ICSE CHEMISTRY 8

CHAPTER 1. Matter

Check Point 1

1. (a) Solid state

(b) They do not get intermixed, i.e., diffusion is not observed among solids.

(c) Solids < Liquids < Gases

(d) When liquids get heated, they expand.

2. (a) Gas (b) Solids (c) Solid (d) Gas

Check Point 2

1. True **2.** False **3.** True **4.** False

TEST YOURSELF

A. 1. atoms or molecules **2.** Gases **3.** diffusion **4.** decreases **5.** melting

B. 1. The process of converting a solid directly into a gas without changing into a liquid is called sublimation.

2. Law of conservation of mass states that mass can neither be created nor be destroyed.

3. The constant temperature at which a solid changes into its liquid state is called melting point.

4. The constant temperature at which a gas changes into its liquid state is called condensation point.

C. 1.

Solids	Liquids	Gases
1. Solids have a fixed shape and fixed volume.	Liquids have fixed volume but no fixed shape.	Gases have no fixed shape and no fixed volume.
2. Solid particles are very closely packed.	Liquid particles are less closely packed.	Gaseous particles are very loosely packed.
3. In solids, intermolecular force of attraction is very strong.	In liquids, intermolecular force of attraction is less strong than solids.	In gases, intermolecular force of attraction is very weak.
4. Intermolecular distance between the solid particles is the least.	Intermolecular distance between the liquid particles is more than solids.	Intermolecular distance between the gaseous particles is the most.

5. Solids are not compressible.	Liquids have very low compressibility.	Gases are highly compressible.
6. Solids are highly rigid.	Liquids are less rigid.	Gases are not rigid at all.
7. Kinetic energy of solid particles is very less.	Kinetic energy of liquid particles is more than solids.	Kinetic energy of gaseous particles is the most.

3.

Homogeneous materials	Heterogeneous materials
The materials having identical distribution of particles as well as identical properties throughout are called homogeneous materials, e.g., detergent in water, alloys, etc.	The materials which do not have identical distribution of particles and have different properties in different parts are called heterogeneous materials, e.g., a mixture of oil and water, etc.

4.

Boiling	Evaporation
1. The process of fast conversion of a liquid into its gaseous state is called boiling.	1. The process of slow conversion of a liquid into its gaseous state is called evaporation.
2. It occurs at boiling point.	2. It occurs at all temperatures.

D. 1. False; Gases undergo diffusion.

2. False; A **gas** can occupy the complete space available in the vessel in which it is stored.

3. True

4. False; Most gases when cooled get converted into their liquid state.

E. 1. Anything which occupies space and has mass is called matter.

2. The state of matter having definite shape and definite volume is called a solid.

The three properties of solids are as follows:

(a) The particles of solids are very closely packed.

(b) Solids are rigid, so, they cannot be compressed easily.

(c) The intermolecular forces in solids are very strong.

4. The main postulates of kinetic molecular theory of matter are as follows:

(a) Matter consists of a large number of small particles, i.e., atoms or molecules.

(b) The particles are in continuous and random motion and have kinetic energy.

(c) If heat energy is provided to matter, its particles move faster, i.e., kinetic energy increases.

(d) If the distance between the particles of matter increases, the force of attraction decreases.

4. Freezing point.

5. Evaporation.

6. Liquid and gas can flow.

7. The process of converting a solid directly into its gaseous state is called sublimation, e.g., iodine, naphthalene, etc.

F. 1. Gases expand to a large extent because intermolecular force of attraction between the gaseous particles is weak and the particles can move away from one another.

2. As naphthalene balls get converted into vapour at room temperature, so, they are kept in cupboards in order to protect the clothes from insects.

3. As solids are rigid and having fixed shape, so, particles of solids cannot move apart. Thus, if two solids are kept together, they do not get intermixed, i.e., diffusion is not observed among solids.

G. 1.–(c) **2.**–(e) **3.**–(a) **4.**–(b) **5.**–(d)

H. 1. (a) **2.** (b) **3.** (a)

THINK ZONE

- Sponge, being solid, is compressed easily because it has pores which are filled with air. On applying pressure on sponge, air leaves the pores and it is compressed easily.
- Gases are not rigid, so, they have lots of spaces between their particles. Therefore, they can be easily compressed.

CHAPTER 2. Physical and Chemical Changes

Check Point 1

1. True **2.** False **3.** False **4.** False **5.** True

Check Point 2

1. ice **2.** chemical **3.** temporary/reversible **4.** reversible

Check Point 3

1. A change in which no new substance is formed is called a physical change.

2. (a) Melting of ice

(b) Cutting of paper

(c) Drying of wet clothes

3. When an iron nail is placed in copper sulphate solution, a new substance called ferrous sulphate is formed and copper gets deposited on the iron nail. So, the reaction observed is chemical change.
4. Most physical changes are reversible.
5. The changes in which new substances are formed are called chemical changes.
6. Burning of coal, baking a *chapati* and growing a plant.

TEST YOURSELF

A. **1.** chemical **2.** rotting of vegetables and fruits **3.** physical; chemical **4.** irreversible **5.** reversible **6.** physical **7.** chemical **8.** physical **9.** physical **10.** chemical

B. **1.** The change which repeats itself after a fixed interval of time is called periodic change, e.g., pendulum of a clock, etc.

2. The change which can be reversed or undone is called reversible change, e.g., melting of ice cream, inflating a balloon, etc.

3. The change which cannot be reversed or undone is called irreversible change, e.g., souring of milk, baking a bread, etc.

4. The change in which no new substance is formed is called physical change, e.g., dissolving sugar in water, tearing a paper, etc.

5. The change in which new substance is formed is called chemical change, e.g., spoilage of food, etc.

C. **1.**

Physical change	Chemical change
● No new substance is formed in a physical change.	● A new substance is formed in a chemical change.
● Most physical changes are reversible.	● Most chemical changes are irreversible.
● A physical change is usually accompanied by a change in shape, size, colour or state.	● A chemical change is usually accompanied by release or absorption of heat or light, evolution of a gas, production of sound or change in smell.
● Most physical changes are temporary.	● Most chemical changes are permanent.
● Some examples of physical changes are dissolving salt in water, inflating a balloon, melting of wax, etc.	● Some examples of chemical changes are rusting of iron, spoilage of food, cooking of food, burning of a substance, etc.

2.

Reversible change	Irreversible change
● A reversible change can be undone or reversed.	● An irreversible change cannot be undone or reversed.
● A reversible change is a temporary change.	● An irreversible change is a permanent change.
● Dissolving, melting, folding, etc., of substances are reversible changes.	● Burning, baking, rotting, cooking, etc., of substances are irreversible changes.

3.

Desirable change	Undesirable change
A change that is useful to us is called a desirable change, e.g., making of food by green plants, ripening of fruits, etc.	A change that is harmful to us is called an undesirable change, e.g., volcanic eruptions, floods, rotting of fruits, etc.

4.

Fast change	Slow change
A change which occurs in a few seconds or minutes is called fast change, e.g., explosion, burning of cooking gas, etc.	A change which occurs in a long time is called a slow change, e.g., growing of a baby into an adult, etc.

5.

Periodic change	Nonperiodic change
The change which repeats itself after a fixed period of time is called periodic change, e.g., sunrise and sunset, etc.	The change which repeats itself at irregular intervals of time is called nonperiodic change, e.g., beating of a drum, etc.

6.

Exothermic change	Endothermic change
A chemical reaction in which heat is evolved is called an exothermic change, e.g., burning of magnesium ribbon, etc.	A chemical reaction in which heat is absorbed is called an endothermic change, e.g., decomposition of calcium carbonate, etc.

D. 1. Physical change **2.** Chemical change **3.** Chemical change
4. Chemical change **5.** Physical change **6.** Physical change
7. Physical change **8.** Chemical change

E. 1. Changes can be classified in many ways as follows:
- Fast and slow changes
- Desirable and undesirable changes
- Periodic and nonperiodic changes
- Reversible and irreversible changes
- Physical and chemical changes

2. When ice is heated, it gets converted into water, i.e., liquid state.

It is a reversible change because when water is cooled, it gets converted into ice again.

3. It is an irreversible change because idli cannot be reversed back into idli batter.

4. When dilute hydrochloric acid is added to zinc metal, zinc chloride and hydrogen gas are formed.

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2(aq)} + \underset{\text{Hydrogen}}{H_2(\uparrow)}$$

5. The characteristics of a chemical change are as follows:

(a) **Change in the colour of reactants:** When an iron nail is placed in copper sulphate solution, a new substance called ferrous sulphate is formed and copper gets deposited on the iron nail.

$$\underset{\text{(Blue)}}{CuSO_4} + \underset{\text{(Brownish-black)}}{Fe} \longrightarrow \underset{\text{(Green)}}{FeSO_4} + \underset{\text{(Reddish-brown)}}{Cu}$$

(b) **Formation of a precipitate:** A precipitate is an insoluble compound formed as a result of a chemical reaction.

