(p) CSIR : [14–20] M

(p) Gate : [4 – 6] M

(s+p) Set : [4 – 8] Q

Main Group Chemistry :

s-block

Grp I	Grp II
Li	Be
Na	Mg
K	Ca
Rb	Sr
Cs	Ba
Fr	Ra

✓

✓

* p-block

13	14	15	16	17	18
B	C	N	O	F	He
Al	Si	P	S	Cl	Ne
Ga	Ge	As	Se	Br	Ar
In	Sn	Sb	Te	I	Kr
Tl	Pb	Bi	Po	At	Xe
					Rn

① Boron family :-

* ① Boranes
* ② Halides
* ③ Nitrides
* B & O compounds (Borates)

Inert pair Effect & Oxidation state :

	Stable O.S
B	+3
Al	+3
Ga	+3 , +1
In	+1
Tl	+1

} +1 O.S stable due to inert pair effect.

+1 O.S stability ↑

+3 O.S stability ↓

Inert pair Effect :

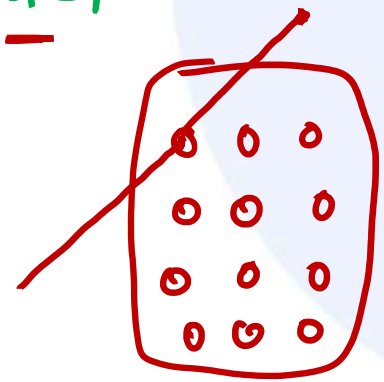
B : $2s^2 2p^1$

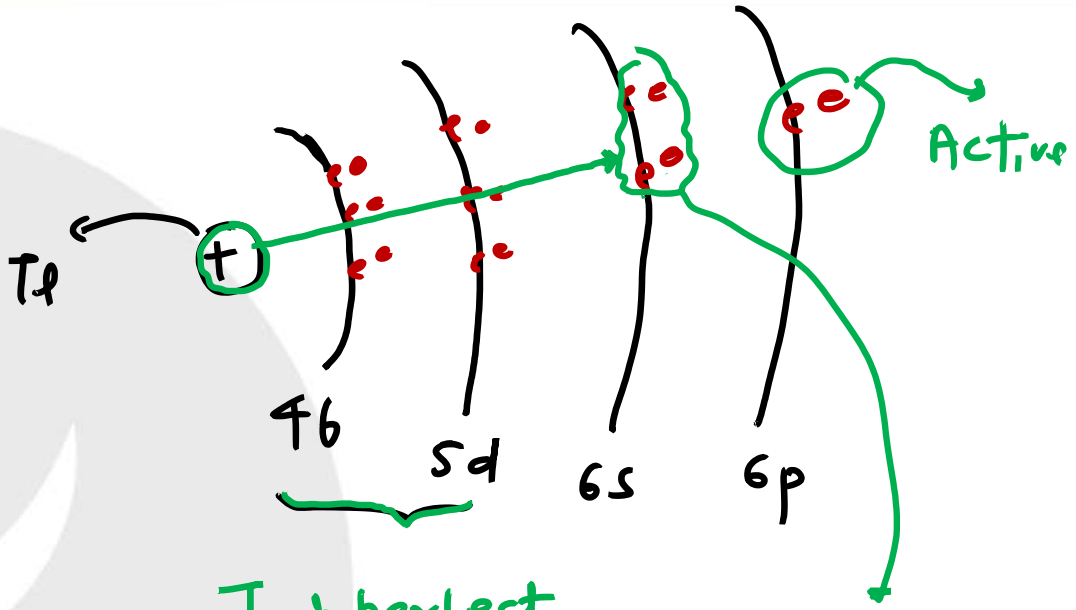
Ga : $3d^{10} 4s^2 4p^1$

Tl : $4f^{14} 5d^{10} 6s^2 6p^1$

Ex : $\overset{+3}{Tl}Cl_3 < \overset{+1}{Tl}Cl$

Tl — 3Cl





Imperfect shielding.
↓
Zeff ↑

Inactive/ Inert {Inert pair effect}

① Boranes / Binary comp of B & H :—

B → 2.0 → $B^{\delta+}$

H → 2.1 → Hydride (H^-)

EN

H > B.

