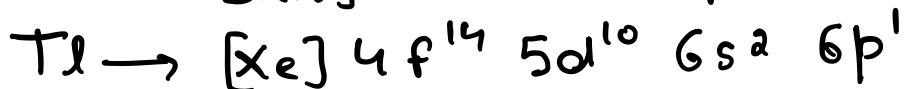
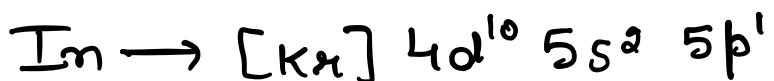
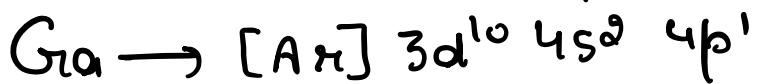
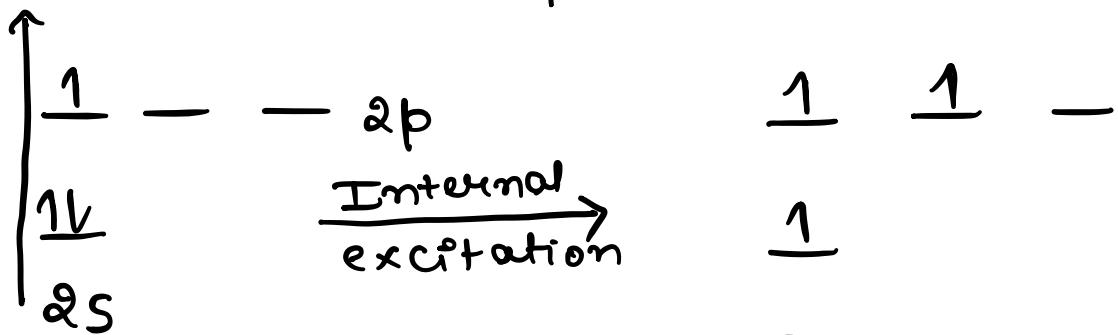
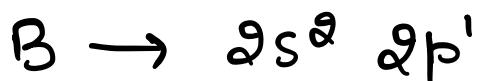


Boron family



① General electronic Config. = $ns^2 np^1$

② Permissible Covalency and Electronegativity :-



$$\text{G.S. v} = 1$$

$$\text{E.S. Covalency} = 3$$



When we move from top to bottom then stability of lower valency increases.

↓
Due to inert pair effect.

* B, Al, Ga, In → +3 stable.

* Tl → +1 more stable.

* $\text{Al}^{+3} > \text{Al}^+$ $\text{Tl}^+ > \text{Tl}^{+3}$

Inert pair
effect.

* B → Non metal.

Al] → metalloid
Ga]

In] → metallic.
Tl]

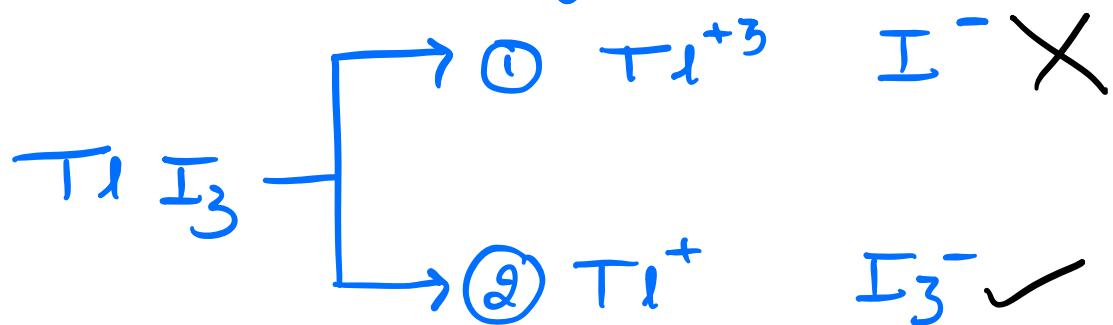
* B_2O_3 → Acidic

Al_2O_3] → Amphoteric.
 Ga_2O_3

In_2O_3] → Metallic.

Tl_2O_3

* $TlI_3 \rightarrow$ sometimes K/A
'Ranley salt'



Extraction of Boron⁰⁻

① When B_2O_3 is treated with Al then gives Boron in the form of B_{12}



Crystalline boron.

'Black lustrous solid'

Gold Schmidt aluminothermic process

② In similar way B_2O_3 is

reduced by Na or Mg.



Amorphous
boron.

'Dark brown
powder'

* Crystalline boron is Icosahedral.

Icos \rightarrow 20 faces

Tetrahedral \rightarrow 4 faces

Octahedral \rightarrow 8 faces.

* Atomicity of crystalline boron = 12
(Dodeca atomic)

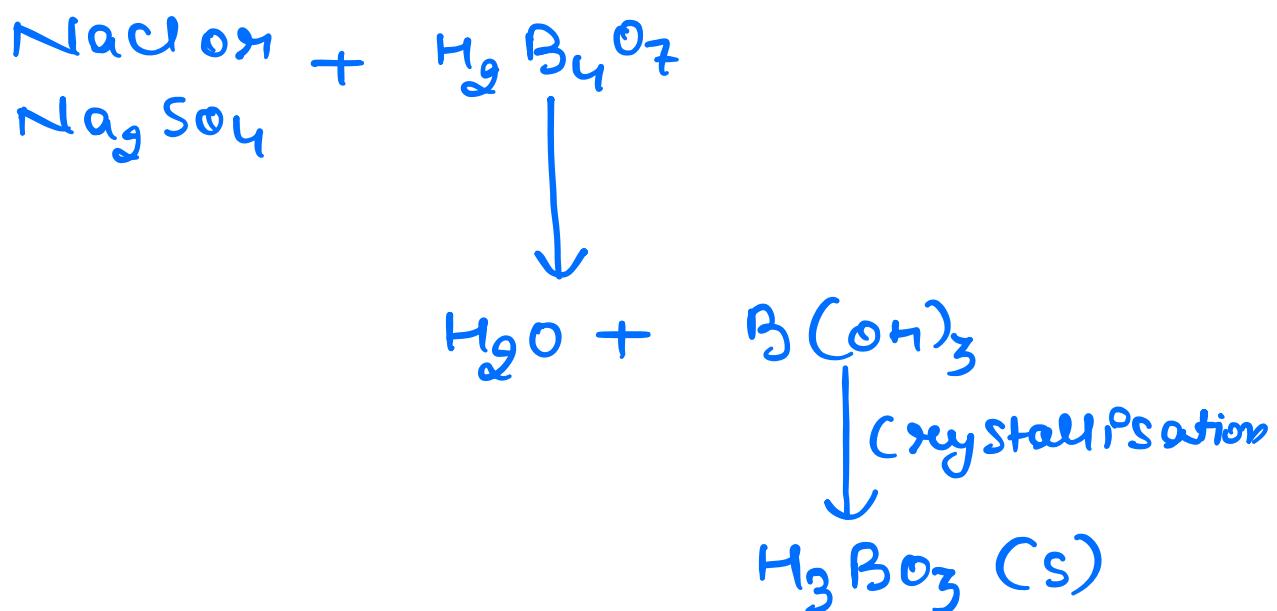
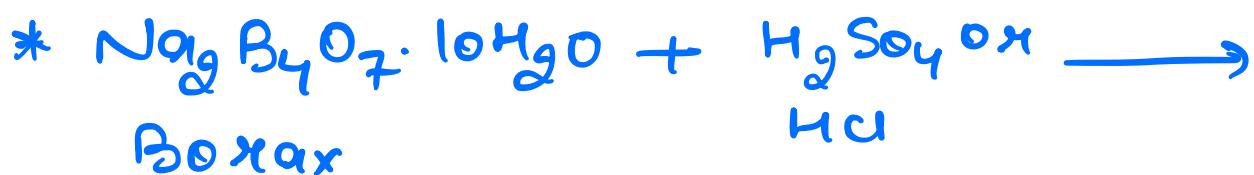
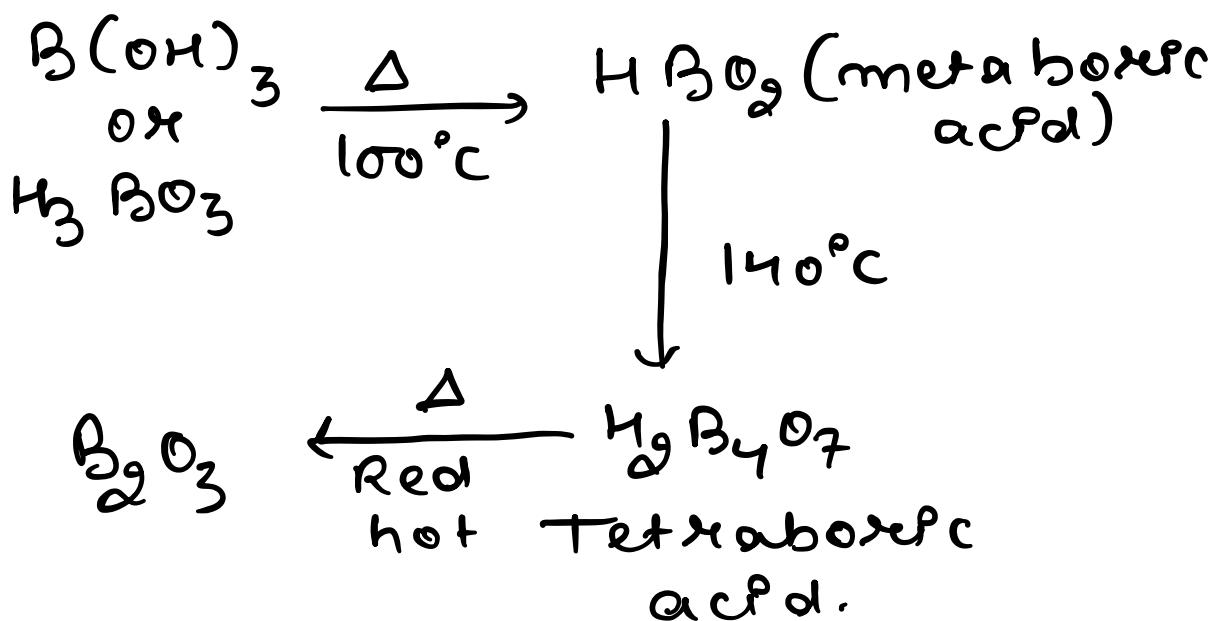
* $\text{B}_2\text{O}_3 \rightarrow$ DP boron + BP oxide.
(Boric anhydride)
Or

