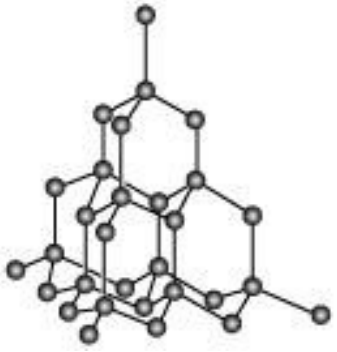
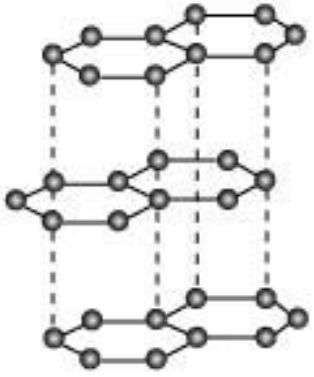
Carbon and Its Compounds

- **Covalent bonds**
- The bonds formed by the sharing of electrons are known as covalent bonds.
- In covalent bonding, both the atoms (that are participating in the bonding) share electrons, i.e., the shared electrons belong to both the atoms.
- Carbon contains four electrons in its valence shell. It always forms covalent bonds as it is difficult for it to lose or gain four electrons in order to complete its octet.

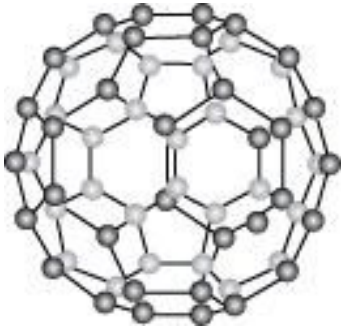
- Allotropes of Carbon
  - Allotropes have different appearances and physical properties, but chemically they are the same.
  - There are three allotropes of carbon: diamond, graphite, and buckminsterfullerene.



Diamond



Graphite



Buckminsterfullerene

Amorphous Solid:

- An amorphous solid is a non-crystalline solid with no well-defined ordered structure.
- Amorphous forms of carbon are: Charcoal, Lampblack or soot; Coal; Coke

1. Carbon is a non-metal which is found in free state in nature in the form of graphite and diamond.

2. Coal cannot be renewed or regenerated again in a short interval of time. It also cannot be reused. So, it is regarded as a non-renewable resource of energy.

3. When trees and animals die, their dead remains got buried inside the earth's crust. They were subjected to very high temperature and pressure. So they got compressed into coal.

4. Coal is classified into four types on the basis of percentage of carbon.

(i) **Anthracite:** Contains 80% carbon

(ii) **Bituminous:** Contains 60% carbon

(iii) **Lignite:** Contains 22% carbon

(iv) **Peat:** Contains 11% carbon

5. Anthracite coal is widely used coal because of higher percentage of carbon.

6. Bituminous coal is a soft coal while lignite coal is regarded as 'Brown Coal'.

7. After compressing of plants and animal remainings, peat coal is formed which then gets converted into anthracite coal due to further compressing.

- **Coal**
- It is used as fuel to cook food. Earlier, it was used in railway engines to produce steam.
- It is used in thermal power stations to generate electricity.

- **Coke, coal tar, and coal gas are the products of coal.**
- **Coke:**
- It is a tough, porous and black substance.
- It is the pure form of carbon and is used in the extraction of steel and many other metals.
- **Coal tar:**
- It is black, thick liquid with unpleasant smell.
- It is the mixture of about 200 substances.
- The products obtained from coal tar are used as starting materials for dyes, drugs, paints, perfumes, etc.
- **Coal gas:**
- It is obtained during the processing of coal to obtain coke.
- It is used as a fuel in many industries situated near the coal processing plants.

Amorphous form:

- **Charcoal:** when a solid organic compound is heated in controlled supply of air, it leaves behind a grey porous residue called charcoal.

- **Wood charcoal:** It is prepared by destructive distillation of dry wood. It is grey brittle solid, porous in nature, bad conductor of heat and electricity, adsorbs gases, liquids and solids and has a density of $1.5 gcm^{-3}$.

- **Bone Charcoal:** It is prepared by destructive distillation of powder obtained from dried bones of dead animals. It is extensively used in decolourising sugarcane juice during the manufacture of sugar.

- **Sugar charcoal:** It is prepared by the destructive distillation of sugar. It is the purest form of carbon amongst the amorphous forms.

- **Lamp black:** When hydrocarbons like kerosene oil, containing a large amount of carbon, are burnt in insufficient supply of air, they burn with smoky flame which on cooling forms lampblack or soot. It is used in black shoe polish, black paints, carbon papers, printer's ink etc.

- **Coke:** It is prepared by destructive distillation of coal. It is used as a household fuel and in the extraction of metals, in the manufacture of water gas and graphite.

- **Coal:** It is a hard and black substance that is used for burning to generate heat

Uses

1. It is used as a fuel for cooking.
2. It is used for heating of bricks.
3. It is used as an industrial fuel.
4. It is used in railway engines to produce steam.
5. It is used in thermal power plants to generate electricity.

- **Petroleum**: It is a mixture of butane, propane and ethane.