Alkanes → C & H

Boranes → B & H.

Preparation :—

① $B + X \longrightarrow BX_3$

X = F, Cl, Br, I

BF_3, BCl_3, BBr_3, BI_3.

BX_3 + Reducing Agent / Hydriding agent $\longrightarrow$ B_2H_6

$NaBH_4$, LiH,

Li; AlH_4, NaH

(2) $2\,BCl_3\,OEt_2 + NaBH_4 \longrightarrow B_2H_6 + \boxed{NaBCl_4} + H_2\uparrow$

(3) BF_3  $+ NaBH_4 \longrightarrow B_2H_6$.

(4) $BF_3 + H_2 + I_2 \longrightarrow B_2H_6$.

(5) $Mg_3B_2 + H_3PO_4 \longrightarrow$ Mix of Boranes

B_3H_9, B_4H_{10}, B_8H_9, B_6H_{10}

$\Delta \downarrow$

B_2H_6.

B_2H_6 : Diborane :-

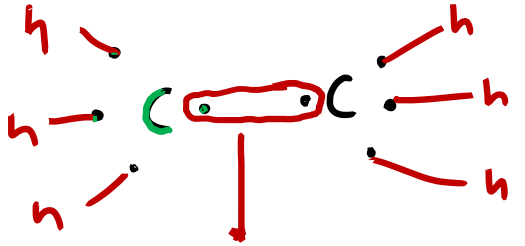
Reactivity :

$$B_2H_6 + 3O_2 \longrightarrow B_2O_3 + H_2O.$$

$$B_2H_6 + 6H_2O \longrightarrow 2B(OH)_3 + 6H_2$$

→ B_2H_6 is air & water sensitive.

Str : C_2H_6



Covalent Bond
(2C-2e⊖)

B : 1 | 1 | 1 | | |
2s 2px 2py 2pz

sp^3

1 | 1 | 1 | |

sp^3 Hyb Orb.

