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## CBSE Class 11 Chemistry Notes Chapter 11 Overview

Six groups of p-block elements, numbered 13 through 18, with the electrical configuration  $ns2np1-6$ , are included in the periodic table. It contains every kind of element, including metal, non-metal, and metalloids. The differences in their electronic configuration's inner core have a significant impact on their chemical and physical properties.

The group's lighter elements have a very consistent group oxidation state. The heavier elements have more stable lower oxidation states and produce  $d\pi-d\pi$  or  $d\pi-p\pi$  bonds. The lighter components, however, form  $p\pi-p\pi$  bonds. Second-period elements have a maximum covalence of 4, however heavier elements can have a greater value due to the lack of a d orbital.

## CBSE Class 11 Chemistry Notes Chapter 11

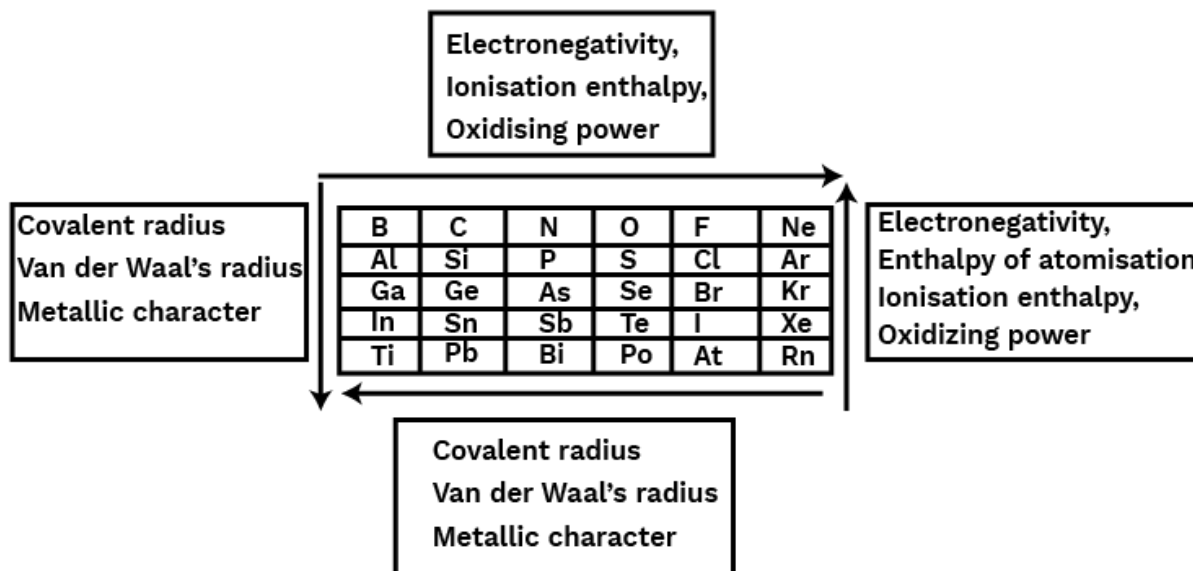
The elements in groups 13 through 18 of the periodic table comprise the p-block. The p-block contains metals, metalloids, and non-metals. The p-block components have an electrical configuration similar to a general  $ns2np1-6$  valence shell structure.

The first members of each group from 13 to 17 of the p-block elements are distinct from the other members of their respective groups in numerous respects due to their small size, strong electronegativity, and lack of d-orbitals.

In comparison to other members of the same group, the first member of a group is better able to form  $p\pi-p\pi$  multiple connections both to elements in the second row (e.g.,  $C=O, C=N, C\equiv N, N=O$ ) and to itself (e.g.,  $C=C, C\equiv C, N\equiv N$ ).

A p-block element's maximum oxidation is its group number minus 10. In groups 13 to 16, the oxidation state two less than the maximal group oxidation state becomes more stable because of the inert pair effect. (The reluctance of s-subshell electrons to form chemical bonds).

