13 CARBON — AN IMPORTANT ELEMENT

CHAPTER ROADMAP

13.1 Carbon – occurrence, properties, allotropes
13.2 Hydrocarbon
13.3 Carbon dioxide – occurrence, properties, uses
13.4 Methane – occurrence, properties, uses

QUICK–RECALL QUESTIONS & ANSWERS

Can you recall? (Textbook page 138)

(1) What is an element? What are the different types of elements?

Ans. A substance that cannot be broken down into simpler substances by any chemical reaction is called an element. Elements are of three types—metals, non-metals and metalloids.

(2) What remains behind on complete combustion of any organic compound?

Ans. On complete combustion of an organic compound, carbon dioxide and water are formed.

(3) What type of element is carbon? Give some information about it.

Ans. Carbon is a non-metallic element. It is the main constituent of all plant and animal products. In nature, it is found in the free state as well as in the combined state (in compounds).

Can you tell? (Textbook page 138)

Q. What is a compound? How are compounds formed?

Ans. A substance produced by a chemical reaction of two or more elements is called a compound. Compounds are obtained directly or indirectly from plants or animals, and they are also obtained from minerals.

OCCURRENCE OF CARBON

1. Carbon is a non-metallic element. It exists in nature in both the free and combined states. In the free state, carbon occurs as diamond and graphite.

CARBON IN COMBINED STATE

- Carbon is present in nature in the following compounds:
  (1) Carbon dioxide (CO_2)
  (2) Calcium carbonate, marble and calamine ($ZnCO_3$)
  (3) Coal, petroleum and natural gas
  (4) Carbohydrates, proteins and fats
  (5) Natural fibres such as cotton, wool and silk

ABUNDANCE OF CARBON (IN EARTH'S CRUST)

2. In the Earth's crust, carbon is present to the extent of approximately **0.27%** in the form of carbonate, coal and petroleum. The proportion of carbon in the form of carbon dioxide (CO_2) in the atmosphere is approximately **0.03%**.

ALLOTROPES OF CARBON

3. Some elements are found in nature in more than one form. They have the same chemical properties but different physical properties. Such forms are called allotropes. Carbon shows allotropy in two forms — crystalline and amorphous.

- **Crystalline allotropes of carbon:** diamond, graphite and fullerene.
- **Amorphous forms of carbon:** coal, charcoal and coke.

(i) Diamond

- Diamonds are found in India in Govalkonda (Karnataka) and Panna (Madhya Pradesh).
- In diamond, each carbon atom is linked to four other carbon atoms by covalent bonds.
- Therefore, diamond has a tetragonal (three-dimensional) structure.
- Diamond is the hardest known substance.
- The density of diamond is 3.5 g/cm^3.
- The melting point of diamond is 3500 °C.
- When it is heated at 800 °C, it gives out CO_2.

(i) Diamond (continued)

- It does not dissolve in any solvent.
- Diamond does not react with acids or alkalies.
- It is a bad conductor of electricity.
- Diamonds are used in glass-cutting and rock-drilling machines.
- It is used in ornaments.
- Diamond knives are used for eye surgery.
- In artificial satellites, diamonds are used to make windows that give protection from radiation in space.

(ii) Graphite

- In the natural state, graphite is found in Russia, New Zealand, America and India.
- In graphite, each carbon atom is bonded to three other carbon atoms in such a way that a **hexagonal layered structure** is formed.
- Thus, the regular arrangement of atoms in graphite is in layers.
- The graphite that occurs in nature is black, soft and smooth, and it is a good conductor of electricity.
- Due to the layered structure, graphite can be used for writing on paper.
- The density of graphite is **1.9 to 2.3 g/cm^3.**
- It does not dissolve in most solvents.
- Graphite is used for making lubricants and carbon electrodes.
- It is used in paints, polish and in pencils for writing.
- Graphite is used in arc lamps which give a very bright light.

(iii) Fullerene

- Fullerene, an allotrope of carbon, is rarely found in nature.
- C_{60}, C_{70}, C_{76}, C_{82} and C_{86} are other examples of fullerene found in small numbers in soot.
- Fullerene molecules are found in the form of buckyballs and buckytubes.
- These molecules are made of 30 to 900 carbon atoms.
- Fullerenes are soluble in carbon disulphide and chlorobenzene.
- Fullerenes are used as insulators.
- Fullerenes are used as a catalyst in water purification.
- Fullerenes exhibit superconductivity at a certain temperature.

4. Amorphous Forms of Carbon

- The arrangement of carbon atoms in amorphous form is not regular.
- Coal, charcoal, coke are the non-crystalline forms of carbon.
- Coal is a fossil fuel.
- The types of coal with the percentage of carbon are:

Type of Coal	Percentage of Carbon
Peat	less than 60 %
Lignite	60 % to 70 %
Bituminous coal	70 % to 90 %
Anthracite	about 95 %

- Coal is used as fuel in factories and homes.
- To obtain coke, coal gas and coal tar, coal is used.
- Coal is used in thermal power plants for generation of electricity.
- The pure coal that remains when coal gas is removed from coal is called coke.
- It is used as a reducing agent.
- Coke is used as domestic fuel.
- Coke is used in the production of water gas ($CO + H_2$) and producer gas ($CO + H_2 + CO_2 + N_2$).

5. Carbon Dioxide : Molecular Formula : CO_2, Molecular Mass 44

Occurrence

- Carbon dioxide occurs in free state in the atmosphere to the extent of about **0.03** %.
- Exhaled air contains about 4 % of CO_2.
- It is found in chalk and shahabad tiles/marble/limestone in compound form.
- In the combustion of wood and fossil fuel coal, CO_2 is given out.

Properties

- Carbon dioxide is a colourless, tasteless and odourless gas.
- It is heavier than air and sparingly soluble in water.
- Carbon dioxide neither burns nor supports burning.

Uses

- Carbon dioxide is used in the manufacture of aerated drinks, solid carbon dioxide, baking soda and washing soda.
- Liquefied CO_2 is used to remove caffeine from coffee.
- It is used in fire extinguishers.
- Liquefied CO_2 is used as a solvent in modern eco-friendly dry cleaning.
- Plants use CO_2 to make their own food.

1 Chemical Reactions of CO_2

$CO_2 + Ca(OH)_2 \longrightarrow$	$CaCO_3 + H_2O$ (Calcium carbonate)
$CO_2 + H_2O \longrightarrow$	H_2CO_3 (Carbonic acid)
$CO_2 + 2NaOH \longrightarrow$	$Na_2CO_3 + H_2O$ (Sodium carbonate)
$CO_2 + Na_2CO_3 + H_2O \longrightarrow$	$2NaHCO_3$ (Sodium bicarbonate)

$$2NaHCO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O + 2CO_2\uparrow$$
(Carbon dioxide)

2 Hydrocarbons

Definition
- Compounds consisting only of carbon and hydrogen are called hydrocarbons.

Key Points
- They are organic compounds with a basic framework of carbon atoms.
- Electronic configuration of carbon: 2,4; valency = 4.
- A carbon atom can form four covalent bonds with either carbon atoms or atoms of different elements.

3 Covalent Compounds

Definition
- Compounds in which atoms are joined by covalent bonds are called covalent compounds.

Properties
- Low melting and boiling points.
- Insoluble in water, but soluble in organic solvents.
- Poor conductors of heat and electricity.

4 Saturated and Unsaturated Hydrocarbons

- Hydrocarbons show a characteristic property: carbon atoms can combine with one another to form covalent bonds, creating chains of carbon atoms.
- These chains may have only single bonds (saturated) or may have a double or triple bond between two carbon atoms (unsaturated).

