



ChapterNotes

chapternotes.in · free NEET & JEE prep

CHAPTER NOTES

The p-Block Elements Class 11 Notes | CBSE Chemistry Chapter 10

- ✓ Chapter-wise notes & important questions
- ✓ Free gamified practice app — streaks, levels, revision
- ✓ Free mock & prediction papers with answer keys

Source: <https://chapternotes.in/cbse/class-11-chemistry/the-p-block-elements-class-11-notes/>



Scan to practice this
chapter free in the app

The p-Block Elements Class 11 Notes | CBSE Chemistry Chapter 10

The p-Block Elements is Chapter 10 of CBSE Class 11 Chemistry — the first big “descriptive inorganic” chapter where you stop calculating and start understanding the *personality* of elements. It covers Group 13 (the boron family) and Group 14 (the carbon family): their periodic trends, the odd-one-out behaviour of boron and carbon, and the handful of compounds that examiners ask about every single year.

By the end of these notes you will know why boron behaves differently from the rest of its group, why carbon forms millions of compounds while silicon forms thousands, and you will be able to recall the structure and uses of borax, boric acid, diborane, CO, CO₂, silicones, silicates, and zeolites on demand. This is a steady scoring chapter carrying roughly 6–8 marks in boards, and a reliable source of fact-based MCQs in NEET and JEE.

Table of Contents

- Key Concepts — general introduction to p-block, Group 13, Group 14, important compounds
 - Weightage in Board & Entrance Exams
 - Important Definitions
 - Solved Examples
 - Important Questions for Board Exams
 - Quick Revision Points
-

Key Concepts

1. General Introduction to the p-Block

The **p-block** contains elements in which the last electron enters one of the three p-orbitals of their outermost shell. It spans Groups 13 to 18 of the periodic table, and its general outer electronic configuration is **ns²np^{1–6}**.

This block is special because it holds metals, non-metals, and metalloids all together — the only block where all three appear. The non-metallic character is strongest at the top-right and metallic character increases as you go down and to the left.

The Inert Pair Effect

As we move down a group, the tendency of the two ns electrons to remain paired and not participate in bonding increases. This is called the **inert pair effect**, and it explains why the lower oxidation state becomes more stable down a group (e.g., Tl⁺ is more stable than Tl³⁺, and Pb²⁺ more stable than Pb⁴⁺).

2. Group 13 — The Boron Family

Group 13 consists of **boron (B)**, **aluminium (Al)**, **gallium (Ga)**, **indium (In)**, and **thallium (Tl)**. Their general outer electronic configuration is ns^2np^1 .

Boron is a non-metal (a metalloid); all the others are metals. The common oxidation state is +3, but due to the inert pair effect the +1 state becomes increasingly stable down the group.

Trends in Group 13

- **Atomic radius:** increases down the group, but Ga is slightly smaller than Al (poor shielding by 3d electrons).
 - **Ionisation enthalpy:** decreases down the group overall (with minor irregularities).
 - **Metallic character:** increases down the group — B is a metalloid, Tl is a soft metal.
 - **Oxidation state:** +3 dominates at the top; +1 stability rises down the group due to inert pair effect.
 - **Nature of oxides:** B_2O_3 is acidic, Al_2O_3 and Ga_2O_3 are amphoteric, In_2O_3 and Tl_2O_3 are basic.
-

3. Anomalous Behaviour of Boron

Boron, the first member of Group 13, differs sharply from the rest of its family. This is due to its **small size, high ionisation enthalpy, high electronegativity, and the absence of d-orbitals** in its valence shell.

- Boron is a non-metal (metalloid); the rest are metals.
- Boron is never found as a B^{3+} ion — it forms only covalent compounds, while others can form ionic compounds.
- The maximum covalency of boron is 4 (no d-orbitals), whereas heavier members can expand their covalency beyond 4.
- Boron forms electron-deficient compounds like BF_3 and diborane (B_2H_6).

Diagonal relationship: Boron resembles silicon (the diagonally placed element of Group 14) more than it resembles aluminium — for example, both B and Si form covalent, polymeric, acidic oxides.

4. Important Compounds of Boron

Borax ($Na_2B_4O_7 \cdot 10H_2O$)

Borax is sodium tetraborate decahydrate, a white crystalline solid. Its correct structural formula is $Na_2[B_4O_5(OH)_4] \cdot 8H_2O$, containing two triangular (BO_3) and two tetrahedral (BO_4) units.

