Inorganic Chemistry

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Boranes → Hydrides of boron are called boranes

Classification of boranes basis on their structure

Or $B_nH_n^{-2}$ B_nH_{n+2}

① **Closo Boranes** → It is a packed cluster. (only ionic)

General formula $B_nH_n^{-2}$ or B_nH_{n+2} B_{12}^{-2} $B_{12}H_{12}^{-2}$ → B_nH_{n+2}

(It not includes the neutral boranes.)

② **Nedo boranes** → It has nest type structure

general formula B_nH_{n+4}

e.g. B_2H_6

③ **Arachno boranes** → General formula B_nH_{n+6}

e.g. B_4H_{10}

④ **Hypho boranes** → General formula

B_nH_{n+8} e.g. $B_{10}H_{18}$

⑤ **Conjuncto boranes** → It involves combination of above two types of boranes. B_nH_m बिना किसी rule के

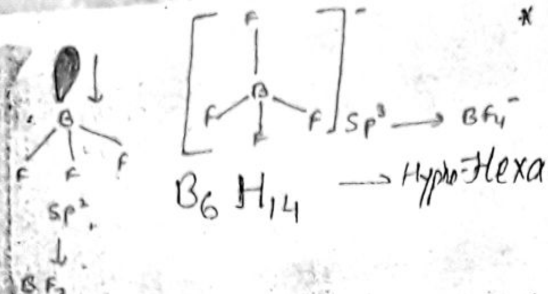
e.g. $B_{13}H_{19}$, $B_{20}H_{14}$.

Nomenclature

B_4H_{10} → Tetraborane (10) ← No of hydrogen.

B_5H_9 → Pentaborane (9)

* BOBORO...



Carbon X

B_6H_{14} → Hypho-Hexaborane (14)

$C_2B_{10}H_{12}$ → dicarbo-closo-decaborane (12)

↳ carbborane

Nido Borane Exa. → B_2H_6 ✓
Nidodiborane (6)

{ Diglyme
Net $CH_3-O-CH_2-CH_2-O-CH_2-CH_2-O-CH_3$

(*) Net बनाने 3 4.5 method.

Prop :- → (a) Flouride + Hydride (Na, B) → B_2H_6 -

① $Mg_3B_2 \xrightarrow{H_3PO_4}$ (Mix of product) $\xrightarrow{\Delta}$ B_2H_6

B_4H_{10} ✓ mainly

| BF का Na Be का Li | के

Reactant - Boron fluoride है
Boron hydride
B_2H_6 ← 6B → $NaBF_4$ (इनमें किसी का किसी है Hydride है reagent)

Boron floride → $8BF_3$ (EXCESS) + $6NaH$ → $6NaBF_4 + B_2H_6$ ① BF - Boron floride + NaH

(LiAlH4 ↓ NaBH4) Net $2BF_3 + 6NaH \longrightarrow B_2H_6 + 6NaF$

② BE - Boron Etherate + LiAlH₄ -

Net $4BF_3 + 3NaBH_4 \xrightarrow{diglyme} 2B_2H_6 + 3NaBF_4$

Net $4[Et_2O \rightarrow BF_3] + 3LiAlH_4 \longrightarrow 2B_2H_6 + 3LiAlF_4 + 4Et_2O$

(c) $2NaBH_4 + I_2 \xrightarrow{diglyme} B_2H_6 + 2NaI + H_2$

(d) $2NaBH_4 + 2H_3PO_4 \longrightarrow B_2H_6 + 2NaH_2PO_4 + 2H_2$

Reactions.

B_2H_6 is used a reducing agent.