The chemical reaction between barium chloride and sodium sulphate can be represented as below:

$$\underset{\substack{\text{Barium}\\\text{chloride}}}{BaCl_2(aq)} + \underset{\substack{\text{Sodium}\\\text{sulphate}}}{Na_2SO_4(aq)} \longrightarrow \underset{\substack{\text{Barium sulphate}\\\text{(White ppt.)}}}{BaSO_4(\downarrow)} + 2NaCl(aq)$$

(c) **Evolution of a gas:** Some reactions are accompanied with evolution of a gas. For example,

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2(aq)} + \underset{\text{Hydrogen}}{H_2(\uparrow)}$$

(d) **Absorption or evolution of heat energy:** Some reactions occur by absorbing heat. For example,

$$\underset{\text{Nitrogen}}{N_2(g)} + \underset{\text{Oxygen}}{O_2(g)} + \text{Heat} \longrightarrow \underset{\text{Nitric oxide}}{2NO(g)}$$

Some reactions occur by evolving heat. For example,

$$\underset{\text{Carbon}}{C(s)} + \underset{\text{Oxygen}}{O_2(g)} \longrightarrow \underset{\text{Carbon dioxide}}{CO_2(g)} + \text{Heat}$$

6. All changes are not desirable. The three desirable changes are as follows:

(a) Cooking of food

(b) Ripening of fruits

(c) Making of food by green plants

7. A list of six changes is given below:

(a) Motion of a planet around the sun

(b) Swaying of branches of a tree

(c) Motion of a boy sitting in a swing

(d) The running of a batsman between the wickets
(e) Freezing of water to form ice
(f) Change of periods in your school

Periodic change	Nonperiodic change
● Motion of a planet around the sun	● Swaying of branches of a tree
● Motion of a boy sitting in a swing	● The running of a batsman between the wickets
● Change of periods in your school	● Freezing of water to form ice

8. (a) **Change of state of the reactants:** When hydrogen and oxygen gases react, they form liquid water.

$$\underset{\text{Hydrogen}}{2H_2(g)} + \underset{\text{Oxygen}}{O_2(g)} \longrightarrow \underset{\text{Water}}{2H_2O(l)}$$

When zinc granules (solid) react with dilute hydrochloric acid, zinc chloride is formed which remains dissolved in the solution and hydrogen gas is evolved.

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

(b) **Change of colour:** On strongly heating white lead nitrate [$Pb(NO_3)_2$] crystals, yellow lead oxide (PbO), brown nitrogen dioxide (NO_2) gas and colourless oxygen (O_2) gas are formed.

$$\underset{\substack{\text{Lead nitrate}\\\text{(White)}}}{2Pb(NO_3)_2} \xrightarrow{\text{Heat}} \underset{\substack{\text{Lead oxide}\\\text{(Yellow)}}}{2PbO} + \underset{\substack{\text{Nitrogen dioxide}\\\text{(Brown)}}}{4NO_2} + \underset{\substack{\text{Oxygen}\\\text{(Colourless)}}}{O_2}$$

On heating green copper carbonate ($CuCO_3$) crystals, a black compound copper oxide (CuO) is formed and colourless carbon dioxide (CO_2) gas is evolved.

$$\underset{\substack{\text{Copper carbonate}\\\text{(green)}}}{CuCO_3} \xrightarrow{\text{Heat}} \underset{\substack{\text{Copper oxide}\\\text{(black)}}}{CuO} + \underset{\text{Carbon dioxide}}{CO_2}$$

(c) **Evolution of a gas:** When zinc granules react with hydrochloric acid, zinc chloride is formed and hydrogen gas is evolved.

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

On mixing baking soda with vinegar, carbon dioxide gas is evolved.

$$\underset{\text{Baking soda}}{2NaHCO_3} + \underset{\text{Vinegar}}{CH_3COOH} \longrightarrow \underset{\substack{\text{Carbon}\\\text{dioxide}}}{CO_2} + \underset{\substack{\text{Sodium}\\\text{carbonate}}}{Na_2CO_3} + \underset{\text{Water}}{3H_2O}$$

(d) **Formation of precipitate:** When sodium chloride solution (colourless) is added to silver nitrate solution (colourless), a white precipitate of silver chloride is formed.

$$\underset{\substack{\text{Silver nitrate}\\ \text{(colourless)}}}{AgNO_3(aq)} + \underset{\substack{\text{Sodium chloride}\\ \text{(colourless)}}}{NaCl(aq)} \longrightarrow \underset{\substack{\text{Silver chloride}\\ \text{(white precipitate)}}}{AgCl(\downarrow)} + \underset{\text{Sodium nitrate}}{NaNO_3(aq)}$$

Ferrous chloride and sodium hydroxide solutions react to form a green precipitate of ferrous hydroxide.

$$\underset{\substack{\text{Ferrous}\\ \text{chloride}}}{FeCl_2(aq)} + \underset{\substack{\text{Sodium}\\ \text{hydroxide}}}{2NaOH(aq)} \longrightarrow \underset{\substack{\text{Ferrous hydroxide}\\ \text{(Green precipitate)}}}{Fe(OH)_2(\downarrow)} + \underset{\text{Sodium chloride}}{2NaCl(aq)}$$

9. **Physical changes:** Dissolving sugar in water, melting of butter, breaking of a glass bottle, clothes being ironed, drying of wet hair, wool being knitted into a sweater

Chemical changes: Burning of a magnesium ribbon, burning sugar, souring of milk

E. **1.** False; Melting of ice is a **physical** change.

2. False; A matchstick burning to produce smoke and some gases is an example of **chemical** change.

3. False; Making of an aeroplane out of a paper is an example of **reversible** change.

4. False; A chemical change **cannot** be usually reversed.

5. True

6. False; Formation of alloys is a **chemical** change.

G. **1.** **Inflating a balloon;** It is a physical change while other three are chemical changes.

2. **Frying of potatoes;** It is a chemical change while other three are physical changes.

H. **1.** When water vapour comes in contact with air, it gets cooled and converted back into water. That is why, changing of water into water vapour is considered a physical change.

2. When sugar and water are mixed, they get mixed with each other completely. When this solution is heated, water evaporates and sugar is left behind. So, mixing of sugar with water is considered reversible change.

3. When cement and water are mixed, a new solid substance is formed which cannot be reversed back into its original form. That is why, mixing of cement with water is considered an irreversible change.

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

J. (a) Fig. (A) (b) Chemical change (c) Irreversible change

THINK ZONE

- Baking of clay is an irreversible change.
- Formation of curd from milk is a chemical change.
- Breaking of glass is an irreversible physical change.

CHAPTER 3. Elements, Compounds and Mixtures

Check Point 1

1. A pure substance made up of same or single type of atoms is called an element.
2. Yes, calcium carbonate is a compound.
3. Yes, compounds are homogeneous.
4. The mixtures which have uniform composition throughout are called homogeneous mixtures, e.g., a mixture of alcohol and water.
5. Mixture of oil and water is a heterogeneous mixture.

Check Point 2

1. Homogeneous **2.** Heterogeneous **3.** Heterogeneous

4. Heterogeneous **5.** Homogeneous

Check Point 3

1. True **2.** False **3.** True **4.** False **5.** True

TEST YOURSELF

A. 1. pure, impure substances **2.** compound **3.** element

4. heterogeneous **5.** homogeneous

B. **1.** Pure substances made up of similar kinds of atoms and cannot be broken down into simpler substances are called elements.

2. Pure substances made up of two or more elements combined together in a fixed ratio by mass are called compounds.

3. Substances made up of two or more substances mixed in any proportion and under any conditions are called mixtures.

4. The method used to separate a mixture of two volatile miscible liquids which differ in their boiling points by about 20ºC is called distillation.

C. 1.

Pure substances	Impure substances
● Substances which are made up of only one kind of atoms or molecules are called pure substances.	● Substances which are made up of two or more than two substances mixed in any ratio are called impure substances.
● They have definite composition and properties.	● They have indefinite composition and properties.
● Iron, gold, sugar, etc., are examples of pure substances.	● Aerated drinks, alloys, etc., are examples of impure substances.

2.

Homogeneous mixtures	Heterogeneous mixtures
● Different constituents are mixed uniformly.	● Different constituents are not mixed uniformly.
● The constituents cannot be easily separated.	● The constituents can be easily separated.

D. 1. The number of atoms present in a molecule is called its atomicity.

2. The properties of compounds differ from the properties of their constituents. So, properties of constituents C and O_2 are different from the properties of carbon dioxide. Here, C is combustible, O_2 is the supporter of combustion but CO_2 extinguishes the fire.

3. Evaporation is used to obtain common salt from salt solution.

4. CO_2 in cold drinks is an example of gas-liquid type of homogeneous mixture.

5. The physical properties involved in the separation of mixtures are as follows:

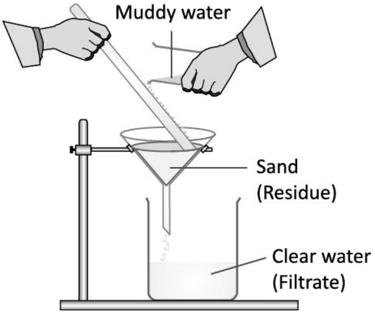
(a) Density
(b) Melting and boiling points
(c) Magnetic properties
(d) Solubility in commonly used solvents
(e) Nature to sublime, etc.

6. The purpose of sedimentation process is to separate heavy insoluble solid components from the liquid components present in the mixture.

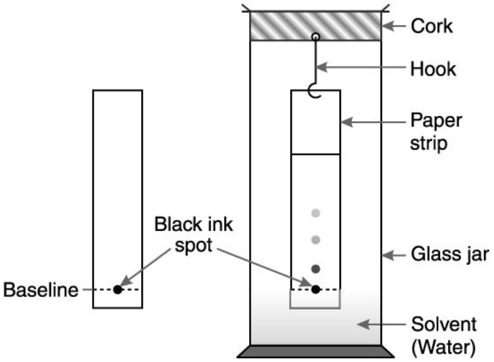
7.

Compounds	Mixtures
1. Compounds are pure substance.	Mixtures are impure substance.
2. They are made up of two or more elements combined in a fixed ratio under fixed condition.	They are made up of two or more elements or compounds present in any ratio under any condition.
3. Compounds are homogeneous.	Mixtures can be homogeneous or heterogeneous.
4. Compounds cannot be separated into its constituents by simple physical methods.	Mixtures can be separated into its constituents by simple physical methods.

