# Chemistry Study Materials for Class 11

## (NCERT Based Revision Notes of Chapter- 11)

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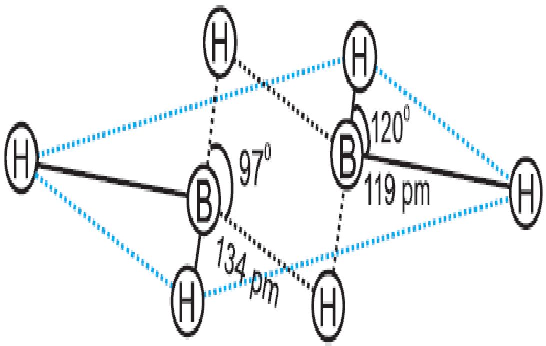
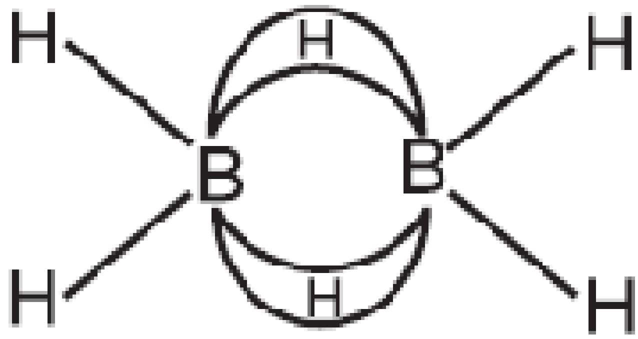
## p- block element

### Structure of Diborane

In diborane, each boron atoms is in $sp^3$ hybridisation. The two boron atoms and 4 hydrogen atoms lie in one plane. These four H atoms are called *terminal hydrogen atoms*. The other two hydrogen atoms lie one above and one below this plane.



These H atoms are called *bridging hydrogen atoms*. The four terminal B-H bonds are regular two centre-two electron bonds while the two bridge (B-H-B) bonds *are three centre-two electron (3c-2e) bonds or banana bonds*. Thus diborane is an *electron deficient compound*.

### Uses of Boron and Aluminium

- Boron fibres are used in making bullet proof vest and light composite material for aircraft.
- Borax and boric acid are used in the manufacture of heat resistant glass.
- Borax is also used as a flux for soldering metals, for giving glazed coating to earthenware.
- It is also used in medicinal soaps.
- Orthoboric acid is used as a mild antiseptic.
- Aluminium is extensively used for making electrical cables.
- It is also used in packing, utensil making, construction, aeroplane and transportation industry.

# Group 14 Elements (Carbon Family)

Group 14 includes Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn), lead (Pb) and Flerovium (Fl).

Among these Carbon and silicon are non-metals, germanium is a metalloid and tin and lead are soft metals. **Oxidation states:** These elements have 4 electrons in their valency shell. The common oxidation states exhibited by these elements are +2 and +4. Carbon also shows negative oxidation states. In +4 oxidation states, they mainly form covalent compounds. Down the group the stability of +2 oxidation state increases due to inert pair effect. The maximum covalency of carbon is 4 due to the absence of vacant d-orbitals.

**Reactivity towards oxygen:** They react with oxygen and form two types of oxides – MO and $MO_2$. $MO_2$ is more acidic than MO. Down the group, the acidity of oxides decreases. The dioxides $CO_2$, $SiO_2$ and $GeO_2$ are acidic, while $SnO_2$ and $PbO_2$ are amphoteric. Among monoxides CO is neutral, GeO is acidic and SnO and PbO are amphoteric.

**Reactivity towards halogen**: They form 2 types of halides – $MX_2$ and $MX_4$. Down the group, the stability of $MX_2$ increases. $GeX_4$ is more stable than $GeX_2$ while $PbX_2$ is stable than $PbX_4$. This is due to inert pair effect. Due to the absence of vacant d-orbitals $CCl_4$ cannot be hydrolysed. While $SiCl_4$ undergoes hydrolysis to give $Si(OH)_4$ [silicic acid].

## Anomalous Properties of Carbon

C shows anomalous properties due to its smaller size, higher electronegativity, higher ionisation enthalpy and unavailability of d orbitals. Some of the anomalous properties of C are:

1. The the maximum covalency of C is four. While other elements of group 14 can extend their covalency beyond 4 due to the presence of vacant d-orbitals.
2. Carbon has unique ability to form pπ– pπ multiple bonds with itself and with other atoms of small size and high electronegativity.
3. Carbon atoms have the tendency to link with one another through covalent bonds to form chains and rings. This property is called ***catenation***. But other elements have less catenation property.

4. $CCl_4$ cannot be hydrolysed, but the tetra halides of other elements can be hydrolysed.

## Allotropes of Carbon

*The existence of an element in two or more forms with same chemical properties but with different physical properties is known as allotropy*. Carbon exists in crystalline and amorphous allotropes. The important crystalline allotropes of Carbon are diamond, graphite and fullerene.

a) **Diamond**: In diamond, each carbon atom is in $sp^3$ hybridisation and linked to four other carbon atoms in a tetrahedral manner. So it has a a rigid three dimensional network of carbon atoms. It is very difficult to break covalent bonds and, therefore, diamond is a hardest substance on the earth. It is used as an abrasive for sharpening hard tools, in making dies and in the manufacture of tungsten filaments for electric light bulbs.