Reduction :- hydrogen जोड़ना

$R-NO_2 \xrightarrow{B_2H_6} R-NH_2$

$R-CHO \xrightarrow{\text{,,}} R-CH_2-OH$

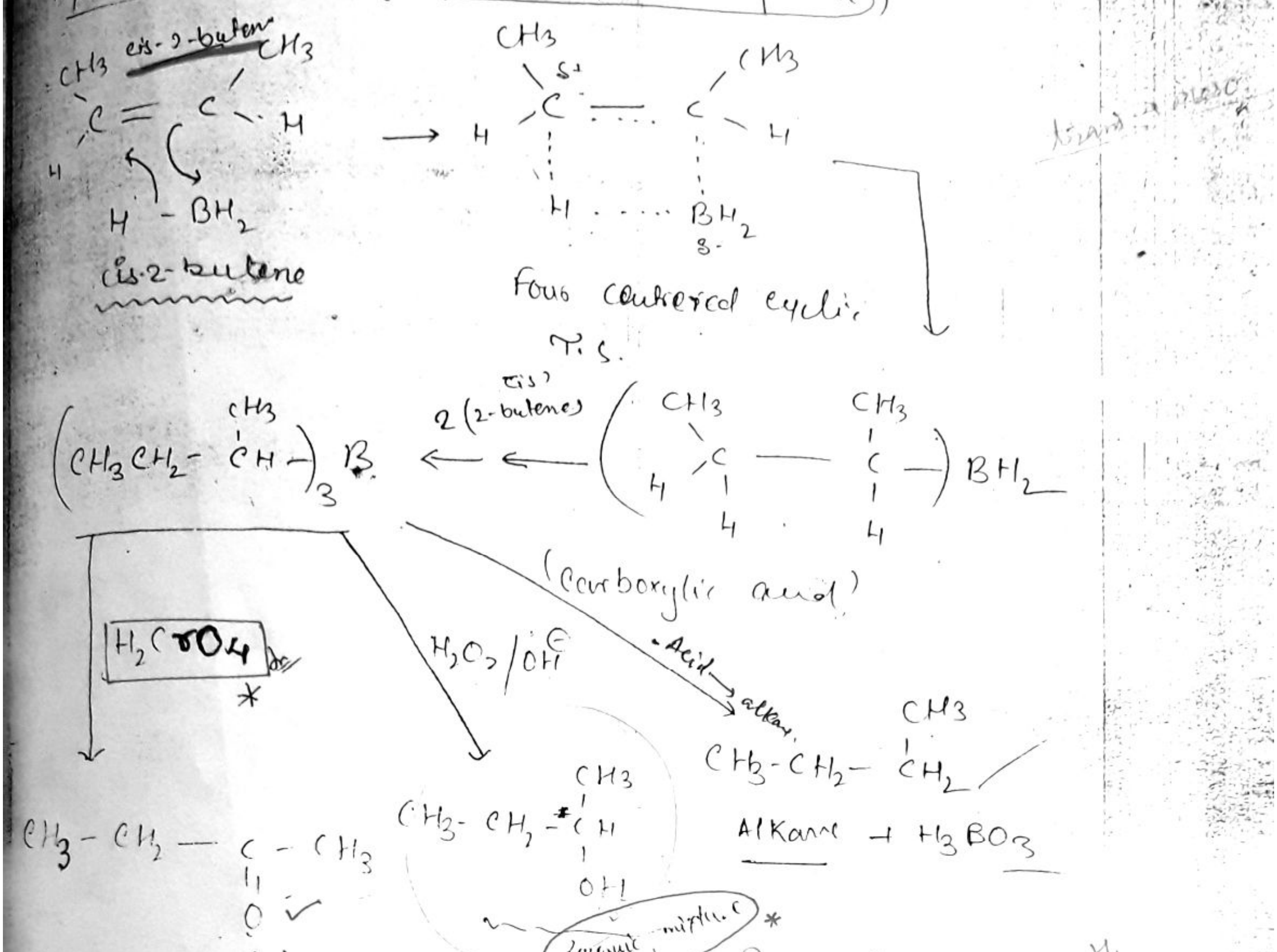
$R-C\equiv N \xrightarrow{\text{,,}} R-CH_2-NH_2$