Saturated hydrocarbons	Hydrocarbons having only single bonds between carbon atoms. **Examples:** Ethane (C_2H_6), which is ($CH_3–CH_3$), propane (C_3H_8), which is ($CH_3–CH_2–CH_3$).
Unsaturated hydrocarbons	Hydrocarbons having at least one multiple bond between carbon atoms. **Examples:** Ethene (C_2H_4), which is ($CH_2=CH_2$); ethyne ($HC\equiv CH$); propene (C_3H_6), which is ($CH_3–CH=CH_2$); propyne (C_3H_4), which is ($CH_3–C\equiv CH$).

5 Properties of Hydrocarbons (General)

- Carbon atom exhibits a characteristic property (catenation): it can form a chain of carbon atoms by covalent bonds.
- Hydrocarbons can form chains, rings or more complex structures with carbon atoms.

6 Methane : Occurrence and Molecular Data

Molecular formula	CH_4
Molecular mass	16

Occurrence
- Methane occurs in natural gas to the extent of 87%.
- It is formed during the decomposition of vegetable matter in the absence of air (anaerobic conditions).
- Obtained from biogas.
- Found in coal mines.
- Present at the surface of marshy places; hence, known as marsh gas.
- In the laboratory, it can be prepared by heating a mixture of hydrogen and carbon monoxide gases at 300°C in the presence of nickel as a catalyst.
- Methane gas is also obtained by fractional distillation of natural gas.

7 Physical Properties of Methane

- Melting point: −182.5°C.
- Boiling point: −161.5°C.
- A colourless gas.
- Density lower than that of water.
- Sparingly soluble in water; highly soluble in organic solvents like gasoline, ether and alcohol.
- Gaseous at room temperature.

8 Chemical Reactions of Methane

(i) Combustion
$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + \text{Heat}$$
(Carbon dioxide)

(ii) Chlorination
$$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$$
(Methyl chloride)

9 Uses of Methane

- Used as a natural gas in fabric mills, paper mills, food processing industry and in petrol purification.
- Compared with many other fuels, methane releases a smaller proportion of CO_2 on combustion; therefore, it is used as a domestic fuel for cooking.
- Used to prepare industrially important organic compounds like ethanol, methyl chloride, methylene chloride and acetylene.

10 Biogas Plant (Begin)

- In a biogas plant, animal dung, wet garbage is decomposed by anaerobic microbes, and this process produces methane gas and carbon dioxide.

Biogas (continued)

- Biogas is a mixture of gases rich in methane (CH_4) about 55–60% and the rest mainly carbon dioxide (CO_2) about 40–45%.
- It is an inexpensive fuel, meets the demand for cooking gas and can also be used in power generation.
- It is a by-product of anaerobic (in the absence of air) decomposition of organic wastes such as cattle dung, sewage and farm residues.
- The slurry left after gas production is a nutrient-rich manure used in agriculture.

QUESTIONS & ANSWERS

Q. 1 Fill in the Blanks :

Complete the following statements by filling in the appropriate word/phrase.

1. In graphite, six carbon atoms are arranged in a ..... pattern and are at fixed distances from one another.
2. Fullerene is an ..... of carbon.
3. ..... turns lime water milky.
4. The charcoal is an ..... form of carbon.
5. Diamond is ..... of electricity.
6. Graphite is a ..... form of carbon.
7. ..... is a good conductor of heat and electricity.
8. Charcoal is ..... and hence has low density.
9. Fullerenes are used as a ..... in water purification.
10. ..... is used in the production of producer gas.
11. In the earth's crust, carbon is present to the extent of approximately ..... in the form of carbonate, coal and petroleum.
12. Hydrocarbons containing at least one multiple bond are called ..... .
13. ..... is the main element in cellular DNA and RNA.

Answer Key (Q.1)

(1) hexagon (2) allotrope (3) carbon dioxide
(4) amorphous (5) bad conductor (6) crystalline
(7) graphite (8) porous (9) catalyst
(10) coke (11) 0.27%
(12) unsaturated hydrocarbons (13) carbon

Q. 2 Choose the correct alternative and write it along with its allotted alphabet :

(1) What is the nature (property) of oxides of non-metals?
(*a*) Acidic (*b*) Basic
(*c*) Neutral (*d*) Amphoteric

(2) How is CO_2 compared with air in terms of heaviness?
(*a*) Lighter than air (*b*) Heavier than air
(*c*) Equal to air (*d*) It is not fixed

(3) Which acid is produced when CO_2 dissolves in water?
(*a*) Carbonic acid (*b*) Hydrochloric acid
(*c*) Acetic acid (*d*) Lactic acid

(4) Which of the following gases is formed when dilute hydrochloric acid is poured on pieces of chalk?
(*a*) Oxygen (*b*) Hydrogen
(*c*) Nitrogen (*d*) Carbon dioxide

(5) Which gases are present in biogas?
(*a*) CO; CH_4 (*b*) CH_4; CO_2
(*c*) CO_2; O_2 (*d*) N_2; S_2

(6) ..... is used to extinguish fires.
(*a*) CO_2 (*b*) NO_2
(*c*) SO_2 (*d*) O_2

(7) When diamond is heated at 800°C in the presence of oxygen, the gas produced is ..... .
(*a*) CO_2 (*b*) CS_2
(*c*) SO_2 (*d*) NO_2

(8) Methane burns with a ..... flame.
(*a*) yellow (*b*) lilac
(*c*) blue (*d*) green

Answer Key (Q.2–Q.8)

(3) (*a*) Carbonic acid **(4)** (*d*) Carbon dioxide
(5) (*b*) CH_4; CO_2 **(6)** (*a*) CO_2
(7) (*a*) CO_2 **(8)** (*c*) blue

* Q. 3 Select the proper option and complete the statements :

(*single, all, double, ionic,* carbon, give and take, hydrogen, multiple bond, share, organic, covalent)

(1) A carbon atom forms a ..... bond with other atoms. In this bond the two atoms ..... electrons.

Q. 3 Complete the sentences using the appropriate word(s) from the word bank.

Word bank: single, all, double, ionic, carbon, give and take, hydrogen, multiple bond, share, organic, covalent.

(1) A carbon atom forms a _____ bond with other atoms. In this bond, the two atoms _____ electrons.
(2) All carbon–carbon bonds in a saturated hydrocarbon are _____ bonds.
(3) At least one carbon–carbon bond in an unsaturated hydrocarbon is a _____.
(4) _____ is the essential element in all organic compounds.
(5) Hydrogen is present in _____ compounds.

Answers: (1) covalent; share (2) single (3) multiple bond (4) carbon (5) organic

Q. 4 State whether the following statements are True or False.

Note : Write *True* or *False* for each statement below. There is no negative marking for an incorrect answer; do not leave any statement unanswered.

(1) All plant and animal products contain carbon as their main constituent.
(2) Sulphur is a naturally occurring allotropic element.
(3) The graphite is a non-crystalline form of carbon.
(4) Fullerenes were named after the architect Richard Buckminster Fuller.
(5) The graphite found in nature is a bad conductor of heat and electricity.
(6) Charcoal is porous, therefore, it has low density.
(7) Plants make their own food by using oxygen.
(8) Methane is a natural fuel.
(9) Methane has two carbon atoms and four hydrogen atoms.
(10) Carbon dioxide is heavier than air.
(11) Diamond is the hardest natural substance.
(12) Methane occurs in natural gas to the extent of 47 %.
(13) Methane is used for the production of organic compound such as acetylene.
(14) In modern fire extinguishers, liquid or solid sodium chloride is filled under pressure.
(15) Our life is dependent on carbon compounds.

Ans. (1) True (2) True (3) False (4) True (5) False (6) True (7) False (8) True (9) False (10) True (11) True (12) False (13) True (14) False (15) True

Q. 5 Find the odd one out in each set and give the reason.

(1) Sugar, paper, cotton, sodium chloride.
Ans. Odd one – sodium chloride. (Others are organic compounds.)