### Trends in Properties of P-Block Elements



### (A) Group 13 Elements: The Boron Family

Aluminium is a metal that shares many chemical properties with boron, while gallium, indium, and thallium are almost fully metallic. Boron is a non-metal.

#### Electronic Configuration:

The valence shell electronic configuration of elements of boron family is  $ns^2np^1$ .

#### Atomic Radii:

The atomic radius increases as one advances along the group because each consecutive member gains an extra electron shell. Compared to Al, Ga has a smaller atomic radius.

An additional 10 d-electrons only slightly reduces the outer electrons' screening effect due to gallium's larger nuclear charge. Consequently, the atomic radius of gallium (135 pm) is smaller than that of aluminium (143 pm).



#### Ionization Enthalpy

The general patterns predict that the ionisation enthalpy values will drop smoothly along the group, however this is not the case.

The decrease from B to Al corresponds with size increases. The discontinuity in ionisation enthalpy values between Al and Ga and between In and Tl is caused by the d and f electrons' low screening effect, which makes them unable to offset the increase in nuclear charge. The first three ionisation enthalpies of each element add up to a very high value.



## Electronegativity

As you go down the group, electronegativity decreases from B to Al and then considerably increases. This is because the atomic sizes of the various elements varies.

## Physical Properties

The element boron is non-metallic. It is an extremely hard solid black hue. It is available in several allotropic forms. Boron's crystalline lattice strength gives it a very high melting point. The remaining group consists of soft metals with low melting points and strong electrical conductivity. Due to its low melting point (303K), gallium may be liquid in the summer.

The high boiling point (2676K) of this substance makes it suitable for use in high temperature measurements. There is an increase in element density from boron to thallium.

## Chemical Properties

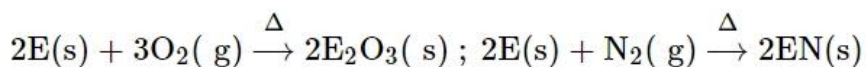
Because boron is so little, its first three ionisation enthalpies add up to a very high value. Because of this, it is unable to create +3 ions and is only able to produce covalent compounds. But when we move from B to Al, the sum of Al's first three ionisation enthalpies decreases substantially, enabling Al to form Al<sup>+3</sup> ions. Conversely, because of insufficient shielding, effective nuclear charge confines ns electrons tightly down the group, reducing their ability to participate in bonding.

Thus, the p-orbital electron may be the only electron involved in bonding. Actually, reports of +1 and +3 oxidation states have been found for Ga, In, and Tl.

These electron-deficient molecules have a proclivity to take a pair of electrons in order to reach a stable electronic state, and so act as Lewis acids. The inclination to act as Lewis acid reduces as the size of the group grows smaller. To create  $\text{BCl}_3 \cdot \text{NH}_3$ ,  $\text{BCl}_3$  simply obtains a lone pair of electrons from ammonia. Most covalent compounds are hydrolysed in water when they are in a trivalent state. The trichloride forms a tetrahedral species  $[\text{M}(\text{OH})_4]^-$  when it is hydrolysed in water; aluminium chloride forms an octahedral ion  $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$  in an acidified aqueous solution.

## Reactivity Towards Air

Boron, in its crystalline state, is non-reactive. On the surface of aluminium, a very thin oxide layer develops, protecting the metal from further assault.  $B_2O_3$  and  $Al_2O_3$  are formed when amorphous boron and aluminium metal are heated in the air. Nitrides are created when dinitrogen is heated to a high temperature.

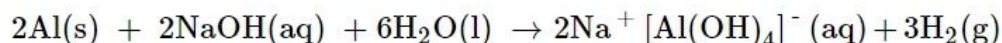
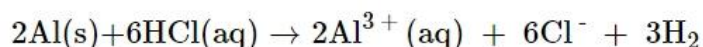


As you progress through the group, these oxides take on different characteristics. When boron trioxide, an acidic chemical, reacts with basic (metallic) oxides, it creates metal borates. Aluminium and gallium oxides are amphoteric, whereas indium and thallium oxides are basic.