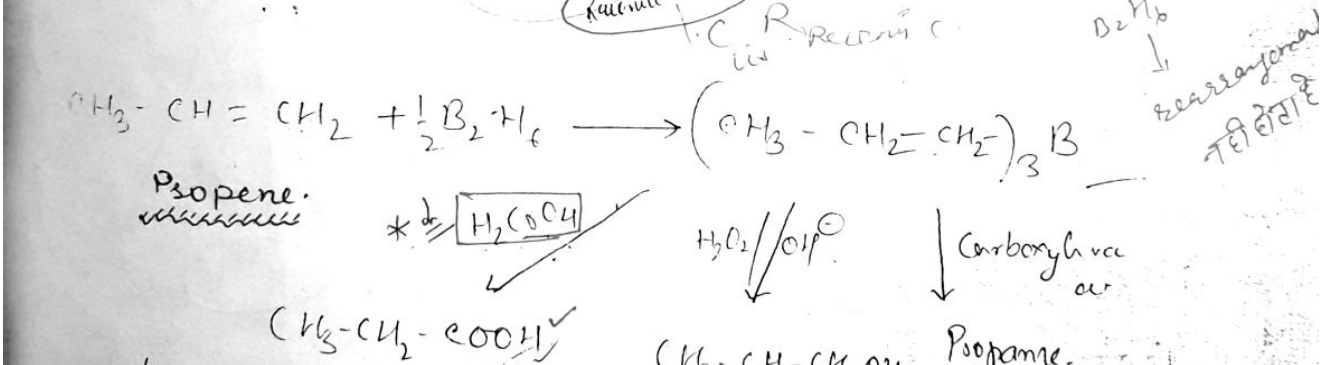
Reaction "राय RAI हा बिना इत आओ" राय ने कहा "
H : LiNa Cl A O
R - Reduction
R - Regeo selectivity e stereo specificity

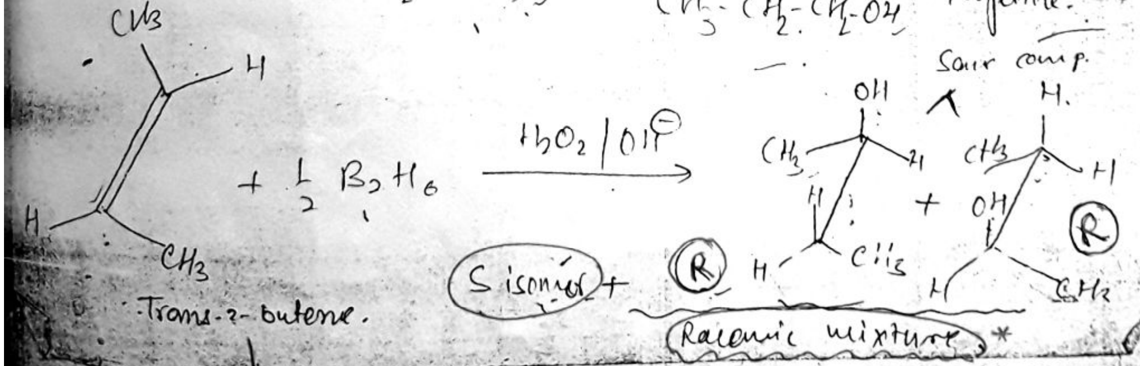
H - H₂O
... LiH

A - Alcohol
D - Oxide

Hydroboration (Regiospecific & stereospecific) ③







Trans → Racemic mixture - R+S

cis → R OR S

Net

③ Reaction with Ammonia.

$B_3N_3H_6$ (4) Borazine

↑ Δ

B_2H_6:

- NH_3 (excess), low temp. → Adduct. $(BH_3 \leftarrow NH_3)$ or $B_2H_6 \cdot 2NH_3$
- NH_3 (excess), high temp. → $(BN)_x$ Boron nitride (Polymer) (Black)
  high T NE polymerisation
- $B_2H_6 : NH_3 = 1:2$, 125°C → $B_3N_3H_6$ (Borazine or Borazole) inorganic benzene.

2 : 1 × 2 = 2 : 2

$B_3N_3H_6$ 1 : 1

④ Change in other boranes.