(2) Anthracite, charcoal, bituminous coal, peat.
Ans. Odd one – charcoal. (Others are different types of coal.)

(3) Carbon, silicon, sulphur, phosphorus.
Ans. Odd one – silicon. (Others are natural allotropic elements.)

(4) Coke, diamond, graphite, fullerene.
Ans. Odd one – coke. (Others are crystalline allotropes of carbon.)

(5) Ethane, ethene, ethyne, propene.
Ans. Odd one – ethane. (Others are unsaturated hydrocarbons.)

(6) Methane, ethane, ethene, propane.
Ans. Odd one – ethene. (Others are saturated hydrocarbons.)

Q. 6 Match the columns.

(1)

Column I	Column II
(1) Fullerene	(a) Na_2CO_3
(2) Graphite	(b) Cutting metals
	(c) Hexagonal arrangements of atoms
	(d) C_{60}

Ans. (1) Fullerene – C_{60}
(2) Graphite – Hexagonal arrangements of atoms.

(2)

Column I	Column II
(1) Methane	(a) Amorphous form of carbon
(2) Anthracite	(b) Carbon dioxide
	(c) Marsh gas
	(d) 95 % carbon

Ans. (1) Methane – Marsh gas
(2) Anthracite – 95 % carbon.

Q.6 Matching Column (Remaining Sets)

(3) Column I	Column II
(1) Caffeine	(a) Water gas
(2) Methane in pure form	(b) Liquefied CO_2
	(c) Super conductivity
	(d) Fractional distillation

Ans. (1) Caffeine – Liquefied CO_2
(2) Methane in pure form – Fractional distillation.

(4) Column I	Column II
(1) Propane	(a) Four C – H bonds
(2) Ethene	(b) Triple bond
	(c) Single bond
	(d) Double bond

Ans. (1) Propane – Single bond
(2) Ethene – Double bond.

Q.7 Short-Answer Questions on Carbon

1 State the occurrence of carbon.

Ans.
- Carbon is a key constituent of all plants and animal products.
- It is a non-metallic element.
- In nature, carbon occurs in the free state as diamond and graphite.
- It also occurs in the combined state in many compounds.

2 In which compound forms does carbon occur?

Ans. In combined state, carbon occurs in the following forms:
- Carbon dioxide (from air),
- Carbonates such as calcium carbonate, marble and calamine ($ZnCO_3$),
- In fuels like coal, petroleum and natural gas,
- In carbonaceous nutrients such as carbohydrates, proteins and fats,
- In natural fibres like cotton, wool, silk, etc.

3 Classify carbon.

Ans. Carbon exists in two forms (allotropy): crystalline and amorphous.

1. **Crystalline form :** Carbon has three crystalline allotropes :
   (i) Diamond (ii) Graphite (iii) Fullerene
2. **Amorphous form :** Carbon has the following amorphous forms :
   (i) Coal (ii) Peat (iii) Lignite (iv) Bituminous
   (v) Anthracite (vi) Charcoal (vii) Coke

4 Explain the properties of carbon.

Ans.
- Carbon exhibits allotropy.
- It exists in more than one form.
- The chemical properties of these different forms are same but their physical properties are different.
- Carbon allotropes are of two types : crystalline and amorphous.

5 What is meant by allotrope?

Ans. Some elements are found in nature in more than one form. They have the same chemical properties but different physical properties. Such forms are called allotropes of an element.

6 Name the naturally occurring allotropic elements.

Ans. Carbon, sulphur and phosphorus are naturally occurring allotropic elements.

7 Name the hardest allotrope of carbon.

Ans. Diamond is the hardest allotrope of carbon.

8 Which allotrope of carbon is used to cut glass?

Ans. Diamond is used to cut glass.

9 What is the shape of a graphite crystal?

Ans. A graphite crystal has a hexagonal shape.

10 Which allotrope of carbon is used in ornaments?

Ans. Diamonds are used in ornaments (jewellery).

11 Which allotrope of carbon is used to make electrodes?

Ans. Graphite is used for making carbon electrodes.

12 How many forms does carbon exhibit allotropy? Give suitable examples.

Ans. Carbon shows allotropy in two forms — crystalline and amorphous.

- **Crystalline form:** atoms are arranged in a definite, ordered pattern. Examples: diamond, graphite, fullerene.
- **Amorphous form:** atoms are arranged irregularly (without long-range order). Examples: coke, coal, etc.

13 State two physical properties of crystalline carbon.

Ans. Two physical properties are:

(i) A crystalline form of carbon has a regular and definite arrangement of atoms.

(ii) It has high melting and boiling points.

14 Write any two physical properties of diamond.

Ans. (i) Pure diamond is the hardest known substance.

(ii) The density of diamond is about 3.5 g/cm^3.

15 Write any three uses of diamond.

Ans. (i) Diamonds are used in glass cutting and rock drilling machines.

(ii) It is used as a precious stone in ornaments (jewellery).

(iii) Diamond knives are used for eye surgery.

16 Write any three properties of graphite.

Ans. (i) Graphite is a naturally occurring black, soft and smooth solid.

(ii) It is a good conductor of electricity.

(iii) The density of graphite is about 1.9 to 2.3 g/cm^3.

17 Write any three uses of graphite.

Ans. (i) Graphite is used for making lubricants.

(ii) It is used for making carbon electrodes.

(iii) Graphite is used in pencils for writing on paper.

18 How will you prove experimentally that graphite is a good conductor of electricity?

Ans. Take a simple electric circuit with a battery, a bulb and copper connecting wires. Place a piece of graphite in the circuit and observe the bulb in two states as shown in Fig. 13.1.

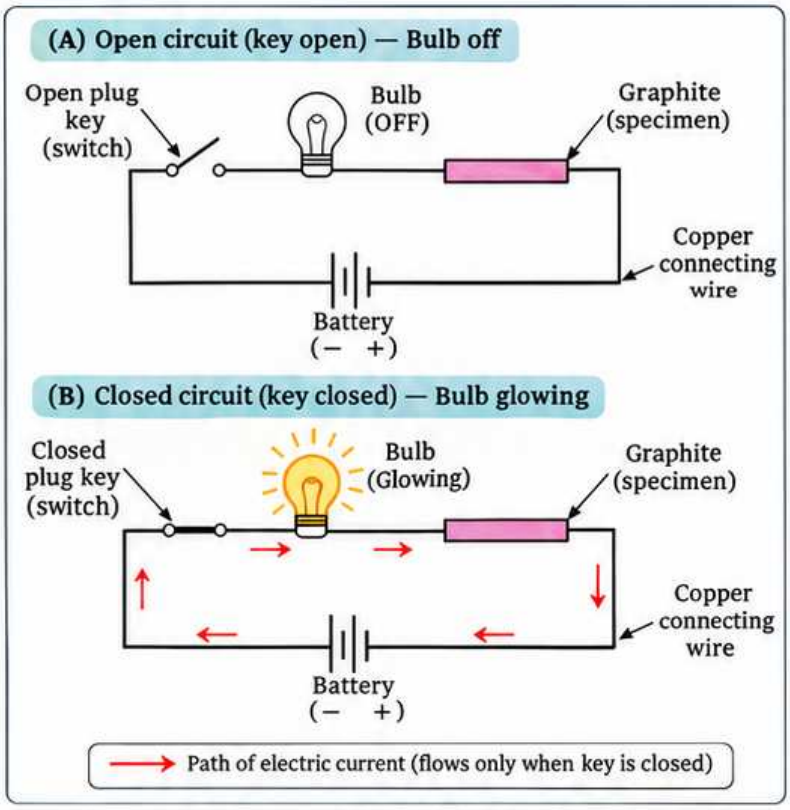


Fig. 13.1 : *Experimental* proof that graphite conducts electricity

Conclusion: When the key is open, the bulb does not glow; when the key is closed, the bulb glows. This shows that graphite is a good conductor of electricity.