## Reactivity Towards Acids and Alkalies

Although aluminium dissolves in mineral acids and aqueous alkalies, giving it an amphoteric quality, boron does not react with acids or alkalies, even at moderate temperatures. When aluminium is dissolved in diluted HCl, dihydrogen is produced.

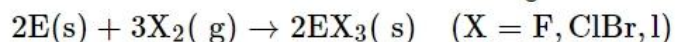
Conversely, concentrated nitric acid inactivates aluminium by covering the metal's surface with a layer of protective oxide. Dihydrogen is created when aluminium reacts with aqueous alkali.



sodium tetrahydroxoaluminate(III)

### 3. Reactivity Towards Halogens:

These elements react with halogen to form trihalides (except  $TlI_3$ ).



## Boron (B)

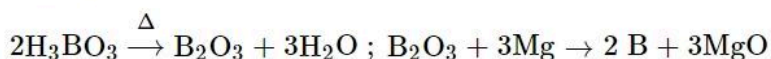
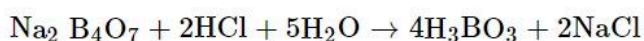
**Occurrence:**

Boron may be found in the following minerals in nature:

- i. Borax  $(\text{Na}^+)_2 \text{B}_4\text{O}_7^{2-} \cdot 10\text{H}_2\text{O}$ . (Boron is part of an anionic complex),
- ii. Boric acid  $\text{H}_3\text{BO}_3$ ,
- iii. Kernite  $\text{Na}_2 \text{B}_4\text{O}_7 \cdot 4\text{H}_2\text{O}$
- iv. Colemanite  $\text{Ca}_2 \text{B}_6\text{O}_{11} \cdot 5\text{H}_2\text{O}$

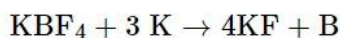
**Extraction of Boron:**

1. In the absence of oxygen, by reducing  $\text{B}_2\text{O}_3$  with magnesium, sodium, or potassium:



The product is heated with  $\text{HCl}$  and filtered after  $\text{K}_2\text{O}$  or  $\text{MgO}$  dissolves, leaving elemental boron behind. Before being dried, it is thoroughly washed to remove the  $\text{HCl}$ . This technique produces a dark amorphous boron powder  $\text{B}$ .

2. By heating potassium fluoroborate ( $\text{KBF}_4$ ) with potassium metal, you can make boron.



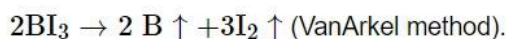
It is then treated with dilute  $\text{HCl}$  to remove  $\text{KF}$  and  $\text{B}$  is then washed and dried.

$\text{B}$  is then washed and dried after being treated with dilute  $\text{HCl}$  to eliminate  $\text{KF}$ .

3. In tiny amounts in pure form (crystalline boron) as a result of

- I. Reduction of  $\text{BBr}_3$  with  $\text{H}_2$  on a heated titanium metal filament at  $1275 - 1475 \text{ K}$ . The vapours of  $\text{Br}_2$  are absorbed in  $\text{Cu}$ , and the vapours of boron that remain are condensed.

- II. Decomposition of  $\text{BI}_3$  vapours using tungsten electrodes and a high-tension arc (80kV).

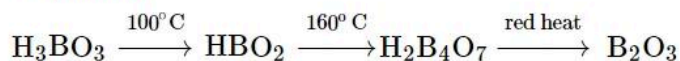
**Uses:**

Boron is utilised in the manufacture of high-impact steel and, since it absorbs neutrons, in reactor rods for atomic reaction control.