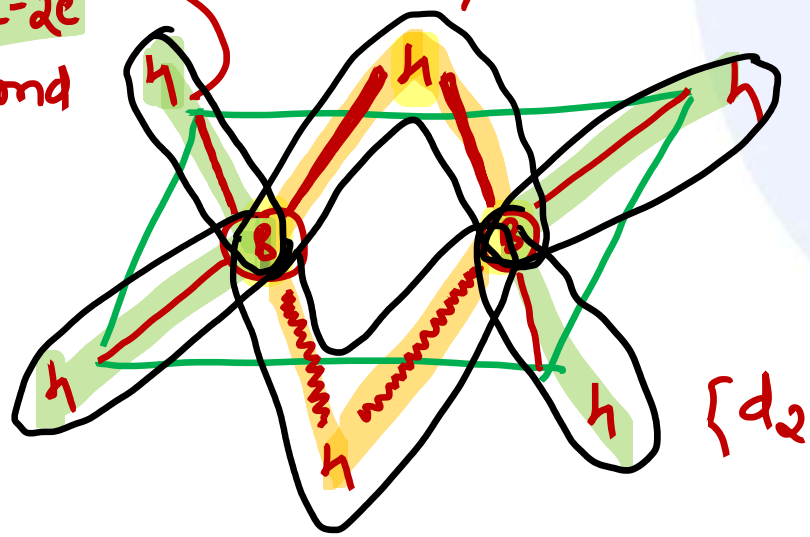
B_2H_6

Banana Bond
Bridge Bond
$c^{\odot}$ def. Bond

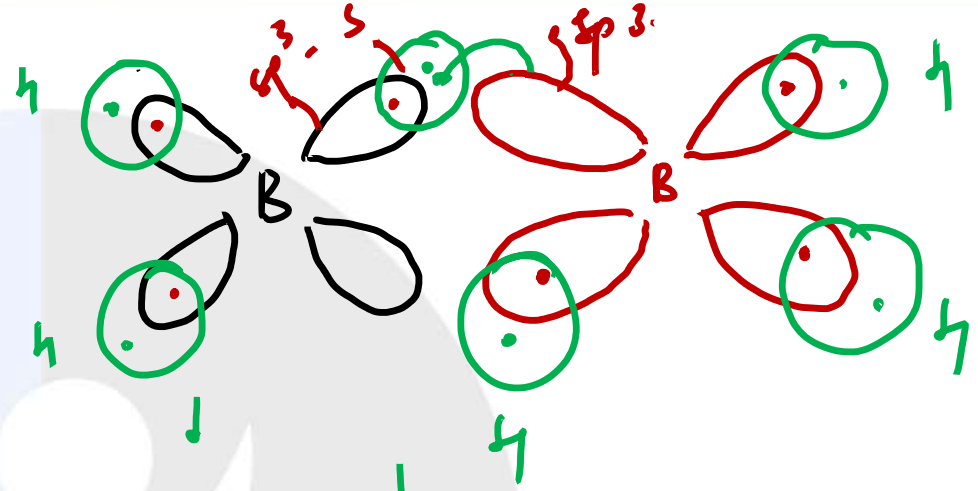
Terminal Bond
$e^{\odot}$ def Bond

$3c\text{-}2e^{\odot} = \underline{2}$

$2c\text{-}2e^{\odot}$ Bond = $\underline{4}$

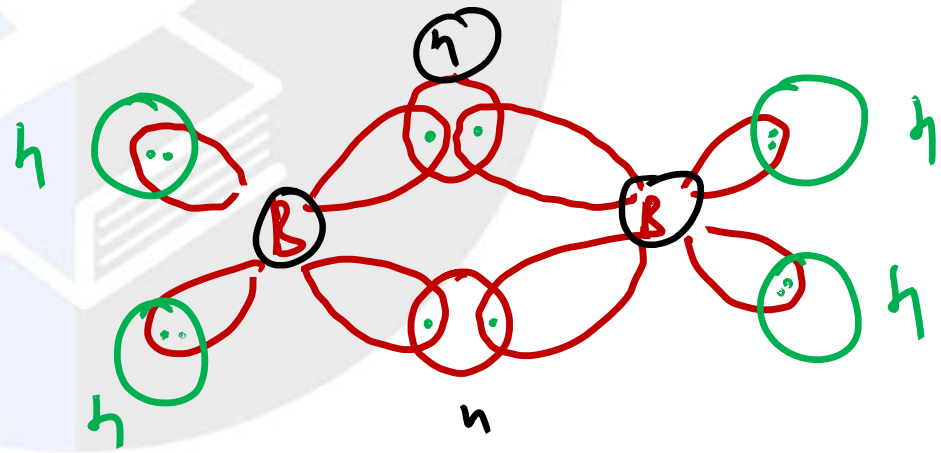


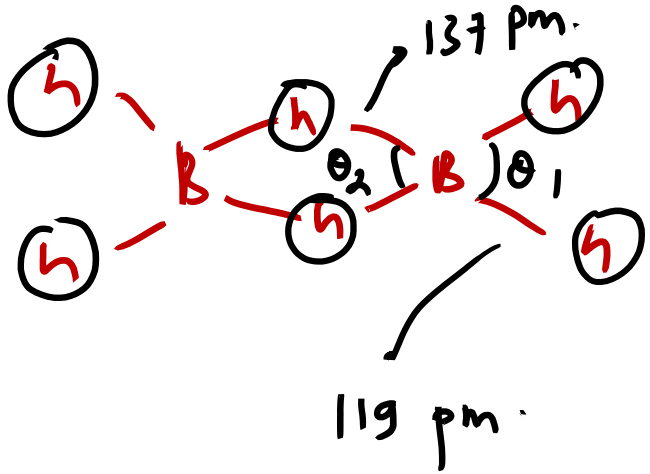
$\{D_{2h}\}$



BH_3

delocalised Bonding





B.A

$\theta_1 = 120^\circ$ $\{\theta_1 > \theta_2\}$

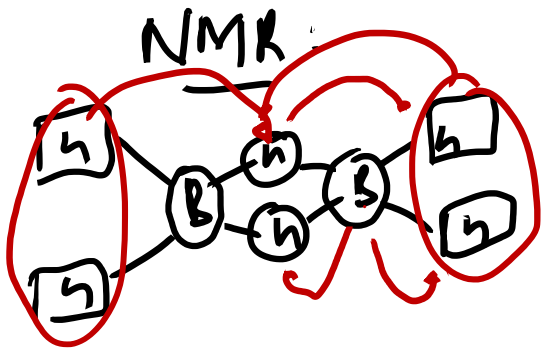
$\theta_2 = 97^\circ$

B.L :

$$(B.L)_{Terminal} < (B.L)_{Bridging}$$

→

