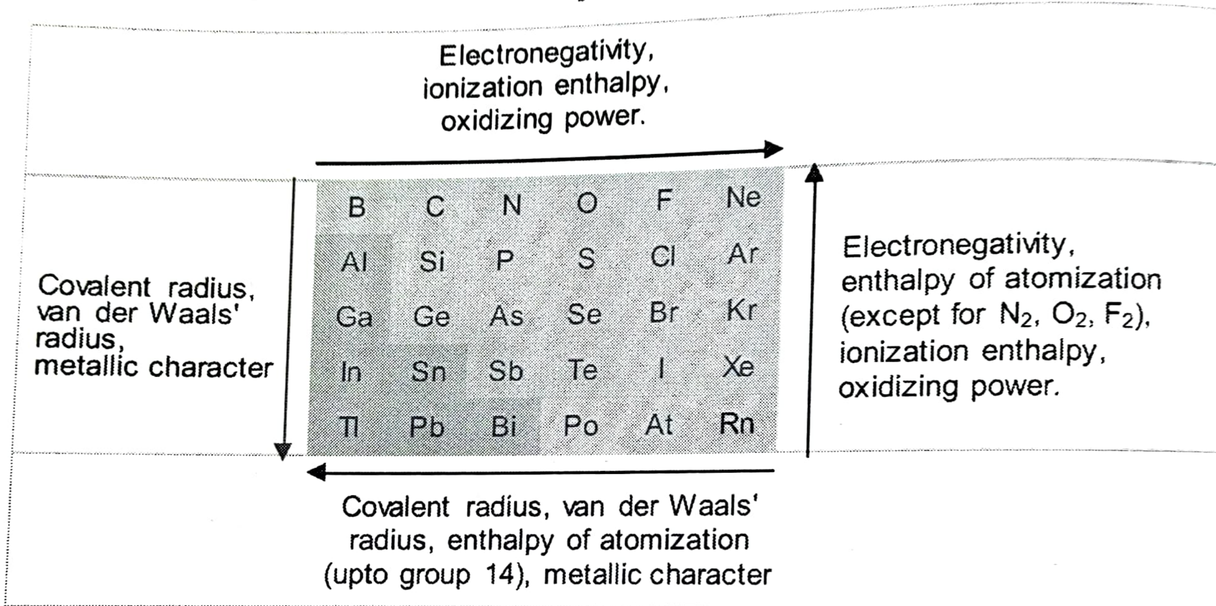
TRENDS IN PROPERTIES OF p-BLOCK ELEMENTS.



(A) GROUP 13 ELEMENTS : THE BORON FAMILY

Oxidation state and trends in chemical reactivity :

General Oxidation State = + 3.

Reactivity towards acids and alkalies

$$2\,Al(s) + 6\,HCl(aq) \longrightarrow 2\,Al^{3+}(aq) + 6\,Cl^{-}(aq) + 3\,H_2(g)$$

$$2Al(s) + 2NaOH\,(aq) + 6H_2O\,(1) \longrightarrow 2Na^{+}[Al(OH)_4]^{-}(aq) + 3H_2(g)$$

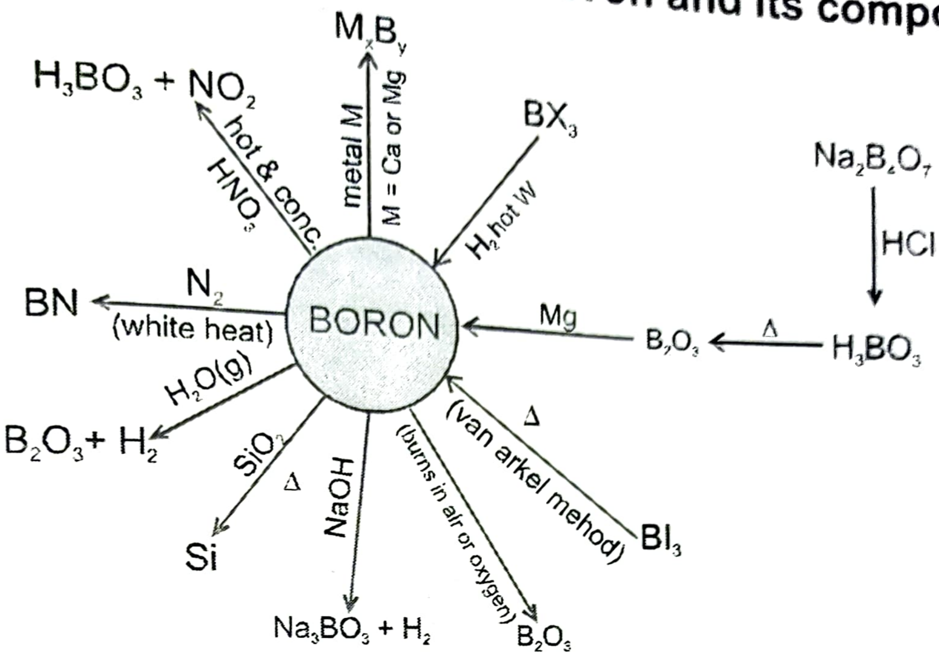
Sodium tetrahydroxoaluminate (III)