8. The filtration method is shown below:



9. Coloured components of mixtures are separated by chromatography. A diagram with regard to it is drawn below:



Paper chromatography

10. When electricity is passed through water, it is separated into its constituents as given below:

$$2H_2O \xrightarrow{\text{Electricity}} 2H_2 + O_2$$

E. **1.** True

2. False; An element **cannot** be broken down into two or more smaller parts by any chemical method.

3. True

4. True

5. True

F. **1.** As alloys have uniform composition, so, they are homogeneous in nature.

2. As oil is lighter than water, so, oil solution swims over water.

G. **1.** Magnetic separation

2. Distillation

3. Filtration and Evaporation

4. Sublimation
5. Evaporation

H. **1.** (c) **2.** (c) **3.** (b) **4.** (d)

I. **1.**– Funnel
2.– China dish
3.– A mixture of sand and iodine
4.– Wire gauze
5.– Burner

THINK ZONE

- Sugar can be separated from sugar solution by evaporating water present in it.
- Compounds are the combination of two or more substances in a fixed proportion under fixed conditions, so, they are homogeneous.

CHAPTER 4. Atomic Structure

Check Point 1

1. An atom is the smallest particle of an element. It is the building block of all matter.
2. The atoms are made up of three particles, i.e., electrons, protons and neutrons.
3. J.J. Thomson discovered the electrons.
4. Cathode rays are a stream of negatively charged particles known as electrons which are emitted from the cathode of a discharge tube on passing an electric current through a gas at very low pressure.
5. Positive charge is present on protons.

Check Point 2

1. True **2.** False **3.** True **4.** False

Check Point 3

1. (a) $\overset{K}{2}\ \overset{L}{8}\ \overset{M}{5}$ (b) $\overset{K}{2}\ \overset{L}{5}$ (c) $\overset{K}{2}\ \overset{L}{8}\ \overset{M}{8}$

2. (a) 2 (b) 6 (c) 2 (d) 7

3. (a) $\overset{K}{2}\ \overset{L}{8}\ \overset{M}{7}$
(b) 7
(c) The number of valence electrons lost, shared or gained by an atom is called its valency. The valency of X is 1– as it requires 1 electron to complete its octet.

(d) It is a nonmetal.

(e) It will form an anion.

TEST YOURSELF

A. **1.** J.J. Thomson **2.** neutral **3.** nucleus **4.** 18 **5.** 16; $\begin{array}{ccc} K & L & M \\ 2 & 8 & 6 \end{array}$

6. Positive; negative **7.** atomic number; mass numbers

8. protium ($^{1}_{1}H$), deuterium ($^{2}_{1}H$), tritium ($^{3}_{1}H$)

B. **1.**–(e) **2.**–(a) **3.**–(d) **4.**–(b) **5.**–(c)

C. **1.** A negatively charged particle of an atom is called **electron.**

2. A positively charged particle of an atom is called **proton.**

3. An uncharged particle present inside the nucleus of an atom is called **neutron.**

4. The arrangement of electrons in various energy levels (or shells) of an element is called electronic configuration.

5. The electrons present in the outermost shell (valence shell) of an atom are called valence electrons.

6. The atom of the same element having same atomic number but different mass numbers is called isotope.

D. **1.**

Cathode rays	Anode rays
Cathode rays are a stream of negatively charged particles known as electrons which are emitted from the cathode of a discharge tube on passing an electric current through a gas at very low pressure.	Anode rays are a stream of positively charged particles known as protons which are emitted from the anode of a discharge tube on passing an electric current through a gas at very low pressure.

2.

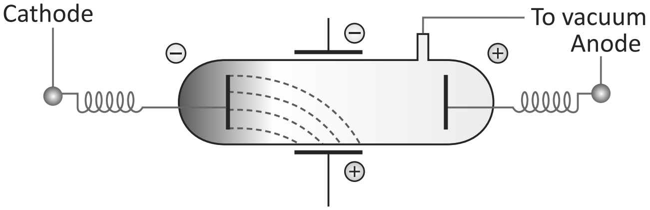
Atomic number	Mass number
(a) Atomic number of an element is defined as the total number of protons present inside the nucleus of an atom.	(a) Mass number of an element is defined as the sum of protons and neutrons present inside the nucleus of an atom.
(b) It is represented by the letter *Z*.	(b) It is represented by the letter *A*.

E. **1.** John Dalton gave the following atomic theory:

- Matter is made up of atoms.
- Atoms are indivisible, i.e., they cannot be cut or divided further.
- Atoms of an element are identical, i.e., they have same size, mass and chemical properties.
- Atoms of different elements are not identical, i.e., they are different from each other. They have different sizes, masses and chemical properties.

- Atoms combine in whole number ratios.
- Atoms can neither be created nor be destroyed.

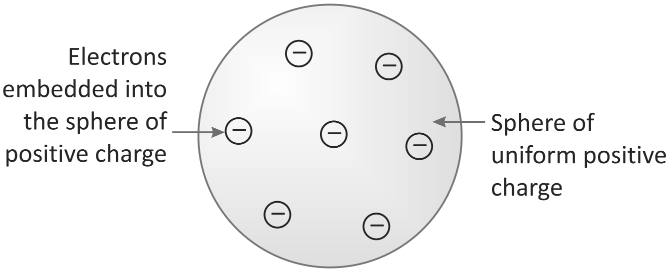
2. JJ Thomson conducted experiments to see how the gases conduct an electric current. In his experiments, he connected a high voltage battery to a discharge tube (made from hard glass) sealed at both ends fitted with two metal plates called electrodes.



Discovery of electrons

When he applied high voltage under low pressure, he observed that the glass walls of the tube glowed a bright-green colour. It was due to the hitting of some invisible rays that travelled in straight lines which are emitted from the cathode. He named these rays as cathode rays. Later, he found that the cathode rays consisted of negatively charged particles. He named these negatively charged particles electrons.

3. J J Thomson proposed his model of an atom as shown in the figure, in which small negatively charged particles called electrons are embedded inside a sphere of a uniform positive charge.



According to J J Thomson:

- An atom has a sphere of positive charge in which protons are present.
- The negatively charged particles called electrons are embedded in this positively charged sphere.
- The positive charge due to protons and negative charge due to electrons balance each other, making an atom electrically neutral.

4. In alpha (α) particle scattering experiment, Rutherford observed that:

- most α-particles passed straight through the gold foil undeflected.
- a small number of α-particles were deflected at small angles while some were deflected at large angles.
- a very few α-particles bounced back just like a ball hitting a wall.

Rutherford came to the following conclusions:

- As the atoms of gold foil allowed most α-particles to pass straight through them, he concluded that an atom has a lot of empty space in it.
- As a small number of α-particles having a positive charge were deflected, he concluded that there is a centre of positive charge inside an atom. As like charges repel each other, the positively charged α-particles are repelled by the positively charged centre inside the atom.
- As very few α-particles bounced back, he concluded that the central core is hard and dense and is very small as compared to the size of an atom. He named the small, dense and positively charged central core of an atom as the nucleus.

5. Rutherford suggested that the negatively charged electrons move in circular orbits with great speed. Maxwell, however, challenged this observation. He argued that according to the radiation theory, charged particles moving with great speed in circular orbits emit energy in the form of radiations. Since electrons (charged particles) are also moving at a high speed in circular orbits around the nucleus, they must release energy continuously in the form of radiations. As a result of reduced energy, the electrons must come closer and closer to the nucleus and ultimately fall into the nucleus taking a spiral path. As a result, the atom should collapse. But, this does not actually happen. Rutherford could not provide a suitable explanation for this.

6. Neils Bohr explained the limitation of Rutherford's model of an atom. He explained that even though the electrons are moving at a high speed around the nucleus of an atom, they do not lose energy. The electrons revolve around the nucleus in 'fixed orbits' (or energy levels). Each orbit has a different radius and definite amount of energy. Thus, electrons in an atom are moving, but the energy of the electron remains stationary in an energy level (or fixed orbit).

7. (a) $\begin{matrix}\text{K}\\1\end{matrix}$ (b) $\begin{matrix}\text{K}&\text{L}&\text{M}\\2&8&1\end{matrix}$ (c) $\begin{matrix}\text{K}&\text{L}&\text{M}&\text{N}\\2&8&8&1\end{matrix}$

(d) $\begin{matrix}\text{K}&\text{L}\\2&3\end{matrix}$ (e) $\begin{matrix}\text{K}&\text{L}\\2&4\end{matrix}$ (f) $\begin{matrix}\text{K}&\text{L}\\2&6\end{matrix}$

8. (a) 20 (b) 40 (c) 20 (d) 20 (e) 20 (f) 2

9. (a) $\underset{2,\ 1}{\text{Li}} \; - \; \underset{\substack{\text{Loses}\\ \text{1 electron}}}{1e^-} \longrightarrow \underset{\substack{2\\ \text{Lithium ion}}}{\text{Li}^+}$

(b) $\underset{2,\ 8,\ 1}{\text{Na}} \; - \; \underset{\substack{\text{Loses}\\ \text{1 electron}}}{1e^-} \longrightarrow \underset{\substack{2,\ 8\\ \text{Sodium ion}}}{\text{Na}^+}$

(c) $\underset{2,\ 8,\ 3}{\text{Al}} \; - \; \underset{\substack{\text{Loses}\\ \text{3 electrons}}}{3e^-} \longrightarrow \underset{\substack{2,\ 8\\ \text{Aluminium ion}}}{\text{Al}^{3+}}$

(d) $\underset{2,\ 8,\ 6}{\text{S}} \; + \; \underset{\substack{\text{Gains}\\ \text{2 electrons}}}{2e^-} \longrightarrow \underset{\substack{2,\ 8,\ 8\\ \text{Sulphide ion}}}{\text{S}^{2-}}$

(e) $\underset{2,\ 8,\ 7}{\text{Cl}} \; + \; \underset{\substack{\text{Gains}\\ \text{1 electron}}}{1e^-} \longrightarrow \underset{\substack{2,\ 8,\ 8\\ \text{Chloride ion}}}{\text{Cl}^-}$

(f) $\underset{2,\ 6}{\text{O}} \; + \; \underset{\substack{\text{Gains}\\ \text{2 electrons}}}{2e^-} \longrightarrow \underset{\substack{2,\ 8\\ \text{Oxide ion}}}{\text{O}^{2-}}$

10. (a) 6 (b) 6 (c) 12 (d) 14 (e) A and B represent carbon.