Ⓐ Heated at (125 - 150°C) in a sealed tube

$B_2H_6 \xrightarrow[\text{Sealed tube}]{125°-150°C} B_4H_{10}$

B_4H_{10} is formed.

$$B_2H_6 \rightleftharpoons 2BH_3$$

$$BH_3 + B_2H_6 \longrightarrow B_3H_9$$

$$B_3H_9 \longrightarrow B_3H_7 + H_2$$

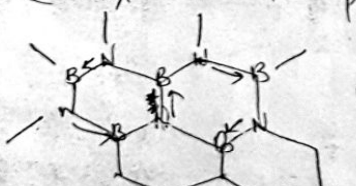
$$B_3H_7 + BH_3 \longrightarrow B_4H_{10}$$

B_2H_6 ⇌ $2BH_3$ → (B_2H_6) B_3H_9 → ($-H_2$) B_3H_7 → (BH_3) B_4H_{10}

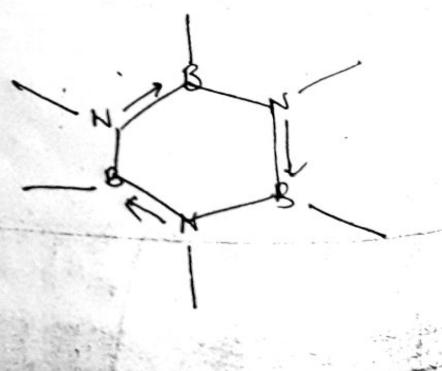
Ⓑ

$$B_2H_6 + H_2 \xrightarrow{200-250°C} B_5H_9$$

$(BN)_x$ is a polymer



Black.



B_2H_6 + alkaline metal ⟶ $MAlH_4$ / MAH_4

(5)

(A) $B_2H_6 + 2LiH \longrightarrow 2Li[BH_4] + H_2$ ($LiAlH_4$ तैयारी, Adduct) — B, Al, Ga, In, Tl

(B) Net ✱ $2B_2H_6 + 2Na \longrightarrow NaBH_4 + NaB_3H_8$ ($LiAlH_4$)

(C) $6Cl_2 + B_2H_6 \longrightarrow 2BCl_3 + 6HCl$ ($AlCl_3$)

(D) $B_2H_6 + MeOH \longrightarrow (MeO)_3B + H_2$ ($Al(OMe)_3$ या $Al(OH)_3$)

(E) Net ✱ $B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$ + High 2040 KJ (Al_2O_3)

Rocket propellent (Fuel); Boric anhydride; amount of energy

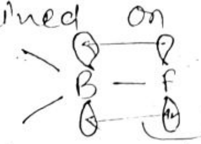
(F) v.I. $B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$

Boric acid.

✱ Net: Acid strength order of boron halides — Asked in NET & GATE

Q. v.I. $BI_3 > BBr_3 > BCl_3 > BF_3$

This can be explained on the basis of back bonding



back bonding.

acid → accept l.p.
BF_3 में B पूरा है, F F F से back bonding करता है।

Q. BX_3 are does not exist as dimer of $AlCl_3$ (i.e. Al_2Cl_6) ✓ — B_2Cl_6 ✗

Reasons → ① Size of Boron atom is small as compare to halogens.
- small size
- steric hindrance

② Causes steric hindrance.

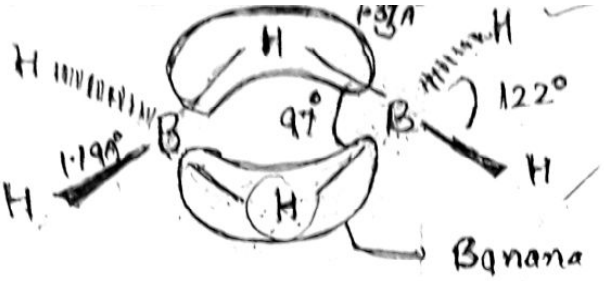
Ans: बोरोन इतना छोटा है कि 6 halogen से जुड़ नहीं सकता।

Boric acid → (अम्ल कि क्षारकता उसके द्वारा दिये H^+ कि संख्या

$H_3BO_3 + H_2O \longrightarrow [B(OH)_4]^{-} + H^{+}$ (mono basic)

$H_3BO_3 + D_2O \longrightarrow [B(OH)_3(OD)]^{-} + D^{+}$

Q. Boric acid is :- Ans - mono basic



bonds

P.G = D_{2h}

* It has
  - four H one type
  - 2 H one type

two center 2e⁻ Bond = (4)

Normal covalent bonds ⟶ 2C − $2e^{\ominus}$ = four (covalent)

Banana bonds ⟶ 3C − $2e^{\ominus}$ = Two (covalent)

three center two e⁻ Bond = (2)

The plane of normal covalent bonds is perpendicular to plane of Banana Bonds.