$\text{B}_2\text{O}_{3\frac{1}{2}} \rightarrow$ Boron Sesquioxide.

$\frac{3}{2}$

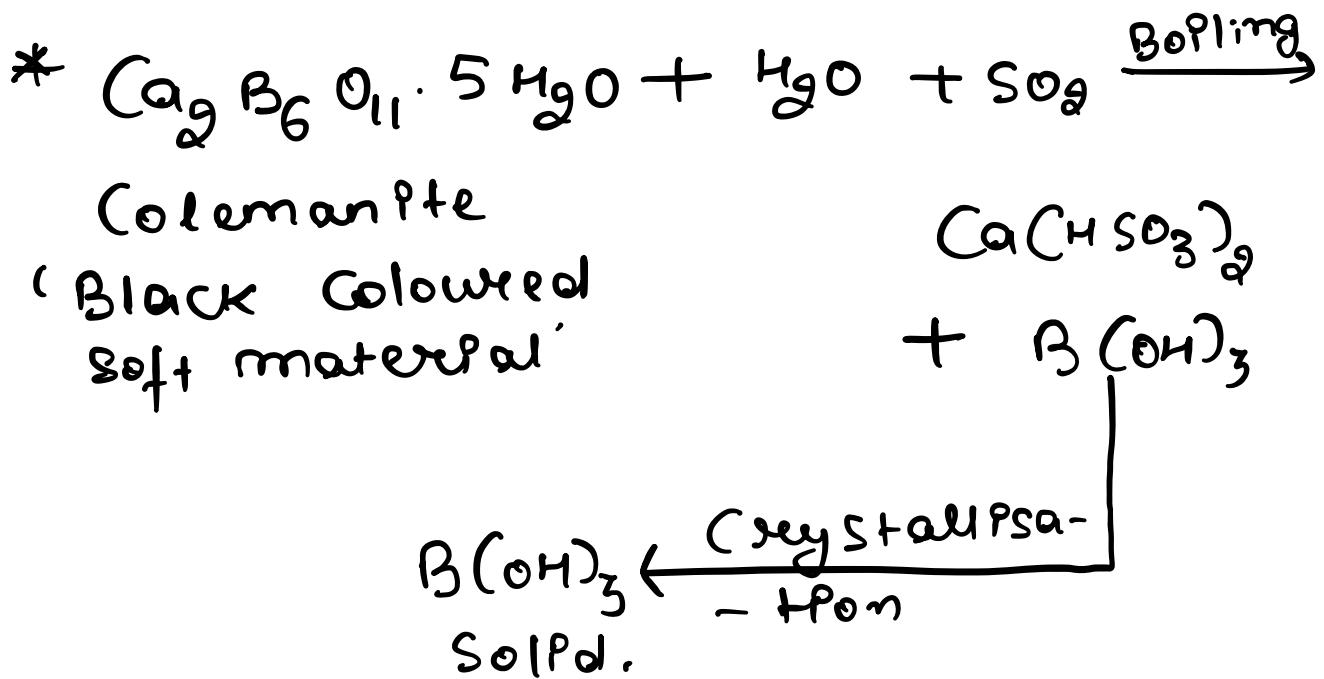
Generation of $\text{B}_2\text{O}_3^{O-}$

1.) Heating of ortho boric acid :-



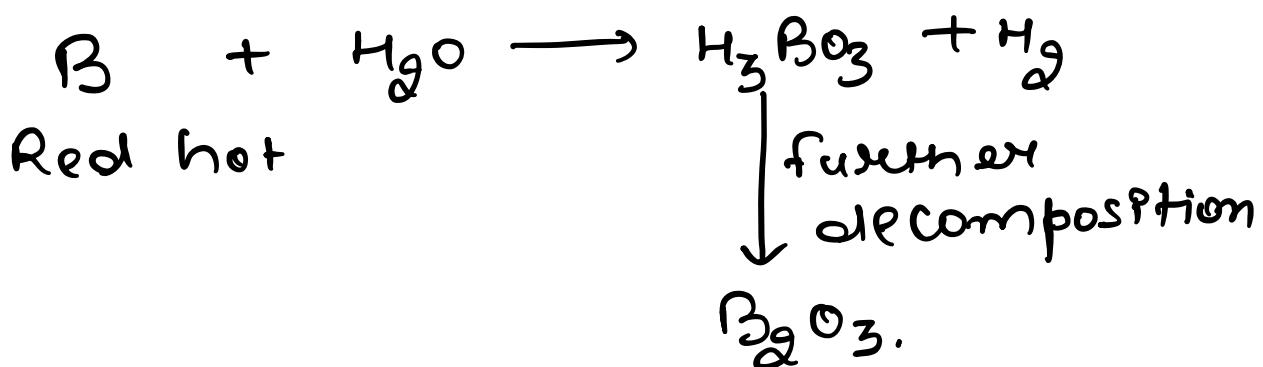
* Because of low solubility

of boric acid finally after crystallisation Pt comes out and Pt appears as $\text{B(OH)}_3 \text{Cs}$.



Properties of boron O^-

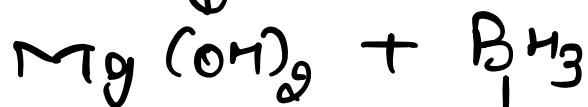
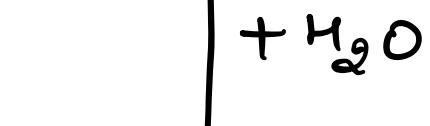
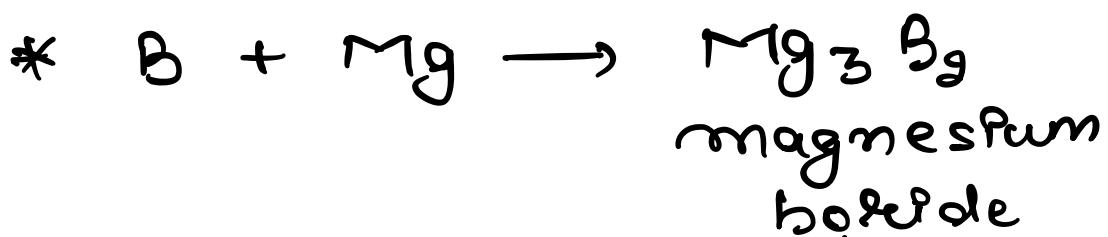
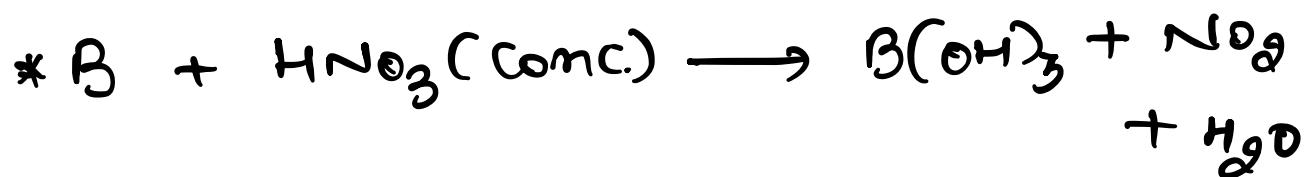
1.) Boron amorphous is more reactive than boron crystalline.