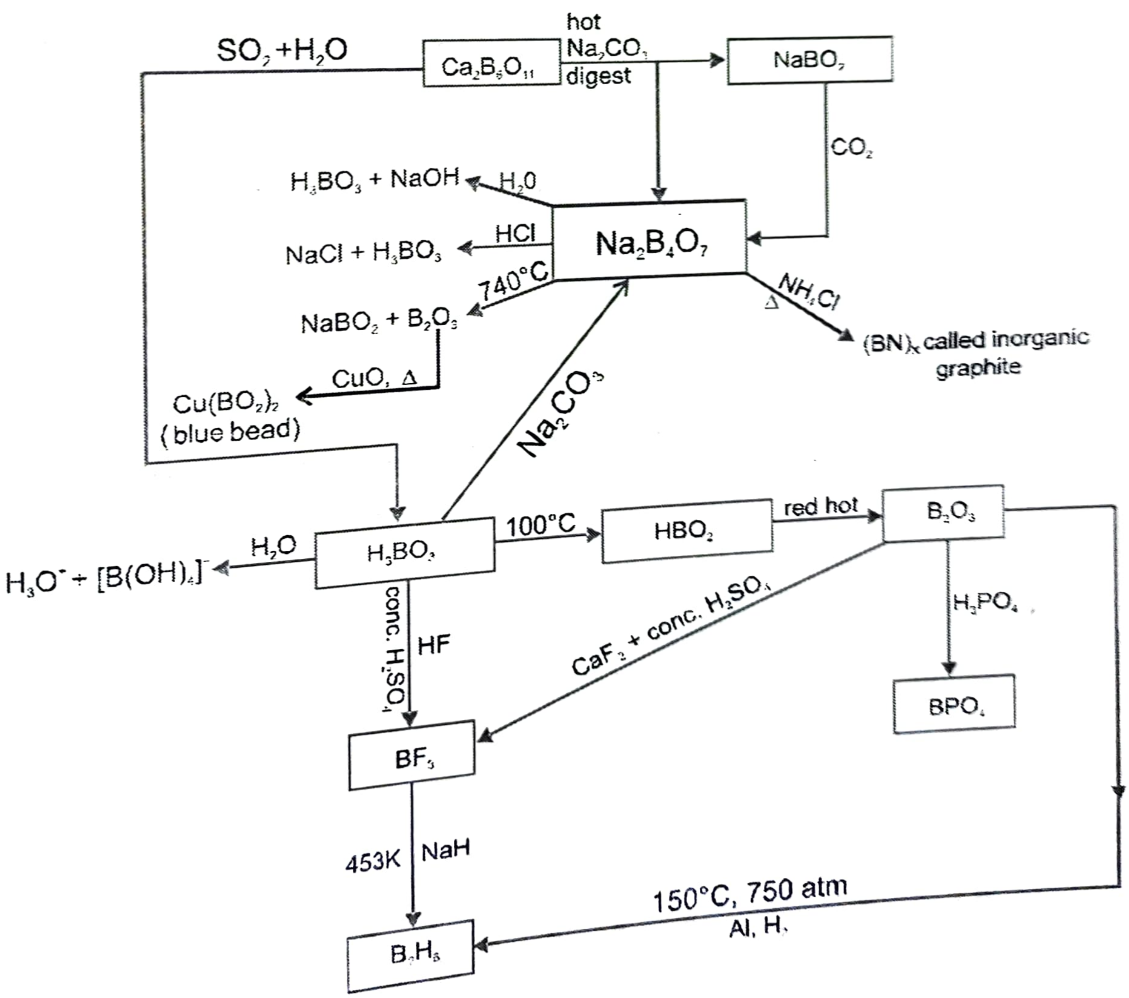
Reactivity towards halogens

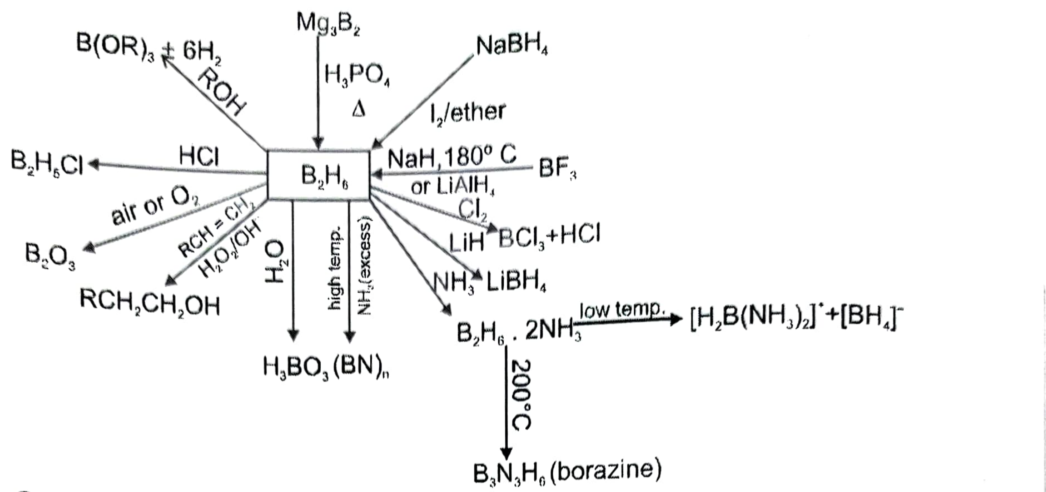
$$2E(s) + 3X_2\,(g) \rightarrow 2EX_3\,(s) \qquad (X = F, Cl\ Br, I)$$

BORON (B):

Some Important Reactions of Boron and its compounds :







○ Small amines such as NH_3, CH_3NH_2 and $(CH_3)_2NH$ give unsymmetrical cleavage of diborane.

$$B_2H_6 + 2NH_3 \longrightarrow [H_2B(NH_3)_2]^+ + [BH_4]^-$$

○ Large amines such as $(CH_3)_3N$ and pyridine give symmetrical cleavage of diborane.

$$2(CH_3)_3N + B_2H_6 \longrightarrow 2H_3B \longleftarrow N(CH_3)_3$$

○ $$B_2H_6 + 2CO \xrightarrow{200°C,\ 20\ atm} 2BH_3CO \text{ (borane carbonyl)}$$

(B) GROUP 14 ELEMENTS : THE CARBON FAMILY

Carbon (C), silicon (Si), germanium (Ge), tin (Sn) and lead (Pb) are the members of group 14.

Electronic Configuration = $ns^2 np^2$.

Oxidation states and trends in chemical reactivity

Common oxidation states = +4 and +2. Carbon also exhibits negative oxidation states. In heavier members the tendency to show +2 oxidation state increases in the sequence Ge < Sn < Pb.

(i) Reactivity towards oxygen :

All members when heated in oxygen form oxides. There are mainly two types of oxides, i.e. monoxide and dioxide of formula MO and MO_2 respectively.

(ii) Reactivity towards water :

Tin decomposes steam to form dioxide and dihydrogen gas.

(iii) Reactivity towards halogen :

These elements can form halides of formula MX_2 and MX_4 (where X = F, Cl Br, I). Stabilitv of dihalides increases down the group.

ANOMALOUS BEHAVIOUR OF CARBON :

Catenation :

The order of catenation is C > > Si > Ge ≈ Sn. Lead does not show catenation. Due to the property of catenation and pπ-pπ bonds formation, carbon is able to show allotropic forms.

