CaSO_4$ in R and $MgSO_4$ in S. On adding an equal amount of soap solution and shaking each test tube well, a good amount of lather will be obtained in the test tubes:

(a) P and Q (b) P and R

(c) P, Q and S (d) Q, R and S

(CBSE 2017)

Ans. (a) P and Q.

9. One of the following organic compounds cannot decolourize the red-brown colour of bromine water. This compound is:

(a) $C_{14}H_{28}$ (b) C_7H_{12}

(c) C_6H_{14} (d) C_9H_{16}

Ans. (c) C_6H_{14}

10. The molecular formula of third member of homologous series of ketones is:

(a) C_4H_8O (b) C_3H_6O

(c) $C_6H_{12}O$ (d) $C_5H_{10}O$

Ans. (d) $C_5H_{10}O$

Life Skills

(Page 116)

1. Two unique properties of carbon are catenation and tetravalent nature. These two unique properties lead to the formation of a large number of covalent compounds.

(a) Why is it that carbon cannot form ionic compounds?

(b) Name an element, other than carbon which exhibits the property of catenation upto seven or eight atoms. Why are these compounds not stable?

(c) Define the terms catenation and tetravalency.

(d) What values can we imbibe into our life from the above two unique properties of carbon?

Ans. (a) Carbon cannot form ionic compounds because for that it will have to lose or gain 4 electrons to form C^{4+} and C^{4-} ions. This is difficult because:

(i) Formation of C^{4+} cation would require the removal of four electrons. A lot of energy would be needed for this process, as it would leave behind a carbon cation with six protons in the nucleus holding on to just two electrons.

(ii) Formation of C^{4-} anion would require the addition of four electrons to the carbon atom. In this case, it would be difficult for nucleus with six protons to hold on to ten electrons.

(b) Silicon shows the property of catenation. However, such compounds of silicon are not stable because silicon is bigger in size than carbon.

(c) Carbon exhibits the unique property to form bonds with other carbon atoms giving rise to large straight chain compounds, branched chain compounds and rings of carbon atoms. This property is known as catenation.

The tendency of an atom with four valence electrons to complete its octet by forming four bonds is known as tetravalency.

(d) From the unique properties of carbon, we learn values such as living in harmony with others, respecting each other's values and helping people.

2. A student observed that while cooking on a LPG gas stove, the outside of the cooking vessels had become black and the flame of the gas stove was yellowish in colour. She explained to her mother that the sooty flame was due to the incomplete combustion of fuel arising out of less supply of air. She also indicated that the incomplete combustion led to the formation of oxides of sulphur and nitrogen causing major environmental pollution.

(a) Name the hydrocarbon which is present in LPG cylinder.

(b) Write the chemical equation indicating the incomplete combustion of the hydrocarbon.

(c) Suggest steps for stopping the incomplete combustion of fuel.

(d) What values did the student display by telling her mother about the incomplete combustion of the fuel and the problems arising out of it?

Ans. (a) LPG is a mixture of propane and butane.

(b) Incomplete combustion of fuels results in the formation of carbon monoxide along with carbon dioxide. The chemical equation for the reaction is as follows:

$$2C_3H_8 + 9O_2 \rightarrow 4CO_2 + 2CO + 8H_2O$$

(c) To check the incomplete combustion of fuels, we should ensure that the air holes of burner are properly adjusted.

(d) The student displayed values such as awareness, critical thinking and concern for the environment.

3. Animal fats (*ghee*, butter, etc.), saturated fats (*dalda*) and some oils (palm oil, groundnut oil, coconut oil, etc.) containing saturated fatty acids, are harmful for our health since they increase the level of saturated fatty acids in our blood. The saturated fatty acids are responsible for the increase of cholesterol level in our blood and cholesterol gets deposited in the heart arteries leading to decrease in flow of blood in the heart and heart attack. A student suggested to his mother not to use saturated fats for cooking but to use oils containing polyunsaturated fatty acids for cooking.

(a) Define hydrogenation.

(b) Why is it that vegetable oils are better cooking medium than saturated fats and animal fats?

(c) What values did the student display by telling his mother to use vegetable oils instead of saturated fats for cooking?

Ans. (a) Addition of hydrogen to unsaturated hydrocarbons in the presence of catalysts such as nickel or palladium to give saturated hydrocarbons is known as hydrogenation.

(b) Vegetable oils contain unsaturated fatty acids. These are good for our health. Animal fats contain saturated fatty acids, excess of which are not good for our health.

(c) The student displayed awareness, scientific aptitude and concern by telling his mother to use vegetable oils instead of saturated fats for cooking.