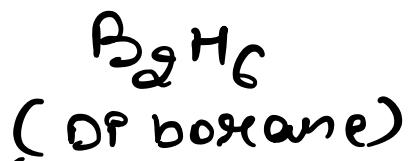
Red
hot

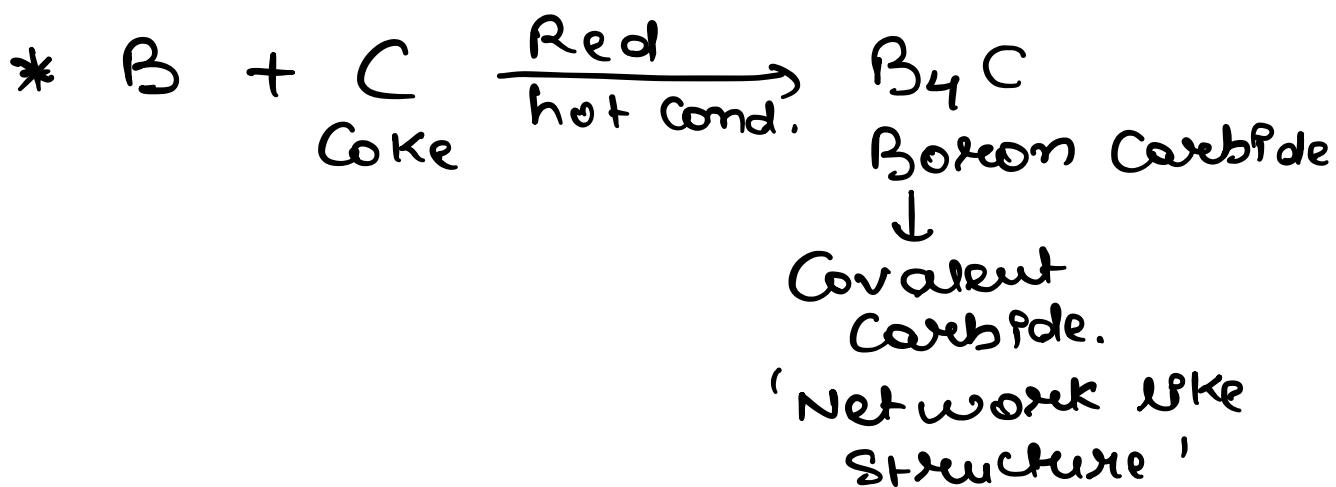
(Glassy mass)

Under cold conditions.



↓ Dimerise





Boron nitride
 on inorganic
 graphite.



Also shown by Al.

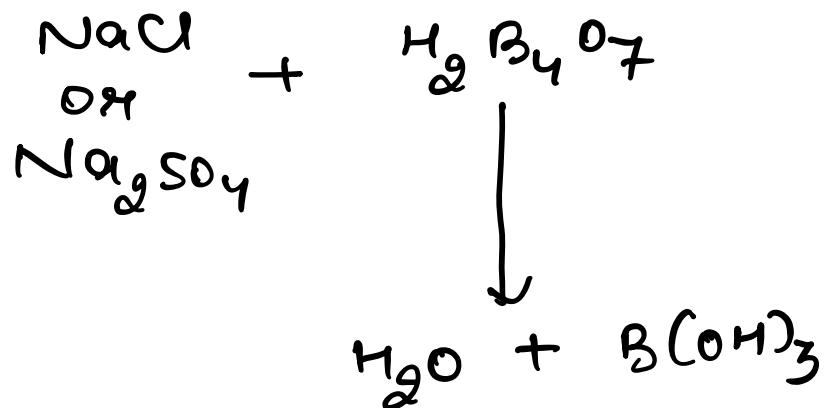


Compounds of boron :-

- 1.) Orthoboric acid.
- 2.) Borax. ($Na_2B_4O_7 \cdot 10H_2O$)
 or Jeweller's borax ($Na_2B_4O_7 \cdot 5H_2O$)
- 3.) B₂H₆ (Diborane)
- 4.) Inorganic benzene or borazene.

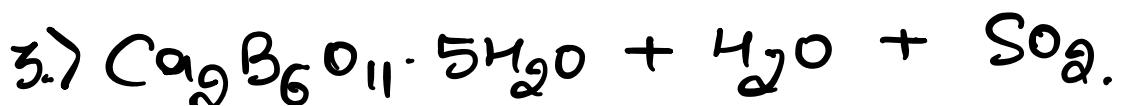
1.) Orthoboric acid (Boric acid)

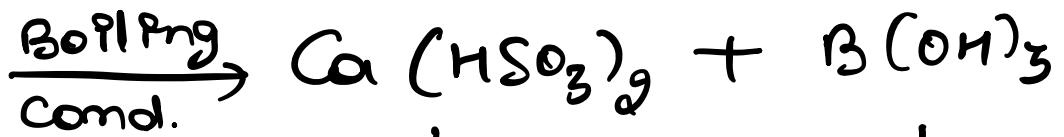
- ① Boric acid is also exist in nature and K/A chilly.
- ② $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O} + \text{HCl}/\text{H}_2\text{SO}_4 \rightarrow \text{Borax}$



* $\text{H}_2\text{B}_4\text{O}_7$ decomposes to B(OH)_3 and after that in this system is subjected to crystallisation then boric acid separate out because of its low solubility.

After crystallisation the left solid is K/A \rightarrow Mother liquor.

