TEACHER'S HANDBOOK

STELLAR LEARNING

Chemistry

10

On Board! BOOKS

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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.

Milestone 1

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

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

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

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

(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) $MgCO_3 \rightarrow MgO + CO_2$

Very Short Answer Type Questions

7. 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.

8. What do you mean by aqueous solution?

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

9. 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.

10. 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.

11. 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.

Short Answer Type-I Questions

12. 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.

13. 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) $2NH_3 + 3CuO \rightarrow N_2 + 3Cu + 3H_2O$

14. 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:

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

Short Answer Type-II Questions

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

16. 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.

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

(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.

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

17. (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:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + Heat$$

Endothermic reaction:

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

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

Long Answer Type Questions

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

19. (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) $4NH_3 + Cl_2 \rightarrow N_2H_4 + 2NH_4Cl$

Milestone 2

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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 oxidized 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 oxidized 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 oxidized when it gains oxygen (an electronegative atom) or loses hydrogen.

Very Short Answer Type Questions

6. In thermit welding, the following reaction occurs:

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

Identify the reducing agent and oxidizing 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.

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

(CBSE 2011)

Ans. Double displacement reaction:

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

8. 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.

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

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

10. 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? **(CBSE 2010)**

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.

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

Short Answer Type-I Questions

11. 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.

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

12. 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

13. 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

14. 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-II Questions

15. 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.

16. 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.

17. (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? **(CBSE 2015)**

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

18. (a) Name the reducing agent, oxidizing agent, substance oxidized 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, oxidizing agent – SO_2, substance oxidized – H_2S, substance reduced – SO_2.

(ii) Reducing agent – Al, oxidizing agent – Cr_2O_3, substance oxidized – Al, substance reduced – Cr_2O_3.

(iii) Reducing agent – PbS, oxidizing agent – H_2O_2, substance oxidized – PbS, substance reduced – H_2O_2.

(iv) Reducing agent – H_2S, oxidizing agent – Br, substance oxidized – 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.

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

19. (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

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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. **(CBSE 2010)**

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 oxidized 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

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Multiple-Choice Questions

1. The following reaction is an example of

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

(i) neutralization 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: When copper oxide is heated in the presence of hydrogen, its colour changes from black to brown.

Reason: A substance is said to be oxidized 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.

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

13. Assertion: Bags of potato chips are flushed with nitrogen.

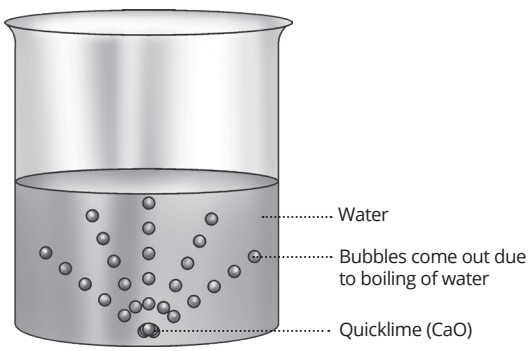
Reason: Nitrogen is very reactive in nature.

Ans. (c) Oils and fats get oxidized 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.

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

(d) 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.

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

(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) 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:

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

(d) 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

15. 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) What are antioxidants?
(d) 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) Antioxidants are the substances that prevent or slow down the process of oxidation.
(d) 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 oxidized
(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 oxidized

(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

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

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

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

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

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

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

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

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

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

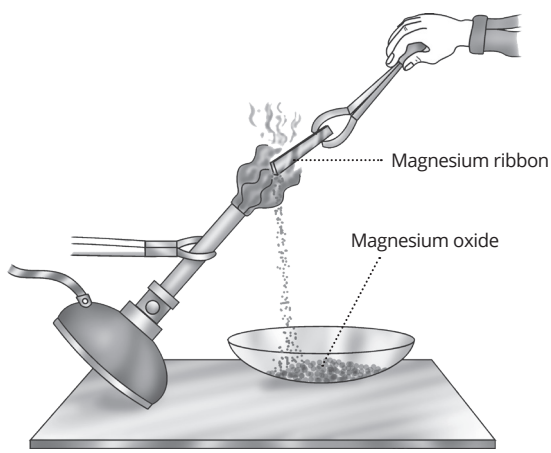
Ans. (iv) $2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$

(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

17. 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) How will you classify the reaction of zinc with dilute hydrochloric acid?

(d) 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) 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.

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

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

Very Short Answer Type Questions

18. 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.

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

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

19. 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.

20. Identify the reducing agent and oxidizing 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 oxidized: NH_3
Substance reduced: O_2
Oxidizing agent: O_2
Reducing agent: NH_3

(b) Substance oxidized: CO
Substance reduced: Fe_2O_3
Oxidizing agent: Fe_2O_3
Reducing agent: CO

21. 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:
$2AgNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

22. 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.

Short Answer Type-I Questions

23. What is the difference between skeletal and balanced chemical equation? Give example. **(CBSE 2009)**

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:

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

24. 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) oxidizing agent and

(b) reducing agent in the reaction. **(CBSE 2010)**

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) Oxidizing agent: ZnO

(b) reducing agent: C

25. 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.

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

26. 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-II Questions

27. 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

28. 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

29. 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

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

30. (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 23)

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 oxidizing agent.

(b) both $FeCl_2$ and H_2S are oxidized.

(c) $FeCl_3$ is oxidized and H_2S is reduced.

(d) H_2S acts as an oxidizing agent.

Ans. (a) $2FeCl_3 + H_2S \rightarrow 2FeCl_2 + 2HCl + S$

In this reaction, H_2S is oxidized and $FeCl_3$ acts as an oxidizing 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.

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

8. The chemical reaction between quicklime and water is characterized 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.

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

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.

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

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)

Value-based Questions

(Optional) (Page 24)

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) $\underset{\text{Iron sulphate}}{2FeSO_4(s)} \rightarrow \underset{\text{iron oxide}}{Fe_2O_3(s)} + SO_2(g) + SO_3(g)$

(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 27)

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 neutralizes 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 neutralized 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.

Milestone 1

(Page 33)

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.

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

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.

Short Answer Type-I Questions

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

Ans. Acids which undergo ionization to a large extent in a solution are called strong acids. For example, hydrochloric acid (HCl), nitric acid (HNO_3), etc.

Acids which undergo ionization 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-II 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.

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

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

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

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

(CBSE 2013)

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) $\underset{\text{(Lime water)}}{Ca(OH)_2} + CO_2 \rightarrow CaCO_3 + H_2O$

(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 ionization 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 neutralization 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^-).

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

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

Milestone 2

(Page 41)

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 $CaSO_4 \cdot 1/2H_2O$.

Very Short Answer Type Questions

7. What happens when electricity is passed through brine?

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

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

8. What happens when water is added to plaster of Paris?

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

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

9. Name the basic salt used in soda acid fire extinguisher.

Ans. Sodium hydrogencarbonate ($NaHCO_3$) is used in soda acid fire extinguishers.

10. Write the names of two salts belonging to sodium family. **(CBSE 2011)**

Ans. Two salts of sodium family are: Na_2SO_4, NaCl

11. 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.

$$2NaHCO_3 + Heat \rightarrow Na_2CO_3 + CO_2 + H_2O$$

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

$$Na_2CO_3.10H_2O + Heat \rightarrow Na_2CO_3 + 10H_2O$$

Short Answer Type-I Questions

12. 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.

13. 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.

14. Write the chemical name and formula of

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

(c) POP.

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	$CaSO_4 \cdot 1/2H_2O$

15. 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? **(CBSE 2008)**

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

Reactions involved:

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

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

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

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

Short Answer Type-II Questions

17. 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 neutralizes the sodium carbonate formed and this will not make the taste of the cake bitter.

18. (a) What is meant by water of crystallization? 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

19. (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 crystallization to form sodium carbonate monohydrate.

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

(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.

Long Answer Type Questions

20. (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:

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

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

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.

21. (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 43)

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 neutralize 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 43)

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) $\underset{\text{Calcium Carbonate}}{CaCO_3}\ (s) + \underset{\text{Water}}{H_2O}\ (l) + \underset{\text{Carbon dioxide}}{CO_2}\ (g) \rightarrow \underset{\text{Calcium hydrogen carbonate}}{Ca(HCO_3)_2}\ (aq)$

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

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 polymerizes 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 oxidizing 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 oxidizing 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 neutralizes 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) Will you classify acetic acid as a strong acid or a weak acid?

(d) 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) 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.

(d) 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 ionized.
(iv) Ethanoic acid is a colourless liquid.

Ans. (iii) Ethanoic acid is highly ionized.

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) What happens when the base used in a soda-acid fire extinguisher is heated?

(d) 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 neutralization reactions. They result in the formation of salt and water. Neutralization 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) Sodium bicarbonate on heating forms sodium carbonate, water and carbon dioxide.

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

(d) The base used in soda-acid fire extinguisher is sodium bicarbonate. Its uses are as follows:

(i) It is used in the preparation of baking powder.

(ii) 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) neutralization reaction

(iii) decomposition reaction

(iv) oxidation reaction

Ans. (ii) neutralization 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 ionized in water.

(ii) partially gets ionized in water.

(iii) do not get ionized in water.

(iv) is a weak acid.

Ans. (i) completely gets ionized 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) Why is it advised to store plaster of Paris in moisture-proof container?

(d) 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) 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.

(d) The uses of plaster of Paris are as follows:

(i) It is used by doctors for supporting fractured bones in the right position.

(ii) 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) How does change in *p*H in our mouth cause tooth decay?
(d) 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) 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.
(d) 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) When a few drops of phenolphthalein are added to aqueous solution of sodium carbonate, what colour change will be observed?

(d) 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 recrystallization. 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) 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.

(d) The uses of sodium carbonate are:

(i) It is used in glass, soap and paper industries.

(ii) 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. Sodium carbonate is used for softening of hard 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 *p*H 2.0 is 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 neutralizes 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.

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.

Short Answer Type-I Questions

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? **(CBSE 2012)**

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-II 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. **(CBSE 2015)**

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

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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) Ionization (ii) Neutralization

(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.

Value-based Questions

(Optional) (Page 48)

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 neutralized.

(d) Scientific temperament, alertness, care for others, etc.

3

Metals and Non-metals

Checkpoint (Page 52)

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.

Milestone 1

(Page 60)

Multiple-Choice Questions

1. Which of the following metals forms an amphoteric oxide?

(a) Calcium (b) Sodium
(c) Copper (d) Aluminium

Ans. (d) Aluminium

2. Which of the following metals is found in liquid state at room temperature?

(a) Sodium (b) Mercury
(c) Chromium (d) Iron

Ans. (b) Mercury

3. The only non-metal to exist as a liquid at room temperature is

(a) bromine. (b) nitrogen.

