◇ Wade's Rules (recap)

For a cluster **BnHm^k**:

- Skeletal electron pairs (SEP) =
  (total valence e for bonding−e used in terminal B–H bonds)/2
- Then compare with **n** (number of skeletal atoms, usually B atoms).
- Types:
  - **Closo**: SEP = n + 1 (closed polyhedron, deltahedral)
  - **Nido**: SEP = n + 2 (one vertex missing from closo)
  - **Arachno**: SEP = n + 3 (two vertices missing)
  - **Hypho**: SEP = n + 4 (three vertices missing)

---

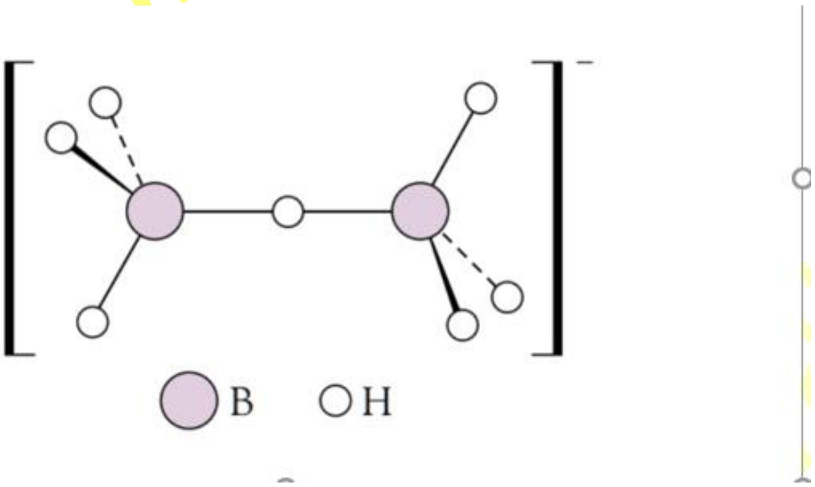
1. $[B_2H_7]^-$

- Valence e^-: 2×3+7×1+1=142×3 + 7×1 + 1 = 14
- Terminal B–H: 6 bonds → 12 e^-
- Left for framework: 14 – 12 = 2 e^- = **1 pair**

➡ This is essentially two **BH_3 units bridged by an H^- ion**.

- Structure: linear or bent **(H–B–H–B–H with bridging H)**.
- It is **not a polyhedral cluster**, but a simple bridged dimer.

📍 **Structure**: a 3-center-2-electron (3c–2e) bridge across B–H–B.



---

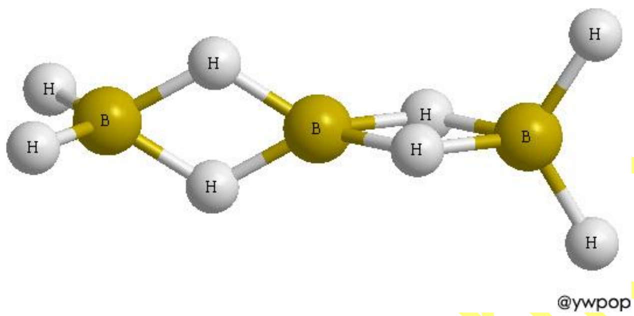
2. $[B_3H_8]^-$

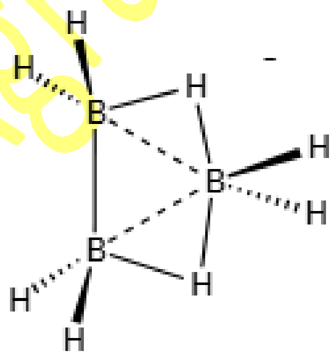
- Valence e^-: 3×3+8×1+1= 3×3 + 8×1 + 1 = 18
- Terminal B–H: 7 → 14 e^-
- Left = 4 e^- = 2 pairs

➡ For n = 3 boron atoms, SEP = 2 → fits **n + ?**

- n + 2 = 5 (not matching, too large)
  Actually, this is a **dimer of $[B_2H_7]^-$ type units**, with bridging hydrogens.
- **Structure**: Two BH_2 terminal groups and one bridging BH_2 with hydrogens making bridges.

📍 **Known structure**: chainlike, with bridging hydrogens giving stability (not a closed deltahedron).