Bond	Bond enthalpy (kJ mol^{-1})	Bond	Bond enthalpy (kJ mol^{-1})
C—C	348	Si—Si	297
Ge—Ge	260	Sn—Sn	240

Allotropes of Carbon

Diamond :

Crystalline lattice sp^3 hybridisation and linked to four other carbon atoms by using hybridised orbitals in tetrahedral manner. The C–C bond length is 154 pm. and produces a rigid three dimensional network of carbon atoms.

Graphite :

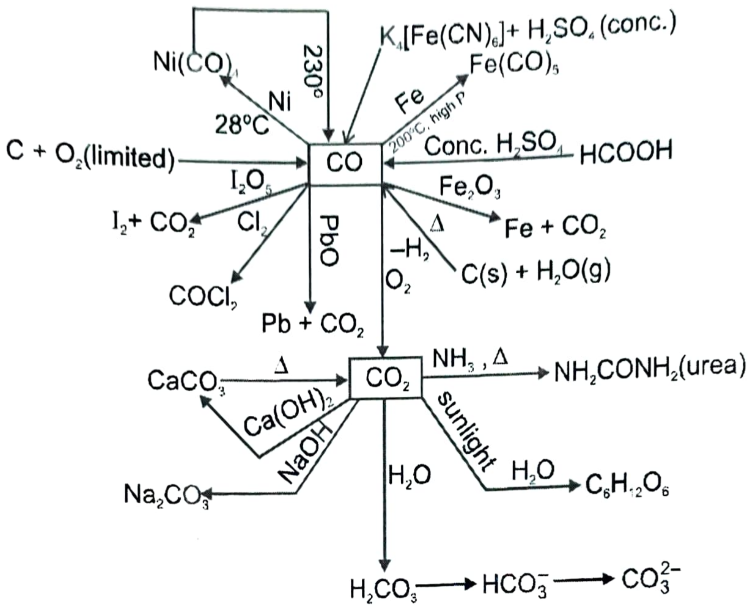
Graphite has layered structure. Layers are held by van der Waal's forces and distance between two layers is 340 pm. Each layer is composed of planar hexagonal rings of carbon atoms. C – C bond length within the layer is 141.5 pm. Each carbon atom in hexagonal ring undergoes sp^2 hybridisation graphite conducts electricity along the sheet. Graphite cleaves easily between the layers and therefore, it is very soft and slippery. For this reason graphite is used as a dry lubricant in machines running at high temperature.

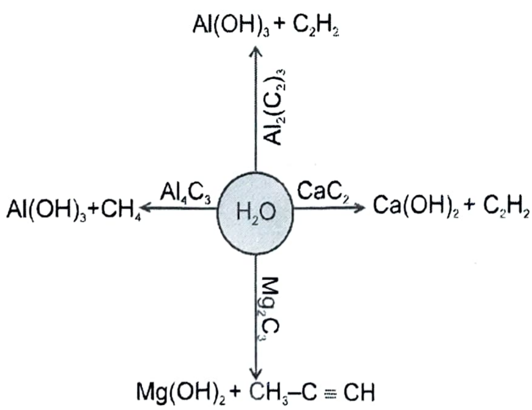
Fullerenes :

C_{60} molecule has a shape like soccer ball and called **Buckminsterfullerene.** It contains twenty six -membered rings and twelve five membered rings. This ball shaped molecule has 60 vertices and each one is occupied by one carbon atom and it also contains both single and double bonds with C – C distance of 143.5 pm and 138.3 pm respectively.

C_{70} – 25 hexagonal rings.

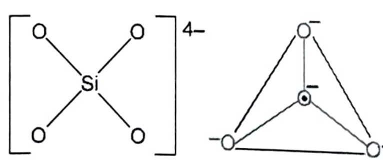
SOME IMPORTANT REACTIONS OF CO, CO_2 AND METAL CARBIDES :





CLASSIFICATION OF SILICATES :

(A) Orthosilicates :

