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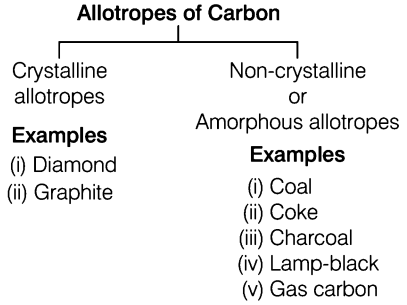
Carbon and its Compounds

Carbon

- It is a non-metallic element.
- It occurs in nature in both pure forms and combination with other elements in the form of compounds. Carbon is found in many non-living things like coal, plastic, petroleum, diesel and kerosene, etc.
- The phenomenon of existence of an element in various physical forms but in same chemical form is known as **allotropy**. The different forms of the same elements are known as **allotropes**.

Allotropes of Carbon

Carbon occurs in nature in combined as well as in the free state. In free form, the various allotropes of carbon are as follows



Crystalline Allotropes

(i) **Diamond** In India, diamonds are found in Panna mines in Madhya Pradesh, Wajrakarur in Andhra Pradesh and Golkunda mines in Karnataka.

- It is the hardest natural substance.
- It is clear, translucent and has its own brilliance.
- It is the densest and purest form of carbon.
- Diamond is used as precious stone. Black diamonds are used for jewellery and cutting glass; and as abrasives.

(ii) **Graphite** In India, graphite is found in Andhra Pradesh, Jammu and Kashmir, Odisha, Bihar, Tamilnadu and Uttar Pradesh.

- It is a dark, grey substance having a greasy feel.
- It is a good conductor of heat and electricity.
- It is used for making carbon arcs electrodes, lead of pencils and as a lubricant for machine parts. It is also used as a moderator in nuclear reactors.

Property	Diamond	Graphite
Occurrence	Rare	Common
Appearance	Colourless, transparent shiny substance	Dark gray shiny solid
Hardness	The hardest natural substance	Soft and smooth
Density	3.5 g/cm³	1.9 to 2.3 g/cm³
Structure	It has a three dimensional rigid structure.	It has a hexagonal ring like structure.
Electrical conductivity	Bad conductor	Good conductor
Thermal conductivity	Bad conductor	Moderate conductor
Uses	(i) used for making jewellery	(i) used for making lead of pencils
	(ii) used in glass cutters and rock drilling equipments	(ii) used as electrodes in dry cells
	(iii) used for making protective windows for space satellites	(iii) used as lubricant in machines.

Non-crystalline Allotropes

(i) **Coal** Coal is the most impure form of carbon. It is obtained from mines. In India, it is found in Raniganj, Zaria, etc. Depending upon carbon contents, coal are of the following types

(a) Peat (60% carbon)
(b) Lignite (70% carbon)
(c) Bituminous (78% to 83% carbon)
(d) Anthracite (90% carbon)

Bituminous is the common variety of coal and anthracite is the purest form of coal.

(ii) **Coke** Coke is obtained by the destructive distillation of the coal. It contains 80% to 95% carbon. It is used as smokeless fuel as a reducing agent in the extraction of metals and in steel.

(iii) **Charcoal** Charcoal is obtained by burning the carbon compounds in the absence of air. It is named after the source from which it is obtained. The different types of charcoal are as follows

(a) **Wood charcoal** is obtained by the destructive distillation of wood. It is a black, porous, brittle solid. It adsorbs odouriferous gases and colouring matter. So, it is used as a fuel, a deodorant, decolorising agent and in making gas masks.

(b) **Animal charcoal** is obtained by the destructive distillation of bones (also known as bone charcoal). It is also used as adsorbent of colouring matter from solutions.

(c) **Sugar charcoal** is obtained by the destructive distillation of sugar or by the action of concentrated sulphuric acid on sugar. It is a pure form of carbon. It is used to obtain metals from their oxides.

(iv) **Lamp black** It is obtained by burning carbon rich oils in an insufficient amount of air. It is used in the manufacture of printer ink, varnishes and carbon papers.