---

3. B_5H_9

- Valence e^-: 5×3+9×1= 5×3 + 9×1 = 24
- Terminal B–H: 9 → 18 e^-
- Left = 6 e^- = 3 pairs

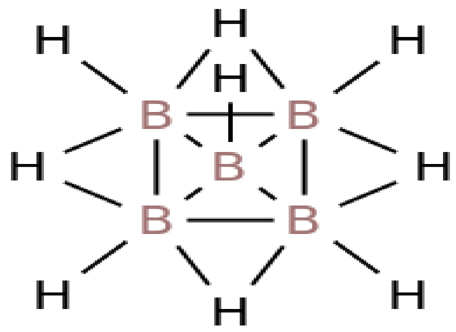
➡ n = 5

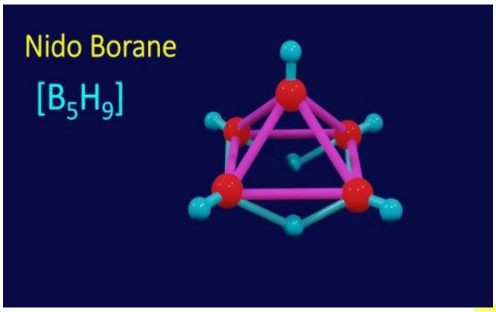
- For **nido**: SEP = n + 2 = 7
- For **arachno**: SEP = n + 3 = 8
  But we only have 3 skeletal pairs?

⚠ Wait: In boranes, often some hydrogens are bridging (not purely terminal). So we don't subtract *all* H bonds as terminal.

☞ Experimentally, **B_5H_9** is **nido** (square pyramidal with one open face).

- Structure: looks like a square pyramid of B atoms with bridging H atoms along edges.

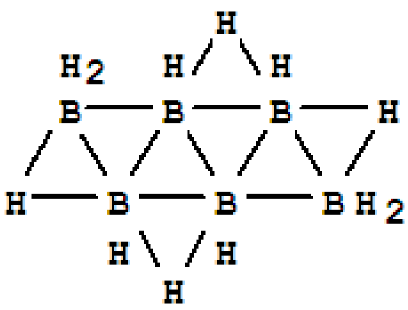


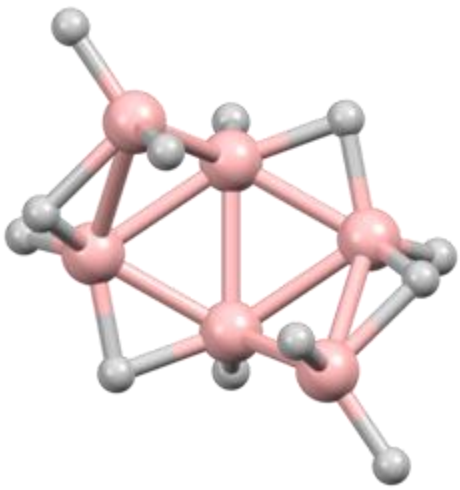


---

4. B_6H_{12}

- Valence e^-: 6×3+12×1= 6×3 + 12×1 = 30
- This is an **arachno-borane** (two missing vertices from closo B_8).
- Structure: **arachno-octahedron fragment**, with bridging hydrogens.





---

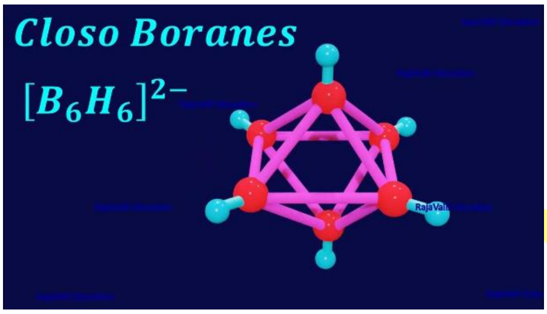
5. $B_6H_6^{2-}$ (closely related to B_6H_6 neutral cluster sometimes written as B_6H_6)

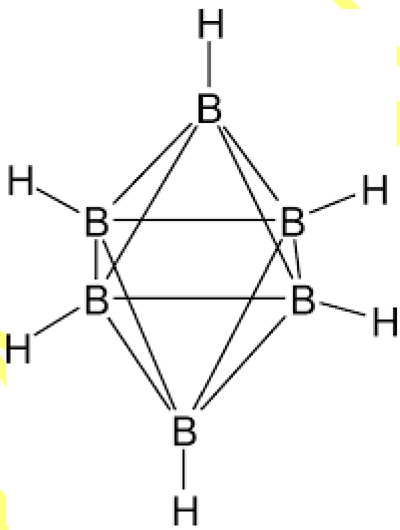
- If neutral B_6H_6: 6×3+6×1= 6×3 + 6×1 = 24 electrons.
- Closo n=6 requires SEP = 7 = 14 e⁻ → matches **$B_6H_6^{2-}$**, not neutral.

Thus:

- **$B_6H_6^{2-}$** = **closo octahedral cluster** (like benzene's electronic analogue).
- Neutral B_6H_6 is unstable, but the dianion is aromatic (like benzene).

📍 **Structure**: octahedron of B atoms with one H on each vertex.





☑ Summary with Figures

1. **$[B_2H_7]^-$** → two BH_3 bridged by one H^- (B–H–B 3c–2e bond).
2. **$[B_3H_8]^-$** → chainlike borane with bridging H's.
3. **B_5H_9** → **nido** (square pyramid fragment).
4. **B_6H_{12}** → **arachno** (octahedral fragment).
5. **$B_6H_6^{2-}$** → **closo** octahedron.
