CHEMISTRY

CLASS NOTES FOR CBSE

Chapter 08. Carbon and Its Compounds

01. Carbon and Its Compounds

Carbon is an element. The symbol of carbon is C. It is a non-metal. The name carbon is derived from the Latin word `*carbo*` which means `*coal*`. This is because carbon is the main constituent of coal. In fact, all the living things, plants and animals, are made up of carbon based compounds which are called organic compounds. Thus, carbon element is present in all living things. A large number of things which we use in our daily life are made of carbon compounds.

Carbon Always Forms Covalent Bonds

The atomic number of carbon is 6 which means that a neutral atom of carbon contains 6 electrons. So, the electronic configuration of carbon is $\underset{2,}{K}\ \underset{4}{L}$. So, it is not possible to remove 4 electrons from a carbon atom to give it the inert gas electron arrangement. It is also not possible to add as many as 4 electrons to a carbon atom due to energy considerations, and acquire the inert gas configuration. It is obvious that the carbon atoms have to acquire the inert gas structure of 8-electrons in their outermost shell by the sharing of electrons. Since carbon atoms can achieve the inert gas electron arrangement only by the sharing of electrons, therefore, carbon always forms covalent bonds.

Carbon is Tetravalent

A carbon atom has 4 electrons in its outermost shell, so it requires 4 more electrons to achieve the stable, 8-electron inert gas electron arrangement, which it gets by sharing. Since one carbon atom requires 4 electrons to achieve the eight-electron inert gas structure, therefore, the valency of carbon is 4.

Self Combination

The most outstanding (or unique) property of carbon is its ability to combine with itself, atom to atom, to form long chains. For example, octane (C_8H_{18}), one of the constituents of petrol, has a chain of 8 carbon atoms, and some of the organic compounds like starch and cellulose contain chains of hundreds of carbon atoms. The property of self combination of carbon atoms to form long chains is useful to us because it gives rise to an extremely large number of carbon compounds (or organic compounds). This is because a long chain of carbon atoms acts as a backbone to which other atoms can attach in a number of ways to form a vary large number of carbon compounds (or organic compounds).The formation of strong bonds by carbon atoms among themselves and with other elements makes the carbon compounds exceptionally stable.

Occurrence of Carbon

(i) In free state, carbon occurs in nature mainly in two forms : diamond and graphite. Another naturally occurring form of carbon called buckminsterfullerene has been discovered recently.

(ii) In the combined state, carbon occurs in nature in the form of compounds such as :
- Carbon dioxide gas in air
- Carbonate (like limestone, marble and chalk)
- Fossil fuels like coal, petroleum and natural gas
- Organic compounds like carbohydrates, fats and proteins and
- Wood, cotton and wool, etc.

02. Allotropes of Carbon

The various physical forms in which an element can exist are called allotropes of the element. The carbon element exists in three solid forms called allotropes. The three allotropes of carbon are :

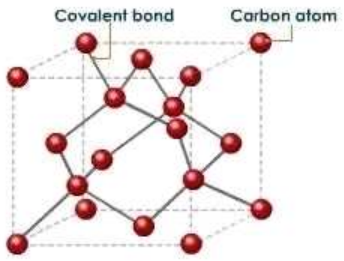
(i) Diamond,
(ii) Graphite and
(iii) Buckminsterfullerene

Diamond : Diamond is a colourless transparent substance having extraordinary brilliance.

Graphite : Graphite is a greyish-black opaque substance.

Structure of Diamond

A diamond crystal is a giant molecule (very big molecule) of carbon atoms. Each carbon atom in the diamond crystal is linked to four other carbon atoms by strong covalent bonds. The four surrounding carbon atoms are at the four vertices (four corners) of a regular tetrahedron.



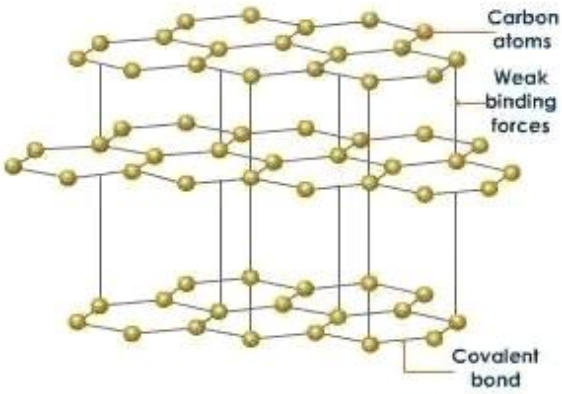
Structure of Diamond

The diamond crystal is, therefore, made up of carbon atoms which are powerfully bonded to one another by a network of covalent bonds. Due to this diamond structure is very rigid. The rigid structure of diamond makes it a very hard substance. It is the great hardness of diamond which makes it useful for making rock borers for drilling oil wells, etc. and for making glass cutters. Diamond is a non-conductor of electricity. We know that a carbon atom has 4 valence electrons in it. Now in a diamond crystal each carbon atom is linked to four other carbon atoms by covalent bonds, and hence all the 4 valence electrons of each carbon atom are used up in forming the bonds. Since there are no free electrons in a diamond crystal it does not conduct electricity.

Structure of Graphite

The structure of graphite is very different from that of diamond. A graphite crystal consists of layers of carbon atoms or sheets of carbon atoms. Each carbon atom in a graphite layer is joined to three other carbon atoms by strong covalent bonds to form flat hexagonal rings.

The various layers of carbon atoms in graphite are quite far apart so that no covalent bonds can exist between them. The various layers of carbon atoms in graphite are held together by weak Van der Waals forces. Since the various layers of carbon atoms in graphite are joined by weak forces, they can slide over one another. Due to the sheet like structure, graphite is a comparatively soft substance. It is the softness of graphite which makes it useful as a dry lubricant for machine parts. Graphite is a good conductor of electricity. This can be explained as follows : We know that a carbon atom has 4 valence electrons in it. Now, in a graphite crystal, each carbon atom is joined to only three other carbon atoms by covalent bonds. Thus, only the three valence electrons of each carbon atom in graphite valence electrons of each carbon atom in graphite are used in bond formation. the fourth valence electron of each carbon atom is free to move. Due to the presence of free electrons in a graphite crystal it conducts electricity. Just like diamond, graphite has also a very, very high melting point.



Structure of Graphite

Uses of Diamond

Diamonds are used in cutting instruments like glass cutters, saw for cutting marble and in rock drilling equipment. Diamonds are used for making jewellery.

Uses of Graphite

Powdered graphite is used as a lubricant for the fast moving parts of machinery. Graphite is a good conductor of electricity due to which graphite is used for making carbon electrodes or graphite electrodes in dry cells and electric arcs. Graphite is used for making the cores of our pencils cells pencil leads and black paints.

Buckminsterfullerene

Buckminsterfullerene is an allotrope of carbon containing clusters of 60 carbon atoms joined together to form spherical molecules. Since there are 60 carbon atoms in a molecule of buckminsterfullerene, so its formula is C_{60} (C-Sixty). Buckminsterfullerene is a football-shaped spherical molecule in which 60 carbon atoms are arranged in interlocking hexagonal and pentagonal rings of carbon atoms. There are twenty hexagons and twelve pentagons of carbon atoms in one molecule of buckminsterfullerene. This allotrope was named buckminsterfullerene after the American architect Buckminster Fuller because its structure resembled the frame work of domeshaped halls designed by Fuller for large international exhibitions.