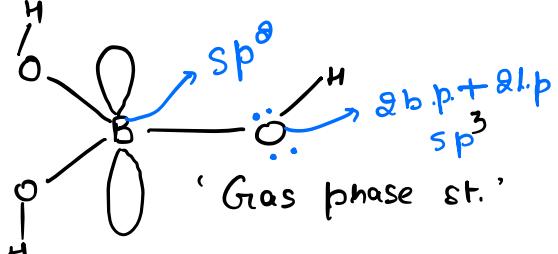




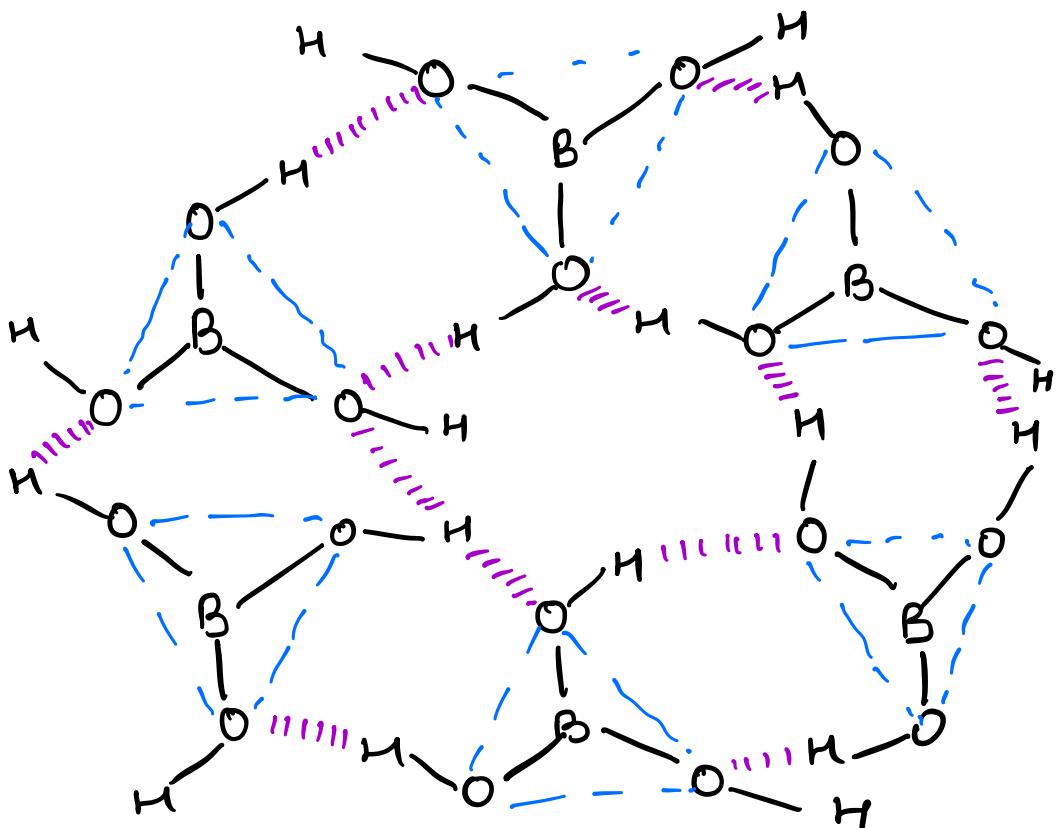
Crystallisation



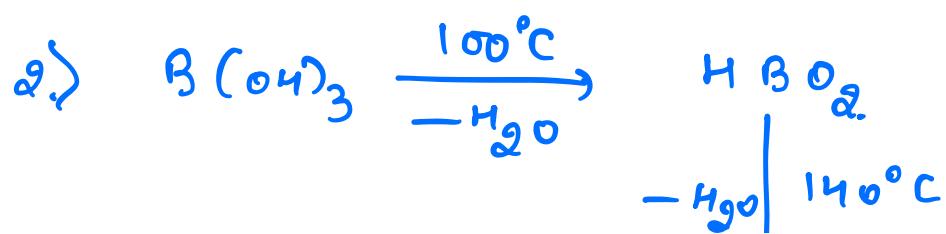
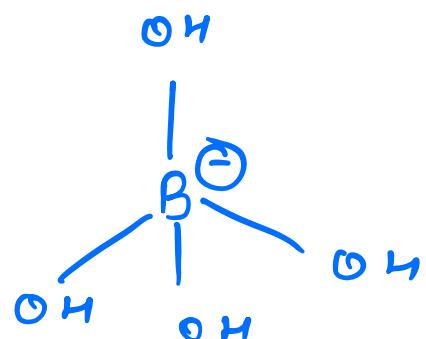
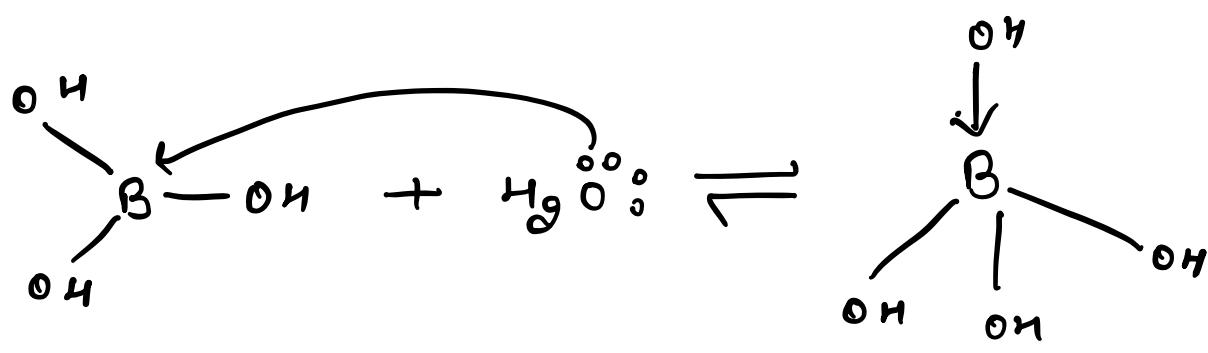
\Rightarrow Properties B^-

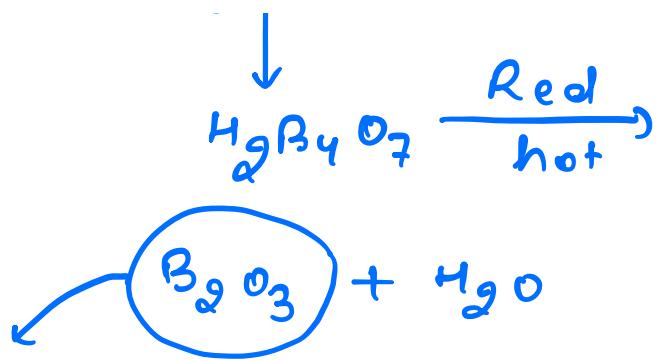


Trigonal planar.



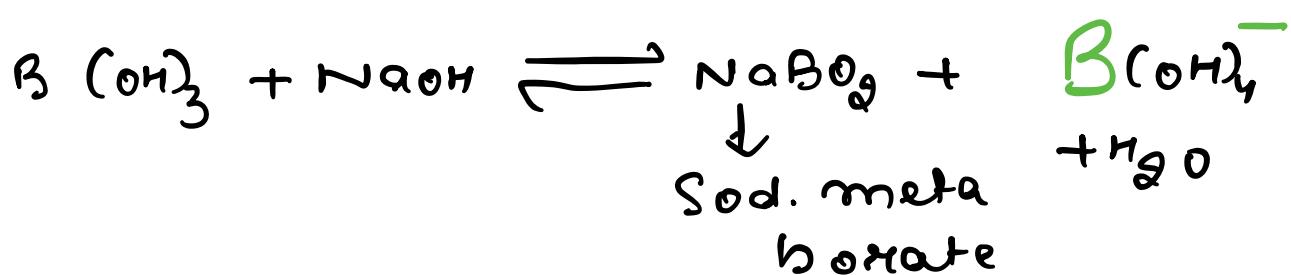
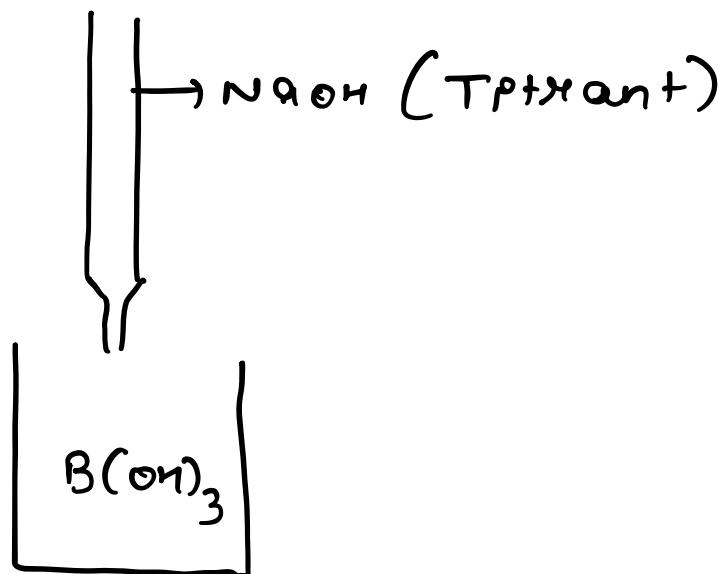
* B(OH)_3 is weak monobasic acid.





