

Complete  
**CHEMISTRY**

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CLASS 11 & 12th



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CLASS 11th

# P-Block Elements

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## 01. Physical Properties

## (i) Atomic Size

Atomic Number	Atomic Radil	Element	Metallic Character
5	85 pm	B	Non-metal
13	143 pm	Al	Metal
31	135 pm	Ga	Metal
49	167 pm	In	Metal
81	170 pm	Tl	Metal

## (ii) Electronegativity

Atoms	B	Al	Ga	In	Tl
Electronegativity	2	1.5	1.6	1.7	1.8

Due to poor shielding of  $3d$  and  $4d$  and lanthanoid contraction.

## (iii) Ionization Energy

$B > Tl > Ga > Al > In$

## (iv) Oxidation States

Stability of +3 oxidation state decreases down the group due to inert pair effect, as well stability of +1 oxidation state increases.

## (v) Melting Point

$B > Al > Tl > In > Ga$

Ga has an unusual structure. It consists of only  $Ga_2$  molecules it has, thus low melting point.

## (vi) Boiling Point

$B > Al > Ga > In > Tl$

**NOTE**  Indium in +1 oxidation state is reducing agent.

## (i) Reactivity towards air

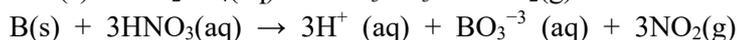
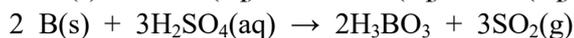
$B_2O_3$	—	Acidic Oxide
$AlO_3$	—	Amphoteric Oxide
$Ga_2O_3$	—	Amphoteric Oxide
$In_2O_3$	—	Basic Oxide
$Tl_2O_3$	—	Basic Oxide



$B_2O_3$  is called boric anhydride as it is anhydride of boric acid

(ii) **Reactivity towards acids**

Boron is not affected by acids agents like HCl and dil.  $\text{H}_2\text{SO}_4$  while all other elements react with conc.  $\text{H}_2\text{SO}_4$  and  $\text{HNO}_3$  Ga and Al develop protective layer of oxide with conc.  $\text{HNO}_3$ .

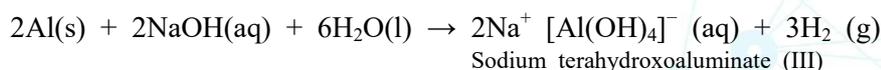


(iii) **Reactivity towards alkalis**

Except indium and thallium all other elements react with alkali solutions



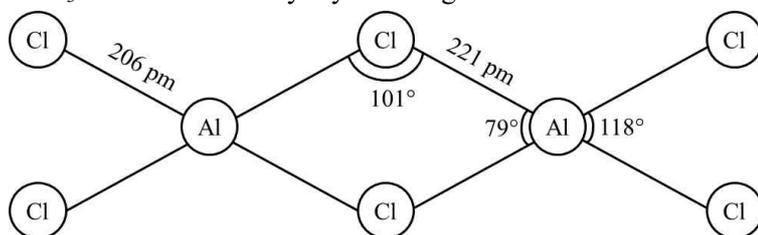
Example, Al also reacts with aq. Alkali and liberates dihydrogen.



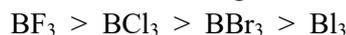
(iv) **Reactivity towards halogens**

Trihalides are formed when these elements react with halogens. All these halides exist as discrete molecular species which are  $sp^2$  hybridised and covalently bonded.  $\text{TlI}_3$  is unstable.

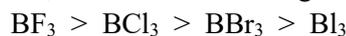
$\text{AlCl}_3$  achieves stability by forming a dimer.



Acidic strength is inversely proportional to back-bonding, as back-bonding decreases from  $\text{BF}_3$  to  $\text{BI}_3$  as given below



Hence, Lewis acidic strength will increase as under



$p\pi-p\pi$  back-bonding is strongest in  $\text{BF}_3$  because both B and F involve  $2p$  orbital in back-bonding. Stability of halides in +3 oxidation state decreases down the group.

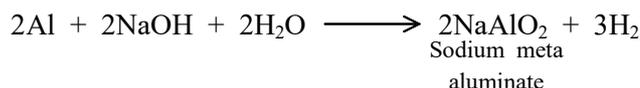
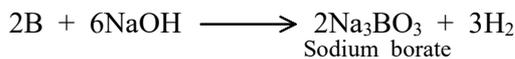
**Anomalous Behaviour of Boron**

- (i) Boron has very small atomic radii, hence greater nuclear attraction on the outermost electrons. It has very high ionisation energy. This gives boron distinctly non-metallic character while the rest are metals.
- (ii) Boron has maximum covalency of four due to non-availability of  $d$ -orbitals while the rest have maximum covalency of six.
- (iii) Boron alone exhibits allotropy.
- (iv) Boron shows +3 oxidation state while others can show +1 and +3 oxidation states.

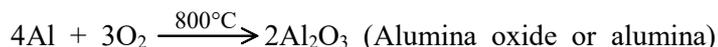
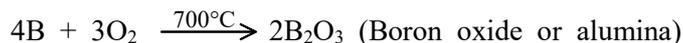
**Comparison of Boron and Aluminium**

- (i) Same Electronic Configuration
- (ii) Same Valency
- (iii) Same Oxidation State

(iv) **Action of alkalis**



(v) **Formation of oxides**



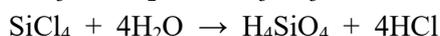
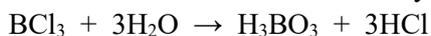
**Dissimilarities between Boron and Aluminium**

Boron and aluminium show dissimilarities in properties due to difference in their electronic configuration, size and ionisation potential. Main points of difference are given in the table.

Boron	Aluminium
(i) Boron is a non-metal	Aluminium is a metal.
(ii) It is a bad conductor of heat and electricity.	It is a good conductor of heat and electricity.
(iii) It has high melting point (m.pt. 2300°C).	It has low melting point (m. pt. 660°C).
(iv) Boron shows allotropy. The allotropic forms are crystalline boron and amorphous boron.	Aluminium does not show allotropy.
(v) Borates are very stable.	Aluminates are less stable.

**Diagonal Relationship of Boron and Silicon**

- (i) Both boron and silicon are non-metals. Both have high melting points [B = 2300°C; Si = 1410°C], high ionisation energies (B = 8.3 eV, Si = 8.20 eV) and are bad conductors of electricity at normal temperature. However, the conductance improves as the temperature increases. Hence, both are semiconductors.
- (ii) Both have nearly equal densities, electronegativities [Density B = 3.30 g mL<sup>-1</sup>; Si = 3.52 g mL<sup>-1</sup>; Electronegativity B = 2.0; Al = 1.8]
- (iii) Both boron and silicon show allotropy.
- (iv) Both Boron and silicon do not form cations as their ionisation energy is very high.
- (v) Most of the compounds of boron and silicon are covalent.
- (vi) Halides of boron and silicon are hydrolysed.



- (vii) Both react with fused alkalis and evolves hydrogen.