Evidences in support of above structure

(1) NMR ⟶ It shows, this compound contains two types of protons in which four H-atom gives one signal of another signle is due to remaining 2-H-atoms.
  - one siglet due to (4H)
  - one singlet due to (2H)

(2) Electron diffraction method ⟶ This method also proved that four H-atom lies in a plane which is perpendicular to plane of another 2-H-atoms.

(3) When B_2H_6 is undergo methylation, only tetra methyl derivates is formed. This also prove the above structure of B_2H_6

Q? Not Hexamethyl ka

(4) STYX CODE - 2002

$C_3N_3H_6$ ⟷ Borazine
↘ Borazol.

(7)

gate balance equation

B

Borazine (Benzene's isoelectronic)

Amonia or ...

Prep. B_2H_6 + NH_3 $\xrightarrow{125°C}$ $B_3N_3H_6$

1 : 2

Net gate

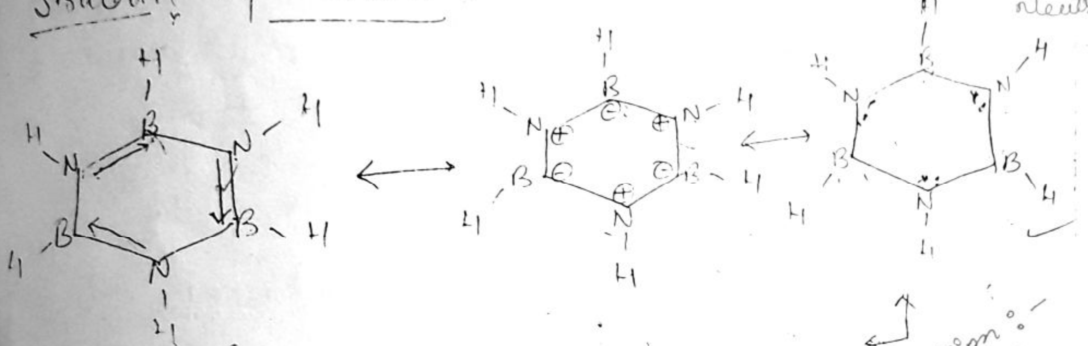
$2BCl_3 + 3NH_4Cl \xrightarrow[\text{Chlorobenzene}]{\text{Reflux (150-156°)}} Cl_3B_3N_3H_3 + 9HCl$ (Trichloroborazine)

↓ $3NaBH_4$

$B_3N_3H_6$ + B_2H_6 + $3NaCl$

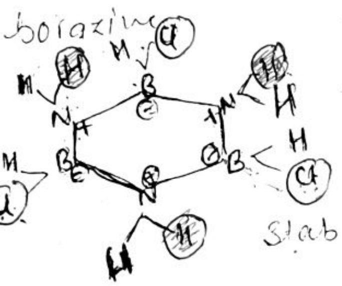
Structure of borazine

resonence structure में सबसे stable वही structure था neutral structure



Addition of HCl on borazine

$B_3N_3H_6 + 3HCl \longrightarrow$



Stab

reaction :- $B_3N_3H_6$ — +ve H reaction करेगा; −ve H reaction करेगा

Similar...

$B_3N_3H_6 + 3H_2O$ or $3CH_3OH$ or $3CH_3I$ ⟶ (Only Cl is replaced.)