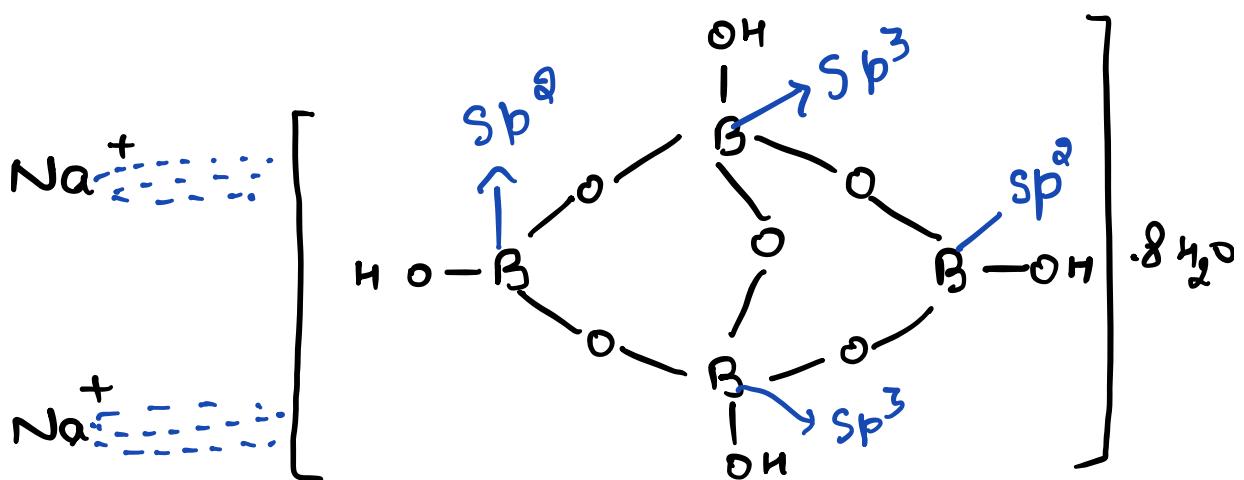
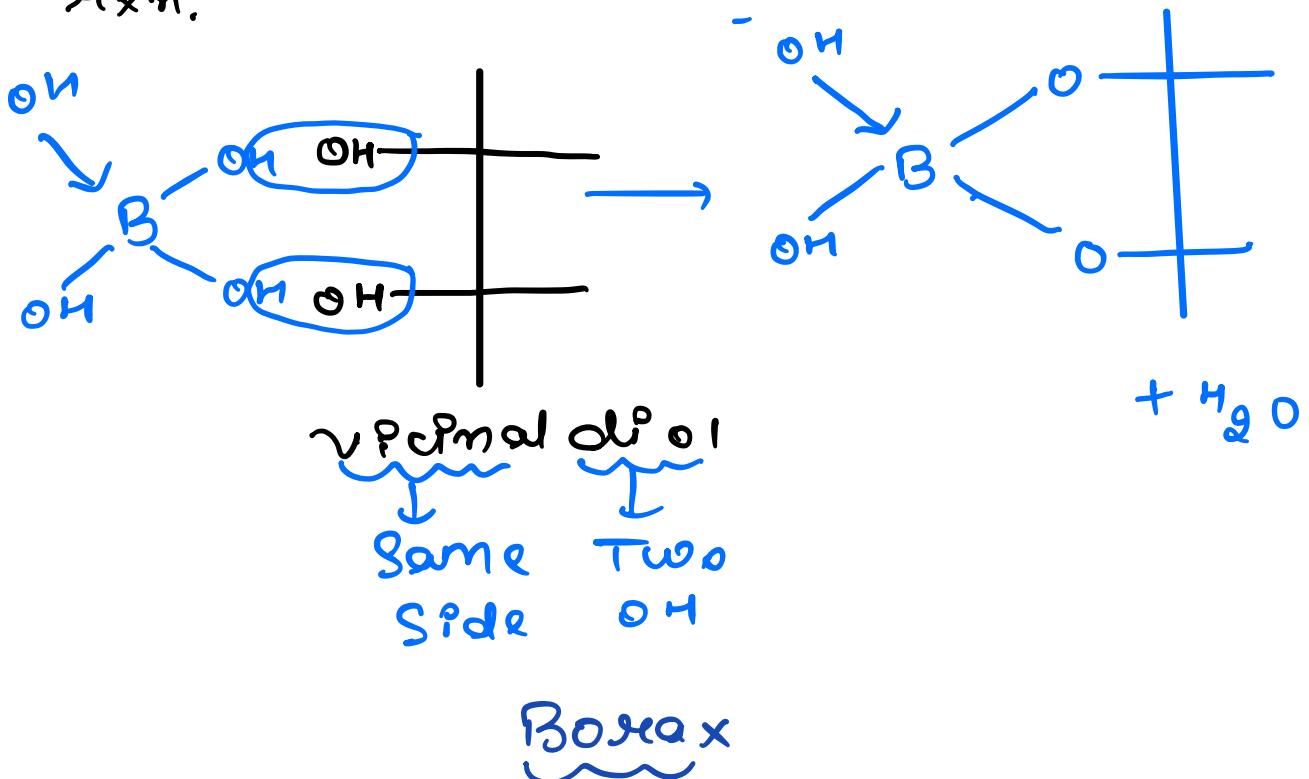
Expt as transparent glass mass which is used in salt analysis.

3) Titration of boric acid with $\text{NaOH } \text{O}^-$

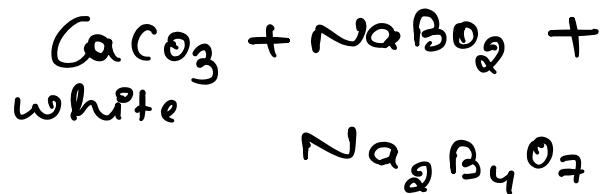
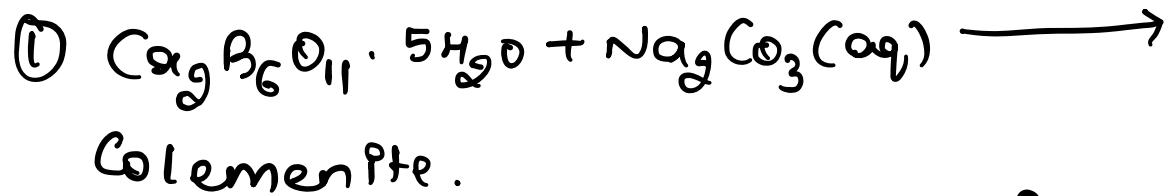


To obtain end point of titr.

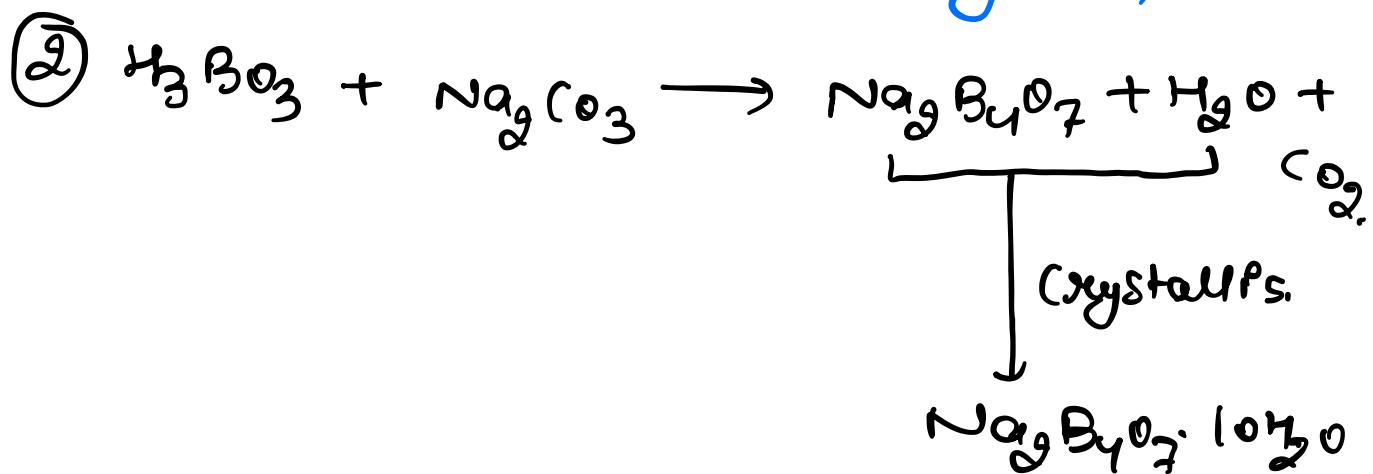
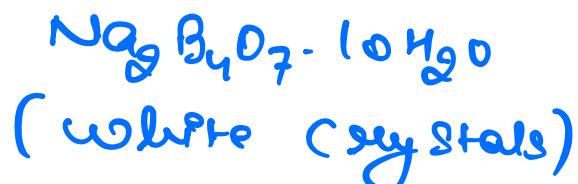
chemical rxn, reversible term should
be converted into pre-reversible
rxn.



Preparation :-



Crystallisation
 ↓



Chemical Properties :-

Cracking



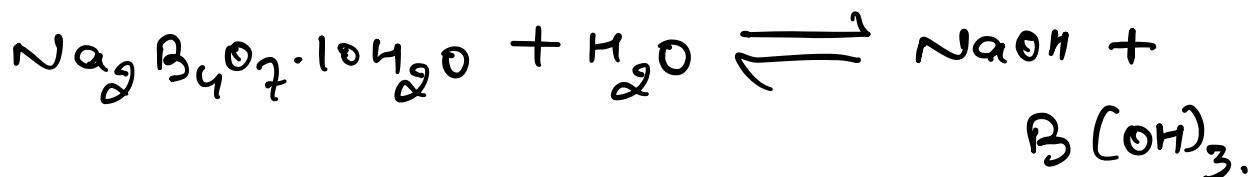
Anhyd. borax.