$B_2H_6 + CH_3 \longrightarrow$ Only Terminal H are replaced without destroying molecule



① ^{11}B NMR = 1

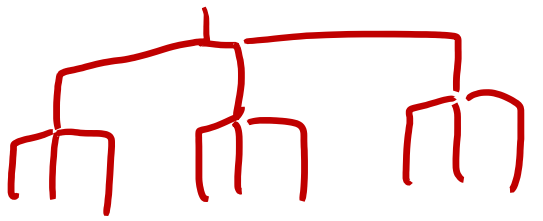
^{10}B ^{11}B

I = 3 I = 3/2

Abundance : 19% 81%

② ^{1}H NMR = 2

{ I = 1/2 }



^{11}B NMR signal :

H_{Ter} (n=2) H_{Bord} (n=2)

= (2nI+1) (2nI+1)

= (2×2×1/2 +1) (2×2×1/2 +1)

= 3 × 3 Triplet of triplet.

^1H NMR

for Ter H

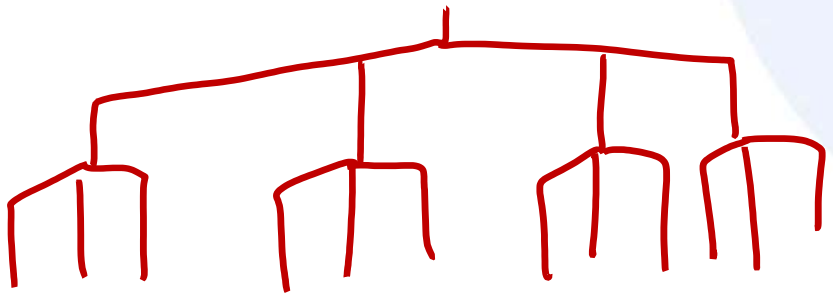
= B. Brid. H

$(2nI+1) \times (2nI+1)$

$= (2\times1\times\frac{3}{2}+1)(2\times2\times\frac{1}{2}+1)$

= (4) × 3. = 12 line.

Quartet of triplet



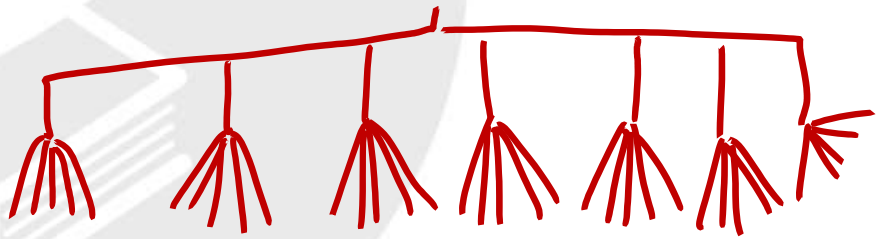
for Bridging H.