## Compounds Of Boron:

- Boron Trioxide ( $B_2O_3$ ) :

### Preparation:



boric acid

### Properties:

1. It is a slightly acidic oxide that forms borates when it interacts with alkalies or bases.  
 $3Na_2O + B_2O_3 \rightarrow 2Na_3BO_3$  (sodium orthoborate).
2. It forms orthoboric acid after a gradual reaction with water. It generates coloured compounds when heated with transition metal salts.  
 $H_2O + B_2O_3 \rightarrow 2HBO_2$ ;  $HBO_2 + H_2O \rightarrow H_3BO_3$   
 $B_2O_3 + P_2O_5 \rightleftharpoons 2BPO_4$

### Orthoboric Acid $H_3BO_3$ :

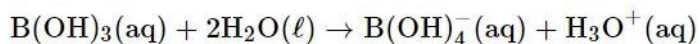
Among the oxyacids of boron are

#### Preparation:

1. A concentrated solution of borax is treated with sulphuric acid to precipitate it.  
 $Na_2 B_4O_7 + H_2SO_4 + 5H_2O \rightarrow Na_2SO_4 + 4H_3BO_3 \downarrow$
2.  $H_3BO_3$  is made by suspending powdered colemanite in water and filtering the surplus  $SO_2$ . White crystals of  $H_3BO_3$  are produced after filtering and chilling the filtrate.  
 $Ca_2 B_6O_{11} + 2SO_2 + 11H_2O \rightarrow 2Ca(HSO_3)_2 + 6H_3BO_3$

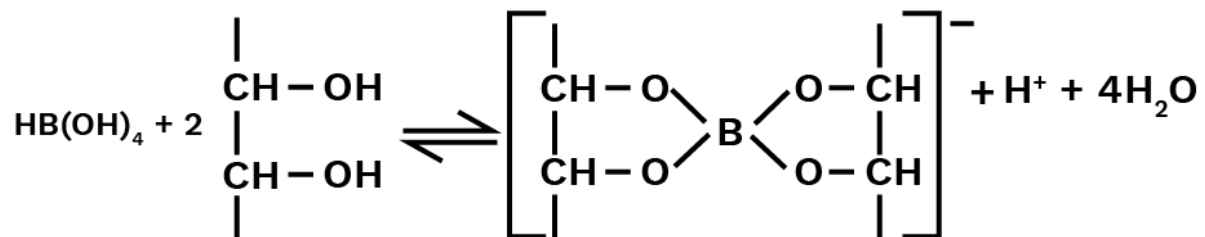
#### Properties:

1. It is a weak monobasic acid, and the boron atom completes its octet in aqueous solution by eliminating  $OH^-$  from water molecules:

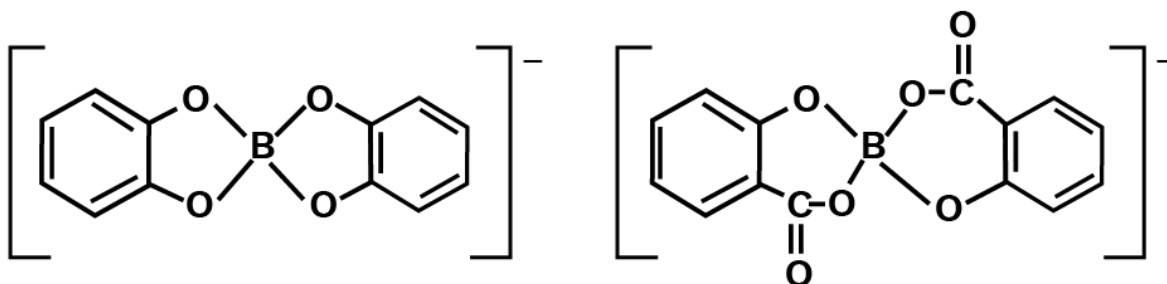


As a result, it acts as a Lewis acid rather than a proton donor. When a polyhydroxy molecule like glycol or glycerol is added to its aqueous solution, it behaves as a strong acid. The great stability of the conjugate bone chelate complex accounts for the acidity.