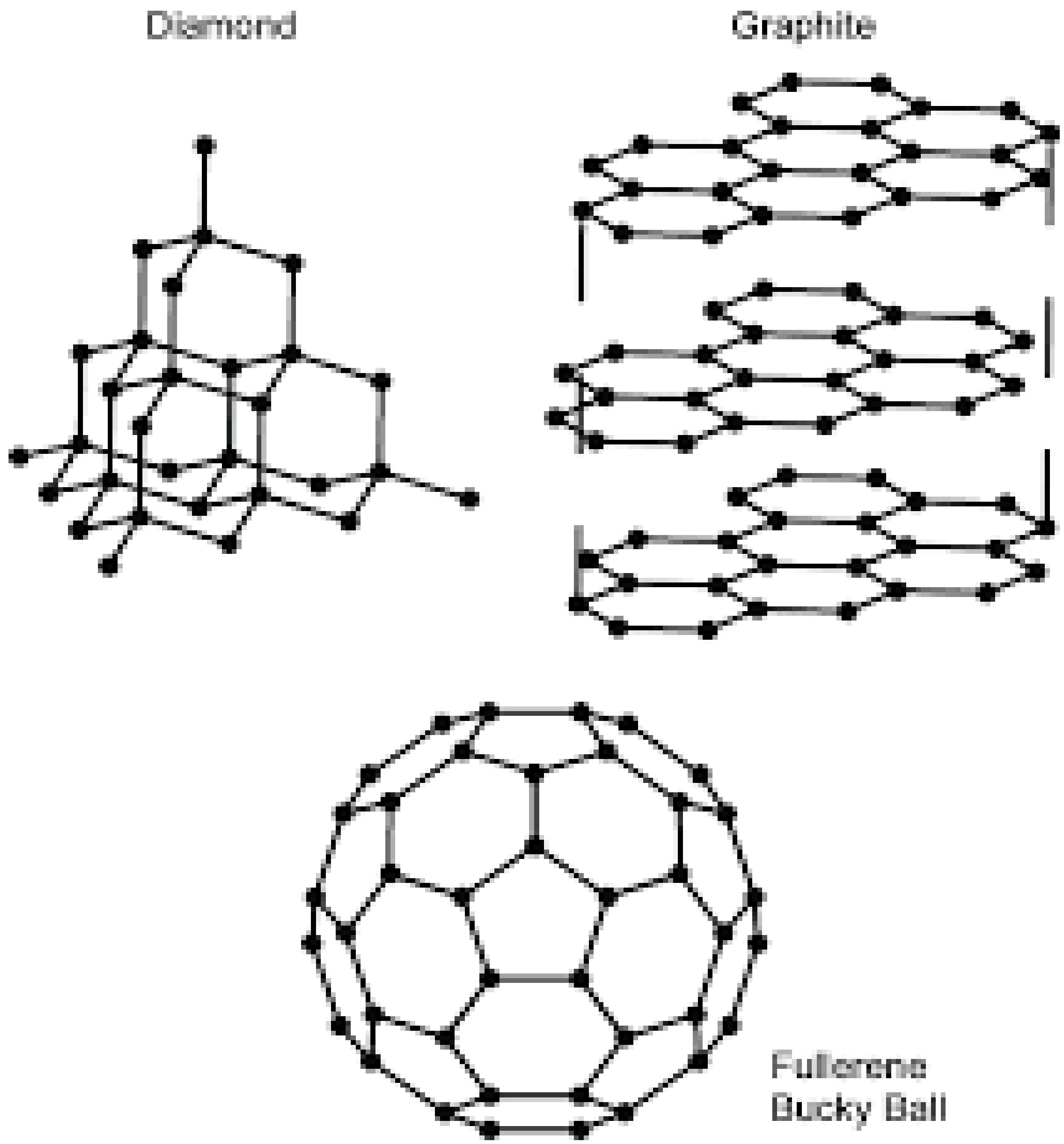
b) **Graphite**: Graphite has a layered structure. Different layers are held by weak van der Waals forces of attraction. Each layer contains planar hexagonal rings of carbon atoms. Here each carbon atom is in $sp^2$ hybridisation and makes three C-C sigma bonds with three neighbouring carbon atoms. Fourth electron forms a π bond. These electrons are delocalised and are mobile. Therefore graphite conducts electricity. Due to layered structure, it is very soft and slippery. For this reason graphite is used as a dry lubricant in machines running at high temperature.

c) **Fullerenes**: These are the cage like spherical molecules of formula $C_{60}$, $C_{70}$, $C_{76}$, $C_{84}$ etc. These are prepared by heating of graphite in an electric arc in the presence of inert gases like helium or argon.

The most commonly known fullerene is $C_{60}$, which is known as Buckminster fullerene. It contains twenty six- membered rings and twelve five membered rings. A six membered ring is fused with six or five membered rings but a five membered ring can only fuse with six membered rings. All the carbon atoms are equal and they undergo $sp^2$ hybridisation. Each carbon atom forms three sigma bonds with other three carbon atoms. The remaining electron at each carbon is delocalised in molecular orbitals. This gives an aromatic character to the molecule.

*Thermodynamically, graphite is the most stable allotrope of carbon*.

Amorphous forms of carbon are charcoal, coke and carbon black. Carbon black is obtained by burning hydrocarbons in limited supply of air. Charcoal and coke are obtained by heating wood or coal respectively at high temperature in the absence of air.

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