11.

S.No.	Name	Symbol	M.N.	A.N.	P	E	N
1.	Magnesium	${}^{24}_{12}\text{Mg}$	24	12	12	12	12
2.	Sodium	${}^{23}_{11}\text{Na}$	23	11	11	11	12
3.	Fluorine	${}^{19}_{9}\text{F}$	19	9	9	9	10
4.	Nitrogen	${}^{14}_{7}\text{N}$	14	7	7	7	7
5.	Calcium	${}^{40}_{20}\text{Ca}$	40	20	20	20	20

F. 1. False; The K-shell of an atom can hold a maximum of **2** electrons.

2. True

3. False; JJ Thomson discovered the **electrons.**

4. True

5. False; A chloride ion is **negatively** charged.

G. 1. This is because an atom has a lot of empty space in it.

2. This is because the mass of an electron is negligible as compared to the mass of an atom.

H. 1. (a) Alpha (α) particles

(b) Positive

(c) This is because the central core (nucleus) of the atom is hard and dense and is very small as compared to the size of an atom.

THINK ZONE

- Rutherford used gold foil in his experiment because gold is the most malleable metal. Gold can be beaten into very thin sheet.
- Atoms are electrically neutral because they have equal number of protons and neutrons.

CHAPTER 5. Language of Chemistry

Check Point 1

1. **Ferric oxide:** Fe_2O_3
   Magnesium nitrite: $Mg(NO_2)_2$
   Ammonium sulphate: $(NH_4)_2SO_4$
   Sodium hydride: NaH
   Zinc carbonate: $ZnCO_3$
2. **KCl:** Potassium chloride
   $Zn(NO_3)_2$: Zinc nitrate
   $(NH_4)_2CO_3$: Ammonium carbonate
   $(NH_4)_2S$: Ammonium sulphide

Check Point 2

1. $P_4 + 5O_2 \longrightarrow 2P_2O_5$
2. $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$
3. $2KNO_3 \longrightarrow 2KNO_2 + O_2$
4. $2NaCl + MgO \longrightarrow Na_2O + MgCl_2$

TEST YOURSELF

A. 1. Symbol **2.** Al **3.** Atomicity **4.** 3 **5.** Two

B. 1. Cu_2O **2.** CaO **3.** HNO_3 **4.** FeS **5.** NH_4OH **6.** MgH_2

C. 1. Ammonium chloride **2.** Calcium carbonate **3.** Zinc sulphide
4. Magnesium chloride **5.** Calcium sulphate **6.** Potassium hydride

D. 1. The short form of an element is known as symbol, e.g., the symbol of sodium is Na.

2. The mass of an atom is called its atomic mass, e.g., the atomic mass of carbon is 12 u.

Elements carbine with their own atoms in a fixed number which is called their atomicity, e.g., all metals are monoatomic.

3. The electronic configuration of sulphur is $\underset{K}{2}\ \underset{L}{8}\ \underset{M}{6}$.

Valence electrons = 6

Valency = 8 – 6 = 2

The electronic configuration of chlorine is $\underset{K}{2}\ \underset{L}{8}\ \underset{M}{7}$.

Valence electrons = 7

Valency = 8 – 7 = 1

4.

Cations	Anions
The radicals having positive charge are called cations, e.g., sodium ion, potassium ion, etc.	The radicals having negative charge are called anions, e.g., chloride ion, oxide ion, etc.

5. The chemical formula $MgCl_2$ indicates the compound magnesium chloride which is made up of one magnesium ion (Mg^{2+}, positive radical) and two chloride ions (Cl^-, negative radicals).

6. The law of conservation of mass states that during a chemical change, mass can neither be created nor be destroyed.

In a balance chemical equation, total mass of reactants is equal to total mass of products, e.g.,

$$\begin{array}{ccccc} 2Ca & + & O_2 & \longrightarrow & 2CaO \\ 2 \times 40 & & 2 \times 16 & & 2(40 + 16)\ u \\ 80\ u & & 32\ u & & 112\ u \\ \multicolumn{3}{c}{\uparrow\!\text{——}\,112\ u\,\text{——}\!\uparrow} & & \end{array}$$

So, the law of conservation is proved.

7. The steps followed to write the molecular formula of a compound are as follows:

- Write the symbols of the radicals side-by-side which form the compound. The radical with positive valency is written on the left and the radical with negative valency on the right.
- At the top right of the symbol of each radical, write its valency.
- Criss-cross (interchange) the valencies of the combining radicals and write them at the base of the radical (as subscripts). Ignore the charges.
- Remove any common factor in valencies.

8. NaCl and CO_2.

9. (i) $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$

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

(iii) $N_2(g) + 2O_2(g) \longrightarrow 2NO_2(g)$

E. 1. The short form of an element is called symbol. For example, the symbol of chlorine is Cl.

2. An atom or a group of atoms having a charge, i.e., positive or negative, on it is called a radical, e.g., hydrogen ion (H^+).

3. The molecular formula of a compound simply represents the elements which make up the compound. It also gives us the exact number of atoms of each element that combines to make molecule of a compound.

4. Chemical changes expressed with the help of symbols and formulae are called chemical equations, e.g.,

$$2Mg + O_2 \longrightarrow 2MgO$$

F. 1. $Na_2O + H_2O \longrightarrow 2NaOH$

2. $CO_2 + C \longrightarrow 2CO$

3. $Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2$

4. $P_4 + 5O_2 \longrightarrow 2P_2O_5$

G. 1. The substances taking part in a chemical reaction are called reactants whereas the new substances formed as a result of reactants are called products.

$$\underbrace{2Ca + O_2}_{\text{Reactants}} \longrightarrow \underbrace{2CaO}_{\text{Product}}$$

2.

Valency	Atomicity
The number of electrons required for atoms of an element to gain, lose or share to attain a stable configuration is called valency.	Elements combine with their own atoms in a fixed number which is called their atomicity.

3.

Balanced chemical equation	Unbalanced chemical equation
A chemical equation in which the number of atoms on reactants and products side is equal is said to be balanced chemical equation.	A chemical equation in which the number of atoms on reactants and products side is not equal is said to be an unbalanced chemical equation.

H. 1. A chemical equation is made more informative to know about
(a) physical states of the reactants and products
(b) evolution of a gas
(c) precipitate formed
(d) condition under the reaction occurs
(e) evolution or absorption of heat during a chemical reaction

2. As the symbol represents one single atom of the element, i.e., indicated by its first one or two letters of English name or Latin name, it is considered the short form of an element.

THINK ZONE

- The catalyst is obtained back after the reaction has been completed.

CHAPTER 6. Chemical Reactions

Check Point 1

1. (a) Double displacement reaction
(b) Decomposition reaction
(c) Combination reaction
(d) Displacement reaction

2. Reaction of magnesium and oxygen is a combination reaction.

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

3. Reaction of barium chloride and sodium sulphate is a double displacement reaction.

$$BaCl_2(aq) + Na_2SO_4(aq) \longrightarrow BaSO_4(\downarrow) + 2NaCl(aq)$$

4.

	Substance oxidised	Substance reduced	Oxidising agent	Reducing agent
(a)	Zinc	Copper sulphate	Copper sulphate	Zinc
(b)	Sodium	Oxygen	Oxygen	Sodium

TEST YOURSELF

A. 1. lead oxide, nitrogen dioxide, oxygen **2.** magnesium
3. displacement **4.** silver chloride, double displacement

B. 1. Oxides are the compounds made up of oxygen and one more element, e.g., oxygen and zinc.

2. Oxides which are neither acidic nor basic are called neutral oxides, e.g., H_2O, etc.

3. An oxidising agent is defined as a substance:
- which provides its oxygen for the oxidation of other substance.
- which removes hydrogen from another substance for its oxidation.

4. A reducing agent is defined as a substance:
- which removes oxygen from another substance for its reduction.
- which provides its hydrogen for the reduction of other substance.

5. A chemical reaction is the change of a substance into a new one that has a different chemical identity.

6. The reaction in which hydrogen is added to a substance and oxygen is removed from a substance is called reduction reaction.

C. 1. A chemical reaction is the change of a substance into a new one that has a different chemical identity.

2. The characteristics of a chemical reaction are as follows:

- Change in colour of reactants
- Change in state of reactants
- Formation of a precipitate
- Evolution of a gas
- Absorption or evolution of heat energy

3.

Exothermic change	Endothermic change
The reaction in which heat is evolved or released is called exothermic reaction, e.g., $C(s) + O_2(g) \rightarrow CO_2(g) + \text{Heat}$	The reaction in which heat is absorbed is called endothermic reaction, e.g., $N_2(s) + O_2(g) + \text{Heat} \rightarrow 2NO(g)$

4. (a) **Change of state of the reactants:** When hydrogen and oxygen gases react, they form liquid water.

$$\underset{\text{Hydrogen}}{2H_2(g)} + \underset{\text{Oxygen}}{O_2(g)} \longrightarrow \underset{\text{Water}}{2H_2O(l)}$$

When zinc granules (solid) react with dilute hydrochloric acid, zinc chloride is formed which remains dissolved in the solution and hydrogen gas is evolved.