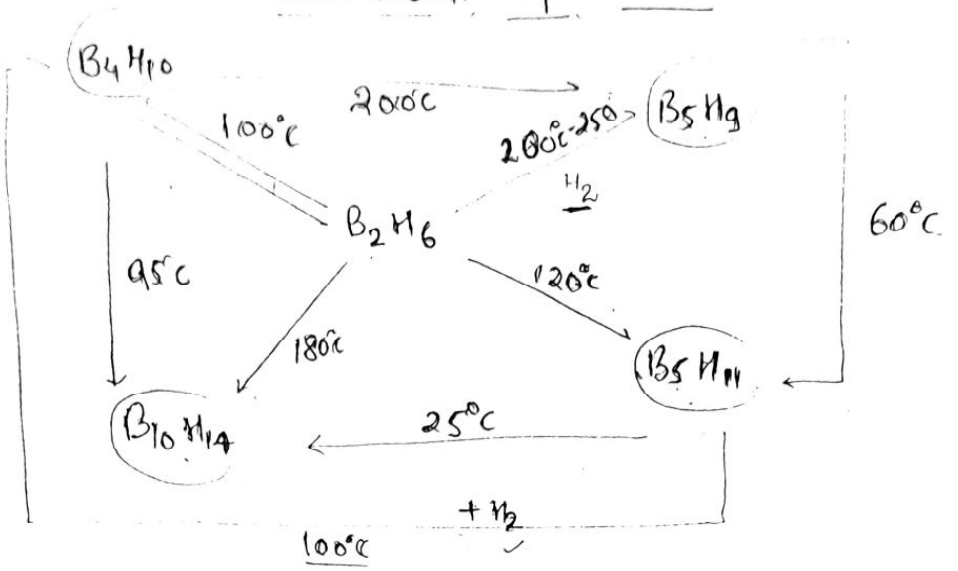
Prep of N-alkylated borazine →

$2BCl_3 + 3[RNH_3]Cl \xrightarrow[\text{Chlorobenzene Reflux}]{150°-156°} Cl_3B_3N_3(R_3) + 9HCl$

↓ $3NaBH_4$

$B_3N_3H_3R_3 + B_2H_6 + 3NaCl$

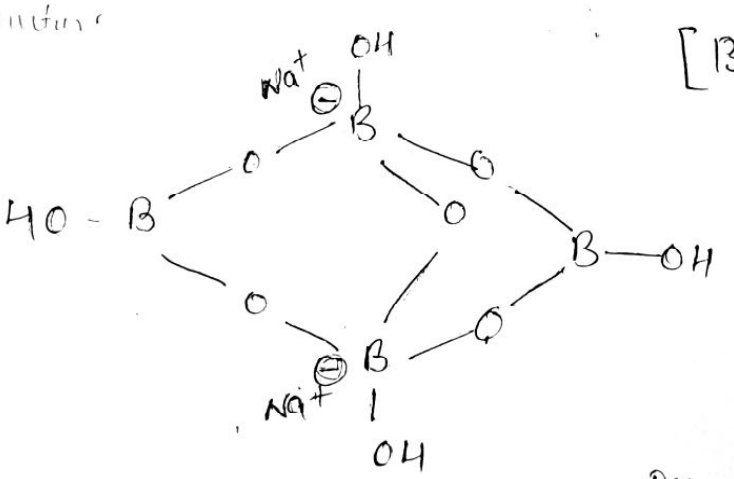
Interconversion of boranes



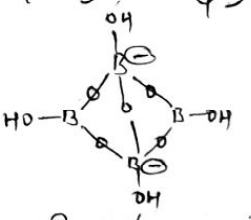
Borax ($Na_2B_4O_7 \cdot 10H_2O$)

$Na_2[B_4O_5(OH)_4] \cdot 8H_2O$ → It may be alkeol.

Structure



$[B_4O_5(OH)_4]^{-2} \cdot 8H_2O$



$\cdot 8H_2O$

Borax Bead Test →

Borax $\xrightarrow{\Delta}$ H_3BO_3 $\xrightleftharpoons{\Delta}$ HBO_2 (metaboric acid) $\xrightarrow{\text{Red heat}}$ B_2O_3 (Boric anhydride)

acid ($NaBO_2$) → $NaBO_3$

H_3BO_3 → H_2O

(*) Borax bead test में intermediate species ?

100% Q. Find paper 9

$B_2O_3 + MO \longrightarrow M(BO_2)$

metal oxide

metal metaborate

(specific colour)

e.g.

$B_2O_3 + CoO \longrightarrow Co(BO_2)_2$

(Blue colour)

Reaction X

$Na_2B_4O_7 \cdot 10H_2O + HCl \longrightarrow NaCl + H_3BO_3 + H_2O$

$BF_3 + HF \longrightarrow HBF_4 \rightarrow H^+ + BF_4^-$

$B_2H_6 \xrightarrow[\text{Heat}]{\text{Red}} 2B + 3H_2$

$B_2H_6 + HCl \longrightarrow B_2H_5Cl + H_2$

Net Structures of boranes.