- **Products and uses of destructive distillation of petroleum**

• **Petroleum product**	• **Uses of the product**
• L.P.G or liquefied petroleum gas	• As a cooking fuel at homes and as a fuel for generating heat in industries
• Diesel	• As a fuel for heavy motor vehicles, electric generators
• Kerosene	• As a fuel in stoves, lamps, and also for jet aircrafts
• Petrol	• As a dry-cleaning agent, solvent, motor fuel, aviation fuel

• Lubricating oil	• For lubrication purposes
• Paraffin wax	• As a base for ointments, making of candles, vaseline etc
• Bitumen	• For road surfacing purposes, paints etc.

Occurence of carbon dioxide:

- Carbon dioxide occurs in free as well as in combined state.
- It is found in air in free state. A large amount of carbon dioxide is found dissolved in water bodies such as oceans, lakes, etc.

Preparation of carbon dioxide:

- Carbon dioxide is also formed when charcoal or hydrocarbons are burned in the air.
- It is also formed when metallic carbonates or metallic hydrogen carbonates are treated with dilute acids.
- It is formed by treating any metallic carbonate with dilute mineral acids.

Some physical properties of carbon dioxide:

- Colourless
- Odourless
- Have sour taste

- Almost water soluble gas
- Non-poisonous in nature

Chemical properties of carbon dioxide:

- It dissolves in water to form carbonic acid (H_2CO_3).
- It combines with alkali to form metal carbonates.
- Carbon reacts with carbon dioxide to form carbon monoxide.
- Carbon dioxide reacts with calcium oxide, i.e. quick lime, to form calcium carbonate.

Uses of carbon dioxide:

- Preservation of food stuff from insects
- Fire extinguishers, especially those designed for electrical fires; use liquid carbon dioxide kept under pressure to extinguish flames
- Solid carbon dioxide is called "dry ice".

1. The process of changing of carbon from inorganic compounds to the organic compounds is defined as carbon cycle.

2. Carbon is present in many forms. Graphite and diamond are the elemental forms of carbon. In the atmosphere, carbon is present as carbon dioxide. Mineral forms of carbon include carbonates or hydrogen carbonates. Components of food like fat, carbohydrate, proteins etc contain carbon as structural component. Carbonate salts form endoskeletons and exoskeletons of many animals.

3. Carbon is utilised by plants in the form of carbon dioxide.

4. Organisms on respiration form carbon dioxide. Some organisms do not need oxygen for respiration, they are known as **anaerobes**. Combustion of various substances releases carbon dioxide in the environment.

5. Carbon dioxide plays a major role in the cyclic transformation of carbon.

6. Many activities increase the amount of carbon dioxide in the environment. For example, burning of fuel, growing number of automobiles, deforestation, and increase in human population etc.

7. Carbon dioxide traps heat effectively due to which temperature of the earth's surface is continuously increasing. This results in global warming. Other gases that contribute in green house effect are water vapour, carbon dioxide, methane and ozone.

8. Global warming has alarming effects such as increase in sea level, ocean acidification, increase in earth's temperature and melting of glaciers.

- **Greenhouse effect**
  - Trapping of heat by gases (CO_2) in the atmosphere.
  - Gases that cause the greenhouse effect are responsible for increasing the temperature of the Earth and thus contributing to the phenomenon called **global warming**.
- **Causes of Green house effect**
  - A part of solar radiations cause warming of the earth's surface.
  - A part of solar radiation is reflected back, which is trapped by the earth's atmosphere. This phenomenon is called green house effect.
- **Green house gases**
  - These are the gases, which trap the solar radiations, and in this way, are responsible for the increase in the temperature of Earth.
  - The examples include carbon dioxide, methane, nitrous oxide, and water vapours.
- **Global warming**

    - The CO_2 level in atmosphere is increasing due to various human activities such as deforestation and burning of fossil fuels.
    - Build up of CO_2 in the atmosphere will result in a rise in the average temperature of earth's atmosphere, leading to global warming.
    - Global warming will lead to melting of glaciers and increase in the sea level.

- Small amount of carbon monoxide is present in urban and industrial areas due to incomplete combustion of fuels in industry as well as in automobiles.

Preparation of carbon mono oxide:

- It is prepared in laboratory from oxalic acid using sulphuric acid.

- Carbon monoxide, being insoluble, bubbles out and is collected by downward displacement of water.

Physical properties of carbon monoxide:

- Colourless

- Odourless

- Tasteless

- Almost a water insoluble gas

- Has nearly the same density as air

- Highly poisonous in nature
- When charcoal is heated to a dull red heat and then carbon dioxide is passed over it, it results in the formation of carbon monoxide.

- Carbon monoxide is a combustible gas, but does not support combustion. As it burns without any smoke and produces a large amount of heat energy, it serves as an excellent fuel.

Chemical properties of carbon monoxide:

- Action with litmus- It is neutral to litmus and thus has no acidic or basic properties.
- Action with oxygen: It burns producing carbon dioxide gas and a lot of heat energy.

- Carbon monoxide reacts with heated metals such as nickel, chromium, and iron to form their respective carbonyls.

- It is a powerful reducing agent. It can reduce almost all metal oxides (exceptions – alkali and alkaline earth metals, aluminum). This is why it is used in the extraction of many metals from their oxide ores.

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