19 Write any two properties of fullerene.

Ans. (i) Fullerene molecules are made up of hollow, cage-like structures of buckyballs and buckytubes.

(ii) These molecules are isolated mainly from 30 to 900 carbon atoms.

Q20 Write any two uses of fullerene.

Ans. Fullerenes are used for different purposes, such as:

(i) They act as insulators.

(ii) They are used as a catalyst in water purification.

(iii) Fullerene exhibits very high thermal conductivity at a definite temperature.

Q21 What are fossil fuels? OR Write a note on fossil fuels.

Ans. Fuels formed over millions of years from the remains of plants and animals are called fossil fuels. They contain carbon-rich compounds and are mainly produced by plants. Coal, petroleum and natural gas are examples of fossil fuels.

Q22 How did coal form in nature?

Ans. Plants and animals continuously received solar energy. Millions of years ago, their remains were buried under the earth due to the action of microorganisms and geological changes. These remains were converted into carbon compounds under high pressure and heat. After a long period, the liquid and gaseous substances in them escaped, and the left-behind material became rich in carbon, forming coal. Thus, coal is a hard, rock-like material obtained from the remains of plants.

Q23 State the types of coal with the percentage of carbon in it.

Ans. Coal is classified into four types based on the percentage of carbon it contains:

Types of coal	Percentage of carbon
(i) Anthracite	about 95
(ii) Bituminous coal	70 – 90
(iii) Lignite	60 – 70
(iv) Peat	less than 60

Q24 What are the different types of coal?

Ans. Coal is a fossil fuel. It contains carbon along with hydrogen and oxygen. It also contains nitrogen, phosphorus and sulphur in small amounts. It occurs in the solid state. Coal is classified on the basis of its carbon content into:

(i) Anthracite (about 95% of carbon), (ii) Bituminous (70 – 90% of carbon), (iii) Lignite (60 – 70% of carbon), (iv) Peat (less than 60% of carbon).

Q25 Name the hardest form of coal.

Ans. Anthracite is the hardest form of coal and contains about 95% of carbon.

Q26 What is charcoal?

Ans. Charcoal is made from animal bones and horns and also from plants (wood) by burning them in the presence of an insufficient supply of oxygen.

Q27 What is meant by coke? State two uses of coke.

Ans. Coke is the pure coal that remains after coal gas has been removed from coal.

Uses of coke:

(1) It is used as a domestic fuel.

(2) It acts as a reducing agent.

(3) It is used in the production of water gas and producer gas.

Q28 Write two physical properties of charcoal.

Ans. (i) Charcoal contains amorphous carbon and some volatile compounds.

(ii) It contains other substances in small amounts.

(iii) It burns with smoke.

Q29 Why are carbon and its compounds used as fuels?

Ans. Fuels are classified on the basis of their physical state as follows:

Physical state of fuel	Examples
Solid fuels	Wood, cellulose $(C_6H_{10}O_5)_n$, coal, carbon, coke
Liquid fuels	Kerosene, carbon, petrol, diesel, ethanol, liquefied carbon
Gaseous fuels	Methane, ethane, butane, isobutane, natural gas, water gas ($CO + H_2$), producer gas

Therefore, carbon and its compounds are used as fuels.

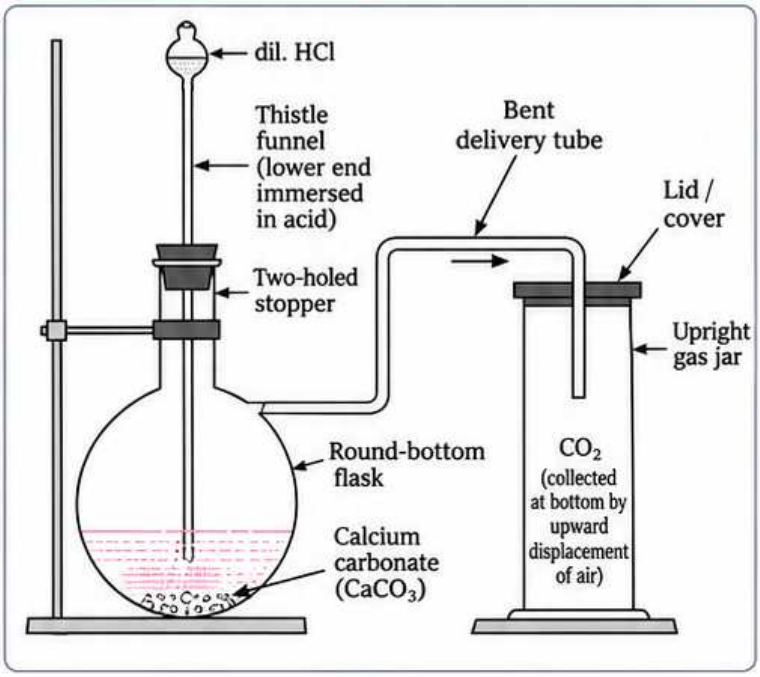
Q30 What are the various sources of carbon dioxide?

Ans. Carbon dioxide (CO_2) is present in air in a very small proportion of about 0.03%. It is released during respiration by plants and animals. It is also obtained from limestone (e.g. chalk, shahabad tiles, marble) and from burning carbonaceous materials such as wood and coal in limited supply.

Q31 How is carbon dioxide gas produced in the laboratory?

Ans. Some pieces of calcium carbonate (limestone) are placed in a round-bottom flask. Dilute hydrochloric acid is added through a thistle funnel whose lower end remains immersed in the acid. The flask is closed with a two-holed stopper carrying the thistle funnel and a bent delivery tube. The CO_2 evolved is led through the delivery tube and collected in an upright gas jar by upward displacement of air.

Laboratory preparation of CO_2



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

Steps (Paraphrased procedure)

1. A reaction occurs between calcium carbonate and hydrochloric acid to produce carbon dioxide.
2. The gas is formed gradually and is collected in four to five gas jars by upward displacement of air.
3. The collected CO_2 can be confirmed by the following:
   (a) Observe the colourless gas formed.
   (b) Smell the gas; it is odourless.
   (c) Remove the lid of a gas jar and test the gas with limewater. It turns milky (due to calcium carbonate formation).
   (d) Place a burning candle in the gas; the flame extinguishes.

Q32 Write the physical and chemical properties of carbon dioxide.

Ans.

(A) Physical properties of carbon dioxide:

- It is a colourless gas.
- It is odourless (tasteless).
- It is heavier than air.
- It is sparingly soluble in water.
- It neither burns nor supports burning.

(B) Chemical properties of carbon dioxide:

The following observations are obtained when CO_2 is passed into different substances:

Chemical properties of CO_2

Test	Observations
Burning candle	It extinguishes.
Universal indicator	–
Limewater	Turns milky white, forming calcium carbonate.
Water	Forms carbonic acid (H_2CO_3).
Blue litmus paper	Turns red.
Red litmus paper	Remains red.

The chemical reactions taking place in the above cases are:

1. $H_2O + CO_2 \rightarrow H_2CO_3$
2. $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

Q33 Write the uses of carbon dioxide.

Ans. Carbon dioxide is used for the following purposes:

1. For the manufacture of aerated drinks.
2. In solid form (dry ice) for refrigeration and cold storage.
3. In fire extinguishers (it does not support burning).
4. Because it is heavier than air, it is used for filling some balloons and for eertain other applications too.

Q34 **Name the gas used in fire extinguishers.**

Ans. Carbon dioxide (CO_2) is used as the extinguishing gas in fire extinguishers.

Q35 **Which gas is used to produce aerated beverages?**

Ans. Carbon dioxide (CO_2) is used to make aerated (drink/ soft) beverages.