(c) oxygen. (d) helium.

Ans. (a) bromine.

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

Very Short Answer Type Questions

7. 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

8. Name two most malleable metals.

Ans. Gold and silver are the most malleable metals.

9. 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.

10. 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)**

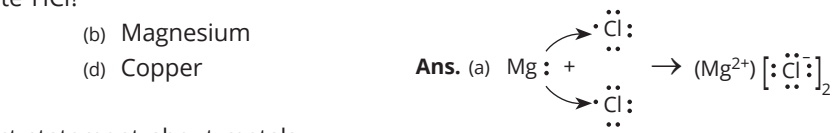
Ans. The non-metal X is carbon. Diamond, a form of carbon, is the hardest natural substance. On the other hand, graphite, another form of carbon, is a good conductor of electricity. So, Y is diamond and Z is graphite.

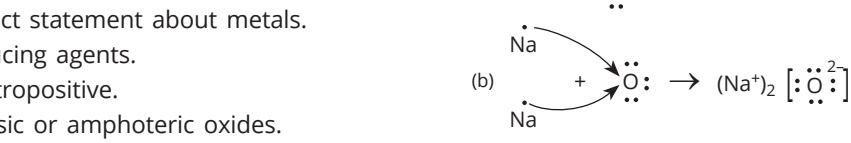
11. In nature, aluminium is found in combined state, while silver/gold is found in free state. Give reason. **(CBSE 2011)**

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.

Short Answer Type-I Questions

12. 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) 

13. 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:

$$ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$$

$$ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$$

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

$$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$$

14. 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.

Short Answer Type-II Questions

15. 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.

$Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$

16. 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. **(CBSE 2012)**

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.

17. 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.

Long Answer Type Questions

18. 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 oxidizing agent. On reaction with metals, it oxidizes 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.

19. 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.

Milestone 2

(Page 68)

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. Galvanization 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

Very Short Answer Type Questions

7. A galvanized article is protected against rusting even if zinc coating is broken. Comment.

Ans. A galvanized 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.

8. 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.

9. 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.

$$3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3 + Heat$$

10. 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.

11. 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.

Short Answer Type-I Questions

12. 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.

13. 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.

14. Differentiate between roasting and calcination process giving an example of each. **(CBSE 2011)**

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 ($ZnCO_3$).

15. 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?

(CBSE 2012)

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-II Questions

16. 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.

17. 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.

$$Zn + H_2O \rightarrow ZnO + H_2$$

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

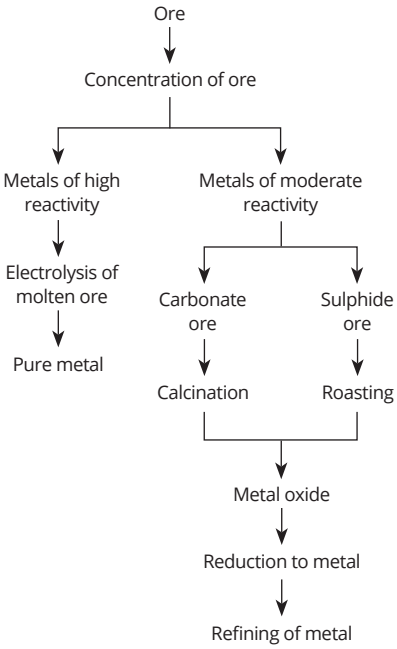
(c) Out of the given metals, only manganese will give hydrogen gas on reaction with 5% nitric acid.

$$Mn + 2HNO_3 \rightarrow Mn(NO_3)_2 + H_2$$

Long Answer Type Questions

18. Draw a flow chart to show extraction of metals of medium and high reactivity from their ores.

Ans.



19. (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.

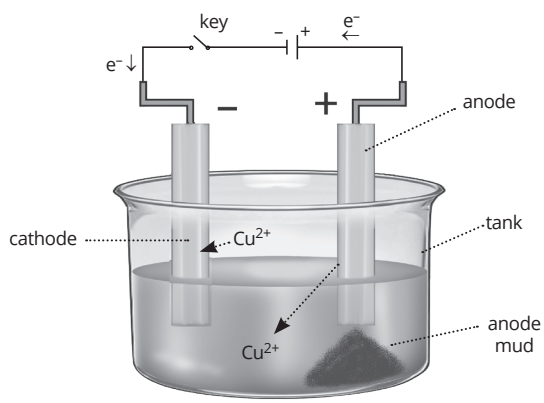
(b) (i) The metal M is copper and its ore is Cu_2S.

(ii) Copper is obtained from its ore by heating the ore in air. The equations involved are as follows:

$$2Cu_2S + 3O_2 \xrightarrow{\text{Heat}} 2Cu_2O + 2SO_2$$

$$2Cu_2O + Cu_2S \xrightarrow{\text{Heat}} 6Cu + SO_2$$

(iii) Refining of copper by electrolysis:



Higher Order Thinking Skills (HOTS) Questions

(Page 70)

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 70)

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 oxidizing agent.

Ans. (a) Nitric acid is a strong oxidizing 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.

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. 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. Anodizing 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) Why does aluminium become passive on corrosion?

(d) What is anodizing?

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) 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.

(d) The process by which a thick layer of aluminium oxide is deposited on the surface of aluminium objects is known as anodizing. 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.

16. 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) What will happen when a piece of dry blue litmus paper is placed in a gas jar containing only sulphur dioxide?

(d) 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) 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.

(d) 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.

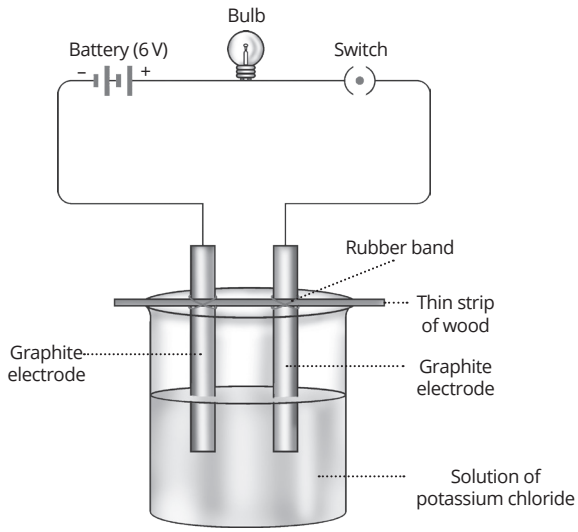
(ii) is amphoteric in nature.

(iii) is basic in nature.

(iv) turns red litmus blue.

Ans. (i) turns blue litmus red.

17. 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) Why does potassium chloride conduct electricity in the aqueous and molten state but not in the solid state?

(d) 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) 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.

(d) 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

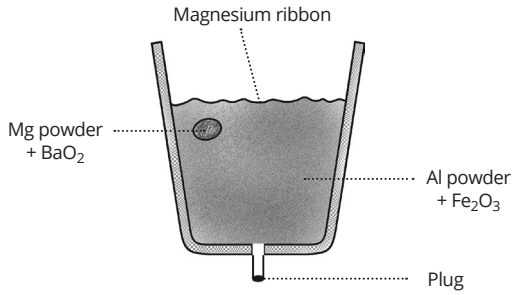
(ii) Chloroform

(iii) H_2O

(iv) CCl_4

Ans. (iii) H_2O

18. 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) What do you mean by aluminothermy?

(d) 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) The reduction of a metal oxide using aluminium as the reducing agent is known as aluminothermy.

(d) 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) oxidizing agent
(ii) reducing agent
(iii) both oxidizing 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 oxidizing agent.
(iv) it is least reactive metal.

Ans. (ii) it has more affinity for oxygen.

19. Galvanization 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 galvanizing iron articles such as electrogalvanizing and thermal spraying. However, the most common method is hot-dip galvanizing. 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) How does zinc prevent rusting of iron?

(d) Suggest any two ways, other than galvanization, 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) Zinc reacts with oxygen to form zinc oxide. This layer prevents further corrosion of zinc. Thus, in galvanized 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.

(d) Apart from galvanization, 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

20. 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.

21. 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.

22. 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.

23. Which element is alloyed with copper to make bronze?

Ans. Tin and zinc are alloyed with copper to make bronze.

24. 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.

25. Why does the reactivity of aluminium decrease if it is dipped in nitric acid solution?

Ans. Nitric acid is a strong oxidizing 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.

Short Answer Type-I Questions

26. 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.

27. (a) What is galvanization?

(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 galvanization.

(b) Pure gold is very soft and not suitable for making jewellery. It is therefore alloyed with copper for making it hard.

28. 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.

29. 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.

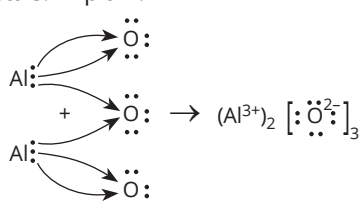
$$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$$

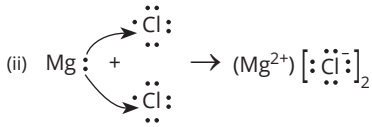
Short Answer Type-II Questions

30. (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.

31. (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.

(CBSE 2016)

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 galvanization: Galvanization is the method of protecting iron and steel articles by coating them with a thin layer of zinc.

Long Answer Type Questions

32. 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: $2Cl^- \rightarrow Cl_2 + 2e^-$

33. 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.

Let's Compete

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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.

Value-based Questions
(Optional)
(Page 75)

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, galvanization 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 79)

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.

Milestone 1

(Page 90)

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

Very Short Answer Type Questions

7. 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}.

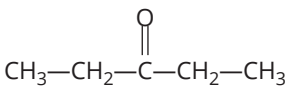
Ans. The compounds with the general formula C_nH_{2n-2} are known as alkynes. The third member of this series is butyne. Its chemical formula is C_4H_6. The fifth member of this series is hexyne. Its chemical formula is C_6H_{10}.