- An aqueous solution of borax is alkaline (it hydrolyses), so it acts as a buffer.
- **Borax bead test:** on heating, borax swells and then melts to a transparent glassy bead of sodium metaborate and boric anhydride ($NaBO_2 + B_2O_3$), used to identify coloured metal ions.
- Reaction on heating: $Na_2B_4O_7 \cdot 10H_2O \rightarrow 2NaBO_2 + B_2O_3 + 10H_2O$.

Orthoboric Acid (H_3BO_3)

Boric acid is a white, soft, soapy solid with a layered structure in which planar BO_3 units are joined by hydrogen bonds.

- It is a weak monobasic acid — but not a protonic acid. It acts as a Lewis acid by accepting OH^- from water: $\text{B}(\text{OH})_3 + 2\text{H}_2\text{O} \rightarrow [\text{B}(\text{OH})_4]^- + \text{H}_3\text{O}^+$.
- On heating, it loses water in steps: $\text{H}_3\text{BO}_3 \rightarrow \text{HBO}_2$ (metaboric acid) $\rightarrow \text{B}_2\text{O}_3$ (boric anhydride).
- Used as a mild antiseptic and in the glass/ceramics industry.

Diborane (B_2H_6)

Diborane is the simplest boron hydride, a colourless, toxic gas that catches fire spontaneously in air. It is an **electron-deficient molecule**.

[DIAGRAM: B_2H_6 structure — two boron atoms each bonded to two terminal H atoms by normal covalent bonds, and bridged by two H atoms through three-centre two-electron (banana) bonds.]

- It contains four terminal B–H bonds (normal 2-centre 2-electron bonds) and two bridging B–H–B bonds (3-centre 2-electron “banana” bonds).
- Combustion: $\text{B}_2\text{H}_6 + 3\text{O}_2 \rightarrow \text{B}_2\text{O}_3 + 3\text{H}_2\text{O}$ (highly exothermic).
- With ammonia it gives borazine ($\text{B}_3\text{N}_6\text{H}_6$), called “inorganic benzene”.

5. Aluminium

Aluminium is the most abundant metal in the Earth’s crust. It is a silvery-white, light, malleable metal showing the +3 oxidation state, and it is the most important member of Group 13 commercially.

- **Amphoteric nature:** aluminium and its oxide react with both acids and alkalis.
 $2\text{Al} + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2$; $2\text{Al} + 2\text{NaOH} + 2\text{H}_2\text{O} \rightarrow 2\text{NaAlO}_2 + 3\text{H}_2$.
- **Passivity:** a thin, tough oxide layer protects aluminium from further corrosion, so concentrated HNO_3 renders it passive.
- AlCl_3 exists as a dimer (Al_2Cl_6) in the vapour and non-polar solvents, completing aluminium’s octet.
- Used in alloys (duralumin), electrical cables, packaging, and as a reducing agent in the thermite process.

6. Group 14 — The Carbon Family

Group 14 consists of **carbon (C)**, **silicon (Si)**, **germanium (Ge)**, **tin (Sn)**, and **lead (Pb)**. Their general outer electronic configuration is ns^2np^2 .

The group shows a clear shift from non-metal to metal: carbon is a non-metal, silicon and germanium are metalloids, and tin and lead are metals. The common oxidation states are +4 and +2.

Trends in Group 14

- **Atomic radius:** increases down the group; the increase from C to Si is large, then small thereafter.
 - **Metallic character:** increases down the group (C → non-metal, Sn, Pb → metals).
 - **Oxidation state:** +4 is stable at the top; +2 stability rises down the group ($\text{Pb}^{2+} > \text{Pb}^{4+}$) due to the inert pair effect.
 - **Catenation:** the self-linking ability decreases down the group: $\text{C} \gg \text{Si} > \text{Ge} \approx \text{Sn} \gg \text{Pb}$. The strong C–C bond explains the millions of carbon compounds.
 - **Nature of oxides:** CO_2 and SiO_2 are acidic, GeO_2 is weakly acidic, SnO_2 and PbO_2 are amphoteric.
-

7. Anomalous Behaviour of Carbon & Allotropes

Carbon, like boron, differs from the rest of its group because of its **small size, high electronegativity, high ionisation enthalpy, and the absence of d-orbitals**. Two unique features stand out: its maximum covalency is 4, and it has an exceptional ability for catenation and $\text{p}\pi\text{--p}\pi$ multiple bonding.

Allotropes of Carbon

- **Diamond:** each carbon is sp^3 hybridised and bonded tetrahedrally to four others, forming a rigid 3-D network. It is the hardest natural substance and does not conduct electricity.
- **Graphite:** each carbon is sp^2 hybridised, forming planar hexagonal layers held by weak van der Waals forces. The delocalised electrons make it a good conductor and a lubricant.
- **Fullerenes (e.g., C_{60}):** cage-like molecules ("buckyballs") with both 5- and 6-membered rings; the only pure, neat allotrope.

