THE P-BLOCK ELEMENTS

GROUP 13 BORON FAMILY

B · Al · Ga · In · Tl

Atomic & Physical Properties

- Electronic configuration: [Noble gas] ns^2np^1
- Oxidation State: +1 & +3
- Metallic character : B (Metalloid) — Al, Ge, In, Tl (Metals)
- Atomic radii, ionic radii, density & stability of +1 oxidation state: Generally increase down the group.
- Boiling point & stability of +3 oxidation state: Decreases down the group.
- Electronegativity: First decreases from B to Al & increases from Al to Ga & then dec. marginally down the group.
- Melting point: Dec. from B to Ga then increases.
- Ionisation Energy: B > Tl > Ga > Al > In
- Lewis Acid: BCl_3, $AlCl_3$ etc behaves as Lewis Acid due to incomplete octet.
- Complex formation: Due to small size, high charge density & availability of vacant d-orbitals.

Chemical Properties

- Reactivity towards Air: $4E + 3O_2 \xrightarrow{\Delta} 2E_2O_3$
  - B_2O_3 (Acidi), Al_2O_3, Ga_2O_3 (Amphoteri), In_2O_3, Tl_2O_3 (Basic)
- $2E + N_2 \xrightarrow{\Delta} 2EN$ {Except + Ga, In, Tl}
- Reactivity towards alkalies: $2B + 6KOH \xrightarrow{773\ K} 2K_3BO_3 + 3H_2$
- Reactivity towards halogens: $2E + 3X_2 \longrightarrow 2EX_3$ (Except Tl_3)
- Reactivity towards Acids: $B + 3HNO_3 \xrightarrow[\Delta]{Con.H_2SO_4} H_3BO_3 + 3NO_2$

Silicates

- Basic Unit is SiO_4^{4-}
- They exist in different structures like chain, ring, sheet or 3-D structure.
- Zeolites are 3-D Silicates in which some of the Si atoms are replaced by Al+3 ions. They are used in water softening.

Anomalous Behaviour of Boron

- Difference in behaviour of B is due to small size high ionisation energy & absence of d-orbital.
- B has high M.P. & B.P.
- B exhibits allotrpy.
- B forms only covalent compounds.

Important Compounds of C & Si

Carbon Monoxide (CO)

- Preparation:
  - $C + 2H_2O \longrightarrow \underbrace{CO + H_2}_{\text{watergas}}$
  - $2C + O_2 + 4N_2 \xrightarrow{123\ K} \underbrace{2CO + 4N_2}_{\text{Producergas}}$
- Highly poisnous due to formation of a complex with haemoglobin.

Silicon Dioxide (SiO_2)

- Covalent, three dimensional network solid.
- Almost non-reactive due to high Si—O bond enthalpy.

Silicons

- Contains repeated R_2SiO units held by Si - O - Si linkage.
- They are water repelling due to non-polar alkyl groups.

Carbondioxide (CO2)

- Preparation: $CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$
- It is consumed during photosynthesis: $6CO_2 + 12H_2O \xrightarrow{h\nu} C_6H_{12}O_6 + 6O_2 + 6H_2O$

GROUP 14 CARBON FAMILY

C · Si · Ge · Sn · Pb

Chemical Properties

- Reactivity towards air: They form oxides of the formula EO and EO_2 on heating with air.
- Acidic Strength of their oxides dec. down the group.
  - $\underbrace{CO_2, SiO_2}_{\text{Acidic}}$ $\underbrace{GeO_2}_{\text{LessAcidic}}$ $\underbrace{SnO_2, PbO_2}_{\text{Amphoteric}}$
- Reactivity towards water: only Sn can decompose.
  - water $\longrightarrow Sn + 2H_2O \xrightarrow{\Delta} SnO_2 + 2H_2$
- Reactivity towards halogen: Except C, all reacts directly with halogens.

Atomic and Physical Properties

- Electronic configuration: [Noble gas] $ns_2\ np_2$
- Oxidation State: +2 & +4
- Atomic radii, metallic character & stability of +2 O.S: Generally increase down the group.
- Catenation: Decreases down the group.
- Allotropy: Except Pb, all other show allotropy.
- Complex compounds formed by all except C due to presence of vacant d-orbital.

Anomalous Behaviour of C

- Due to small size, high ionisation energy & absence of d-orbitals.
- C is hardest having m Pt & b Pt amont the elements of 9-14.
- Shows maximum covalency of 4 while rest show maximum of 6.
- C has maximum tendency for catenation & multiple bonding ($p\pi$-$p\pi$) & show allotropy.

Important Compounds of Boron

Borax

$Na_2B_4O_7 \cdot 10H_2O$

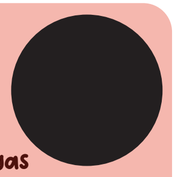
White Crystalline Solid

preparation: $4H_3BO_3 + Na_2CO_3 \longrightarrow Na_2B_4O_7 + 6H_2O + CO_2$

reaction: $Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + 4H_3BO_3$

Diborane

B_2H_6



Colourless, highly toxic gas

preparation: $2BF_3 + 6NaH \xrightarrow{456\ K} B_2H_6 + 6NaF$

reaction: $B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$

Orthoboric Acid (H_3BO_3)

H_3BO_3

White crystalline solid with soapy touch

preparation: $Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 2NaCl + 4H_3BO_3$

reaction: $H_3BO_3 \xrightarrow{370K} \underbrace{HBO_2}_{\text{Monoboric acid}} + H_2O$