8. Draw the structure of:
(a) Butanol (b) Pentanone

Ans. (a) Butanol

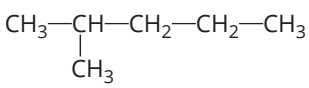
$CH_3—CH_2—CH_2—CH_2—OH$

(b) Pentanone



9. Write the structural formula of one isomer of *n*-hexane.

Ans. Isohexane is an isomer of *n*-hexane. Its structural formula is

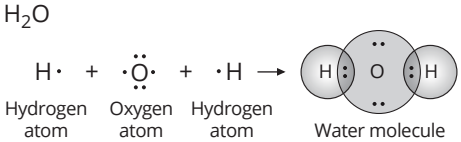


10. Write the names of the following:
(a) $CH_3CH_2COCH_2CH_3$
(b) HCOOH

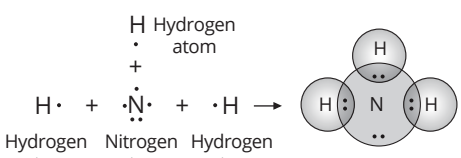
Ans. (a) Pentan-3-one
(b) Methanoic acid

11. Draw the electron-dot structures for
(a) H_2O (b) NH_3.

Ans. (a) H_2O



(b) NH_3



Short Answer Type-I Questions

12. 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.

13. 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.

14. (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-II Questions

15. (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

16. What are covalent compounds? Why are they different from ionic compounds? List their three characteristic properties. **(CBSE 2016)**

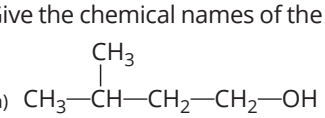
Ans. Covalent compounds are the compounds that are formed by sharing of electrons between atoms. They are different from ionic compounds because ionic compounds are formed by transfer of electrons. The three characteristic properties of covalent compounds are:

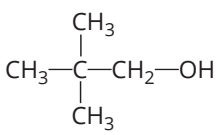
(i) Covalent compounds have low melting and boiling points.

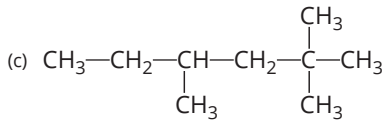
(ii) They are poor conductors of electricity.

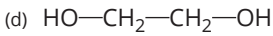
(iii) Covalent compounds are soluble in non-polar solvents such as chloroform but insoluble in polar solvents such as water.

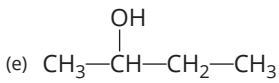
17. Give the chemical names of the following compounds:

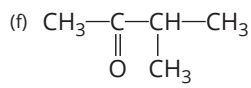
(a) 

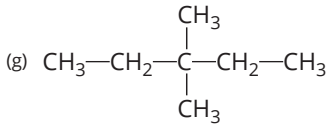
(b) 

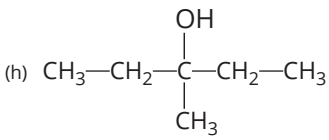
(c) 

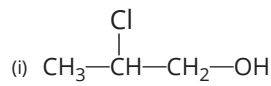
(d) 

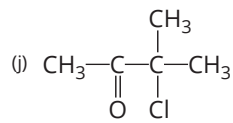
(e) 

(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

18. (a) Define the term 'isomers'.

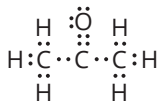
(b) Draw two possible isomers of the compound with molecular formula C_3H_6O and write their names. Also give their electron dot structures. **(CBSE 2013)**

Ans. (a) The compounds having the same chemical formula but different structures are known as isomers.

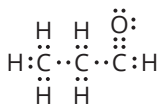
(b) The two possible isomers of the compound with the molecular formula C_3H_6O are propanone (CH_3COCH_3) and propanal (CH_3CH_2CHO). The electron dot structures of these compounds are

as follows:

Electron dot structure of propanone



Electron dot structure of propanal



19. 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?

(CBSE 2014)

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.

20. (a) Define structural isomer and draw the isomeric structures of butane. Compare the structure of benzene and cyclohexane by drawing them.

(CBSE 2015)

(b) Why is graphite a good conductor of electricity but diamond is a non-conductor of electricity?

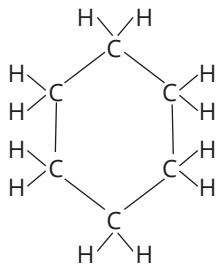
(c) Draw the structure of butanoic acid.

Ans. (a) Compounds having the same molecular formula but different structures are known as structural isomers. The structural isomers of butane are as follows:

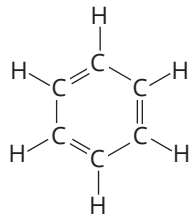
$CH_3—CH_2—CH_2—CH_3$ (*n*-Butane)

$CH_3—CH(CH_3)—CH_3$ (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) $CH_3—CH_2—CH_2—\overset{\overset{O}{\|}}{C}—OH$

Milestone 2

(Page 100)

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.

Short Answer Type-I Questions

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. **(CBSE 2013)**

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. **(CBSE 2011)**

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.

Short Answer Type-II Questions

17. 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) Decolourization 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.

18. What is the difference between molecules of soap and detergents chemically? Explain the cleansing action of soap. **(CBSE 2015)**

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.

19. (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. **(CBSE 2011)**

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

20. 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:

$$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + H_2O + CO_2$$

21. (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? **(CBSE 2016)**

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 102)

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:

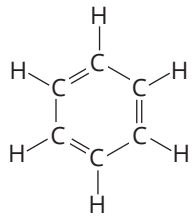
$$\underset{\text{Ethanol (Compound P)}}{CH_3CH_2OH} \xrightarrow[443\ K]{\text{conc. } H_2SO_4} \underset{\text{Ethene (Compound Q)}}{CH_2=CH_2} + H_2O$$

$$\underset{\text{Ethene (Compound Q)}}{CH_2=CH_2} + H_2 \xrightarrow{\text{Ni catalyst}} \underset{\text{Ethane (Compound R)}}{CH_3-CH_3}$$

$$2CH_3—CH_3 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$$

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?

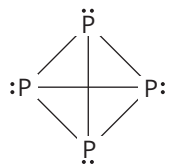
Ans. The compound X is benzene. Its structure is as follows:



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:

$$\underset{\text{Ethyl ethanoate (Compound A)}}{CH_3COOCH_2CH_3} \xrightarrow[\text{catalyst}]{\text{acid}} \underset{\text{Ethanoic acid (Compound C)}}{CH_3COOH} + \underset{\text{Ethanol (Compound B)}}{CH_3CH_2OH}$$

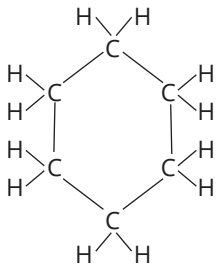
$$\underset{\text{(Compound B)}}{CH_3CH_2OH} \xrightarrow[K_2Cr_2O_7]{\text{acidified}} \underset{\text{Ethanoic acid (Compound C)}}{CH_3COOH}$$

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 102)

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 oxidizing agent.

Ans. (a) Alkaline potassium permanganate and acidified potassium dichromate are strong oxidizing agents and they can oxidize 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 ionize 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.

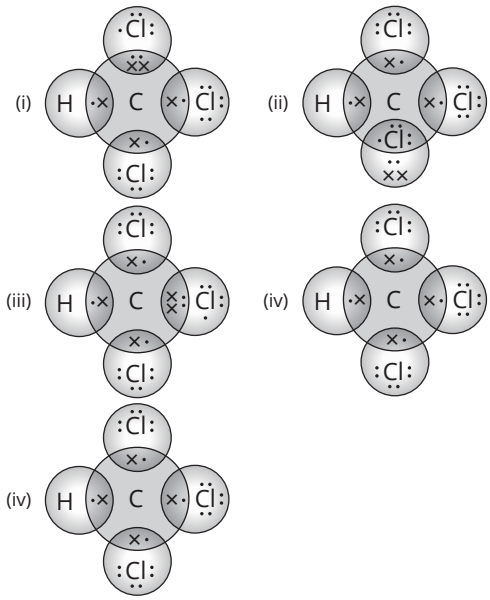
(ii) it exhibits strong intermolecular forces of attraction.

(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) $C_2H_5OH + CH_3COOH \xrightarrow{conc.\ H_2SO_4} CH_3COOC_2H_5 + H_2O$

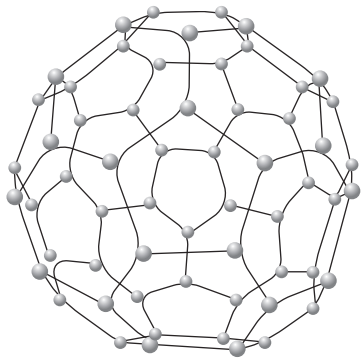
(e) When ethyl alcohol and acetic acid are mixed, the resulting ester has a chemical formula

(i) $CH_3COOC_2H_5$ (ii) $C_2H_5COOC_2H_6$

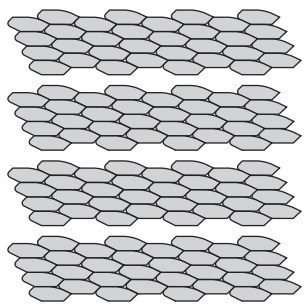
(iii) $C_2H_5COOC_2H_5$ (iv) CH_3COOCH_3

Ans. (i) $CH_3COOC_2H_5$

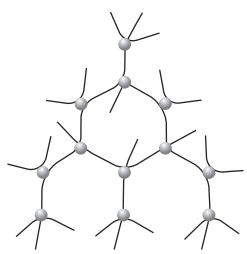
17. Fullerenes were first discovered in 1985 by H.W. Kroto, R.E. Smalley and R.F. Curl. They received the Nobel Prize in chemistry in 1996 for their work. Fullerenes are a class of carbon allotropes (other being diamond and graphite) consisting of molecules of carbon atoms. These molecules may be in 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) $(CH_3)_2CHCH(CH_3)_2$

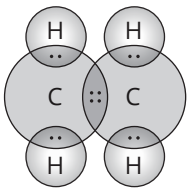
(b) $CH_3CHCH_3CH_2CH_3$

Ans. (a) 2,3-Dimethylbutane

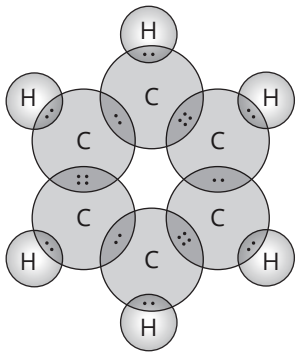
(b) 2-Methylbutane

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



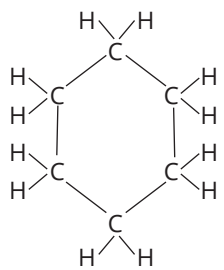
Electron-dot structure of benzene

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 $CH_3{-}CH(OH){-}CH_3$.