↓
Δ
continuous heating



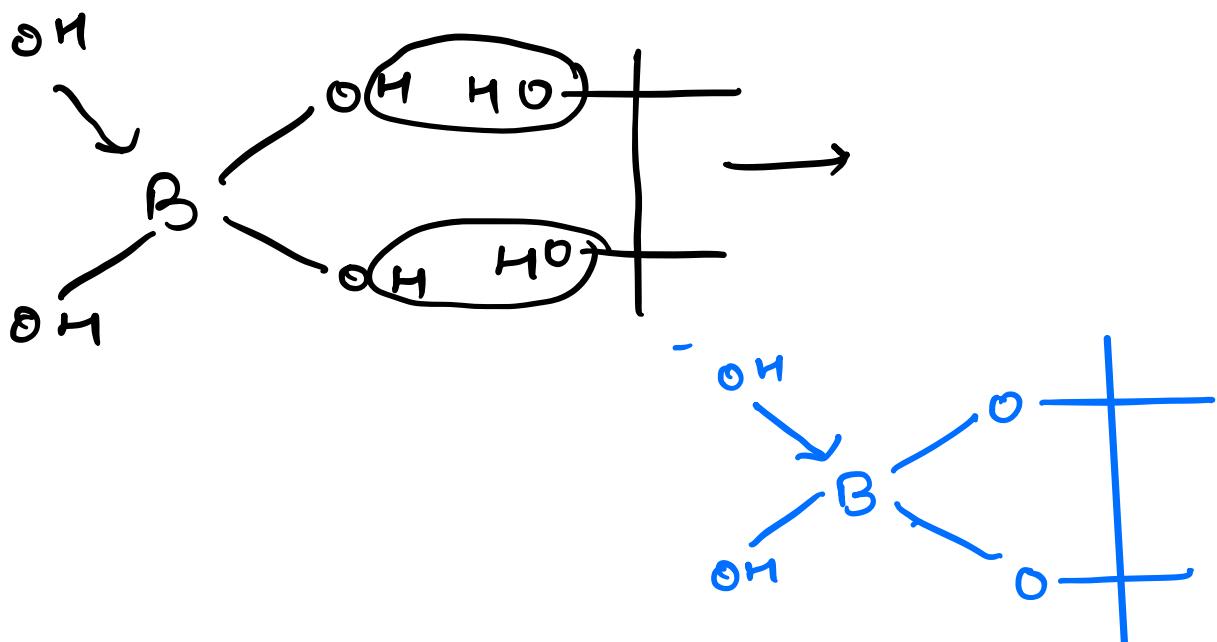
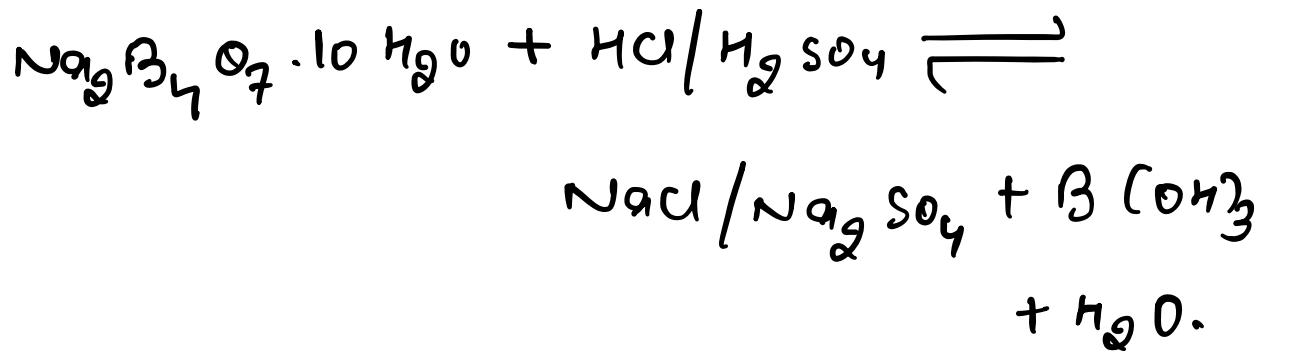
↓
Transparent
glassy mass.

- ② When borax is dissolved in water then it breaks into NaOH and boric acid, due to presence of NaOH its sol. So, it is basic in nature.



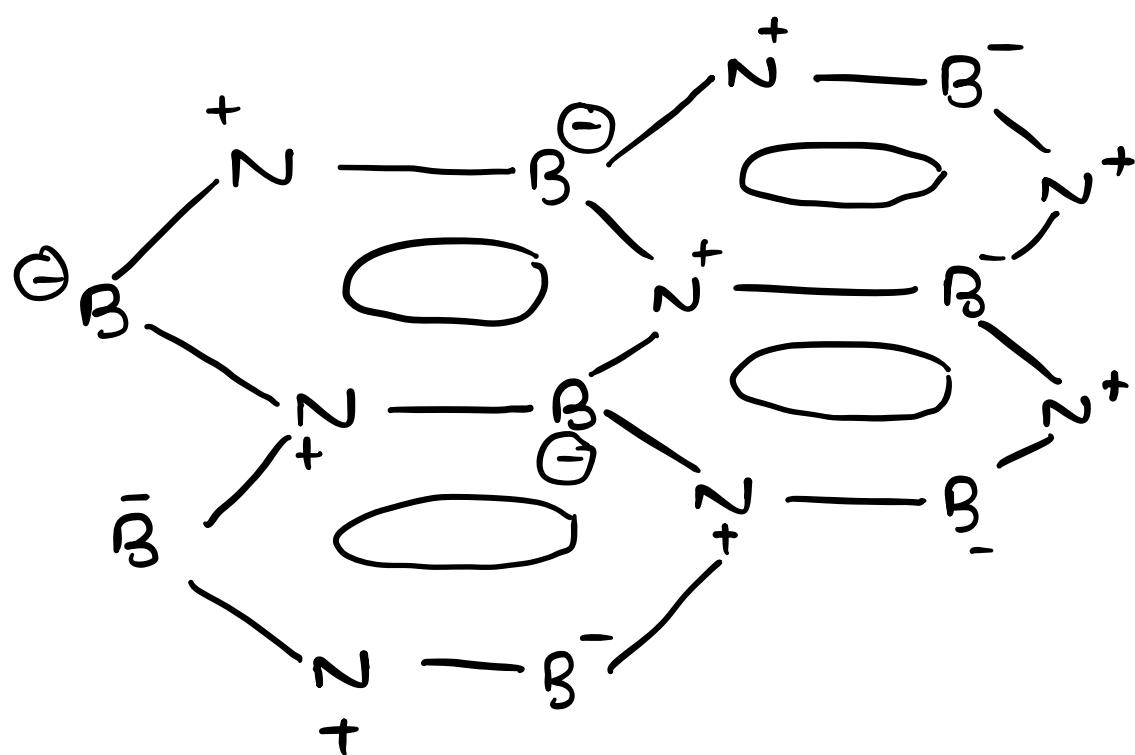
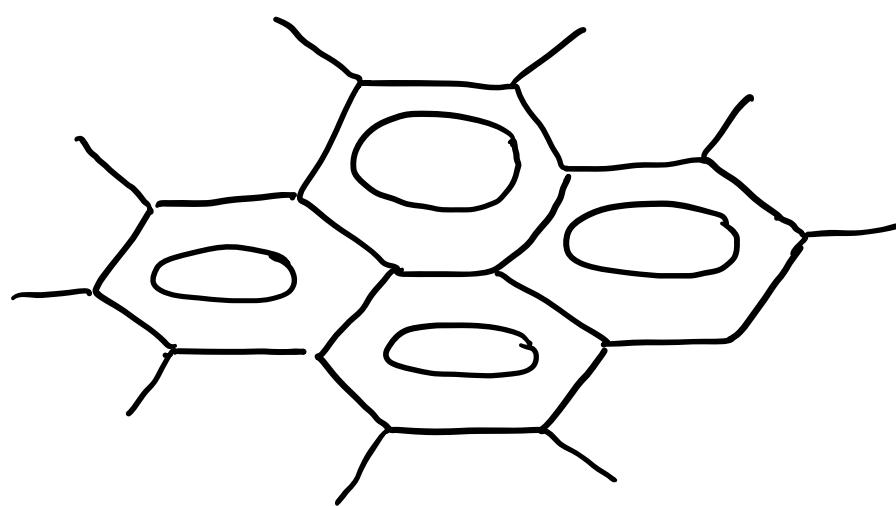
- ③ Titration of borax with mineral acids :-

* Here a visual dip will be used to convert reversible rxn into an irreversible rxn.



Inorganic graphite (BN_x)

- * Inorganic graphite has PSO structural and PSO electronic with graphite.
- * It has network or polymeric structure.