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

(b) **Change of colour:** On strongly heating white lead nitrate [$Pb(NO_3)_2$] crystals, yellow lead oxide (PbO), brown nitrogen dioxide (NO_2) gas and colourless oxygen (O_2) gas are formed.

$$\underset{\substack{\text{Lead nitrate}\\\text{(White)}}}{2Pb(NO_3)_2} \xrightarrow{\text{Heat}} \underset{\substack{\text{Lead oxide}\\\text{(Yellow)}}}{2PbO} + \underset{\substack{\text{Nitrogen dioxide}\\\text{(Brown)}}}{4NO_2} + \underset{\substack{\text{Oxygen}\\\text{(Colourless)}}}{O_2}$$

On heating green copper carbonate ($CuCO_3$) crystals, a black compound copper oxide (CuO) is formed and colourless carbon dioxide (CO_2) gas is evolved.

$$\underset{\substack{\text{Copper carbonate}\\\text{(Green)}}}{CuCO_3} \xrightarrow{\text{Heat}} \underset{\substack{\text{Copper oxide}\\\text{(Black)}}}{CuO} + \underset{\text{Carbon dioxide}}{CO_2}$$

(c) **Evolution of a gas:** When zinc granules react with hydrochloric acid, zinc chloride is formed and hydrogen gas is evolved.

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

On mixing baking soda with vinegar, carbon dioxide gas is evolved.

$$\underset{\text{Baking soda}}{2NaHCO_3} + \underset{\text{Vinegar}}{CH_3COOH} \longrightarrow \underset{\substack{\text{Carbon}\\\text{dioxide}}}{CO_2} + \underset{\substack{\text{Sodium}\\\text{carbonate}}}{Na_2CO_3} + \underset{\text{Water}}{3H_2O}$$

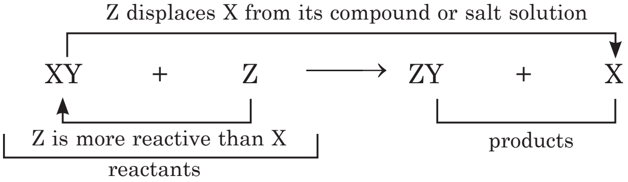
(d) **Formation of precipitate:** When sodium chloride solution (colourless) is added to silver nitrate solution (colourless), a white precipitate of silver chloride is formed.

$$\underset{\substack{\text{Silver nitrate}\\\text{(Colourless)}}}{AgNO_3(aq)} + \underset{\substack{\text{Sodium chloride}\\\text{(Colourless)}}}{NaCl(aq)} \longrightarrow \underset{\substack{\text{Silver chloride}\\\text{(White precipitate)}}}{AgCl(\downarrow)} + \underset{\text{Sodium nitrate}}{NaNO_3(aq)}$$

Ferrous chloride and sodium hydroxide solutions react to form a green precipitate of ferrous hydroxide.

$$\underset{\substack{\text{Ferrous}\\\text{chloride}}}{FeCl_2(aq)} + \underset{\substack{\text{Sodium}\\\text{hydroxide}}}{2NaOH(aq)} \longrightarrow \underset{\substack{\text{Ferrous hydroxide}\\\text{(Green precipitate)}}}{Fe(OH)_2(\downarrow)} + \underset{\text{Sodium chloride}}{2NaCl(aq)}$$

5. (a) **Displacement reaction:** A reaction in which a more reactive metal displaces a less reactive metal from its salt solution is called a displacement reaction. A displacement reaction can be represented as:



For example, when a piece of copper is placed in silver nitrate solution, the solution slowly turns blue.

$$\underset{\substack{\text{Silver nitrate}\\\text{(Colourless)}}}{2AgNO_3} + \underset{\substack{\text{Copper}\\\text{(Reddish-brown)}}}{Cu} \longrightarrow \underset{\substack{\text{Copper nitrate}\\\text{(Blue)}}}{Cu(NO_3)_2} + \underset{\substack{\text{Silver}\\\text{(Grey)}}}{2Ag}$$

Here, copper displaces silver from silver nitrate solution.

(b) **Decomposition reaction:** A reaction in which a single reactant decomposes (breaks down) to give two or more products is called a decomposition reaction. This reaction can be represented as:

$$\underset{\text{Single reactant}}{XY} \longrightarrow \underset{\text{Two or more products}}{X + Y \text{ (and Z)}}$$

Decomposition of a substance can be brought about in any of the following ways:

- By heating the substance
- By passing electricity through the substance
- In the presence of sunlight

For example, green ferrous sulphate crystals decompose on heating, as follows:

$$\underset{\substack{\text{Ferrous sulphate}\\ \text{(Green)}}}{2FeSO_4} \xrightarrow{\text{Heat}} \underset{\substack{\text{Ferric oxide}\\ \text{(Reddish-brown)}}}{Fe_2O_3} + \underset{\substack{\text{Sulphur dioxide}\\ \text{(Smell of}\\ \text{burning sulphur)}}}{SO_2} + \underset{\substack{\text{Sulphur}\\ \text{trioxide}}}{SO_3}$$

Here, ferrous sulphate crystals decompose on heating to form three products, i.e., ferric oxide, sulphur dioxide gas and sulphur trioxide gas.

(c) **Combination reaction:** A reaction in which two or more reactants combine together to form a single product is called a combination reaction. Such a reaction can be represented as follows:

$$\underbrace{X \quad + \quad Y}_{\text{2 reactants}} \longrightarrow \underset{\text{Single product}}{XY}$$

For example, when magnesium burns in air, a white ash of magnesium oxide is formed.

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

(d) **Double displacement reaction:** A reaction in which aqueous solutions of two compounds react by exchange of their ions to form two new compounds is called a double displacement reaction. It can be represented as:

$$\underbrace{\underbrace{WX \quad + \quad YZ}_{\text{Ions are exchanged}}}_{\text{Reactants}} \longrightarrow \underbrace{WY \quad + \quad ZX}_{\text{Products}}$$

For example, aqueous solutions of silver nitrate and sodium chloride react to form a white precipitate of silver chloride and sodium nitrate.

$$\underset{\text{Silver nitrate}}{AgNO_3(aq)} + \underset{\text{Sodium chloride}}{NaCl(aq)} \longrightarrow \underset{\substack{\text{Silver chloride}\\ \text{(White precipitate)}}}{AgCl(\downarrow)} + \underset{\text{Sodium nitrate}}{NaNO_3(aq)}$$

6. **Redox reaction:** A reaction in which reduction and oxidation take place simultaneously is called a redox reaction. For example,

Removal of oxygen (reduction)

$$\underset{\text{Copper oxide}}{CuO} + \underset{\text{Hydrogen}}{H_2} \longrightarrow \underset{\text{Copper}}{Cu} + \underset{\text{Water}}{H_2O}$$

Addition of oxygen (oxidation)

Here, copper oxide is losing oxygen, so, it is being reduced to copper. On the other hand, oxygen is being added to hydrogen, so, hydrogen is being oxidised to water.

In this reaction, both reduction and oxidation are taking place simultaneously. Thus, it is an example of a redox reaction.

7.

Substance oxidised	Substance reduced	Oxidising agent	Reducing agent
(a) H_2S	I_2	I_2	H_2S
(b) H_2	CuO	CuO	H_2

8. (a) X is a nonmetal.

(b) Oxide Y is a nonmetallic or acidic oxide.

(c) The solution produced is acidic in nature.

D. 1. True

2. False; Hydrogen sulphide is acting as an **reducing** agent.

3. False; Burning of coal is an **endothermic** reaction.

E. 1. No reaction takes place because copper is less reactive than iron. Thus, copper cannot displace iron from ferrous sulphate solution.

2. When carbon dioxide gas comes in contact with limewater, it forms a white solid substance called calcium carbonate ($CaCO_3$) which turns the solution milky.

The change can be represented as:

$$\underset{\text{Limewater}}{Ca(OH)_2(aq)} + \underset{\text{Carbon dioxide}}{CO_2(g)} \longrightarrow \underset{\substack{\text{Calcium carbonate}\\\text{(White insoluble)}}}{CaCO_3(\downarrow)} + \underset{\text{Water}}{H_2O(l)}$$

3. A mixture of alcohol and water can be separated by fractional distillation because alcohol and water have different boiling points. The boiling point of alcohol is 78°C and that of water is 100°C.

4. This is because tap water contains some dissolved salts. These tend to raise the boiling point of water above 100°C. Soluble impurities in water increase its boiling point.

F. 1. (c) **2.** (b) **3.** (d)

G. 1. (a) No.

(b) This is because copper is less reactive than iron and, therefore, it cannot displace iron from ferrous sulphate solution.

2. (a) A chemical change takes place due to which the colour of solution changes.

(b) The blue colour of copper sulphate slowly fades away and changes to green. A reddish-brown deposit is seen on the iron nail.

(c) The change in colour is observed because iron being more reactive than copper, displaces copper from $CuSO_4$ solution and forms ferrous sulphate which is green in colour.

(d)
$$\underset{\substack{\text{Copper sulphate}\\\text{(Blue)}}}{CuSO_4} + \underset{\text{Iron}}{Fe} \longrightarrow \underset{\substack{\text{Ferrous sulphate}\\\text{(Green)}}}{FeSO_4} + \underset{\text{Copper}}{Cu}$$

THINK ZONE

- This is because copper is less reactive than zinc and, therefore, it cannot displace zinc from zinc sulphate solution. So, no reaction occurs.
- No, this is because both plastic and wood do not conduct electricity.