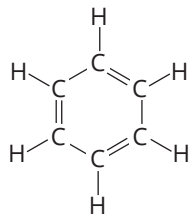
Short Answer Type-I Questions

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. **(CBSE 2011)**

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-II Questions

29. (a) Give the IUPAC name of HCOOH.
(b) Give one advantage of soaps over detergents.
(c) How is scum formed? **(CBSE 2012)**

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 107)

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) $C_5H_{10}O$

Value-based Questions

(Optional) (Page 108)

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.

5

Periodic Classification of Elements

Checkpoint (Page 112)

1. Why are metals called electropositive and non-metals are called electronegative?

Ans. Metals are called electropositive elements because they have a tendency to lose electrons and form cations. On the other hand, non-metals are called electronegative elements because they have a tendency to gain electrons and form anions.

2. Give two examples each of metals and non-metals.

Ans. Sodium (Na) and potassium (K) are examples of metals, while hydrogen (H) and nitrogen (N) are examples of non-metals.

3. What are metalloids? Give two examples.

Ans. Elements that exhibit the properties of both metals and non-metals are known as metalloids. Boron and silicon are examples of metalloids.

4. Write the electronic configuration of the following elements:

(a) Sodium (b) Oxygen
(c) Chlorine (d) Magnesium

Ans. (a) 2,8,1 (b) 2,6
(c) 2,8,7 (d) 2,8,2

5. If an element has 5 electrons in the outermost *M* shell, what element is this and what valency can it have?

Ans. If an element has 5 electrons in its outermost *M* shell, it means its *K* and *L* shells are full. So, the atomic number of the element will be 2 + 8 + 5 = 15. This element is phosphorus. It shows valencies of 3 and 5.

6. How are cations and anions formed?

Ans. Cations are formed when atoms lose electrons. Anions are formed when atoms gain electrons.

7. What are noble gases? Give two examples.

Ans. Noble gases are elements present in group 18 of the periodic table. These elements exist as gases and their outermost shells are completely filled. That is, they have complete duplet or octet of electrons.

8. Define valency.

Ans. The combining capacity of atoms of elements is known as valency.

9. Give the symbols of a set of isotopes.

Ans. Carbon-12 and carbon-14 are two isotopes of carbon. They are represented by the symbols $^{12}_{6}C$ and $^{14}_{6}C$.

10. What is the maximum number of electrons which can be accommodated in the *L* shell?

Ans. The maximum number of electrons that can be accommodated in the *L* shell is 8.

Milestone 1

(Page 123)

Multiple-Choice Questions

1. *Eka*-aluminium has properties similar to

(a) scandium (b) gallium
(c) germanium (d) thallium

Ans. (b) gallium

2. For an element R, the general formula of oxides of group I elements in Mendeleev's Periodic Table is

(a) R_2O_3 (b) R_2O
(c) RO (d) RO_2

Ans. (b) R_2O

3. How many groups are there in the modern periodic table?

(a) 7 (b) 18
(c) 8 (d) 16

Ans. (b) 18

4. The Newland's Law of Octaves was found to be applicable only up to

(a) calcium (b) chromium

(c) potassium (d) cobalt

Ans. (a) calcium

5. Groups of elements having similar properties in Dobereiner's classification of elements were called

(a) octaves. (b) groups.

(c) periods. (d) triads.

Ans. (d) triads.

6. In Newland's classification, the then known elements were arranged in the order of increasing

(a) atomic number. (b) melting point.

(c) atomic mass. (d) density.

Ans. (c) atomic mass.

7. Which of the following sets belongs to the same period?

(a) Li, Na, K (b) Li, Mg, Ca

(c) F, Cl, Br (d) Ga, Ge, As.

Ans. (d) Ga, Ge, As

Very Short Answer Type Questions

8. X, Y and Z are the elements of Dobereiner's triad. If the atomic mass of X is 7 and that of Z is 39, what would be the atomic mass of Y?

Ans. In the Dobereiner's triads, the mass of the middle element is the average of atomic masses of the other two elements of the triad. In the given triad of elements, Y is the middle element. So, its atomic mass will be equal to

$$\frac{\text{Atomic mass of element X} + \text{Atomic mass of element Z}}{2}$$

$$= \frac{7+39}{2} = 23$$

9. Why do you think the noble gases are placed in a separate group?

Ans. Noble gases are placed in a separate group because they have completely filled outermost shells. They are unreactive and have completely different properties from other elements.

10. Why did Mendeleev leave gaps in his Periodic table?

Ans. Mendeleev left gaps in his periodic table because he predicted the existence of some elements which had not been discovered at that time. The undiscovered elements were to be placed in these gaps.

11. What is meant by periodicity in properties of elements with reference to periodic table? **(CBSE 2012)**

Ans. Periodicity in properties of elements in the periodic table refers to the recurrence in the properties of elements after regular intervals when arranged in the order of increasing atomic number.

12. Why are noble gases missing from Newlands' octave?

Ans. Noble gases are missing from Newlands' octave because they were not discovered at the time when Newland gave his classification of elements.

Short Answer Type-I Questions

13. List any three observations which pose a challenge to Mendeleev's Periodic Table.

Ans. Two observations that pose a challenge to Mendeleev's periodic table are as follows:

(i) The sequence of some of the elements was inverted so that elements with similar properties could be placed together. For example, cobalt with atomic mass 58.9 was placed before nickel with atomic mass 58.7.

(ii) Hydrogen was placed along with alkali metals. However, it also showed properties similar to halogens. So, the position of hydrogen could not be correctly defined.

(iii) Elements with different properties have been placed in the same group.

14. Where should hydrogen be placed in the modern periodic table? Give reason to support your answer.

Ans. Mendeleev placed hydrogen along with alkali metals. Like alkali metals, hydrogen has one electron in its outermost shell and combines with halogens, oxygen and sulphur to form different compounds. On the other hand, like halogens, it needs one electron more to complete its outermost shell and exists as diatomic molecule. Hence, no fixed position can be assigned to hydrogen in the periodic table. In the modern periodic table hydrogen has been placed in group I of the periodic table.

15. (a) What are the two criteria used by Mendeleev to classify the elements in his Periodic table?

(b) Besides gallium, which two other elements have been discovered for which Mendeleev had left gaps in his periodic table?

Ans. (a) The two criteria used by Mendeleev for classifying elements in his periodic table are as follows:

(i) Atomic masses of elements

(ii) Formulae of hydrides and oxides formed by elements

(b) Besides gallium, scandium and germanium have been discovered for which Mendeleev had left gaps in his periodic table.

16. (a) X and Y are two elements having similar properties which obey Newlands' law of octaves. How many elements are there in between X and Y?

(b) Write two reasons responsible for late discovery of noble gases. **(CBSE 2013)**

Ans. (a) According to Newlands' law of Octaves, when elements are arranged in the increasing order of atomic mass, the properties of every eighth element are similar to that of the first. So, if X and Y are two elements that have similar properties and obey Newlands' law of octaves, then there would be 6 elements between them.

(b) Two reasons for the late discovery of noble gases are as follows:

(i) Noble gases are very inert.

(ii) They are present in very low concentrations in our atmosphere.

17. The electrons in the atoms of four elements A, B, C and D are distributed in three shells having 1, 3, 5 and 7 electrons in the outermost shell, respectively. State the period in which these elements can be placed in the Modern Periodic Table. Write the electronic configuration of the atoms of A and D and the molecular formula of the compound formed when A and D combine.

(CBSE 2014)

Ans. We know that atoms of different elements with the same number of occupied shells are placed in the same period. Since in the given elements, the electrons are distributed in three shells, they all belong to the 3^{rd} period of the periodic table. As the elements have 1, 3, 5 and 7 electrons in their outermost shells, their inner two shells will be completely filled. So, the electronic configurations of elements A, B, C and D are as follows:

A: 2, 8, 1

B: 2, 8, 3

C: 2, 8, 5

D: 2, 8, 7

Both A and D will show a valency of 1. So, the chemical formula of the compound formed between A and D will be AD.

18. Among the following elements F, Cl, Br and I, which does not fit in a triad? Give reason to support your answer.

Ans. Out of fluorine, chlorine, bromine and iodine, fluorine does not fit into a triad. According to the law of triads, the atomic mass of the middle element should be the average of the masses of the other two elements of the triad. The atomic mass of bromine is the average of atomic masses of chlorine and iodine. However, the atomic mass of chlorine is not equal to the average of atomic masses of fluorine and bromine.

Short Answer Type-II Questions

19. (a) State Modern periodic law. How is it different from Mendeleev's periodic law?

(b) Initially it was believed that atomic mass of beryllium was 13. But Mendeleev suggested that its atomic mass should be 9.

(i) Was Mendeleev's suggestion correct?

(ii) How had he reached to this conclusion?

Ans. (a) The Modern Periodic Law states that the properties of elements are periodic functions of their atomic numbers. According to Mendeleev's periodic law, the properties of elements are periodic functions of their atomic masses.

(b) (i) Mendeleev's suggestion was correct as the atomic mass of beryllium is 9.

(ii) Mendeleev reached this conclusion while formulating his periodic table. He found that the periodic law given by him and the position of beryllium assigned by him in the periodic table did not agree with the then atomic mass of beryllium, which was 13. Later, it was proved that the atomic mass of beryllium is 9.

20. (a) What is the importance of the Modern Periodic Table?

(b) How were the positions of cobalt and nickel resolved in the modern periodic table?

Ans. (a) The Modern Periodic Table gives the arrangement of elements into specific groups and periods. In this table, elements with similar properties are placed together in a single group. This makes the study of elements easier and more organized.

(b) The atomic mass of cobalt is more than that of nickel. Yet, cobalt was placed before nickel by Mendeleev in his periodic table. In the Modern Periodic Table, elements are arranged in the order of increasing atomic numbers. The atomic number of cobalt is 27 while that of nickel is 28. So, cobalt will be placed before nickel. This resolved the positions of cobalt and nickel in the Modern Periodic Table.

Long Answer Type Questions

21. (a) Why do we classify elements?

(b) What are the two criteria used in the development of Modern Periodic table?

(c) State the positions of metals, non-metals and metalloids in the periodic table.

(d) Would you place the two isotopes of chlorine, Cl-35 and Cl-37 in the same slot or different slots of Modern Periodic Table? Give reasons.

(CBSE 2011)

Ans. (a) Today, 118 elements are known to us. The study of the properties of each element and the compounds formed by them would not only be time-taking and tedious, but also a

complex process. This is why we need to classify elements.