Q36 **Write the reaction that takes place while extinguishing fire.**

Ans. The CO_2 in a soda–acid type fire extinguisher is produced by the reaction between sodium hydrogencarbonate and sulphuric acid:

$$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2\uparrow$$

Q37 **How will you verify the properties of carbon dioxide?**

Ans. The properties of CO_2 can be confirmed by the following tests:

(1)	**Effect on flame** :	A burning candle (or flame) is extinguished in CO_2.
(2)	**Limewater test** :	When CO_2 is passed through limewater, it turns milky due to formation of $CaCO_3$.
(3)	**Litmus test** :	Moist blue litmus paper turns red in CO_2, showing its acidic nature (due to formation of carbonic acid).

Q38 **What is meant by a saturated hydrocarbon? Give examples.**

Ans. A saturated hydrocarbon is a hydrocarbon containing only single covalent bonds between carbon atoms (i.e., no double or triple bonds).

Examples: Ethane, Propane, Methane.

Q39 **Write the properties of covalent compounds.**

Ans. Covalent compounds generally show the following characteristics:

- They have low melting and boiling points.
- They are insoluble in water.
- They are soluble in organic solvents (e.g., ether, benzene).
- They are poor conductors of heat and electricity.

Q40 **Complete the following sequence of hydrocarbons and explain the chemical bond of any one hydrocarbon.**

Ans. The sequence of hydrocarbons (alkanes) is:

$$CH_4 \rightarrow C_2H_6 \rightarrow C_3H_8 \rightarrow C_4H_{10} \rightarrow C_5H_{12}$$

Chemical bond (e.g., in CH_4): In methane (CH_4), the carbon atom forms four covalent (single) bonds—one with each of four hydrogen atoms.

Q41 **What is meant by an unsaturated hydrocarbon? Give examples.**

Ans. An unsaturated hydrocarbon is a hydrocarbon that contains at least one multiple bond between carbon atoms (i.e., a double bond or a triple bond).

Examples: Propene, Ethyne, Propyne.

Q42 **Classify the following compounds into saturated and unsaturated hydrocarbons:**
$(CH_3 - CH_3)$, $(CH_2 = CH_2)$, $(CH_3 - C \equiv CH)$.

Ans.

Saturated hydrocarbons (only single bonds)	**Unsaturated hydrocarbons** (with double/triple bond)
$CH_3 - CH_3$ (Ethane)	$CH_2 = CH_2$ (Ethene)
	$CH_3 - C \equiv CH$ (Propyne)

Q43 **What is meant by a covalent bond?**

Ans. A covalent bond is a chemical bond formed by the sharing of one or more pairs of electrons between two atoms.

Q44 **Write the meaning of unsaturated hydrocarbons and give examples.**

Ans. An unsaturated hydrocarbon is a hydrocarbon containing one or more multiple bonds between carbon atoms (double or triple bonds).

Examples: Propene, Ethyne, Propyne.

Q.45 Write the molecular formula of methane.

Ans. The molecular formula of methane is CH_4.

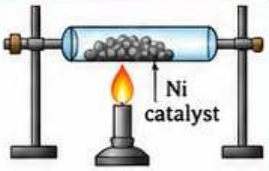
Q.46 How many atoms of carbon and hydrogen are present in a molecule of methane?

Ans. A molecule of methane contains one carbon atom and four hydrogen atoms (CH_4).

Q.47 How is methane gas prepared in the laboratory?

Ans. Methane is obtained by heating a mixture of hydrogen and carbon monoxide at 300 °C in the presence of a nickel (Ni) catalyst.

$$H_2 + CO \xrightarrow[300\ °C]{Ni\ (catalyst)} CH_4$$



Q.48 What are the various sources of methane?

Ans. Methane is found from several sources:

- **Major source:** It is a component of **natural gas** to the extent of about 87%.
- **Formation:** It is produced by the **anaerobic** decomposition of organic matter in the absence of air.
- **Other sources:** It is present in biogas, gobar gas and coal gas.
- **Occurrence:** It is found in **coal mines**, and is also known as **marsh gas** because it occurs at the surface of marshy places.

Q.49 State the properties of methane.

Ans. Important properties of methane are:

- Melting point = −182.5 °C.
- Boiling point = −161.5 °C.
- It is a colourless gas.
- The density of liquid methane is less than that of water.
- It is sparingly soluble in water but highly soluble in organic solvents such as gasoline, ether and alcohol.
- At room temperature, methane exists in the gaseous state.

m.p. = −182.5 °C
b.p. = −161.5 °C

Q.50 State the uses of methane.

Ans. Methane has several important uses:

- It is a natural gas used in fabric mills, paper mills, food processing industries and in the purification of petrol.
- Because its combustion releases a smaller amount of CO_2 than that of water (i.e., compared with many other fuels), it is used as a domestic fuel for cooking.
- It is used for the manufacture of important organic compounds such as ethanol (C_2H_5OH), methyl chloride (CH_3Cl), methylene chloride (CH_2Cl_2) and acetylene (C_2H_2).


Domestic cooking fuel


Fabric, paper & food industries

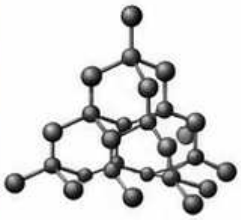

Petrol purification

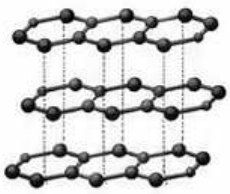

Manufacture of ethanol, CH_3Cl, CH_2Cl_2 & C_2H_2

Q.8 Explain the following :

(1) Why are diamond, graphite and fullerenes crystalline forms of carbon?

Ans. (1) A crystalline form of carbon has a regular and definite arrangement of atoms. (2) In diamond, each carbon atom is linked to four other carbon atoms by covalent bonds in a three-dimensional (tetrahedral) structure. (3) In graphite, each carbon atom is bonded to three other carbon atoms in such a way that a hexagonal layered structure is formed. (4) In fullerene, e.g., C_{60}, the carbon atoms are joined to each other in pentagonal and hexagonal rings to form a cage-like (buckyball) structure. As a result, diamond, graphite and fullerene are crystalline forms of carbon.


Diamond (tetrahedral 3D)


Graphite (hexagonal layers)


Fullerene, C_{60} (buckyball with pentagons and hexagons)

(2) Why is methane called marsh gas?

Ans. Methane is formed by the decomposition of plants and animal matter at the surface of marshy lands. Hence, methane is called marsh gas.

(3) Why are petrol, diesel and coal known as fossil fuels?

Ans. Millions of years ago, the remains of plants and animals got buried under the earth. Due to the action of microorganisms, the gaseous substances in these remains were released into the atmosphere and the rest was converted, under tremendous pressure, into liquid and solid substances. Over a long period of time, the liquid part gave rise to petroleum (yielding petrol and diesel on fractional distillation) and the solid part formed coal. Hence, petrol, diesel and coal are called fossil fuels.

(4) What are the uses of various allotropes of carbon?

Ans. Refer to *Q.7 (15), (17), (20) and (24).*

(5) Why is CO_2 used in fire extinguisher?

Ans. Carbon dioxide neither burns nor supports burning. (1) It is not poisonous. (2) It is heavier

than air. When CO_2 is discharged on a burning object, it spreads over it, covers the surface and cuts off its contact with air. As a result, the fire is extinguished. Therefore, carbon dioxide is used in fire extinguishers for putting out fires.

(6) Practical Uses of CO_2

1. **Aerated drinks :** Carbon dioxide is used in the manufacture of aerated drinks.
2. **Solid carbon dioxide (dry ice) :** CO_2 is converted into solid form for cold storage, and it also helps to keep milk and milk products and other frozen substances cool during transport.
3. **Special effects :** It is used to create a mist in dramas and movies.
4. **Fire extinguishers :** CO_2 obtained by chemical reaction or kept under pressure is used in fire extinguishers.
5. **Decaffeination :** Liquefied CO_2 is used to remove caffeine from coffee.
6. **Dry cleaning :** Liquefied CO_2 is used as a solvent in dry cleaning.