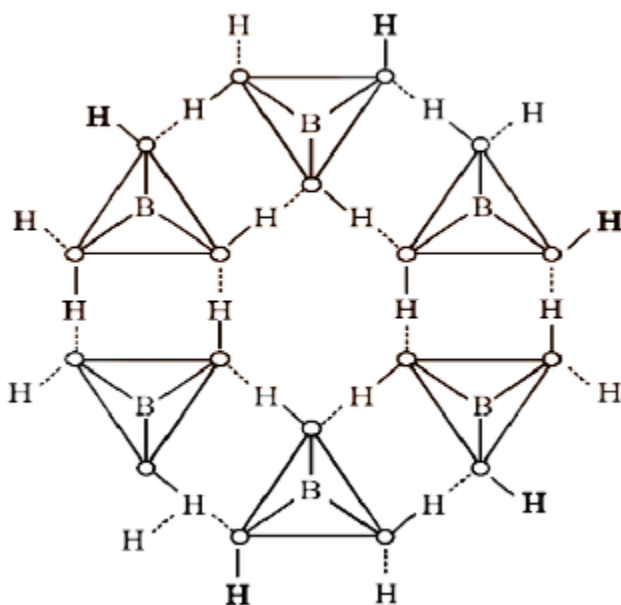




Catechol and salicylic acids create comparable complexes, but ethanol does not.



Orthoboric acid dissolves better in hot water than in cold, and it feels greasy to the touch. Planar units of  $\text{BO}_3$  are connected by hydrogen bonds to form a multilayer structure.



**Uses:**

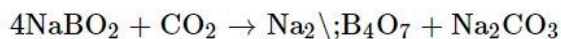
It's an antiseptic, and the water solution may be used to cleanse your eyes. In addition, it is utilised in the glass, enamel, and pottery industries.

### Preparation:

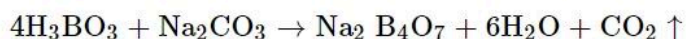
Borax can be found in nature, but it can also be produced using the methods listed below.

1. From Colemanite mineral. When colemanite powder is heated in a solution of  $\text{Na}_2\text{CO}_3$ , the precipitation of  $\text{CaCO}_3$  takes place.

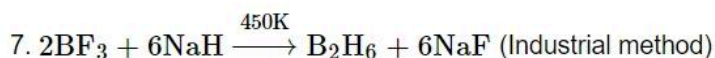
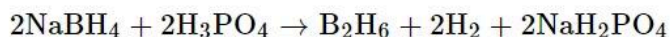
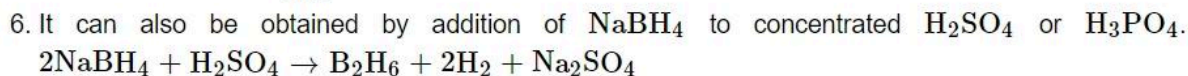
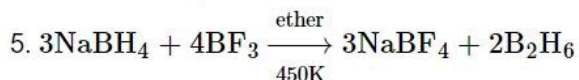
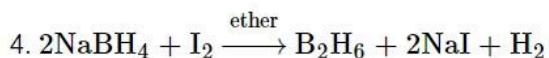
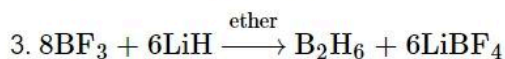
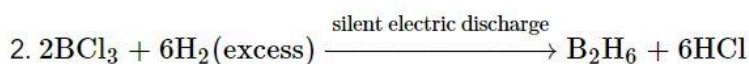
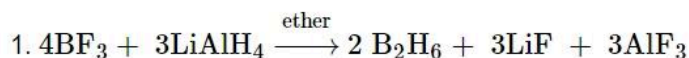
When white crystals of borax precipitate, the filtrate is cooled. On treatment with  $\text{CO}_2$ , the mother liquor changes  $\text{NaBO}_2$  to  $\text{Na}_2\text{B}_4\text{O}_7$ , which precipitates out after crystallisation.