= B Ter H

$= (2nI+1) \times (2nI+1)$

$= (2\times2\times\frac{3}{2}+1) \times (2\times4\times\frac{1}{2}+1)$

= 7 × 5 = 35 lines



Classification of Boranes :—

① B_nH_{n+2} / $B_nH_n^{-2}$ → Closo

② B_nH_{n+4} / $B_nH_n^{-4}$ → Nido

③ B_nH_{n+6} / $B_nH_n^{-6}$ → Arachno

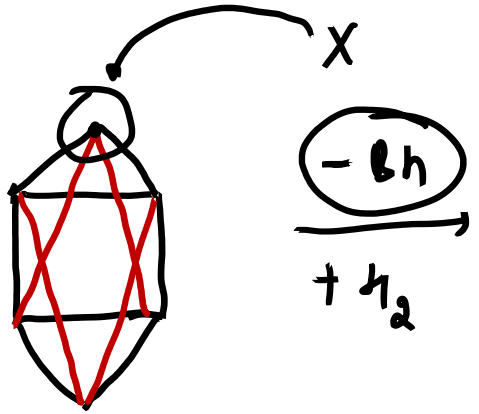
④ B_nH_{n+8} / $B_nH_n^{-8}$ → Hypo

⑤ B_nH_{n+10} / $B_nH_n^{-10}$ → Klado

} Diamagnetic & $e^{\ominus}$ deficient

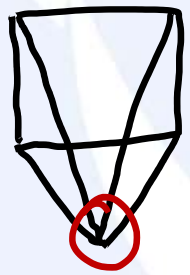
As No. of H ↑, Str of Boranes becomes more open.

B_6H_8 / $B_6H_6^{-2}$



Closo - Oh.

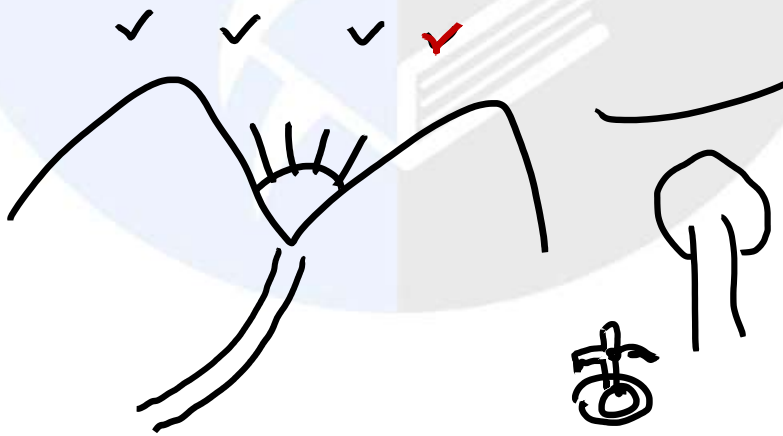
B_5H_9



Nido · Sq pyramidal

B_4H_{10}

Arachno - Butterfly.



→ B + H → Boranes

→ B + H + C → Carboranes

→ B + H + Z → Heteroboranes.

$BH \rightarrow B + H = 4e^{\ominus} \rightleftharpoons C$

fragment 3 + 1

B	C	N	O
Al	Si	P	S
Ga	Ge	As	Se
In	Sn	Sb	Te
$3Vc^{\ominus}$	$4e^{\ominus}$	$5e^{\ominus}$	$6e^{\ominus}$
↓	↓	↓	↓
B	BH	BH_2	BH_3

B_nH_{n+2} +4 +6 +8 +10

① $C_4B_2H_4$ → $(BH)_4B_2H_4$ → B_6H_8 → Closo

$(BH_2)_2(BH)B_2H_4$ → B_5H_{10} → Nido

N →

$\overline{4N}$

① $C_2B_{10}H_{12}$ ② $N_2C_2B_2H_4$ (5 vc) ③ $Sn_2C_2N_2B_4H_6$

④ $P_2As_2B_4H_6C_2$ ⑤ $C_2B_6H_8(Ge)_2(Sn)_2$.

Thank you