(b) The two criteria used for the development of the Modern Periodic Table are as follows:
  (i) Atomic number of elements
  (ii) Formulae of hydroxides and oxides formed by elements.

(c) Of the 118 elements known, majority are metals. A few of them are non-metals, while the remaining are metalloids. Metals occupy the left and centre parts of the periodic table, while non-metals occupy the right side of the periodic table. Metalloids are placed between the metals and non-metals. Thus, as we move from left to right in a period, the metallic character decreases while non-metallic character increases.

(d) The two isotopes of chlorine would be placed in the same slot in the Modern Periodic Table. This is because in the Modern Periodic Table, elements are arranged in the order of increasing atomic numbers and not masses.

22. (a) How does the electronic configuration of an atom of an element relate to its position in the modern periodic table?

(b) How could the modern periodic law removes various anamolies of Mendeleev's periodic table? Explain with examples.

(c) Give two examples each of the following.
  (i) Group 2 elements
  (ii) Group 17 elements
  (iii) Group 18 elements

Ans. (a) In the Modern Periodic Table, elements with the same number of valence electrons are placed in the same group. Different elements in the same period have the same number of occupied shells.
  (i) The number of occupied shells can tell us about the period to which the element belongs.
  (ii) For elements of groups 1, 2 and 13 to 18, we can calculate the group number from the number of valence electrons. If the number of valence electrons is 1 or 2, the group number will be 1 or 2, respectively. For the elements containing 3, 4, 5, 6, 7 and 8 electrons in their valence shells, the group number will be 13, 14, 15, 16, 17 and 18 respectively.

(b) The anomalies of Mendeleev's periodic table were removed in the Modern Periodic Table in the following manner:
  (i) In Mendeleev's periodic table, some elements with higher atomic masses were placed before elements with lower atomic masses (for example, cobalt was placed before nickel). In the Modern Periodic Table, elements are arranged in the order of increasing atomic numbers. This resolves the anomalous placement of some elements in the periodic table.
  (ii) Another problem in Mendeleev's periodic table was the placement of isotopes. Since the Modern Periodic Table is based on atomic numbers, it resolves the problem of placement of isotopes.

(c) (i) Magnesium and calcium
  (ii) Chlorine and bromine
  (iii) Helium and neon

Milestone 2

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Multiple-Choice Questions

1. On moving from left to right in a period, the size of the atom
  (a) decreases
  (b) increases
  (c) first decreases and then increases
  (d) does not change

Ans. (a) decreases

2. Which of the following is not a correct statement about the trends when going from left to right across the periods of Periodic Table?
  (a) Elements become less metallic in nature
  (b) The number of valence electrons increases
  (c) The atoms lose their electrons easily
  (d) The oxides become more acidic.

Ans. (c) The atoms lose their electrons easily.

3. In the Periodic Table, with increase in atomic number, the metallic character of the elements
  (a) decreases in a period and increases in a group.
  (b) increases in a period and decreases in a group.
  (c) increases both in a period and a group.
  (d) decreases both in a period and a group.

Ans. (a) decreases in a period and increases in a group.

4. Which of the following sets of elements is arranged in the order of increasing electronegativity?
  (a) Cl, Br, F (b) F, Br, Cl
  (c) Br, Cl, F (d) F, Cl, Br

Ans. (c) Br, Cl, F

5. Which of the following represents the elements in the order of increasing atomic radius?
  (a) I < Br < Cl (b) Na < Mg < C

(c) C < N < Cl (d) Li < Na < K

Ans. (d) Li < Na < K

Very Short Answer Type Questions

6. Which one from the each group has the larger size?

(a) Na or Cl (b) Cl or F

Ans. (a) Sodium has a larger size than chlorine. Both the elements belong to the third period. As we move from left to right in a period, the atomic size decreases.

(b) Chlorine has a larger size. Both chlorine and fluorine belong to group 17 of the periodic table. As we move down in a group, the atomic size increases.

7. Which one from the each group has smaller size?

(a) K or Na (b) B or C

Ans. (a) Sodium has a smaller size. Both sodium and potassium belong to group 1 of the periodic table. As we move down in a group, the atomic size increases.

(b) Carbon has a smaller size than boron. Both boron and carbon belong to the second period of the periodic table. As we move from left to right in a period, the atomic size decreases.

Short Answer Type-I Questions

8. Consider the following arrangement of elements:

1	2	13	14	15	16	17	18
Lithium			Carbon		Oxygen	L	Neon
X			E		G	Q	
Y						R	
Z						T	

(a) Give the letter of most reactive metal and non-metal.

(b) Name the family of elements represented by L,Q, R and T.

(c) Name one element in each case occurring in groups 2, 13 and 15.

Ans. (a) In the given arrangement of elements, the most reactive metal will be Z and the most reactive non-metal will be L.

(b) The family of elements represented by L, Q, R and T is halogens.

(c) The elements occurring in group 2, 13 and 15 are magnesium, aluminium and phosphorus respectively.

9. Referring to the elements of the periodic table with atomic number 3 to 18, answer the following questions.

(a) Which of them are noble gases?

(b) Which of them are halogens?

(c) Which of these elements have valency 4?

Ans. (a) Neon and argon are noble gases. They belong to group 18 of the periodic table.

(b) Fluorine and chlorine are halogens. They belong to group 17 of the periodic table.

(c) Carbon and silicon exhibit a valency of 4. They belong to group 14 of the periodic table.

Short Answer Type-II Questions

10. Consider the elements Li, Be, B, C, N, O, F and Ne. Answer the following questions.

(a) Which element(s) will form cations?

(b) Which element is an alkali metal?

(c) Which element is the most electronegative?

Ans. (a) Of the given elements, lithium and beryllium will form cations. Both of these elements are metals.

(b) Of the given elements, lithium is an alkali metal.

(c) The most electronegative element out of the given elements is fluorine.

11. The position of three elements A, B and C in the periodic table are shown below:

Group VI	Group VII
___ ___ ___ B	___ A ___ C

Give reasons for the following statements:

(a) Element A is a non-metal.

(b) Element B has a larger atomic size than element C.

(c) Element C has a valency of 1.

Ans. (a) Elements of main group VII (also known as group 17 in the Modern Periodic Table) have seven electrons in their outermost shells. Thus, element A will accept an electron in its outermost shell to complete its octet. This characteristic is shown by non-metals. So, element A is a non-metal.

(b) Both elements B and C belong to the same period of the periodic table. As we move from left to right in a period, the atomic size decreases. Hence, element B has a larger atomic size than element C.

(c) Elements of main group VII have seven electrons in their outermost shells. They need only one electron to complete their octet. Thus, element C has a valency of 1.

Long Answer Type Questions

12. The electronic configuration of an element X is 2,8,6.

(a) What is the group number of the element X in periodic table?

(b) What is the period number of element X in the periodic table?

(c) What is the number of valence electrons in an atom of X?

(d) What is the valency of X?

(e) Is it metal or non-metal? Give reasons.

Ans. (a) Element X has six electrons in its valence shell. Hence it belongs to group 16 of the periodic table.

(b) The electrons of element X are distributed in three shells. Hence it belongs to the third period of the periodic table.

(c) An atom of element X contains six valence electrons.

(d) Element X has six valence electrons and it needs two more electrons to complete its octet. Thus, the valency of element X is 2.

(e) Element X is a non-metal. It has six electrons in its valence shell and needs two more to complete its octet. It will do so by gaining two electrons. This characteristic is shown by non-metals. Thus X is a non-metal.
It belongs to group 16 and the third period of the periodic table. The element is sulphur.

13. The following table shows the position of six elements A, B, C, D, E and F in the periodic table.

	1	2	3 to 12	13	14	15	16	17	18
2	A					B			C
3		D			E				F

Using the above table, answer the following questions:

(a) Which element is a metal with valency 2?

(b) Which element is a non-metal with valency 3?

(c) Out of B and E, which one has larger atomic radius and why?

(d) Write a common name for the family of elements C and F.

(e) Write the valency of element C giving reasons.

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Ans. (a) Element D belongs to group 2 of the periodic table. Hence, the metal with a valency of 2 is element D.

(b) Element B has five valence electrons. It needs three more electrons to complete its octet. Hence, a non-metal with a valency of 3 is element B.

(c) Out of element B and E, element E has a larger atomic radius. Atomic radius of elements increases as we go down a group and decreases as we move form left to right across a period. Element E belongs to the third period and 14^{th} group. It occurs before element B in a period and after element B in a group. Hence, element E has larger atomic radius than element B.

(d) Elements C and F belong to group 18 of the periodic table. The family of these elements is called noble gases.

(e) The valency of element C will be zero. This is because its octet is complete, and it does not need more electrons to accommodate in its valence shell.

14. The following elements represent the Group 2 of the Periodic Table: Be, Mg, Ca, Ba, Ra.

(a) Which has larger atomic radius — Be or Ca?

(b) Which is more metallic — Be or Ba?

(c) Write the formula of hydroxide of Ra.

(d) Write the formula of oxide of Ba.

(e) Which has the highest atomic radius?

Ans. (a) Calcium has a larger atomic radius. As we move down in a group, the atomic size increases. Calcium and beryllium both belong to group 2 of the periodic table. So, calcium is bigger in size than beryllium.

(b) As we move down a group, the metallic character increases. Barium is placed after beryllium in group 2. So, it is more metallic than beryllium.

(c) Elements of group 2 show a valency of 2. Thus, the formula of the hydroxide of radium will be $Ra(OH)_2$.

(d) Elements of group 2 show a valency of 2. Thus, the formula of the oxide of barium will be BaO.

(e) The atomic radius increases as we move down a group. So, radium will have the highest atomic radius.

15. The positions of A to J are given in the Periodic Table containing only the main group elements.

						A	B
C			D	E		F	
G						H	
I						J	

(a) Which is the most reactive metal?

(b) Which is the most reactive non-metal?

(c) Which element has the highest atomic radius?

(d) Which element has the lowest atomic radius?

(e) Name one element in each case occurring in the groups 1, 14 and 17.

Ans. (a) Metallic character increases as we go down a group and decreases as we move from left to right across a period. So, element I will be the most reactive metal.

(b) Non-metallic character increases as move from left to right across a period and decreases down a group. So, the most reactive non-metal will be A.

(c) Atomic radius decreases across a period and increases down a group. So, element I will have the highest atomic radius.

(d) Element A will have the lowest atomic radius.

(e) In the given table, the element occurring in group 1 is element C. Elements D and H occur in groups 14 and 17 respectively.