2. From orthoboric acid. The action of  $\text{Na}_2\text{CO}_3$  on orthoboric acid produces borax.



### Preparation:



## Aluminium

### Extraction (Hall-Heroult Process)

Aluminium is extracted from the mineral ore known as bauxite ( $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ ). To start, the ore is first purified using Bayere's technique.  $\text{Al}_2\text{O}_3$  that is anhydrous is mixed and fused.

Electrolytic reduction is applied to the fused combination of  $\text{Na}_3\text{AlF}_6$  &  $\text{CaF}_2$  when aluminium is obtained at the cathode. Aluminium is purified by Hoope's technique.



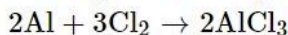
**Properties:**

Aluminium is a silvery metal with a density of 2.7 g/cc and a melting point of 660°C, as well as being an excellent heat and electrical conductor. It is ductile and malleable.

**1. Action of Air:** Dry air has no effect on aluminium. However, wet air creates a thin coating of  $\text{Al}_2\text{O}_3$  on its surface, which dulls its brilliance. It burns to create  $\text{Al}_2\text{O}_3$  and  $\text{AlN}$  at extremely high temperatures.

**2. Reaction with Halogens:**

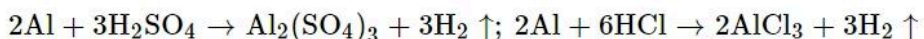
When gaseous halogens travel through aluminium, the halide forms in an anhydrous state.



**3. Action of Alkalies:** When heated with concentrated  $\text{NaOH}$ , it releases  $\text{H}_2$  gas and forms a colorless sodium aluminate solution.



**4. Action of Acids:** Aluminium interacts with both dilute  $\text{H}_2\text{SO}_4$  and  $\text{HCl}$  but not with concentrated  $\text{HNO}_3$ , since concentrated  $\text{HNO}_3$  causes aluminium to become passive, producing a protective oxide coating on the surface.

**Uses**

Aluminium is utilized for plating tanks, pipes, iron bars, and other steel items to prevent corrosion, manufacturing of aluminium cables, precise instruments, surgical apparatus, aircraft bodies, train coaches, motorboats, and automobiles.

**Compounds of Aluminium**

It's also known as alumina. It may be found in the form of bauxite and corundum in nature. It can also be found in gemstones. Topaz yellow, sapphire blue, ruby red, amethyst violet, and emerald green are some of the most important aluminium oxide stones.

**Properties:**

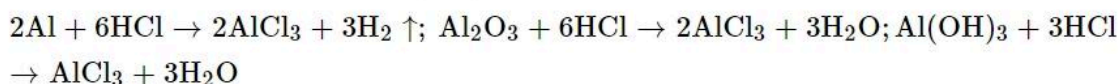
It's a white amorphous powder that's insoluble in water but soluble in acids (forming, for example  $\text{AlCl}_3$ ) and alkalies, making it amphoteric. It's a polar covalent molecule with a positive charge.

**Uses:**

It is employed in the extraction of aluminium, the creation of fake gems, the production of aluminium compounds, and the fabrication of furnace linings. As a catalyst in organic processes, it is a refractory substance.

**Preparation:**

1. By mixing aluminium,  $\text{Al}_2\text{O}_3$ , or  $\text{Al}(\text{OH})_3$  in dilute  $\text{HCl}$  :



The solution gained is filtered and crystallized and the crystals of  $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$  are obtained.

2. Anhydrous  $\text{AlCl}_3$  is obtained by the action of  $\text{Cl}_2$  on heated aluminium.

3. By heating a mixture of  $\text{Al}_2\text{O}_3$  and coke and passing chlorine over it.  
$$\text{Al}_2\text{O}_3 + 3\text{C} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3(\text{anhy.}) + 3\text{CO} \uparrow$$

**Preparation:**

## Oxidation States and Trends in Chemical Reactivity

Group 14 elements consist of four electrons in their outermost shell. The most common oxidation states for these elements are +4 and +2, along with carbon, which also exhibits negative oxidation states. Because the total of the ionisation enthalpies of the first four compounds is quite big, compounds at the +4 oxidation state are often covalent in nature. Higher in the sequence  $\text{Ge} < \text{Sn} < \text{Pb}$ , heavier components are more likely to exhibit the +2 oxidation state.