How CO_2 Works in a Fire Extinguisher ?



CO_2 is stored in a cylinder under high pressure. When released, it expands rapidly and, being heavier than air, spreads over the burning material. It blankets the fire and separates it from air (oxygen), so the fire goes out.

Q. 9 Write short notes on :

(1) Diamond (2) Graphite (3) Fullerene (4) Coal (5) Coke (6) Fire extinguisher (7) Biogas plant (8) Methane structure formula.

(1) Diamond

- **Occurrence :** Diamonds are found in India in Govalkonda (Karnataka) and Panna (Madhya Pradesh).
- **Structure :** Each carbon atom in diamond is joined to four other carbon atoms by covalent bonds. The arrangement is tetrahedral, so diamond has a three-dimensional network structure.

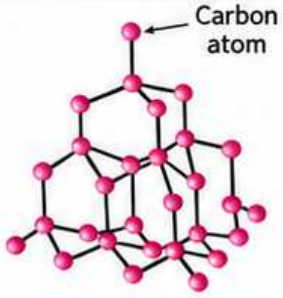


Fig. 13.3 : Diamond – 3D tetrahedral network of carbon atoms

- **Properties :**
  - It is the hardest known substance.
  - Its density is 3.5 g/cm³.
  - Its melting point is 3500 °C.
  - On heating to 800 °C, it gives CO_2.
  - It is insoluble in any solvent.
  - It does not react with acids or alkalis.
  - It is a bad conductor of electricity.
- **Uses :**
  - It is used in glass cutting and rock drilling machines.
  - Diamond knives are used in eye surgery.
  - It is used in artificial satellites.
  - Diamonds are used to make windows that protect from radiation in space.

(2) Graphite

- **Occurrence :** In the natural state, graphite is found in Russia, New Zealand, America and India.

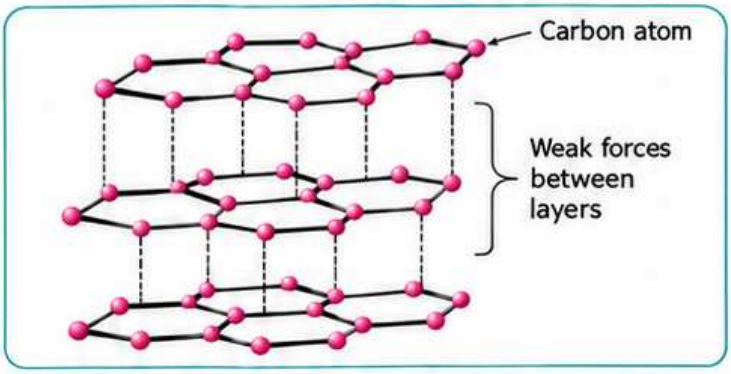


Fig. 13.4 : Graphite – layered hexagonal structure of carbon atoms

- **Structure :** In graphite, each carbon atom is bonded to three other carbon atoms in such a manner that hexagonal layers are formed. The atoms are arranged regularly within each layer, and graphite has a layered structure.
- **Properties :**
  - It is black, soft and smooth in nature.
  - It is a good conductor of electricity.
  - Its density is 1.9 to 2.3 g/cm³.
  - It does not dissolve in most solvents.
- **Uses :**
  - It is used for making lubricants and carbon electrodes.
  - It is used in paints, polish and in pencils for writing.
  - It is used in arc lamps, which give a very bright light.

(3) Fullerene



Fig. 13.5 : Fullerene – C_{60} (Buckyball)

- **Fullerene :** Fullerene is an allotrope of carbon that is rarely found in nature. C_{60}, C_{70}, C_{76}, C_{82} and C_{86} are other examples of fullerene found in small numbers in soot.
- **Structure :** In fullerene, C_{60} atoms are joined to each other in pentagonal and hexagonal arrangements.

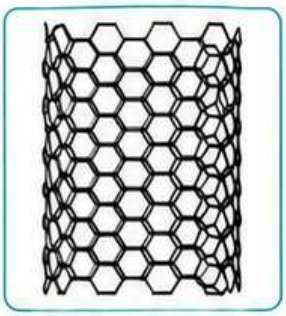


Fig. 13.6 : Buckytube (carbon nanotube)

- Thus, the structure of fullerene is like a football.
- The fullerene molecules are found in the form of buckyballs and buckytubes.
- These molecules are made of 30 to 900 carbon atoms.
- Fullerenes are soluble in carbon disulphide and chlorobenzene.
- Fullerenes are used as insulators.

Q.9 Short Notes (Continued)

(a) Fullerene

- Fullerenes are used as a catalyst in water purification.
- Fullerenes exhibit superconductivity at a certain temperature.

(4) Coal

- Coal is a fossil fuel. Millions of years ago, the remains of plants and animals got buried under the earth.
- They contain energy-rich molecules of carbon compounds originally made by plants.
- Coal is classified on the basis of carbon content into peat (less than 60 %), lignite (60 – 70 %), bituminous (70 – 90 %) and anthracite (about 95 %).
- Depending on the percentage of carbon, the heat generated changes.
- **Uses :** (i) Coal is used as fuel in factories and homes. (ii) Coal is used to obtain coke, coal gas and coal tar. (iii) Coal is used in thermal power plants for generation of electricity.

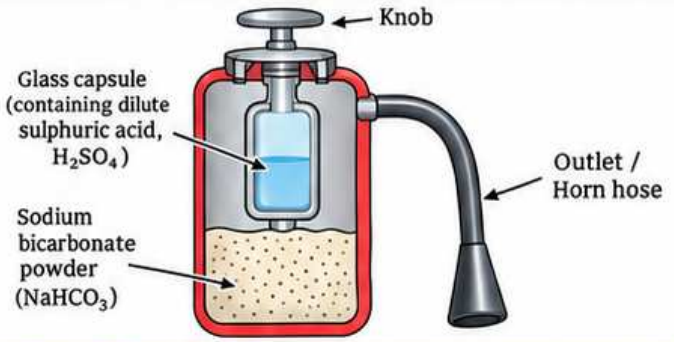
(5) Coke

- The pure coal that remains when coal gas has been removed from coal, is called coke.
- Coke contains about 90 – 95 % carbon and it does not contain volatile substances.
- Coke is hard in nature and burns without smoke.
- Hence, coke produces more heat than coal.
- It is used as a domestic fuel.
- It is a reducing agent.
- Coke is used in the production of water gas and producer gas.

(6) Fire Extinguisher

- A fire extinguisher contains sodium bicarbonate powder.
- Dilute sulphuric acid (H_2SO_4) is placed in a glass capsule.
- The capsule breaks on pressing the knob, the dilute H_2SO_4 comes in contact with $NaHCO_3$, the chemical reaction takes place to produce carbon dioxide (CO_2).
- CO_2 is not combustible and does not support combustion.
- When it is spread out on a burning object, it covers the object and separates it from air.
- Thus, the fire is extinguished.