Higher Order Thinking Skills (HOTS) Questions

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1. What property do all elements in the same column of the periodic table as boron have in common?

Ans. Boron belongs to group 13 of the periodic table. Elements in this group show a valency of 3. They form chlorides, oxides, and hydroxides with the formula MCl_3, M_2O_3 and $M(OH)_3$, where M represents any group 13 element.

2. Arrange Be, O, N, Li, C and B in the increasing order of atomic radius. What is the common feature of these elements?

Ans. The arrangement of Be, O, N, Li, C and B in the increasing order of atomic radius is as follows:

O < N < C < B < Be < Li

All these elements belong to the second period of the periodic table.

3. The size of cation is smaller while that of an anion is bigger than the atom from which it is formed. Comment.

Ans. A cation is formed when an atom loses one or more electrons. As a result, a cation has more protons in its nucleus than electrons in its shells. So, the protons pull the electrons more strongly towards the nucleus, which causes the size of the cation to decrease.

An anion is formed when an atom gains one or more electrons. As a result, an anion has more electrons in its shells than protons in its nucleus. The addition of electrons results in increase in repulsion between the electrons, and the size of the anion increases.

4. According to Newlands' law of Octaves, there is periodic similarity in properties of every eighth element. But in the Modern Periodic Table, we find that for second and third period, every ninth element resembles the first. Explain.

Ans. When Newlands' gave the law of Octaves, noble gases were not discovered. So, in the Newlands' arrangement of elements, every eighth element had properties similar to the first one. However, the Modern Periodic Table contains noble gases. They are placed in group 18. This is why, for the second and third periods in the Modern Periodic Table, the properties of every ninth element resemble the first one.

5. An element B belongs to the second period and group 13. Give the formula of its oxide and chloride. Find the neutral atom in the periodic table which has the same number of electrons as Na^+ and F^-. What is this number?

Ans. We are given that the element B belongs to the second period and group 13 of the periodic table. This element is boron. The formula of its oxide is B_2O_3 and its chloride is BCl_3.

The number of electrons in sodium atom is 11. So, the number of electrons in Na^+ ion will be 10. The number of electrons in fluoride ion will also be 10. The element whose atomic number is 10 is neon.

Self-Assessment

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Multiple-Choice Questions

1. Which of the following is the outermost shell for the elements of period 2?

(a) *N* shell (b) *M* shell

(c) *L* shell (d) *K* shell

Ans. (c) *L* shell

2. The elements M, N, O, P and Q have atomic number 9, 11, 17, 12 and 13 respectively. Identify the pair of elements which belong to the same group.

(a) P and Q (b) M and O

(c) N and P (d) M and N

Ans. (b) M and O

3. The elements B, Si and Ge are

(a) semi-metals

(b) non-metals

(c) metals

(d) non-metals, semi-metals and metals, respectively

Ans. (a) semi-metals

4. Which of the following remains unchanged on moving down a group?

(a) Non-metallic character (b) Atomic radius

(c) Valence electrons (d) Metallic character

Ans. (c) Valence electrons

5. The elements on the right side of the Periodic Table are

(a) transition metals (b) non-metals

(c) metals (d) semi-metals

Ans. (b) non-metals

Assertion–Reason Type Questions

For question numbers 6 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.

6. **Assertion:** In Mendeleev's periodic table, atomic mass does not increase in a regular manner while going from one element to the next.

   Reason: Mendeleev inverted the sequence of some elements in his periodic table to place similar elements together.

Ans. (a) In his periodic table, Mendeleev inverted the sequence of some elements so that elements with similar chemical properties were placed together. For example, cobalt (atomic mass = 58.9) was placed before nickel (atomic mass = 58.7 u).

7. **Assertion:** The positions of cobalt and nickel remain unexplained in the Modern Periodic Table.

   Reason: Elements are arranged in the order of increasing atomic numbers in the Modern Periodic Table.

Ans. (d) In the Modern Periodic Table, elements are arranged in the order of increasing atomic number. The atomic number of cobalt is 27 while that of nickel is 28. Hence, the positions of cobalt and nickel in the Modern Periodic Table are correct.

8. **Assertion:** In the third period, chlorine is the smallest element while sodium is the largest element.

   Reason: As we move from left to right in a period, the atomic size decreases.

Ans. (a) Atomic size decreases as we move from left to right in a period because with increase in atomic number, the nuclear charge increases while the electrons are added to the same shell. Thus, there is increased attraction between the nucleus and the electrons, which pulls the electrons closer to the nucleus, thereby reducing the size of the atom.

9. **Assertion:** Size of elements decreases as we move down a group.

   Reason: A new shell is added as we move from one element to the next down a group.

Ans. (d) As we move down a group, atomic size increases because a new shell of electrons is added at each succeeding element. Thus, the distance between the outermost shell and the nucleus increases.

10. **Assertion:** Noble gases were discovered late.

    Reason: Noble gases are inert and present in low concentrations in the atmosphere.

Ans. (a) Noble gases are chemically unreactive and present in very low concentrations in the atmosphere and this is why they were discovered late.

11. **Assertion:** Calcium is more metallic in nature than magnesium.

    Reason: The tendency to lose electrons decreases down the group.

Ans. (c) Both calcium and magnesium belong to group 2 of the periodic table. As we move down a group, size of the atom increases and hence their tendency to lose electrons also increases. More is the tendency to lose electrons, more will be the metallic character.

12. **Assertion:** The valencies of sodium and potassium are 1 and 2, respectively.

    Reason: Sodium and potassium belong to the same group of the periodic table.

Ans. (d) Sodium and potassium both belong to group 1 of the periodic table and they have one electron in their valence shells. Hence, their valency is 1.

13. **Assertion:** Out of phosphorus, sulphur, chlorine and bromine, chlorine is the most electronegative element.

    Reason: Non-metallic character increases down a group and decreases across a period.

Ans. (c) As we move from left to right, the size of the atom decreases. Due to the more nuclear charge and small size, the tendency of an atom to gain electrons increases. More is the non-metallic character, more will be the electronegativity. So, electronegativity increases across a period and decreases down the group.

14. **Assertion:** Modern Periodic Table resolves the issue of placement of isotopes of elements.

    Reason: According to the Modern periodic Law, the properties of elements are a periodic function of their atomic numbers.

Ans. (b) In the Modern Periodic Table, elements are arranged in the order of increasing atomic numbers and this resolves the issue of placement of isotopes of elements.

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. John Newlands was an English chemist who is known for his work on classification of elements. After Dobereiner's Law of Triads, Newlands gave the Law of Octaves. He compared this arrangement of elements with the octaves in music. In 1887, Newlands received the Davy Medal for his work on classification of elements from the Royal Society, London. However, his work did not receive much acceptance and became irrelevant.

I. (a) What is meant by Dobereiner's triads?

(b) State the Newlands' law of octaves.

(c) Which fundamental property was used by Dobereiner and Newlands for their classification of elements?

(d) State any one limitation of Newlands' arrangement of elements.

Ans. (a) When elements with similar properties are arranged into groups of three, called triads, then the atomic mass of the middle element is nearly equal to the arithmetic mean of the atomic masses of the other two elements. Such groups of elements is called Dobereiner's triad.

(b) According to Newlands law of octaves, when elements are arranged in the increasing order of atomic mass, every eighth element has properties similar to the first one.

(c) Both Dobereiner and Newlands used atomic mass for their classifications of elements.

(d) Elements with different chemical properties were placed in the same group. For example, cobalt and nickel were placed in one slot in the same group as halogens.

II. (a) In Dobereiner's triads, elements were arranged in the order of increasing

(i) atomic number
(ii) atomic mass
(iii) melting point
(iv) density

Ans. (ii) atomic mass

(b) The atomic masses of lithium and potassium are 7 u and 39 u, respectively. If lithium, sodium and potassium form a Dobereiner's triad, what will be the atomic mass of sodium?

(i) 23 u (ii) 32 u
(iii) 46 u (iv) 53 u

Ans. (i) 23 u

(c) In Newlands' classification, elements were arranged in the order of increasing

(i) valency
(ii) atomic volume
(iii) atomic mass
(iv) density

Ans. (iii) atomic mass

(d) The elements in which of the following options were placed in the same slot in Newlands' law of octaves?

(i) F and Cl (ii) Co and Ni
(iii) Mn and Zn (iv) O and Br

Ans. (ii) Co and Ni

(e) The Newlands' law of octaves was found to be applicable only till

(i) cobalt (ii) iron
(iii) zinc (iv) calcium

Ans. (iv) calcium

16. Dmitri Ivanovich Mendeleev was a Russian chemist. He is best known for his work on periodic classification of elements. In his periodic table, he arranged elements in the increasing order of atomic mass in different rows and columns. Around the same time, Lothar Meyer, a German chemist, also came up with his classification of elements. In Meyer's classification as well, elements were arranged in the order of increasing atomic mass. However, Meyer's work was published a few months after Mendeleev's periodic table. This is why Mendeleev got more recognition and credit for his periodic table.

I. (a) State the Mendeleev's periodic law.

(b) Which compounds were considered and used by Mendeleev for classifying elements?

(c) Why did Mendeleev leave gaps in his periodic table?

(d) How placement of isotopes was a problem in Mendeleev's periodic table?

Ans. (a) According to Mendeleev's Periodic Law, the properties of elements are a periodic function of their atomic masses.

(b) For classifying elements, Mendeleev considered oxides and hydrides formed by elements.

(c) Mendeleev predicted the existence of some elements which had not been discovered at that time. He left gaps for these elements in

his periodic table. He named these elements by prefixing a Sanskrit numeral *Eka* to the name of the preceding element in the same group.

(d) In Mendeleev's periodic table, elements are arranged in the order of increasing atomic mass. Isotopes are atoms of an element having the same atomic number but different atomic mass. Hence, isotopes should have been placed separately in Mendeleev's periodic table. However, no separate place was given for isotopes.

II. (a) According to Mendeleev's periodic law, the properties of elements are a periodic function of their

(i) atomic mass
(ii) atomic volume
(iii) atomic size
(iv) atomic number

Ans. (i) atomic mass

(b) For the classification of elements, Mendeleev considered and used

(i) only sulphides formed by elements.
(ii) only oxides formed by elements.
(iii) only hydrides formed by elements.
(iv) oxides and hydrides formed by elements.

Ans. (iv) oxides and hydrides formed by elements.

(c) The formula of the chloride formed by *eka*-aluminium is similar to that formed by

(i) scandium. (ii) manganese.
(iii) gallium. (iv) germanium.