CHAPTER 7. Hydrogen

Check Point

1. H_2
2. Hydrogen
3. Water, nitric acid, sodium hydroxide and methane
4. When an electric current is passed through acidified water, it splits up into hydrogen gas and oxygen gas.
5. Sodium and potassium react violently with water.

TEST YOURSELF

A. **1.** Hydrogen **2.** H_2 **3.** free **4.** electrolysis **5.** Hydrogen sulphide **6.** sodium hydroxide, hydrogen gas **7.** ammonia **8.** hydrides **9.** pop **10.** extraction of metals

B. **1.** The molecular formula of hydrogen means that two atoms of hydrogen combine with each other to form H_2 molecule.

2. Hydrogen is the third most abundant element on the earth's surface. In free state, on the earth, it occurs in traces mainly in volcanic gas. However, outside the earth, hydrogen is the most common element in the universe. The sun and other bright stars are mainly composed of hydrogen. Hydrogen gas occurs in them in the free state.

Hydrogen gas occurs mostly in the combined state on the earth. In fact, it is an important constituent of several compounds, i.e., water (H_2O), nitric acid (HNO_3), sulphuric acid (H_2SO_4), hydrochloric acid (HCl), acetic acid (CH_3COOH), etc.

3. Some physical properties of hydrogen are as follows:
- Hydrogen is the lightest known element.
- It is a colourless, tasteless and odourless gas.
- It is sparingly soluble in water.
- It cannot be easily liquefied.
- It is easily absorbable in metals like platinum and palladium.

4. The four chemical properties of hydrogen are as follows:

(a) Hydrogen gas is neutral, i.e., it is neither acidic nor basic in nature. It has no effect on litmus paper.

(b) In diffused sunlight, equal volumes of hydrogen and chlorine gases combine to form hydrogen chloride gas.

$$\underset{\text{Hydrogen gas}}{H_2} + \underset{\text{Chlorine gas}}{Cl_2} \xrightarrow{\text{Sunlight}} \underset{\text{Hydrogen chloride gas}}{2HCl}$$

In direct sunlight, the above reaction becomes explosive.

(c) Hydrogen gas reacts with nitrogen gas to form ammonia gas. The reaction takes place in the presence of iron (a catalyst).

$$\underset{\text{Hydrogen gas}}{3H_2} + \underset{\text{Nitrogen gas}}{N_2} \overset{\text{Fe}}{\rightleftharpoons} \underset{\text{Ammonia gas}}{2NH_3}$$

(d) On heating, hydrogen gas combines with sulphur to form hydrogen sulphide gas. This gas smells like rotten eggs.

$$\underset{\text{Hydrogen gas}}{H_2} + \underset{\text{Sulphur}}{S} \xrightarrow{\text{Heat}} \underset{\text{Hydrogen sulphide gas}}{H_2S}$$

5. In laboratory, hydrogen gas is prepared by the action of dilute sulphuric acid on zinc granules. The reaction is as follows:

$$\underset{\text{Zinc granules}}{Zn} + \underset{\text{dil. sulphuric acid}}{H_2SO_4} \longrightarrow \underset{\text{Zinc sulphate}}{ZnSO_4} + \underset{\text{Hydrogen gas}}{H_2}$$

6. Test for Hydrogen: Bring a burning matchstick near the mouth of the gas jar filled with hydrogen. The matchstick extinguishes and a 'pop' sound is heard. This shows that the gas filled in the gas jar is hydrogen.

7. Any substance that removes oxygen from another substance or supplies hydrogen to it is called a reducing agent.

Yes, hydrogen is a reducing agent.

8. Hydrogenation is a process in which unsaturated organic compounds combine with hydrogen to form saturated organic compounds.

9. In diffused sunlight, equal volumes of hydrogen and chlorine gases combine to form white fumes of hydrogen chloride gas.

$$\underset{\substack{\text{Hydrogen}\\\text{gas}}}{H_2} + \underset{\substack{\text{Chlorine}\\\text{gas}}}{Cl_2} \xrightarrow{\text{Sunlight}} \underset{\substack{\text{Hydrogen}\\\text{chloride gas}}}{2HCl}$$

10. Neither red litmus paper nor blue litmus paper show any colour change with hydrogen gas. This shows that hydrogen gas is neutral, i.e., it is neither acidic nor basic.

11. Haber's Process is used to manufacture ammonia gas commercially.

12. The four uses of hydrogen are as follows:

- Hydrogen is used in the manufacture of ammonia gas.
- Vegetable *ghee* is made from vegetable oils by the addition of hydrogen, i.e., by the process of hydrogenation.
- Hydrogen is used in the manufacture of various chemicals like methyl alcohol, hydrochloric acid, synthetic petrol, etc.
- Hydrogen is used in breaking crude oil to get gasoline (petrol), fuel oil, etc.

13. Hydrogen is considered to be a clean fuel because on burning, it produces only water.

14.

Substance oxidised	Substance reduced	Oxidising agent	Reducing agent
(a) H_2	CuO	CuO	H_2
(b) H_2	Fe_3O_4	Fe_3O_4	H_2
(c) Al	Fe_2O_3	Fe_2O_3	Al

C. 1. $Zn + H_2O \longrightarrow ZnO + H_2$

2. $Mg + 2HCl \longrightarrow MgCl_2 + H_2$

3. $2Na + 2H_2O \longrightarrow 2NaOH + H_2$

4. $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$

5. $Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

6. $3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$

7. $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$

8. $Ca + H_2 \longrightarrow CaH_2$

D. 1. False; A single hydrogen atom **cannot** exist on its own.

2. True

3. False; Pure hydrogen burns with a **blue** flame to form steam.

4. True

5. False; Hydrogen is **used** in the manufacture of chemicals.

E. 1. A mixture of liquid oxygen and liquid hydrogen produces tremendous amount of energy. That is why, hydrogen is used as a fuel in space rockets.

2. Hydrogen is used to weld metals because it releases a large amount of heat energy which is required to weld metals.

3. This is done to convert vegetable oils into vegetable *ghee* on commercial scale by the process of hydrogenation.

$$\text{Vegetable oil} + \text{hydrogen} \xrightarrow{\text{Ni}} \text{Vegetable } \textit{ghee}$$

F. 1. When an electric current is passed through acidified water, it splits up into hydrogen gas and oxygen gas.

$$2H_2O \xrightarrow{\text{Electricity}} 2H_2 + O_2$$

2. Zinc reacts with steam to produce hydrogen gas.

$$Zn + H_2O \longrightarrow ZnO + H_2$$

3. Hydrogen combines with calcium to form calcium hydride.

$$Ca + H_2 \longrightarrow CaH_2$$

4. Hydrogen is added to vegetable oil to produce vegetable *ghee*.

$$\text{Vegetable oil} + \text{Hydrogen} \xrightarrow{\text{Ni}} \text{Vegetable } \textit{ghee}$$

5. When a burning matchstick is brought near the mouth of a gas jar filled with hydrogen gas, the matchstick extinguishes and a 'pop' sound is heard.

G. 1. (c) **2.** (d) **3.** (c) **4.** (d) **5.** (a)

H. 1. (a) Hydrogen gas

(b) Because delivery tube is dipped in dil. H_2SO_4 due to which gas produced during the reaction is not able to enter it.

THINK ZONE

- Hydrogen gas is collected by downward displacement of water as it is lighter than water and sparingly soluble in water.
- This is because hydrogen is lighter than air and helps the weather balloons to float. The balloons can rise high in the atmosphere.

CHAPTER 8. Water

Check Point 1

1. increases **2.** cooled **3.** colloidal **4.** true solution

Check Point 2

1. The fixed number of loosely bound water molecules present per molecule of some compounds (salts) is called water of crystallisation.

2. Water of crystallisation can easily be removed on heating because water molecules are loosely bound.

3. Displacement reaction.
4. The substances which absorb moisture from their surroundings but their physical state remains the same are called hygroscopic substances, e.g., sodium hydroxide, etc.
5. Calcium chloride.

Check Point 3

1. The water which lathers easily with a soap is called soft water, e.g., distilled water.
2. The salts of calcium and magnesium when dissolved in water cause hardness of water.
3. Temporary hardness of water can be removed by boiling.
4. The minerals like calcium and magnesium present in hard water are good for the formation of healthy teeth and bones.

TEST YOURSELF

A. **1.** 100, 0 **2.** poor **3.** universal **4.** Temporary
5. hydrogen, oxygen **6.** hard

B. **1.** Rainwater
2. Washing soda
3. Water table

C. **1.** A solvent which dissolves many substances in it, is called a universal solvent.
2. The substance which absorbs moisture from its surroundings is called hygroscopic substance, e.g., sodium hydroxide.
3. The compounds having fixed number of water molecules loosely bound per molecule of it are called hydrated salts, e.g., magnesium sulphate ($MgSO_4.7H_2O$).
4. The substance which dissolves the other substance in it is called solvent, e.g., water.
5. The substance which gets dissolved in water or another substance is called solute, e.g., sugar.

D. **1.** Differences between hard water and soft water

Hard water	Soft water
1. Hard water does not lather readily with a soap.	1. Soft water lathers readily with a soap.
2. It contains dissolved chlorides, sulphates or bicarbonates of calcium and magnesium in it.	2. It does not contain chlorides, sulphates or bicarbonates of calcium and magnesium in it.
3. River water and sea water are examples of hard water.	3. Distilled water is an example of soft water.