Soda-Acid Fire Extinguisher (Cutaway View)



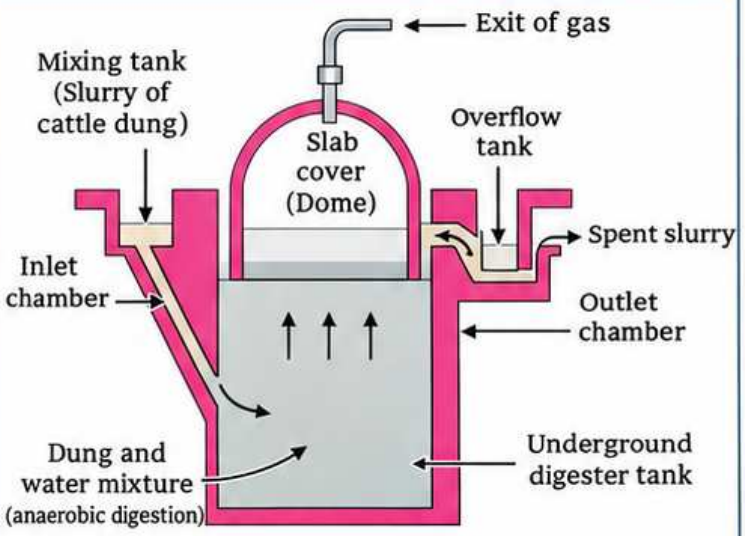
Chemical reaction :

$$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2\uparrow$$

(7) Biogas Plant

- In a biogas plant, animal dung, wet garbage is decomposed by anaerobic microbes.
- This produces methane gas and carbon dioxide and it is called **biogas.**
- Biogas contains about 55 % to 60 % methane (CH_4) and the rest is carbon dioxide (CO_2).
- It is a cheap fuel and meets the demand for cooking gas.
- It is also used in the production of electricity.
- Biogas is convenient to use and in addition to this the by-product of the process can be used as a very good manure.
- The production of biogas is an anaerobic process.
- It takes place in two stages.

Biogas Plant (Cross-section)

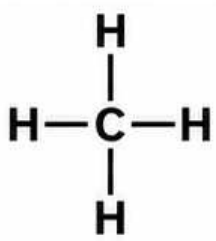


Two Stages in the Production of Biogas :

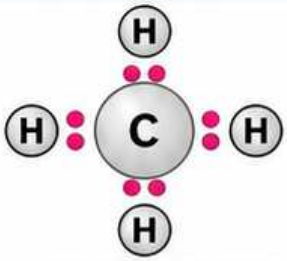
1. **Production of acids :** The biodegradable complex organic compound is decomposed by microbes leading to the formation of organic acids.
2. **Methane gas production :** The methanogenic bacteria act on the organic acids to produce methane gas.

(8) Methane Structural Formula

- Methane is the simplest hydrocarbon containing only one carbon atom in its molecule. The electronic



Structural formula of methane (CH_4)



Electron-dot model: four shared pairs

Methane (CH_4) is a compound of carbon and hydrogen. The electronic configuration of carbon is 2,4. Carbon has four valence electrons in the outermost shell. It shares one electron with each of four hydrogen atoms (each having one electron), forming four single covalent C–H bonds. Thus, the carbon atom attains an octet (8 electrons) and each hydrogen attains a duplet (2 electrons), forming methane (CH_4).

Q.10 Give scientific reasons :

1 Graphite is a good conductor of electricity.

Ans. (1) Graphite is a soft, greyish-black crystalline allotrope of carbon. (2) In graphite, each carbon atom is bonded to three other carbon atoms, forming a hexagonal planar structure. (3) The fourth valence electron of each carbon is **delocalized (free)** and can move throughout the layers. (4) Due to these free electrons, graphite conducts electricity.

2 Graphite is not used in ornaments.

Ans. (1) In natural form, graphite is a soft, greyish-black and slippery substance. (2) Ornaments are usually made from hard and lustrous metals. (3) Since graphite is soft and lacks metallic lustre, it cannot be used in ornaments.

3 Lime water turns milky when CO_2 is passed through it.

Ans. When CO_2 is passed through fresh lime water [$Ca(OH)_2$], a white precipitate of calcium carbonate ($CaCO_3$) is formed, due to which the lime water turns milky.

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

4 Diamonds are used in rock drilling machines.

Ans. (1) Diamond is a crystalline allotrope of carbon. (2) In diamond, each carbon atom is covalently bonded to four other carbon atoms, forming a rigid **tetrahedral** three-dimensional network. (3) This strong covalent network makes diamond extremely hard. (4) Hence, diamonds are used in rock drilling machines.

5 Coke produces more heat than coal. OR Coke is a superior fuel than wood and coal.

Ans. (1) The calorific value of a fuel depends upon its carbon content. (2) Coke contains about **90 – 95 %** carbon. (3) The main combustible component of wood is cellulose, a carbonaceous substance. (4) Coal contains about 10 – 80 % carbon, depending upon the type of coal. (5) Hence, coke produces more heat than coal and is a superior fuel than wood and coal.

Fact : Coke contains 90 – 95 % carbon.

6 Biogas is an eco-friendly fuel.

Ans. (1) Biogas contains about 55 – 60 % methane and the rest is carbon dioxide. (2) Biogas is a very cheap fuel, which meets the demand for cooking gas. (3) Biogas burns almost instantaneously to provide heat quickly. (4) The combustion of biogas can be easily controlled. (5) It does not produce any solid waste products. (6) It can be transported easily and can be supplied through pipes to limited distant places. (7) It has high heat content, hence biogas is an eco-friendly fuel.

7 Carbon dioxide is used in fire extinguishers.

Ans. (1) Carbon dioxide is not **combustible** and does not support combustion. (2) It is heavier than air. (3) When it is spread on a burning object, it covers the object and separates it from air. (4) Thus, the fire is extinguished. Hence, carbon dioxide is used in fire extinguishers.

8 Methane is used as fuel.

Ans. (1) Methane burns in air with a pale blue, non-luminous flame to form carbon dioxide and water. (2) The reaction evolves a large amount of heat. (3) Hence, methane is used as a fuel.

Combustion of methane :

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + \text{much heat}$$

(Pale blue, non-luminous flame)

9 The valency of carbon is 4.

Ans. (1) The electronic configuration of carbon is 2,4. (2) If four electrons are added to the second orbit of carbon, its octet is completed and its electronic configuration becomes stable like that of the nearest inert gas neon (2,8). (3) Therefore, the valency of carbon is 4.

Q. 11 Use Your Brain Power !

(1) Does an electric charge form on atoms when a covalent bond is formed between them? Why is a single C–C bond between two carbon atoms strong and stable?

Ans. No. When two carbon atoms are joined by a covalent bond, no electric charge is produced on the atoms. Carbon shows the property of forming covalent bonds because it can share its valence electrons with other atoms. The C–C single bond is strong and stable because it is a covalent bond formed by sharing of a pair of electrons between the two carbon atoms.

(2) Is the density of CO_2 more or less than that of air?

Ans. The density of CO_2 is more than that of air.

Q. 12 Distinguish Between the Following :

(1) Crystalline Form of Carbon and Non-crystalline (Amorphous) Form of Carbon

Sr. No.	Crystalline Form of Carbon	Non-crystalline (Amorphous) Form of Carbon
1.	It has a regular and definite arrangement of carbon atoms.	It has an irregular arrangement of carbon atoms; the arrangement is not regular.
2.	In crystalline form, carbon is extremely hard and has a definite structure.	In non-crystalline form, carbon is brittle and does not have a definite (crystalline) structure.

(2) Diamond and Graphite

Sr. No.	Diamond	Graphite
1.	Diamond is an extremely hard material.	Graphite is black, soft and smooth.
2.	In diamond, each carbon atom is linked to four other carbon atoms (four neighbours) in a tetrahedral (3D) arrangement.	In graphite, each carbon atom is linked to three other carbon atoms (three neighbours) in hexagonal layers.
3.	Diamond is a bad conductor of electricity.	Graphite is a good conductor of electricity.
4.	It is used as an ornament (jewellery) and also for cutting and drilling glass.	It is used as a lubricant.

(3) Coal and Coke

Sr. No.	Coal	Coke
1.	Coal is a fossil fuel formed by the burial of plants.	Coke is obtained when coal is heated in the absence of air (destructive distillation).
2.	It contains free (amorphous) carbon and other complex carbon compounds.	It contains about 90 – 95 % carbon.
3.	It contains some volatile matter.	It does not contain any volatile matter.
4.	It burns with smoke.	It burns without producing smoke (it is smokeless).
5.	It produces less heat than coke.	It produces more heat than coal.