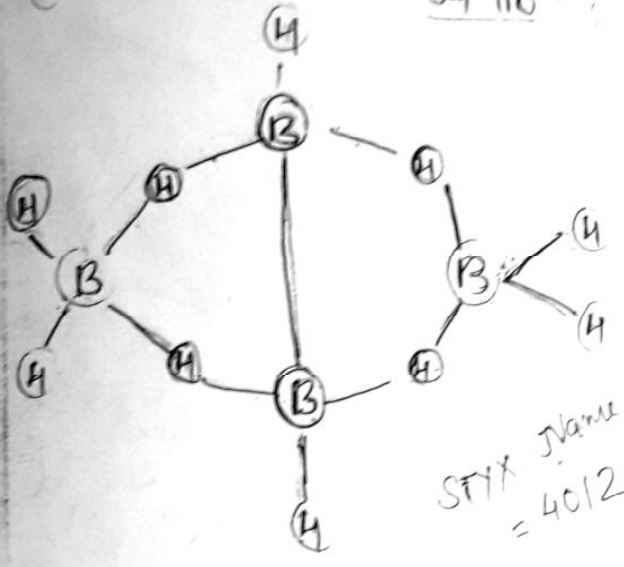
2c — 2e bonds → Normal covalent bonds → B — H, B — B

→ two centers
→ two electrons

3c — 2e bonds → bridged bonds → B — H ··· B, B ··· B ··· B

→ Packed boron → B, B, B

(i) Structure of B_4H_{10} : Tetraborane-10



Total no of valence electrons

$= 4 \times 3 + 10 \times 1 = 22$

STYX Name → Structure draw.

$= 4012$

Electrons in 2C — 2e bonds

Covalent B–H bonds $= 6 \times 2 = 12\ e^-$

Covalent B–B bond $= 1 \times 2 = 2\ e^-$

Electrons in 3C–2e bonds

Four bridge bonds viz B···H--B bond

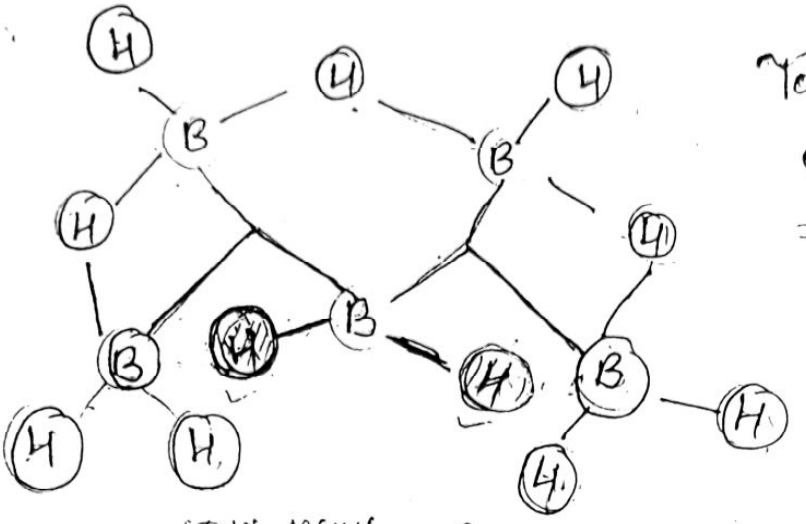
$= 4 \times 2 = 8e$

Total valance electron = 22

(ii) Structure of B_5H_9 { Pentaborane – 9 }

Total no of valence e's

$= 3 \times 5 + 1 \times 9 = 24$



Total no of Valences
$= 5 \times 3 + 11 \times 1$
$= 26$ e⊖

STYX name = 3203

2C- 2e bonds
- B-H bonds $= 8 \times 2 = 16$ e⊖
- B-B bonds = Nil

3C- 2e bonds
- B···H···B bonds $= 3 \times 2 = 6$ e⊖
- B(B)(B) bonds $= 2 \times 2 = 4$ e⊖

Total no. of Valences = 26 e⊖

B_2H_6 → * use
- In hydroboration for the formation of → Alcahals, Acids, Ketones
- → Rocket propellents. (fuel)
- → In Reduction

$5 \times 2 = 10$

3/13