2. Differences between temporary hardness and permanent hardness

Temporary hardness	Permanent hardness
1. Temporary hardness is caused due to the presence of dissolved bicarbonates of calcium and magnesium in water, i.e., calcium bicarbonate [$Ca(HCO_3)_2$] and magnesium bicarbonate [$Mg(HCO_3)_2$].	1. Permanent hardness is caused due to the presence of dissolved chlorides and sulphates of calcium and magnesium in water, i.e., calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$), calcium sulphate ($CaSO_4$) and magnesium sulphate ($MgSO_4$).
2. It can be removed both by boiling and by adding washing soda.	2. It cannot be removed by boiling but can be removed by adding washing soda (Na_2CO_3).

3.

Colloidal solution	Suspension
A heterogeneous solution in which the solute particles are neither dissolved nor settled down is called colloidal solution, e.g., starch in water.	A heterogeneous solution in which the solute particles are large and insoluble in the solvent is called a suspension, e.g., muddy water.

4.

Saturated solution	Unsaturated solution
A solution which cannot dissolve more amount of the solute at a given temperature is called a saturated solution.	A solution in which more solute can be dissolved at a given temperature is called an unsaturated solution.

E. 1. Rainwater, surface water (as snow, river water and sea water) and groundwater are different sources of water.

2. Water is a compound made up of two elements hydrogen and oxygen.

3. The four physical properties of water are as follows:

- Water is a good solvent.
- It is tasteless, transparent, colourless and odourless.
- It has a density equal to 1 g cm^{-3}.
- It does not conduct electricity.

4. The hardness of water is caused due to the presence of certain dissolved salts of calcium and magnesium in water. These salts are calcium sulphate ($CaSO_4$), magnesium sulphate ($MgSO_4$), calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$), calcium bicarbonate [$Ca(HCO_3)_2$] and magnesium bicarbonate [$Mg(HCO_3)_2$].

5. The hardness of water can be removed by following processes:

Removal of temporary hardness by boiling: Temporary hardness caused due to dissolved calcium bicarbonate and magnesium bicarbonate can be removed by boiling. This happens because on heating for some time, soluble calcium bicarbonate and magnesium bicarbonate salts present in water decompose to form calcium carbonate and magnesium carbonate respectively. These carbonates are insoluble in water and are then separated by filtration.

Removal of temporary and permanent hardness by adding washing soda: Washing soda (sodium carbonate, Na_2CO_3) is used to remove both types of hardness, i.e., temporary as well as permanent hardness. Washing soda reacts with calcium and magnesium salts present in hard water to form insoluble carbonates of calcium and magnesium which are then removed by filtration.

6. The disadvantages of hard water are as follows:

(a) Hard water is unfit for drinking purpose as it upsets stomach.

(b) It is unfit for washing clothes or bathing as it forms sticky scum rather than lather which gets settled on the clothes.

(c) If hard water is used in boilers, it forms a hard deposit on the inner wall of the boiler which reduces its efficiency.

7. (a) **Reaction between sodium and water:** Sodium reacts vigorously with water to form a clear solution of sodium hydroxide. Hydrogen gas is also produced in this reaction.

$$\underset{\text{Sodium}}{2Na} + \underset{\text{Water}}{2H_2O} \longrightarrow \underset{\substack{\text{Sodium}\\\text{hydroxide}}}{2NaOH} + \underset{\text{Hydrogen}}{H_2}$$

(b) **Reaction between magnesium and water:** Magnesium reacts with water to form magnesium oxide and hydrogen gas.

$$\underset{\text{Magnesium}}{Mg} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Magnesium oxide}}{MgO} + \underset{\text{Hydrogen}}{H_2}$$

(c) **Reaction between magnesium oxide and water:** Magnesium oxide reacts with water to form magnesium hydroxide.

$$\underset{\substack{\text{Magnesium}\\\text{oxide}}}{MgO} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\substack{\text{Magnesium}\\\text{hydroxide (alkali)}}}{Mg(OH)_2}$$

(e) **Reaction between calcium oxide and water:** Calcium oxide dissolves in water to form calcium hydroxide.

$$\underset{\text{Calcium oxide}}{CaO} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Calcium hydroxide}}{Ca(OH)_2}$$

F. 1. False; All the **insoluble** solid impurities settle down at the bottom of the sedimentation tank.

2. False; **Calcium** and magnesium salts make the water hard.

3. False; **Soft** water is fit for washing.
4. True
5. True

G. 1. Sea water is saline because the river water flowing into seas brings lots of salts with it. These salts remain dissolved in sea water and make it saline.

2. Water is called a universal solvent because it dissolves many substances in it.

3. Temporary hardness of water can be removed by boiling because on heating salts of calcium and magnesium bicarbonates for some time, they decompose to form calcium carbonate and magnesium carbonate respectively. These carbonates are insoluble in water and are then separated by filtration.

4. When clothes are washed in hard water, the calcium and magnesium salts react with soap which result in the formation of a dirty white curdy precipitate called scum that makes washing difficult. This results in the wastage of lots of water. Also, the washed clothes appear dull due to the formation of scum.

H. 1. (b) **2.** (b) **3.** (a) **4.** (a) **5.** (b)

I. 1. Egg albumin in water
2. Calcium and magnesium bicarbonate in water
3. Boiling
4. Copper sulphate

J. 1. $2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(l) + H_2(g)$
2. $Mg + H_2O \longrightarrow MgO + H_2$

THINK ZONE

- Oilspill in seas can cause a major damage to marine ecosystems. Oilspills are harmful to fish, which when exposed to oil may experience reduced growth, changes in respiration rate. It also affects survival of eggs and larvae.

CHAPTER 9. Carbon and Its Compounds

Check Point 1

1. The self-linking property of carbon atoms to form long chains is called **catenation.**

2. Diamond and graphite are **crystalline** forms of carbon.

3. Compounds made of only carbon and hydrogen are called **hydrocarbons.**
4. **Diamond** is the hardest natural substance.

Check Point 2

1. Coke, coal gas, ammoniacal liquor and coal tar

2. Wood charcoal **3.** Lamp black **4.** Sugar charcoal and water

Check Point 3

1. combustion **2.** kJ/kg **3.** ignition **4.** transport

Check Point 4

1. Carbon monoxide **2.** Carbon dioxide **3.** Na_2CO_3 **4.** Soluble
5. Red

<u>TEST YOURSELF</u>

A. 1. Methane **2.** crystalline **3.** four **4.** high **5.** graphite
6. amorphous **7.** carbon dioxide **8.** milky **9.** carbon dioxide
10. calorific value **11.** coke, coal gas, ammoniacal liquor, coal tar
12. shoe polish **13.** methane **14.** Compressed Natural Gas
15. calorific value **18.** ignition temperature

B. 1. The self-linking property of carbon atoms to form long chains is called catenation.

2. Allotropy is the phenomenon of existence of an element in more than one forms in the same physical state.

3. The process of strongly heating a substance in the absence of air is called destructive distillation.

4. Combustion is a chemical reaction in which a substance reacts with oxygen present in the air to produce heat and light.

5. Organic compounds containing carbon and hydrogen only are called hydrocarbons.

6. A fuel is a substance that can burn in the presence of air to produce heat energy.

C. 1. Differences between crystalline and noncrystalline forms of carbon:

Crystalline form of carbon	Noncrystalline form of carbon
● In crystalline form, carbon atoms are arranged in a systematic manner.	● In noncrystalline form, carbon atoms are not arranged in any systematic manner, i.e., they are arranged haphazardly.
● Diamond, graphite and fullerenes are crystalline forms of carbon.	● Coal, charcoal and coke are noncrystalline forms of carbon.

2. Differences between diamond and graphite:

Property	Diamond	Graphite
Colour	Transparent	Greyish-black
Texture	Very hard	Soft and slippery
Density	Very high (3.5 g/cm^3)	Lower than diamond (2.2 g/cm^3)
Heat conduction	Poor conductor of heat	Good conductor of heat
Electricity conduction	Poor conductor of electricity	Good conductor of electricity
Shape of crystals	Tetrahedral three dimensional structure	Hexagonal two dimensional sheet-like structure

D. 1. In nature, carbon occurs in combined state in many rocks and minerals as carbonates. Limestone, marble and chalk are examples of carbonates. Fuels like compressed natural gas (CNG), coal, petroleum, etc., are made up of carbon compounds.

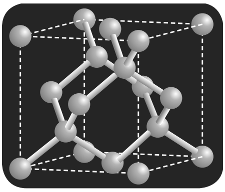
All living organisms, i.e., plants and animals, are made up of carbohydrates, fats, proteins and vitamins. These all are compounds of carbon.

2. Diamond, graphite and fullerenes are crystalline forms of carbon while coal, charcoal, lamp black and coke are noncrystalline or amorphous forms of carbon.

3. The three physical properties of diamond are given below:

- Diamond is very hard. It is the hardest naturally occurring substance.
- It is transparent and it sparkles in light.
- It is a poor conductor of heat and electricity.

4. In diamond, each carbon atom is joined (bonded) to four other carbon atoms by strong bonds. The four carbon atoms lie at the four corners of a tetrahedron. This tetrahedral arrangement of carbon atoms results in a rigid, three-dimensional structure of diamond.

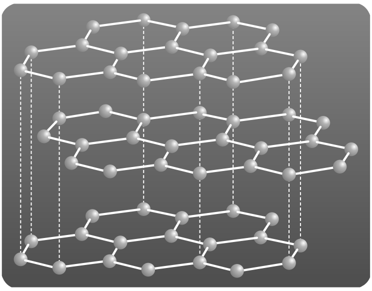

Structure of diamond

5. Three uses of diamond are as follows:

- Diamond is used as a tool for cutting glass and drilling rocks.
- It is used in making high precision thermometers.
- It is used by eye surgeons to remove cataract from eye with great precision (accuracy).