[TABLE: Diamond is sp^3 , 3-D, hard, insulator; Graphite is sp^2 , 2-D layers, soft, conductor; Fullerene is sp^2 , spherical cage, molecular solid.]

8. Oxides of Carbon — CO and CO_2

Carbon Monoxide (CO)

Carbon monoxide is a colourless, odourless, highly poisonous gas formed by the incomplete combustion of carbon. It is neutral and a powerful reducing agent.

- It is toxic because it binds to haemoglobin about 300 times more strongly than oxygen, forming carboxyhaemoglobin and blocking oxygen transport.
- It is a good reducing agent, used in metallurgy: $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$.

Carbon Dioxide (CO_2)

Carbon dioxide is a colourless, odourless acidic gas. It is a linear, non-polar molecule ($\text{O}=\text{C}=\text{O}$) and the main greenhouse gas responsible for global warming.

- It dissolves in water to form weak carbonic acid: $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3$.
- Solid CO_2 ("dry ice") sublimates directly and is used as a refrigerant.

- Essential for photosynthesis, which keeps the carbon cycle balanced.
-

9. Silicones

Silicones are synthetic organosilicon polymers containing repeating R_2SiO units, with a backbone of alternating silicon and oxygen atoms ($-Si-O-Si-O-$) and organic groups attached to silicon.

- They are prepared by the hydrolysis of dialkyl/diaryl dichlorosilanes (R_2SiCl_2) followed by polymerisation.
 - They are water-repellent (hydrophobic), heat-resistant, and chemically inert.
 - Uses: water-proofing fabrics, lubricants, sealants, electrical insulators, and biomedical implants.
-

10. Silicates and Zeolites

Silicates

Silicates are compounds in which the basic structural unit is the SiO_4^{4-} **tetrahedron**. These tetrahedra link by sharing oxygen corners to form chains, sheets, or three-dimensional networks.

- When all four corner oxygens are shared, the neutral, giant covalent solid silica (SiO_2) results.
- Examples include feldspar, asbestos, mica, and zeolites.

Zeolites

Zeolites are three-dimensional aluminosilicates with a porous, cage-like structure, formed when some silicon atoms in SiO_4 are replaced by aluminium (giving an AlO_4 unit and a negative charge balanced by cations).

- Used as **ion-exchangers** to soften hard water (Permutit process).
 - ZSM-5 is used as a catalyst to convert alcohols directly into petrol (gasoline).
 - Used as molecular sieves and as catalysts in the petrochemical industry.
-

Weightage in Board & Entrance Exams

Exam	Typical Weightage	Most-Tested Areas
CBSE Board (Class 11)	6–8 marks	Anomalous behaviour, borax/boric acid, diborane structure, allotropes, silicones
JEE Main / Advanced	1–2 questions	Inert pair effect, structure of diborane & borax, catenation trend
NEET	1–2 questions	Properties of CO/CO ₂ , oxides' acidic-basic nature, uses of zeolites & silicones

[TABLE: Question-type split — VSA (1 mark): definitions & formulae; SA (2–3 marks): anomalous behaviour, diborane bonding, CO toxicity; LA (5 marks): borax structure & bead test, allotropes comparison, silicones preparation.]

Important Definitions

Term	Definition
p-Block element	Element in which the last electron enters a p-orbital; configuration ns^2np^{1-6}
Inert pair effect	Reluctance of the ns^2 electron pair to bond, stabilising lower oxidation states down a group
Diagonal relationship	Similarity between an element and the one placed diagonally to it (e.g., B and Si)
Electron-deficient compound	A molecule with fewer electrons than needed for normal bonds, e.g., B ₂ H ₆ , BF ₃
Three-centre two-electron bond	A "banana" bond where two electrons bind three atoms, as in the B–H–B bridge of diborane
Catenation	Self-linking of like atoms into chains/rings; strongest in carbon
Allotropy	Existence of an element in two or more forms differing in physical properties
Silicones	Organosilicon polymers with an –Si–O–Si– backbone and organic side groups
Zeolite	Porous three-dimensional aluminosilicate used as ion-exchanger and catalyst
Amphoteric oxide	An oxide that reacts with both acids and bases, e.g., Al ₂ O ₃

Solved Examples

Example 1

Why does boron form only covalent compounds and never the B^{3+} ion?