Ans. (iii) gallium.

(d) In which of the following options the sequence of the given elements was inverted by Mendeleev (with respect to atomic mass) while arranging elements in his periodic table?

(i) Mg and Al (ii) As and Se
(iii) I and Te (iv) Se and Br

Ans. (iii) I and Te

(e) According to Mendeleev, the general chemical formula of the oxides formed by the elements of group V is

(i) EO (ii) EO_2
(iii) E_2O_3 (iv) E_2O_5

Ans. (iv) E_2O_5

17. Henry Moseley, an English chemist, studied the X-ray spectra of different chemical elements. He observed that when the square root of frequencies of emitted X-rays was plotted against atomic numbers, a straight-line graph was obtained. Thus, he showed that atomic number is a more fundamental property for classifying elements than atomic mass. This led to the formulation of the Modern Periodic Law and the Modern Periodic Table.

I. (a) State the Modern Periodic Law.

(b) How many groups and periods are there in the Modern Periodic Table?

(c) How many elements are present in the first and second period of the Modern Periodic Table?

(d) State any one instance where the Modern Periodic Table resolves the shortcomings of the Mendeleev's Periodic Table.

Ans. (a) According to the Modern Periodic Law, the properties of elements are a periodic function of their atomic numbers.

(b) There are 18 groups and seven periods in the Modern Periodic Table.

(c) There are seven periods in the Modern Periodic Table. The number of elements in the first and second period are as follows:

First period = 2 elements

Second period = 8 elements

(d) In the Mendeleev's Periodic Table, the position of isotopes was a limitation. However, in the Modern Periodic Table, elements are arranged in the order of increasing atomic number. Hence, their placement doesn't pose a challenge in the Modern Periodic Table.

II. (a) According to the Modern Periodic Law, the properties of elements are a periodic function of their

(i) atomic mass
(ii) atomic size
(iii) atomic volume
(iv) atomic number

Ans. (iv) atomic number

(b) How many groups are there in the Modern Periodic Table?

(i) 7 (ii) 8
(iii) 10 (iv) 18

Ans. (iv) 18

(c) How many elements are present in the fourth period of the periodic table?

(i) 2 (ii) 8
(iii) 18 (iv) 32

Ans. (iii) 18

(d) Which of the following statements is incorrect?

(i) In the Modern Periodic Table, elements are arranged in the order of increasing atomic number.

(ii) In the Modern Periodic Table, elements are arranged in the order of decreasing atomic number.

(iii) In the Modern Periodic Table, the atomic number increases progressively as we move from one element to next element.

(iv) In the Modern Periodic Table, the isotopes of an element are assigned the same position inspite of having different atomic masses.

Ans. (ii) In the Modern Periodic Table, elements are arranged in the order of decreasing atomic number.

(e) In the Modern Periodic Table, the elements in a group have the same

(i) atomic number

(ii) atomic mass

(iii) electronic configuration

(iv) valency

Ans. (iv) valency

18. Determining the atomic size of elements is a complicated task. This happens mainly because of two reasons. Firstly, radius of an atom is very small (of the order of 10^{-10} m). Secondly, the electron cloud surrounding the nucleus does not have a sharp, well-defined boundary. Thus, atomic size of an element can be estimated than being determined exactly. Generally, this is done by determining the distance between the two atoms in their compounds.

I. (a) What is meant by atomic size?

(b) How does the atomic size of elements vary down a group?

(c) As we move from magnesium to chlorine in the third period, a decrease in atomic size is observed. Why?

(d) Arrange the following atoms in the increasing order of atomic size.

K, S, O, F and P

Ans. (a) Atomic size means the radius of an atom of an element. Broadly, it can be defined as the distance between the centre of the nucleus and the outermost shell of an atom.

(b) Atomic size increases as we move down the group because a new shell of electrons is added at each succeeding element.

(c) As we move across a period from left to right, the atomic size decreases. This is because with increase in atomic number, the nuclear charge increases while the electrons are added to the same shell. Thus, there is increased attraction between the nucleus and the electrons, which pulls the electrons closer to the nucleus, thereby reducing the size of the atom.

(d) The arrangement of the given elements in the increasing order of atomic size is:

F < O < S < P < K

II. (a) How does the atomic size of elements vary across a period?

(i) It increases across a period.

(ii) It decreases across a period.

(iii) It first decreases then increases across a period.

(iv) It first increases then decreases across a period.

Ans. (ii) It decreases across a period.

(b) Which of the following has the largest atomic radius?

(i) Na (ii) K

(iii) Cs (iv) Sn

Ans. (iv) Sn

(c) Which of the following correctly represents the increasing order of atomic size?

(i) F < O < S < P < K

(ii) O < F < S < P < K

(iii) S < O < F < P < K

(iv) K < O < S < P < F

Ans. (i) F < O < S < P < K

(d) As we move from magnesium to chlorine in the third period, the atomic size

(i) increases.

(ii) decreases.

(iii) first decreases then increases.

(iv) first increases then decreases.

Ans. (ii) decreases.

(e) How does the atomic radius of elements vary down a group?

(i) It increases down a group.

(ii) It decreases down a group.

(iii) It first decreases then increases down a group.

(iv) It does not vary down a group.

Ans. (i) It increases down a group.

19. Metals are electropositive in nature, that is, they have a tendency to lose electrons. The more electropositive is a metal, the more is its metallic character. Conversely, non-metals are electronegative in nature, that is, they have a tendency to gain electrons. The more electronegative is an element, the more is its non-metallic character. As we move from left to right in a period, metallic character decreases

while non-metallic character increases. Highly electropositive elements are placed towards the left-hand side, while highly electronegative elements are placed towards the right-hand side of the periodic table. The metalloids separate metals from non-metals.

I. (a) What do you mean by electronegativity?

(b) How does the metallic character vary down a group?

(c) Arrange the following elements in the decreasing order of non-metallic character.

B, C, N, F and Si

(d) What are metalloids? Give an example.

Ans. (a) The tendency of an atom in a molecule to attract a shared pair of electrons towards itself is called as electronegativity.

(b) As we move down a group, the size of the atom increases. Hence, the outermost electron becomes farther from the nucleus, and thus the tendency of an atom to lose the valence electron increases. So, the metallic character also increases.

(c) The arrangement of the given elements in the decreasing order of non-metallic character is as follows:

F > N > C > B > Si

(d) Elements which exhibit the characteristics of both metals and non-metals are known as metalloids. For example, boron, germanium, etc.

II. (a) Which of the following correctly represents the increasing order of metallic character of the given elements?

(i) P < Si < Be < Mg < Na

(ii) Na < Si < Be < Mg < P

(iii) Si < P < Be < Mg < Na

(iv) Mg < P < Si < Be < Na

Ans. (ii) Na < Si < Be < Mg < P

(b) The correct order of decreasing electronegativity is

(i) I > Cl > Br > F > At.

(ii) Cl > Br > F > I > At.

(iii) F > Cl > Br > I > At.

(iv) Br > Cl > F > I > At.

Ans. (i) I > Cl > Br > F > At.

(c) Identify the correct reason for the variation of metallic character across a period.

(i) Metallic character increases across a period due to decrease in atomic size as well as decrease in the tendency to lose electrons.

(ii) Metallic character decreases across a period due to decrease in atomic size as well as decrease in the tendency to lose electrons.

(iii) Metallic character increases across a period due to increase in atomic size and decrease in the tendency to lose electrons.

(iv) Metallic character increases across a period due to decrease in atomic size and increase in the tendency to lose electrons.

Ans. (iii) Metallic character increases across a period due to increase in atomic size and decrease in the tendency to lose electrons.

(d) Which of the following correctly represents the decreasing order of non-metallic character?

(i) B > N > F > C > Si

(ii) Si > N > C > B > F

(iii) C > F > N > B > Si

(iv) F > N > C > B > Si

Ans. (iv) F > N > C > B > Si

(e) Which one of the following reasons correctly justifies that 'nitrogen (atomic number 7) is more electronegative than phosphorus (atomic number 15)' ?

(i) N and P belong to the same group and electronegativity decreases down the group.

(ii) N and P belong to the same period and electronegativity decreases across the period.

(iii) N and P belong to the same group and electronegativity increases down the group.

(iv) N and P belong to the same period and electronegativity increases across the period.

Ans. (i) N and P belong to the same group and electronegativity decreases down the group.

Very Short Answer Type Questions

20. An element with atomic number 4 combines with another element with atomic number 17. What would be the formula of the compound?

Ans. Let the symbol of the element with atomic number 4 be X and that of the element with atomic number 17 be Y. So, valency of element X will be 2 and that of element Y will be 1. Hence, the formula of the compound will be XY_2.

21. Why is K more reactive than Li?

Ans. Potassium is bigger in size than lithium. Hence, it will be easier for potassium to lose an electron from its valence shell than lithium. This is why potassium is more reactive than lithium.

22. Write the following elements in order of their increasing atomic size:
Magnesium, Sodium, Aluminium.

Ans. The arrangement of the given elements in the order of their increasing atomic size will be:
Al < Mg < Na

23. How many elements are there in the lanthanoid series?

Ans. There are 14 elements in the lanthanoid series.

24. State the relation between metallic character of elements and reactivity, and non-metallic character of non-metals and reactivity.

Ans. As the metallic character of metals increases, their reactivity increases. The metallic character increases down the group and decreases across a period.
As the non-metallic character of non-metals increases, their reactivity increases. The non-metallic character of elements increases across a period and decreases down the group.

Short Answer Type-I Questions

25. Why does the electronegativity decrease on moving down a group and increase in a period on moving from left to right? Give reasons.

Ans. Electronegativity of elements decreases on moving down a group. Due to the increase in size with increase in atomic number, the tendency of an atom to attract the shared pair of electrons decreases. Hence electronegativity decreases on moving down a group.
Electronegativity of elements increases across a period. On moving from left to right in a period, the atomic radius decreases and the nuclear charge increases. Due to the combined effect of decreasing atomic radius and increasing nuclear charge, the shared pair of electrons is more strongly attracted towards the nucleus. As a result, electronegativity increases in a period from left to right.