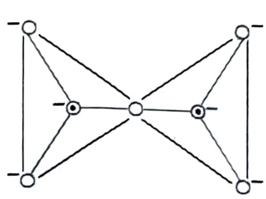


O = Oxygen
• = Silicon

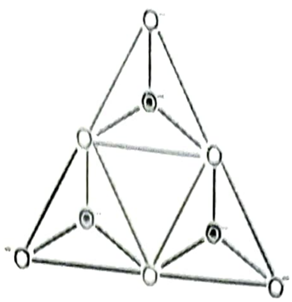
	Tecto (3D)	Chain	Ring	Ortho	Sheet	Pyro	Double chain
Si	1	1	1	1	2	2	4
O	2	3	3	4	5	7	11

3D

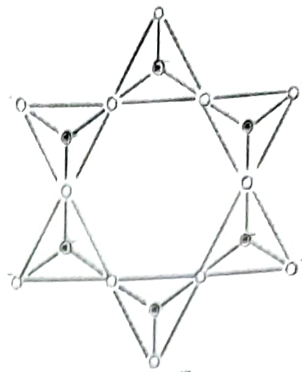
(B) Pyrosilicate :



(C) **Cyclic silicates :**

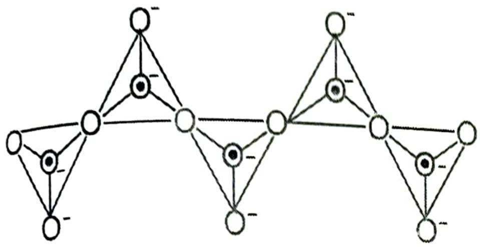


$Si_3O_9^{6-}$

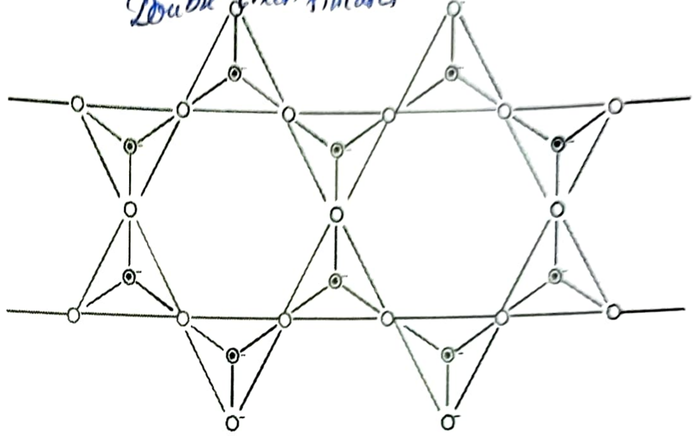


$Si_6O_{18}^{12-}$

(D) **Chain silicates :**



Double chain silicates



(E) **Two dimensional sheet silicates :**

In such silicates, three oxygen atoms of each tetrahedral are shared with adjacent SiO_4^{4-} tetrahedrals. Such sharing forms two dimension sheet structure with general formula $(Si_2O_5)_n^{2n-}$

(F) **Three dimenstional sheet silicates :**

These silicates involve all four oxygen atom in sharing with adjacent SiO_4^{4-} tetrahedral units.

SILICONES :

Silicones can be prepared from the following types of compounds only.

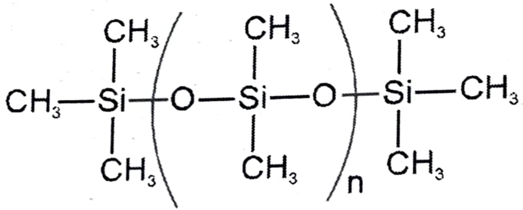
(i) R_3SiCl (ii) R_2SiCl_2 (iii) $RSiCl_3$

Silicones from the hydrolysis of $(CH_3)_3SiCl$

$$2\,(CH_3)_3SiCl \xrightarrow{H_2O} 2(CH_3)_3Si(OH) \longrightarrow$$

$$CH_3-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large CH_3}{|}}{Si}}-OH + HO-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large CH_3}{|}}{Si}}-CH_3 \xrightarrow{-H_2O} CH_3-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large CH_3}{|}}{Si}}-O-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large CH_3}{|}}{Si}}-CH_3$$

Silicones from the hydrolysis of a mixture of $(CH_3)_3$ SiCl & $(CH_3)_2$ $SiCl_2$



When a compound like CH_3SiCl_3 undergoes hydrolysis, a complex cross-linked polymer is obtained.

The hydrocarbon layer along the silicon-oxygen chain makes silicones water-repellent.