Answer: Boron has a very small size and very high ionisation enthalpy. Removing three electrons to form B^{3+} needs more energy than is released by lattice/hydration, so it is energetically unfavourable. Hence boron shares electrons and forms only **covalent** compounds.

Example 2

Explain why diborane (B_2H_6) is called an electron-deficient molecule.

Answer: B_2H_6 has 12 valence electrons but needs more to form eight normal 2-electron bonds. It has four normal terminal B–H bonds and two **three-centre two-electron B–H–B bridge bonds**. Since there are not enough electrons for all conventional bonds, it is electron-deficient.

Example 3

Why does the +1 oxidation state become more stable than +3 down Group 13?

Answer: Down the group the **inert pair effect** increases — the ns^2 electrons become reluctant to participate in bonding. So Tl prefers the +1 state, making Tl^+ more stable than Tl^{3+} .

Example 4

Why is carbon monoxide poisonous?

Answer: CO binds to the haemoglobin of blood about **300 times more strongly than O_2** , forming carboxyhaemoglobin. This blocks oxygen transport to the tissues, which can be fatal.

Example 5

Why does carbon show the maximum tendency for catenation in Group 14?

Answer: The C–C bond is exceptionally strong (about 348 kJ/mol) because of carbon's small size and effective orbital overlap. Bond strength falls down the group (Si–Si, Ge–Ge weaker), so catenation is greatest in carbon — explaining its millions of compounds.

Example 6

What happens when borax is heated strongly? Write the reaction.

Answer: Borax first loses water of crystallisation, swells, and then melts to a clear glassy bead: **$Na_2B_4O_7 \cdot 10H_2O \rightarrow 2NaBO_2 + B_2O_3 + 10H_2O$** . The bead (sodium metaborate + boric anhydride) is the basis of the borax bead test for coloured metal ions.

Important Questions for Board Exams

1-Mark Questions (VSA)

1. Write the general outer electronic configuration of p-block elements.
2. What is the inert pair effect?
3. Why is boric acid considered a weak monobasic acid?
4. Name the hardest allotrope of carbon and give the hybridisation of its carbon atoms.
5. Give one important use of zeolites.

2–3-Mark Questions (SA)

1. Explain the anomalous behaviour of boron with any three points.
2. Describe the structure of diborane and explain the bonding in it.
3. Compare the structures and properties of diamond and graphite.
4. What are silicones? How are they prepared, and give two uses.

5-Mark Questions (LA)

1. Discuss the trends in oxidation state and the nature of oxides down Group 13, explaining them in terms of the inert pair effect.
 2. Explain the structure of borax and describe the borax bead test with relevant reactions.
 3. Discuss catenation in Group 14 and explain why carbon shows it to the greatest extent. Compare the acidic/basic nature of the oxides of the group.
-

Quick Revision Points

- p-block: Groups 13–18; general configuration ns^2np^{1-6} ; holds metals, non-metals, metalloids
- Inert pair effect $\rightarrow$ lower oxidation state more stable down a group (Tl^+ , Pb^{2+})
- Group 13 (ns^2np^1): +3 common; oxide nature B_2O_3 acidic $\rightarrow$ Al_2O_3 amphoteric $\rightarrow$ Tl_2O_3 basic
- Boron is anomalous — small size, no d-orbitals, max covalency 4, only covalent compounds; diagonal with Si
- Borax: $Na_2B_4O_7 \cdot 10H_2O \rightarrow 2NaBO_2 + B_2O_3$ on heating; basis of bead test
- Boric acid H_3BO_3 — weak monobasic Lewis acid; layered, H-bonded structure
- Diborane B_2H_6 — electron-deficient; 4 terminal B–H + 2 bridging 3c–2e bonds
- Aluminium — amphoteric, made passive by conc. HNO_3 ; $AlCl_3$ dimerises to Al_2Cl_6
- Group 14 (ns^2np^2): +4 and +2; catenation $C \gg Si > Ge \approx Sn \gg Pb$
- Carbon allotropes: diamond (sp^3 , hard, insulator), graphite (sp^2 , conductor, lubricant), fullerene (C_{60})

- CO — neutral, poisonous (carboxyhaemoglobin), reducing agent; CO₂ — acidic, greenhouse gas
 - Silicones — –Si–O–Si– polymers, water-repellent; zeolites — porous aluminosilicates, ion-exchangers/catalysts
-

Next Chapter: Chapter 11 — Organic Chemistry: Some Basic Principles and Techniques



Got this PDF from a friend?

Everything here is free at **chapternotes.in** — 134 chapters of notes, a gamified practice app, and full NEET mock & prediction papers.



Scan to practice this chapter free in the app