26. Compare the properties of germanium with the properties of *eka*-silicon predicted by Mendeleev.

Ans. Some properties of *eka*-silicon and germanium are compared in the following table:

Property	*Eka*-silicon	Germanium
Atomic mass	72	72.630
Density (g/cm^3)	5.5	5.323
Colour	Grey	Grey
Oxide	EO_2 (Stable)	GeO_2 (Stable)

27. Give one example of each:
(a) Metal and non-metal having the valency 2.
(b) Element with completely filled outermost shell.
(c) Element with three shells, having 4 electrons in the outermost shell. **(CBSE 2014)**

Ans. (a) Magnesium is an example of a metal having a valency of 2. Oxygen is an example of a non-metal having a valency of 2.
(b) Neon is an example of an element having completely filled outermost shell.
(c) Silicon is the element having three shells and possessing 4 electrons in the outermost shell.

28. State giving explanation why argon (atomic mass = 39.9) has been rightly placed before potassium (atomic mass = 39.1) in the Periodic Table.

Ans. The atomic number of argon is 18 and its electronic configuration is 2, 8, 8. On the other hand, the atomic number of potassium is 19 and its electronic configuration is 2, 8, 8, 1. Since the atomic number of potassium is more than that of argon, it is placed after argon in the periodic table.

Short Answer Type-II Questions

29. With reference to Mendeleev's periodic table, answer the following questions:
(a) Write the formula of hydride and oxide of silicon.
(b) Name the element in group I which do not resemble alkali metals.
(c) In group VI why does tellurium (Te) with atomic mass 127.60 comes before iodine (I) with atomic mass 126.90.

Ans. (a) The formulae of the hydride and oxide of silicon are SiH_4 and SiO_2.
(b) Hydrogen is placed in group I of the periodic table. However, it is a non-metal and not an alkali metal.
(c) While arranging elements in his periodic table, Mendeleev found that the properties of iodine were similar to that of fluorine, chlorine and bromine. This is why, he placed iodine before tellurium in his periodic table.

30. Two elements with symbol X (atomic number 11) and Y (atomic number 13) are placed in the third period of the Modern Periodic Table.
(a) Which amongst the two has more metallic character?
(b) Calculate the valency of each element.
(c) Element Y is smaller than X in terms of atomic size. Is the statement true? Justify.

Ans. (a) Element X will have more metallic character. Element Y is placed after element X in the same period. As we move across a period from left to right, the metallic character decreases.
(b) The electronic configuration of element X will be 2, 8, 1 and that of element Y will be 2, 8, 3.

So, the valencies of X and Y will be 1 and 3 respectively.

(c) This statement is true. This is because both element X and Y occur in the third period of the periodic table. As we move across a period from left to right, the atomic size decreases.

Long Answer Type Questions

31. The following elements represent second period of the Periodic Table: Li, Be, B, C, N, O, F, Ne.

(a) Which elements react together to give a compound of the type XY?

(b) Which elements form cations?

(c) Which elements exist as monoatomic gas?

(d) Which elements are semi-metals?

(e) Which element is the lightest?

Ans. (a) Both lithium and fluorine show a valency of 1. They will combine to form lithium fluoride, which has the chemical formula LiF. This is a compound of the type XY.

(b) Out of the given elements, lithium and beryllium are metals. They will form cations.

(c) Neon will exist as a monoatomic gas. It is a noble gas.

(d) Out of the given elements, boron is a semi-metal.

(e) Out of the given elements, lithium is the lightest.

32. (a) Give reasons for the following:

(i) All elements in a group have similar chemical properties.

(ii) Atomic radius increases as we move from top to bottom in a group.

(iii) Mendeleev left gaps in his periodic table.

(b) What is a metalloid?

(i) Give the names of the metalloids in the periodic table along with their atomic number.

(ii) In which groups of the periodic table are they located?

Ans. (a) (i) All elements in a group have the same number of valence electrons and therefore exhibit the same valency. Hence they undergo similar chemical reactions and form compounds having similar chemical formulae. This is why the chemical properties of elements in a group are the same.

(ii) On moving down a group, a new shell of electrons is added at each succeeding element. Hence, the electrons in the valence shell of each succeeding element lie farther and farther away from the nucleus. Consequently, the attraction of the nucleus for the electrons decreases and as a result, the atomic radius increases with increase in atomic number. Also, the increase in atomic radius due to the addition of new shells is so large that it outweighs the contractive effect of increased nuclear charge. As a result, the atomic radius increases on moving down a group from top to bottom.

(iii) Mendeleev left gaps in his periodic table for the yet to be discovered elements. He also predicted the properties of these elements.

(b) (i) An element that shows the properties of both metals and non-metals is called a metalloid. The names of the metalloids and their atomic numbers are as follows:

Element	Atomic number
Boron	5
Silicon	14
Germanium	32
Arsenic	33
Antimony	51
Tellurium	52
Polonium	84

(ii) Metalloids are placed in different groups of the periodic table. The names of metalloids and their respective group numbers are given in the following table.

Element	Group Number
Boron	13
Silicon	14
Germanium	14
Arsenic	15
Antimony	15
Tellurium	16
Polonium	16

Let's Compete

(Page 132)

Multiple-Choice Questions

1. Out of the four elements shown below, which one is a halogen?

(a) Na (b) K

(c) Br (d) O

Ans. (c) Br

2. Which of the following has the least electronegativity?

(a) Oxygen (b) Argon

(c) Nitrogen (d) Boron

Ans. (b) Argon

3. The atomic radius of elements increases on moving down a group because

(a) nuclear charge increases.

(b) atomic mass increases.

(c) added electrons are accommodated in new electron shells.

(d) atomic number increases.

Ans. (c) added electrons are accommodated in new electron shells.

4. In a group, the ionization energy decreases from top to bottom because of

(a) increase in atomic size

(b) decrease in chemical reactivity

(c) decrease in electronegativity

(d) increase in density

Ans. (a) increase in atomic size

5. Which of the following groups form anions most readily?

(a) Nitrogen family (b) Oxygen family

(c) Halogen family (d) Alkali metals

Ans. (c) Halogen family

6. Which of the following set of elements is in the order of increasing metallic character?

(a) C, O, N (b) Mg, Al, Si

(c) Na, Li, K (d) Be, Mg, Ca

Ans. (d) Be, Mg, Ca

7. The element with atomic number 14 is hard and form acidic oxide and a covalent halide. To which of the following categories does the element belong?

(a) Non-metal

(b) Metal

(c) Semi-metal

(d) Left hand side elements

Ans. (c) Semi-metal

8. The most electropositive element is

(a) Cs. (b) Ga.

(c) Li. (d) Pb.

Ans. (a) Cs

9. In the long form of Periodic Table, the properties of elements are periodic functions of their

(a) atomic number (b) atomic mass

(c) atomic radius (d) none of these

Ans. (a) atomic number

10. The number of elements in the third period of Periodic Table is

(a) 6. (b) 8.

(c) 18. (d) 32.

Ans. (b) 8

Value-based Questions

(Optional) (Page 133)

1. In the supermarket, toothpastes are kept together at one place and hair oils are kept together somewhere else. In the development of periodic table, scientists attempted to classify the elements in the order of increasing atomic masses/atomic numbers and obtained an orderly arrangement out of apparent chaos. In the Modern Periodic Table, the elements are systematically arranged in rows and columns with increasing atomic numbers and space has been reserved for future elements to be discovered. The properties of an element and its compounds can be predicted from its position in the Periodic Table.

(a) What is the need to classify the elements?

(b) State the relation between valence electrons of elements and properties of elements in a group in the Periodic Table.

(c) What values are displayed by the scientists while attempting to classify the elements?

Ans. (a) Today, 118 elements are known to us. The study of the properties of each element and the compounds formed by them would not only be time-taking and tedious, but also a complex process. This is why we need to classify elements.

(b) Elements belonging to the same group have the same number of valence electrons and therefore exhibit similar chemical properties. Elements that possess 1 to 4 electrons in their valence shells are metals or semi-metals, while elements that possess 5 to 8 electrons in their valence shells are non-metals or semi-metals.

(c) The scientists displayed properties such as hard work, curiosity to know more, organizational skills and determination.

2. Electronic configuration plays an important role in building the long form of Periodic Table. The properties of elements depend on their electronic configuration. Electronic configuration of elements changes systematically both in a group and in a period.

(a) Define valence electron and valence shell.

(b) Why is it that the outermost electronic shell of an element is called valence shell?

(c) State the trend in properties (ionic or covalent) of chlorides of second period elements.

(d) Is it possible to compare the value of education in building a healthy society and a

strong nation to the usefulness of electronic configuration in building the Modern Periodic Table? Give reasons.

Ans. (a) The outermost shell in an atom is known as valence shell and the electrons present in the outermost shell of an atom are known as valence electrons.

(b) The outermost shell is called the valence shell because the electrons present in this shell determine the combining capacity or valency of an element.

(c) The elements of the second period are Li, Be, B, C, N, O, F and Ne. As we go from lithium to nitrogen, the ionic character of chlorides reduces and the covalent character increases. Chlorine reacts with fluorine to form chlorine monofluoride. Neon does not react with chlorine since it is an inert gas.

(d) Just like education helps in building a progressive and modern society with a healthy outlook, the electronic configuration helps in building the Modern Periodic Table. Elements with similar chemical properties are grouped together, which makes the arrangement of 118 elements organized and their study easier.

3. Mendeleev's periodic classification was based on atomic masses of the elements. This led to several discrepancies in periodicity among elements. Moseley observed that atomic number was a better fundamental property of an element and in the Modern Periodic Table, the elements are classified on the basis of atomic number.

(a) Define Modern Periodic Law.

(b) Why is it that Modern Periodic Table is better than Mendeleev's Periodic Table?

(c) In the Modern Periodic Table, the elements are classified on the basis of atomic number and the elements are placed in successive groups on the basis of increasing atomic numbers. Similarly, our society is divided on the basis of money. Do you agree with this?

Ans. (a) The Modern Periodic Law states that the properties of elements are periodic functions of their atomic numbers.

(b) In the Modern Periodic Table, elements are arranged in the order of increasing atomic numbers. As a result, the elements with similar properties are arranged together. There occurs a regular increase in atomic numbers and a proper gradation of properties. On the other hand, in Mendeleev's periodic table, elements were arranged in the order of increasing atomic masses. The increase in atomic mass was not regular. In some cases, elements with lower atomic mass were placed after elements with higher atomic mass. The placement of isotopes also posed a challenge. These problems are resolved in case of the Modern Periodic Table, since it classifies elements according to the atomic numbers.

(c) Just like elements are classified into groups on the basis of atomic numbers, our society too, unfortunately, is divided into groups on the basis of money. There are very rich people, rich people, middle class people, poor people, people below poverty line and other groups of people. This difference can be reduced if people are provided proper education and opportunities for progress.