It results from the valence shell electrons'  $ns^2$  incapacity to form bonds. As one moves through the group, the relative stability of these two oxidation states changes. Only four times may carbon surpass its covalence. It is something that other gang members are capable of. The reason for this is that they contain the d orbital. As a result, their halides are hydrolyzed, and they tend to accept electron pairs from donor species to form complexes.

## Allotropes of Carbon

There are several allotropic forms of carbon, including amorphous and crystalline forms. Graphite and diamond are two well-known crystalline forms of carbon. Fullerenes are a third type of carbon that were discovered in 1985 by H.W. Kroto, E. Smalley, and R.F. Curl.

### Diamond

It has a crystalline structure. Using hybridised orbitals, each carbon atom in a diamond is joined to four other carbon atoms in a tetrahedral pattern after undergoing  $sp$  hybridization. The C-C bond has a length of 154 pm. Expanding into space, the structure forms a rigid, three-dimensional network of carbon atoms. In this structure, directional covalent bonds are present throughout the lattice.

Due to its remarkable resistance to breaking long-lasting covalent bonds, diamond is the hardest material in the universe. In addition to being used to create colours and tungsten filament for light bulbs, it is employed as an abrasive to sharpen hard tools.

### **Graphite:**

Graphite is a layered material. The layers are held together by van der Waal's forces, and there is 340 pm separating them. The carbon atoms in each layer are grouped into planar hexagonal rings. The C-C bond length in the layer is 141.5 pm. Every carbon atom in a hexagonal ring undergoes  $sp^2$  hybridization, resulting in the formation of three sigma bonds with neighbouring carbon atoms. And the fourth electron forms a  $\pi$  bond.

The sheet is filled with scattered electrons. Graphite transfers electricity throughout the sheet because electrons are movable. Graphite cleaves easily between the layers, making it especially slick and smooth. Consequently, in machines that cannot utilise oil and must run at high temperatures, graphite is used as a dry lubricant.

### **Fullerenes:**

Graphite is heated in an electrical arc with inert gases like argon or helium to produce fullerenes. Fullerenes are the only pure form of carbon due to its smooth shape and absence of "dangling" connections. One type of molecule that resembles a cage is called a fullerene. The  $C_{60}$  compound known as buckminsterfullerene resembles a football.

This set consists of twelve five-membered rings and twenty six-membered rings. A ring with six members can be fused with any other ring that has six members, whereas a ring with five members can only be fused with other rings that have six members. Every carbon atom is identical and experiences  $sp^2$  hybridization.

## **Uses of Carbon**

Plastic is mixed with graphite fibres to create composite materials that are lightweight and highly durable. Composites are used to make canoes, fishing rods, planes, and tennis rackets. Because graphite is a great conductor, it is utilised for industrial electrolysis and as electrodes in batteries.

Acids and alkalies cannot be diluted using graphite crucibles. Activated charcoal is employed in air conditioning systems to control odour, water filters to eliminate organic pollutants, and hazardous gas absorbers. Carbon black finds application as a dark pigment in black ink and as a filler in automobile tyres. Coke is mostly used as fuel and as a reducing agent in metallurgy. A precious stone used in jewellery is the diamond.

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- Additionally, all of these materials are available for download on our website. Students can use these files a day or two prior to the exam to help them prepare more effectively.
- All necessary notes are available for free of charge.
- Along with these, students can also receive the appropriate help with their syllabus, questions about any subject, and other related

A revision note is one that is extremely vital and can be created by students or by other outside providers. It is used to write down calculations, crucial information, and things to keep in mind. Additionally, because it is convenient, students can make the most of it by having it with them throughout tests.