(v) **Gas carbon** It is the side product of destructive distillation of coal. It is a good conductor of electricity, so used for making electrodes.

Compounds of carbon

1. **Carbon monoxide** (CO) Carbon monoxide is a colourless, tasteless gas with faint odour. It is extremely poisonous in nature. It is an air pollutant. It is formed by the incomplete combustion of carbonaceous matter.
2. **Carbon dioxide** (CO_2) It is the product of complete combusion of carbonaceous matter, respiration, fermentation, etc.
   - It constitutes 0.03% of air and its increased amount causes global warming.
   - At atmospheric pressure and –78.5°C, CO_2 comes in solid form, i.e., solid CO_2 is formed. Solid CO_2 is technically known as dry ice.

Petroleum

- Petroleum is a dark coloured, thick crude oil having an unpleasant odour.
- It is found deep below the earth's crust trapped in rocks in certain areas. The name petroleum means 'rock oil' (petra=

rock, oleum=oil). It is also called crude oil or mineral oil.

- Petrol and diesel are obtained from petroleum. Petrol is used as a fuel in light automobiles (e.g. motorcycles, scooters and cars), whereas diesel is used in heavy motor vehicles (e.g. trucks and tractors).

Various Constituents of Petroleum and their Uses

The various constituents of petroleum and their uses are given below in the table.

Constituents of petroleum	Uses
Liquified Petroleum gas (LPG)	Fuel for home and industry
Petrol	Motor fuel, aviation fuel, solvent for dry cleaning
Kerosene	Fuel for stoves, lamps and for jet aircrafts
Diesel	Fuel for heavy motor vehicles, electric generators
Lubricating oil	Lubrication
Paraffin wax	Ointments, candles, vaseline, etc.
Asphalt	Paints, road surfacing

Fuels

A fuel may be defined as any substance which supplies heat energy on burning without production of excessively undesirable side products, e.g. wood, coal, LPG, etc.

Fuel	Composition	Source
Water gas	Carbon monoxide (CO) + hydrogen (H_2)	By passing steam over red hot coke
Producer gas	Carbon monoxide (CO) + nitrogen (N_2)	By passing insufficient air over red hot coke
Oil gas	Methane (CH_4) + ethylene (C_2H_4) + acetylene (C_2H_4)	By destructive distillation of kerosene
Coal gas	Hydrogen (H_2) + methane (CH_4) + ethylene + acetylene + CO	By fractional distillation of wood
Natural gas	Methane (83%) + ethane	From petroleum
LPG	Butane (C_4H_{10}) + propane (C_3H_8)	From oil wells
Bio-gas or Gobar gas	Methane (CH_4) + carbon dioxide (CO_2) + hydrogen (H_2) + nitrogen (N_2)	From organic wastes

Flame

- The portion of gas or vapour that burns in air is called a flame.
- The flames are of two types–blue flame (non-luminous) and yellow flame (luminous).
- **Blue flame** indicates that the fuel has burnt completely in air or oxygen, while **yellow flame** indicates that the fuel has burnt in an insufficient supply of oxygen or air.

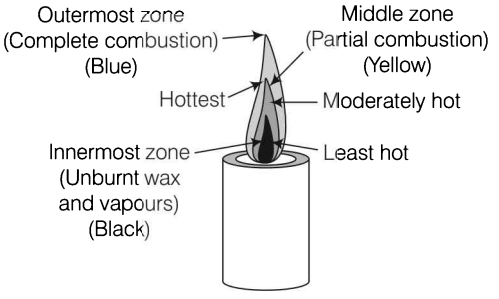
Candle Flame

A candle flame consists of three zones :

(i) **Innermost Zone** Black zone with unburnt vapour or wax. This zone is the least hot part of candle flame.

(ii) **Middle or Central Zone** Yellow zone shows incomplete combustion.

(iii) **Outermost Zone or Blue zone** This zone has the highest temperature in the flame.