6. In graphite, carbon atoms are arranged in parallel layers which can easily slide over each other.

In each layer, carbon atoms are arranged in hexagons. Within each layer, each carbon atom is joined (bonded) to three other carbon atoms very strongly. However, carbon atoms bonded to adjacent layers are held together by weak forces. That is why, the different layers can slide over each other.



Structure of graphite

7. The three physical properties of graphite are as follows:

- Graphite is soft, opaque and slippery.
- It is greyish-black in colour.
- It is a good conductor of heat and electricity.

8. The three uses of graphite are as follows:

- Graphite is used to make pencil lead.
- It is used as a lubricant.
- It is used for making electrodes.

9. When coal burns, it produces carbon dioxide, nitrogen dioxide and a lot of smoke.

10. When carbon is treated with ferric oxide, iron and carbon monoxide are formed.

$$\underset{\text{Ferric oxide}}{Fe_2O_3} + \underset{\substack{\text{Carbon}\\\text{(Wood charcoal)}}}{3C} \longrightarrow \underset{\text{Iron}}{2Fe} + \underset{\substack{\text{Carbon}\\\text{monoxide}}}{3CO}$$

11. To show that wood charcoal adsorbs colour from some substances, add charcoal to a solution containing brown sugar and water in a test tube. Boil the solution for some time and filter it. The colour of the solution gets removed and the solution becomes colourless.

12. (a) Two uses of lamp black are as follows:

- Lamp black is used in making black paint.
- It is used in rubber industry.

(b) Two uses of animal charcoal are as follows:

- Animal charcoal is used as a decolourising agent in sugar industry to remove brown colour of sugarcane juice.
- It is used in the removal of coloured impurities from solutions.

13. A fuel is a substance that can burn in the presence of air to produce heat energy.

The characteristics of a good fuel are as follows:

- A good fuel is easy to store and transport.
- It is not expensive.
- It is readily available.
- It neither produces harmful gases on burning nor leaves behind any ash.
- A good fuel has a high calorific value, i.e., it should produce a large amount of heat on burning.
- It burns safely and is readily combustible.
- Its ignition temperature is above the room temperature.

14. (a) Solid fuels : Coal and wood

(b) Liquid fuels : Petrol and kerosene

(c) Gaseous fuels : Natural gas and biogas

15. Four different types of coal are anthracite, bituminous, lignite and peat. Their carbon percentages are given in the following table:

Types of coal	Carbon percentage
Anthracite	94–98%
Bituminous	65–70%
Lignite	38–40%
Peat	30%

16. Two uses of coke are as follows:

(a) Coke is used in the extraction of metals like iron.

(b) It is used in the preparation of fuel gases like producer gas and water gas.

17. Water is one of the most common fire extinguishing agents used. It works by removing heat and oxygen from the fire triangle. It reduces the temperature of combustible substance below its ignition temperature. Water vapours surround the combustible material. This results in cutting off the air supply and causing the fire to extinguish.

18. Carbon dioxide gas is a very good fire extinguisher. It works by taking away oxygen and heat from the fire.

Carbon dioxide gas is a nonflammable gas and is heavier than oxygen. It, therefore, covers the fire like a blanket. This results in cutting off the contact between the combustible substance and oxygen. Carbon dioxide also works by cooling the combustible substance below its ignition temperature. Thus, the fire gets controlled.

19. Two methods of preparation of carbon dioxide gas are as follows:

(a) Charcoal burns in the presence of oxygen to produce carbon dioxide gas.

$$\underset{\text{(Charcoal)}}{\underset{\text{Carbon}}{C}} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{dioxide}}{\underset{\text{Carbon}}{CO_2}} + \text{Heat} + \text{Light}$$

(b) Methane (CH_4) burns in oxygen to produce carbon dioxide gas and water.

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

20. (a) Carbon dioxide gas reacts with sodium hydroxide to form sodium carbonate and water.

$$\underset{\text{dioxide}}{\underset{\text{Carbon}}{CO_2}} + \underset{\text{hydroxide}}{\underset{\text{Sodium}}{2NaOH}} \longrightarrow \underset{\text{carbonate}}{\underset{\text{Sodium}}{Na_2CO_3}} + \underset{\text{Water}}{H_2O}$$

(b) When carbon dioxide gas is passed through limewater, limewater turns milky due to the formation of insoluble calcium carbonate.

$$\underset{\text{Limewater}}{Ca(OH)_2} + \underset{\text{Carbon dioxide}}{CO_2} \longrightarrow \underset{\text{(Milky)}}{\underset{\text{Calcium carbonate}}{CaCO_3}} + \underset{\text{Water}}{H_2O}$$

E. 1. Carbon atom has a unique property of linking with other carbon atoms to form long chains. This self-linking property of carbon atoms to form long chains is called catenation. Due to catenation, a large number of carbon compounds are known.

2. In diamond, each carbon atom is joined (bonded) to four other carbon atoms by strong bonds. Therefore, diamond has no free electrons to conduct electricity. This makes diamond a nonconductor of electricity.

In graphite, each carbon atom is joined (bonded) to three other carbon atoms. So, there are free electrons in graphite due to which graphite can conduct electricity.

3. Being good conductor of electricity, graphite is used to make electrodes for dry cells, and also in electrolysis.

4. Wood charcoal is a better fuel than wood because it neither produces smoke on burning nor does it cause air pollution. Wood charcoal produces more heat on burning than an equal mass of wood whereas wood burns producing a lot of smoke causing air pollution.

5. Carbon dioxide gas is used in fire extinguishers because it is a nonflammable gas and is heavier than oxygen. It, therefore, covers the fire like a blanket. This cuts off the contact between the combustible substance and oxygen. Carbon dioxide also works by cooling the combustible substance below its ignition temperature. Thus, the fire gets controlled.

6. Charcoal is used as a decolourising agent because it adsorbs colour to remove coloured impurities from substances and in sugar industry to remove colour from crude sugar to make it white.

F. **1.** False; Stone is a **noncombustible** substance.

2. True

3. True

4. False; Water **cannot** be used to extinguish fire caused due to electrical equipments.

5. True

6. True

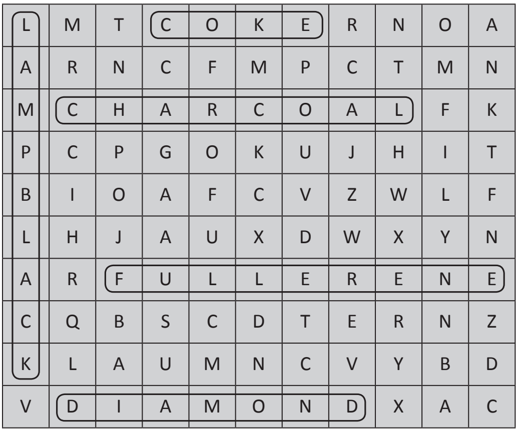
G. **1.** (b) **2.** (c) **3.** (d) **4.** (c) **5.** (d) **6.** (b) **7.** (c) **8.** (a) **9.** (d)

H. **1.** (a) Wood shavings

(b) Wood gas

(c) Combustible

I.



L	M	T	C	O	K	E	R	N	O	A
A	R	N	C	F	M	P	C	T	M	N
M	C	H	A	R	C	O	A	L	F	K
P	C	P	G	O	K	U	J	H	I	T
B	I	O	A	F	C	V	Z	W	L	F
L	H	J	A	U	X	D	W	X	Y	N
A	R	F	U	L	L	E	R	E	N	E
C	Q	B	S	C	D	T	E	R	N	Z
K	L	A	U	M	N	C	V	Y	B	D
V	D	I	A	M	O	N	D	X	A	C

1. **Lamp black** is also known as *kajal* in Hindi. It contains about 99% carbon. It can be prepared by burning wax, vegetable oils or turpentine oil in a limited supply of air. It is a greasy and black solid. It is very soft to touch and it gives an oily feel.

   Lamp black is used in making black paint and printing ink.

2. **Coke** is a very important fuel. It is greyish-black in colour with a rough texture. It contains 98% carbon.

Coke is obtained by the destructive distillation of coal. When coal is heated in the absence of oxygen (air), volatile impurities (having low melting and boiling points) and moisture get removed. The solid left behind is coke.

Coke a smokeless fuel, is used in the extraction of metals like iron, in the preparation of fuel gases like producer gas and water gas.

3. **Charcoal** is an impure form of carbon. It is prepared by heating carbon compounds in the absence of air. Depending upon the source, charcoal is classified as wood charcoal, sugar charcoal and animal charcoal. Wood charcoal is a black-coloured solid. It is soft, porous and brittle. It adsorbs poisonous gases. Sugar charcoal is the purest form of amorphous carbon. Animal charcoal is highly porous and a good adsorbent. It contains 10–12% carbon. Animal charcoal is prepared by the destructive distillation of animal bones, i.e., by strongly heating animal bones in the absence of air. Animal charcoal, therefore, is also called bone charcoal.
4. **Fullerenes** are crystalline form of carbon. These contain a large number of carbon atoms, ranging from 60 to 350.
5. **Diamond** is the purest crystalline form of carbon. It is the hardest natural substance found. It is clear and it sparkles in light. Diamond is used in making jewellery, cutting and drilling tools, precision thermometers, etc.

THINK ZONE

- Diamonds are used as a tool for cutting glass and drilling rocks because diamond is the hardest known substance. All diamonds are not suitable for making jewellery and are instead used for other industrial purposes.
- Diamond is used for making protective windows for space satellites because it is the hardest known substance. It cannot be scratched or cut by a passing meteor or other space debris.