Q. 13 Describe the Following Chemical Reactions by Giving Their Balanced Equations :

(1) Carbon dioxide is passed through a solution of sodium hydroxide.

Ans. When carbon dioxide is passed through a solution of sodium hydroxide, sodium carbonate is formed.

Balanced equation : $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

Q.13 Chemical Reactions (Continued)

Reactions (2) to (6) and their explanations:

(2) Formation of sodium bicarbonate

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

Ans. When carbon dioxide is passed through a solution of sodium carbonate, sodium bicarbonate ($NaHCO_3$) is formed.

(3) Formation of carbonic acid

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

Ans. When carbon dioxide is passed through water, it dissolves in it to form carbonic acid (H_2CO_3).

(4) Limewater turns milky

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

Ans. When carbon dioxide is passed through limewater [$Ca(OH)_2$], it turns milky due to the formation of insoluble calcium carbonate ($CaCO_3$).

(5) Combustion of methane in air

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + heat$$

Ans. Methane is a combustible gas. When methane is burnt in air, it burns with a blue flame, forming carbon dioxide and water and liberating 213 kcal mol^{-1} of heat.

(6) Chlorination of methane (in presence of UV light)

$$CH_4 + Cl_2 \xrightarrow{Light} CH_3Cl + HCl$$

Ans. When methane gas reacts with chlorine in the presence of UV light at a temperature of 250 °C – 400°C, methyl chloride (CH_3Cl) is formed. This reaction is called chlorination of methane.

Q.14 Complete the following chemical reactions:

(1) ..... + ... $\longrightarrow$ $CO_2 + 2H_2O$ + Heat

(2) ..... + ... $\longrightarrow$ $CH_3Cl + HCl$

(3) $2NaOH + CO_2 \longrightarrow$ ..... + ...

(4) $Na_2CO_3 + H_2O + CO_2 \longrightarrow$ .....

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

Ans. (Q.14) Correct and balanced equations:

(1) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ + Heat

(2) $CH_4 + Cl_2 \xrightarrow{Light} CH_3Cl + HCl$

(3) $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$

(4) $Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3$

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

Q.15 Paragraph based question

Read the following paragraph and answer the questions based on it:

The existence of a substance in different physical forms while having the same chemical composition is called allotropy. Carbon shows allotropy. The two allotropes of carbon are diamond and graphite.

Diamond is a hard, beautiful, crystalline substance. In diamond, each carbon atom is covalently bonded to four other carbon atoms in a regular tetrahedral arrangement, forming a rigid three-dimensional network.

Graphite is a soft, greyish-black, crystalline substance. In graphite, each carbon atom is bonded to three other carbon atoms in a hexagonal planar structure, and these layers are held together by weak forces between them.

The physical properties of diamond and graphite are different, but their chemical properties are the same. Diamond has no mobile electrons in it, so it is a non-conductor of electricity (an insulator). On the other hand, graphite has free electrons that can move throughout its layers, so it is a good conductor of electricity.

Uses :

- Diamond is used as a precious stone in jewellery.
- Black diamonds are used for cutting glass.
- Graphite is used in making electrodes and carbon, lubricants and lead pencils.

Q.15 Paragraph-Based Questions

(1) What is allotropy?

Ans. The phenomenon of existence of a substance in different physical forms, but in the same chemical form, is called allotropy.

(2) Name the allotrope of carbon which conducts electricity.

Ans. Graphite conducts electricity.

(3) Name the soft, brittle allotrope of carbon.

Ans. Graphite is the soft, brittle allotrope of carbon.

(4) Which allotrope of carbon is used to cut glass?

Ans. Diamond is used to cut glass.

(5) Name the allotrope of carbon which has regular tetrahedron, three dimensional structure.

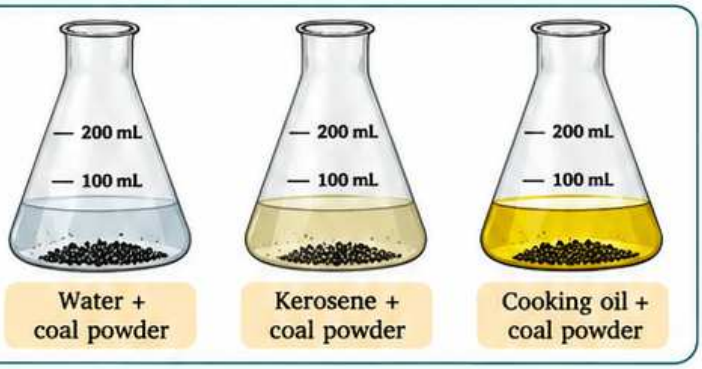
Ans. Diamond has a regular tetrahedral, three-dimensional structure.

Q.16 Activity-Based Questions

(Textbook pages 143 & 144)

(1) Solubility of coal

- **Apparatus :** 3 conical flasks, stirrer.
- **Chemicals :** Water, kerosene, cooking oil, coal powder, etc.
- **Procedure :** Take three conical flasks and put cooking oil, water and kerosene, respectively, in each. Add half a spoonful of coal powder to each flask and stir well with a stirrer. Observe the mixtures in the three conical flasks.



Observations :

- In all the three flasks, the coal powder does not dissolve and remains undissolved (settles at the bottom).

Questions :

(i) In which of the solvents – water, kerosene and cooking oil does the coal powder dissolve?

Ans. Coal powder does not dissolve in water, kerosene or cooking oil.

(ii) What inference will you draw about the solubility of carbon?

Ans. Carbon is insoluble in all solvents.

(2) Reaction of carbon with oxygen

- **Apparatus :** Coal, match box, moist litmus paper, etc.
- **Procedure :** Ignite the coal. Hold the moist blue litmus paper over the gas released on igniting the coal. Note the observation.

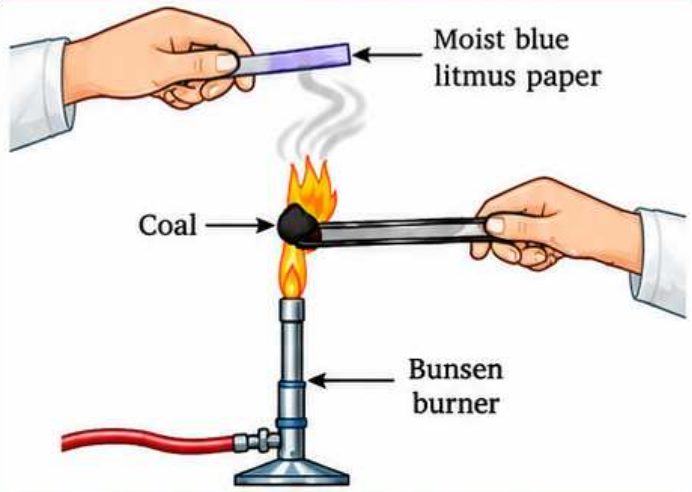


Fig. 13.10 : Reaction of carbon with oxygen

Questions :

(i) With which gas in the air does the coal react on igniting?

Ans. Oxygen from air reacts on igniting the coal.

(ii) What is the substance formed?

Ans. The substance formed is carbon dioxide (CO_2).

(iii) What change takes place in the litmus paper?

Ans. Wet blue litmus turns red.

(iv) Write down the chemical reaction taking place in the above procedure.

Ans. $C + O_2 \longrightarrow CO_2\uparrow$

Carbon + Oxygen → Carbon dioxide

ACTIVITY

Activity 1 : (Textbook page 138)

(1) Take some milk in an evaporating dish. Heat the evaporating dish on a Bunsen burner. What remains behind at the bottom of an evaporating dish on complete evaporation of the milk?

Ans. Carbon remains behind at the bottom of an evaporating dish on the complete evaporation of the milk.