Candle Flame

Practice Exercise

1. Carbon is a/an
(a) allotrope (b) metal
(c) non-metal (d) gas

2. Which one of the following is not an allotrope of carbon?
(a) Graphite (b) Diamond
(c) Coal (d) Wood

3. The hardest form of carbon is
(a) graphite (b) diamond
(c) lamp black (d) charcoal

4. Which property of diamond makes it useful for cutting glass?
(a) Bad conductor of electricity
(b) Hardness
(c) High density
(d) Transparent

5. Which property of graphite is used for making electrodes?
(a) Soft and slippery
(b) Opaque
(c) Good conductor of electricity
(d) None of the above

6. Graphite is used in nuclear reactor
(a) as a lubricant
(b) as a fuel
(c) for lining the inner side of the reactor as an insulator
(d) as moderator

7. Diamond and graphite do not differ in
(a) appearance
(b) structure
(c) chemical composition
(d) density

8. Which one of the following is marsh gas?
(a) Methane (b) Butane
(c) Ethane (d) *iso*-butane

9. When coal burns
I. carbon monoxide in formed
II. carbon dioxide in formed
III. nitrogen dioxide in formed
Choose the correct option.
(a) I only (b) II only
(c) I and II (d) I, II and III

10. Which substance is formed by the carbonisation of dead vegetation?
(a) Coal (b) Coke
(c) Coal gas (d) Coal tar

11. Fossil fuels are obtained from
(a) remains of non-living materials
(b) dead remains of birds only
(c) dead remains of insects only
(d) dead remains of living organisms

12. Which of the following is not a petroleum product?
(a) Paraffin wax (b) Lubricating oil
(c) Petrol (d) Coke

13. Coal, ... and natural gas are the fossil fuels and their amounts in the earth are limited. ..... forests and minerals, etc are exhaustible natural resources. As per present estimate, the known existing petroleum reserves will last at most a few hundred years. This would lead to energy crises. Moreover, the burning to these fuels is a major cause of ..... pollution.
Choose the correct order to fill up the blanks.
(a) wood, solar energy, air
(b) petroleum, hydroelectricity, water
(c) petroleum, fossil fuels, air
(d) wood, coal, soil.

14. The destructive distillation of bones gives
(a) wood charcoal (b) animal charcoal
(c) sugar charcoal (d) coke

15. Coal is processed in industries to get some useful products. Which of the following is not obtained from coal?
(a) Coke (b) Coal tar
(c) Coal gas (d) CNG

16. Which one of the following is decolorising agent?
(a) Coke (b) Animal charcoal
(c) Lamp black (d) Coal

17. Which of the following in used in making of ointment, vaseline, candles etc.?
(a) Lubricating oil (b) Paraffing wax
(c) Coal (d) Diesel

18. Water gas is a mixture of
(a) CO_2 and H_2O (b) CO and CH_4
(c) CO and H_2 (d) Co and N_2

19. Complete combustion of CH_4 gives
(a) $CO_2 + H_2O$ (b) $CO_2 + H_2$
(c) $COCl_2$ (d) $CO + CO_2 + H_2O$

20. Choose the set that consists major component of bio-gas.
(a) Methane, acetylene, carbon monooxide
(b) Ethane, butane, propane
(c) Butane, carbon dioxide, hydrogen
(d) Methane, carbon dioxide, hydrogen

21. Which color is shown by flame due to insufficient supply of oxygen?
(a) Blue (b) Green
(c) Yellow (d) Black

22. Which zone of flame have the highest temperature?
(a) Middle (b) Outer
(c) Inner (d) Both (a) and (b)

Answers

1	*(c)*	2	*(d)*	3	*(b)*	4	*(b)*	5	*(c)*	6	*(d)*	7	*(c)*	8	*(a)*	9	*(c)*	10	*(a)*
11	*(d)*	12	*(d)*	13	*(c)*	14	*(b)*	15	*(d)*	16	*(b)*	17	*(b)*	18	*(c)*	19	*(a)*	20	*(d)*
21	*(c)*	22	*(b)*																