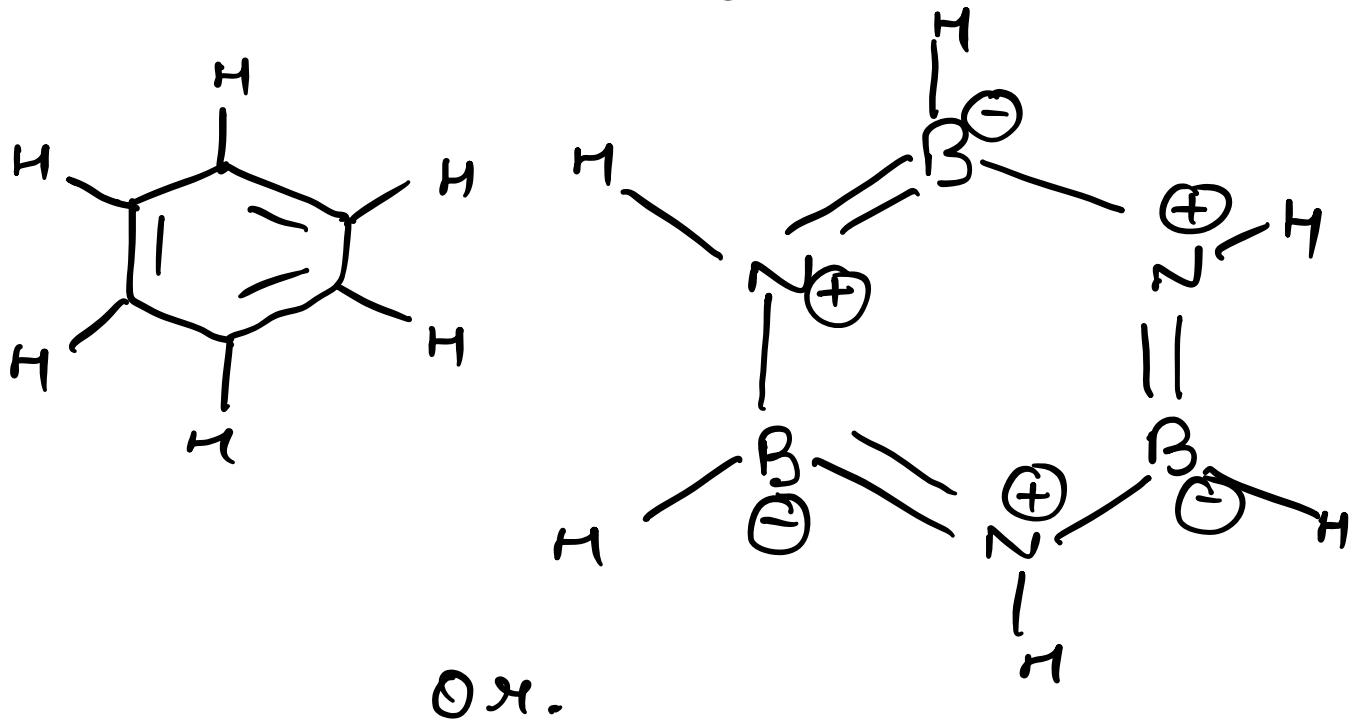


- * This is a network like 8t.
- * Ratio of boron to nitrogen is 1:1

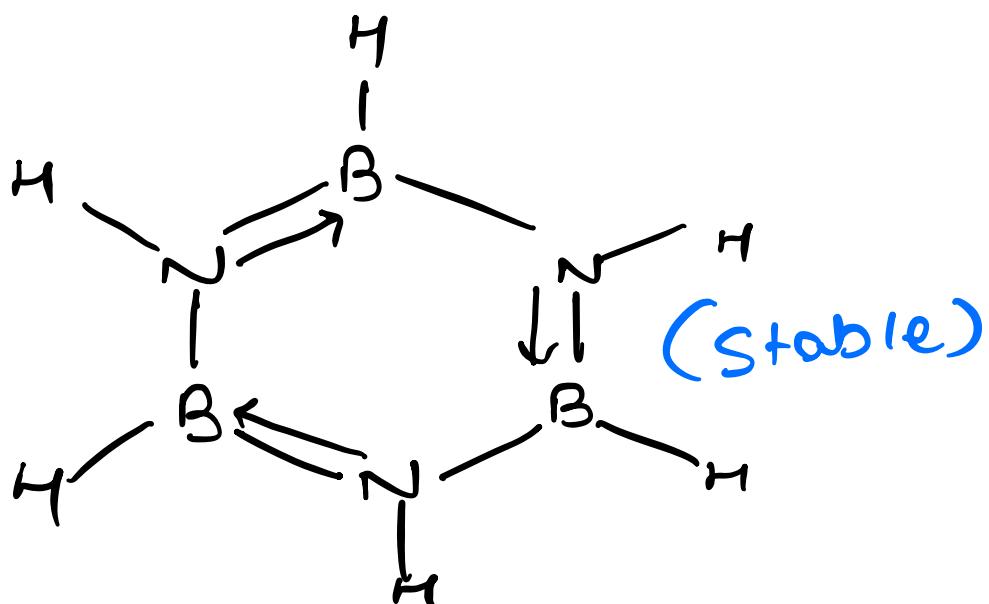
Inorganic benzene.

(Borazene)

* It is ρ_{SO} structural and σ_{SO} electronpoor with benzene.

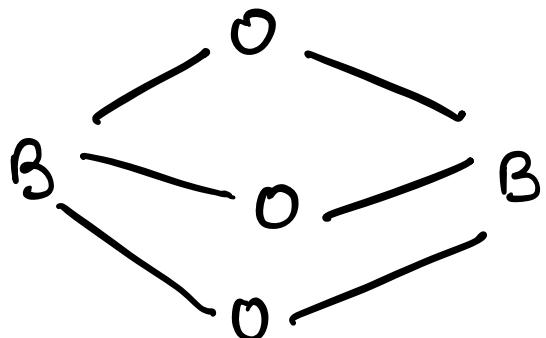
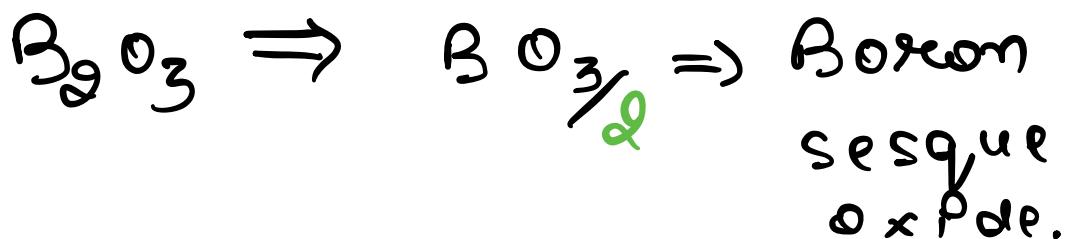
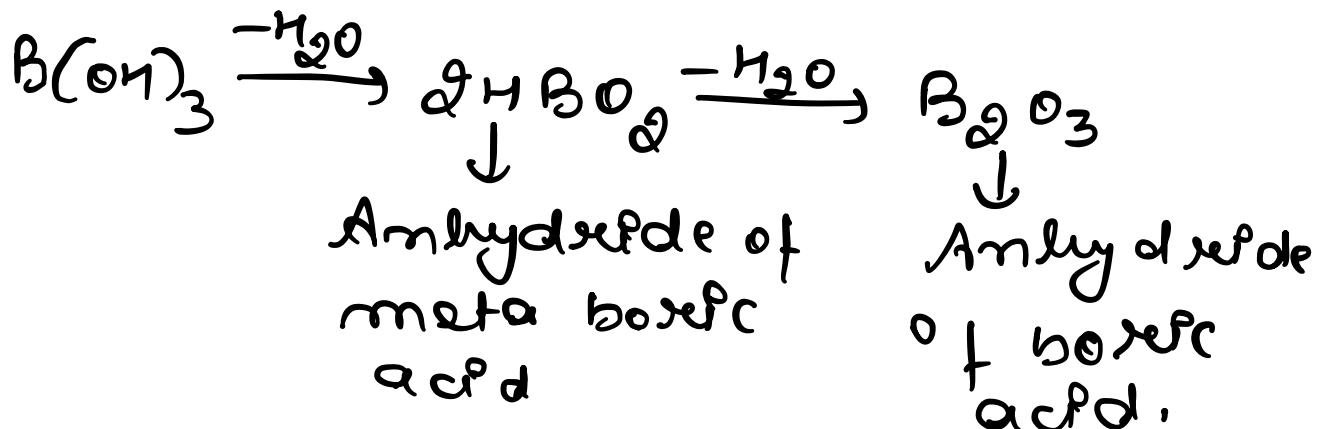


Or.





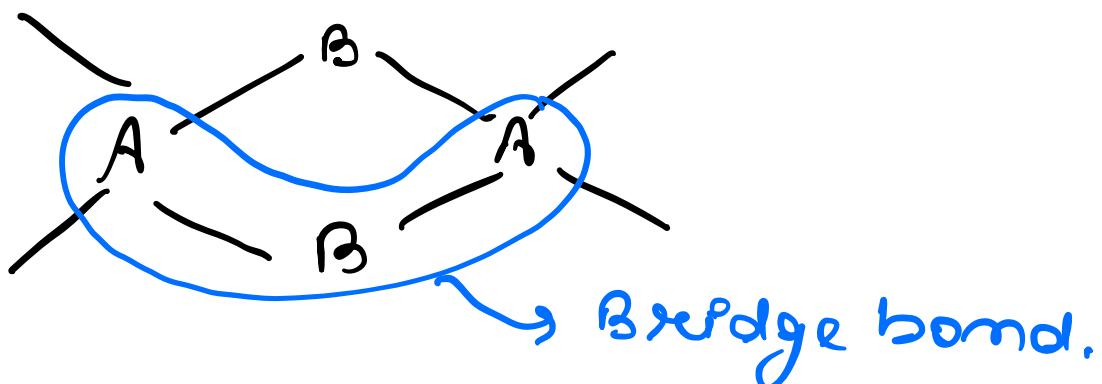
Diboron trioxide.



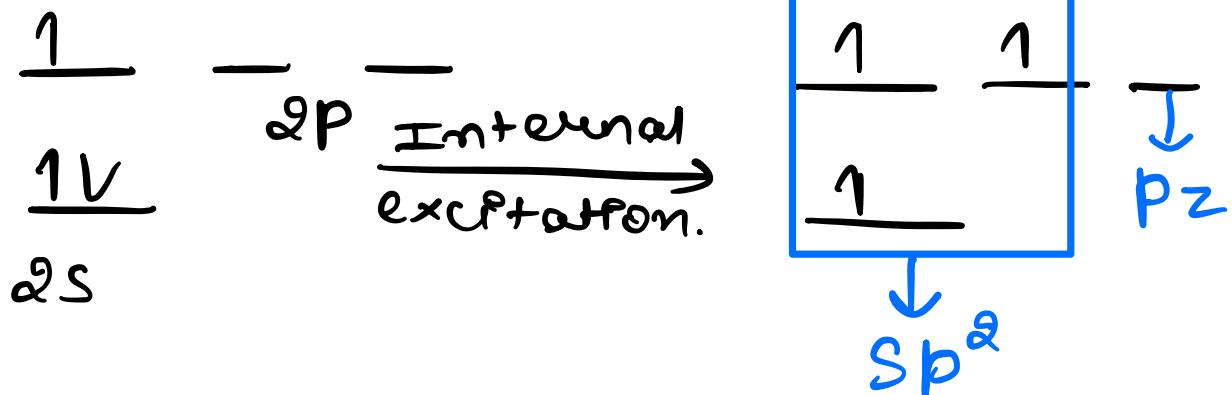
Multicentre-multipole bonding or

Bridge bonding.

* Bridge bonding is the bonding in which two or more atoms are connected as.



\Rightarrow Bonding in dP borane :-

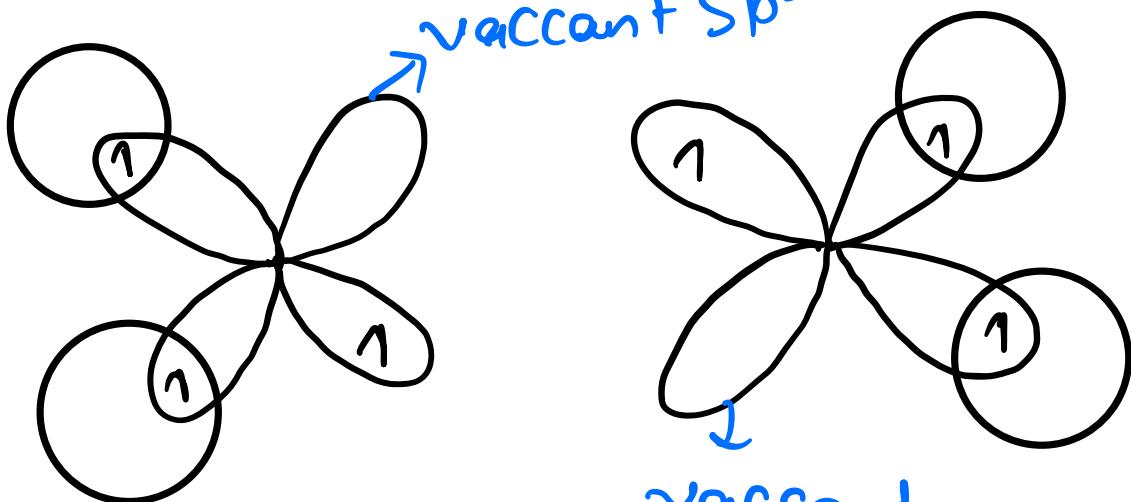


In diborane.
(Hydrogenation)

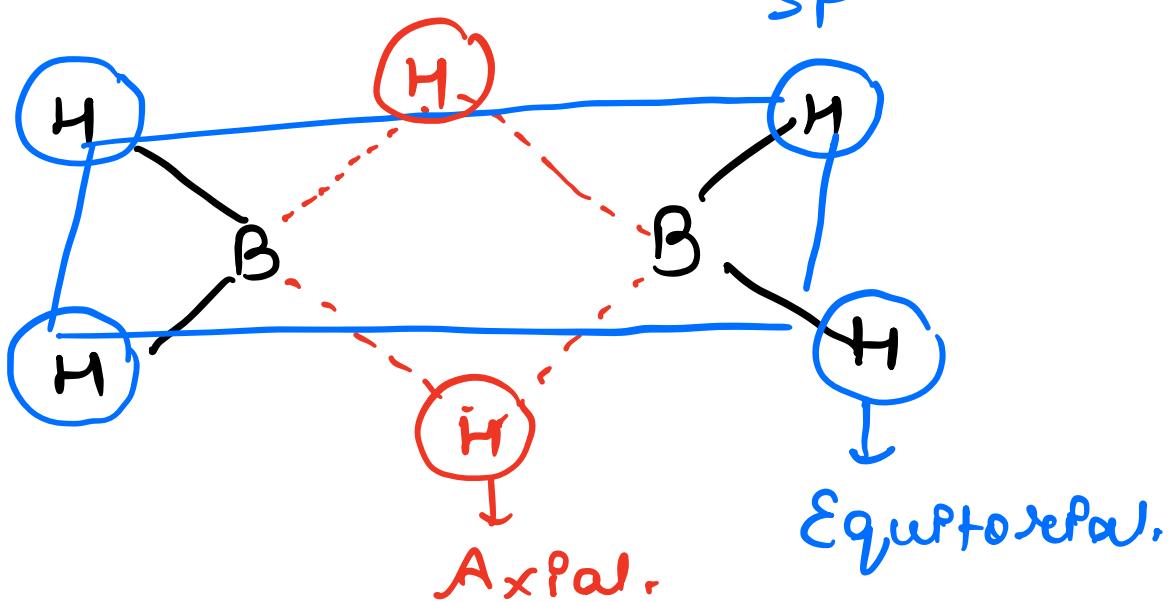
1 1 1

4 - sp^3 hybrid orbitals,

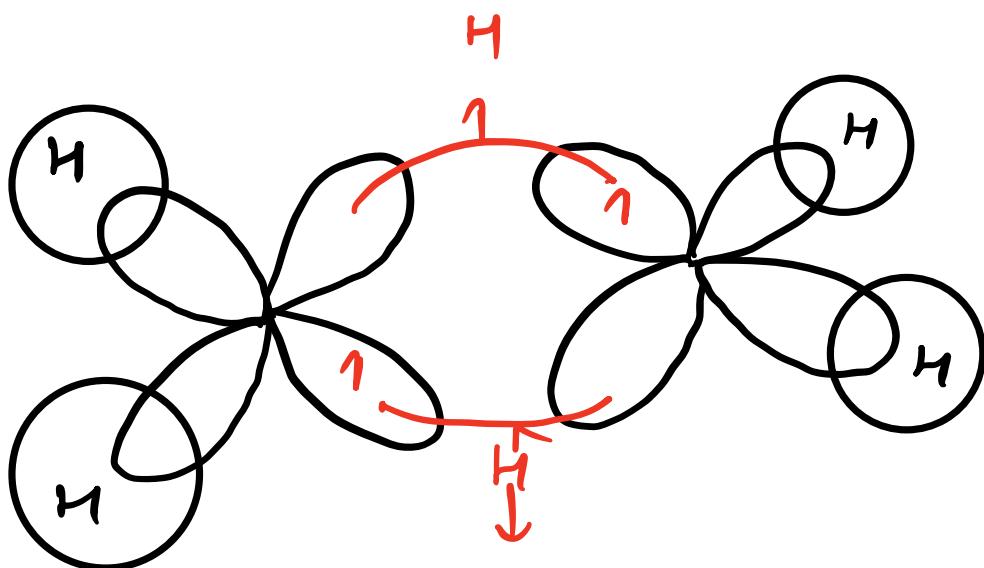
vaccant sp^3



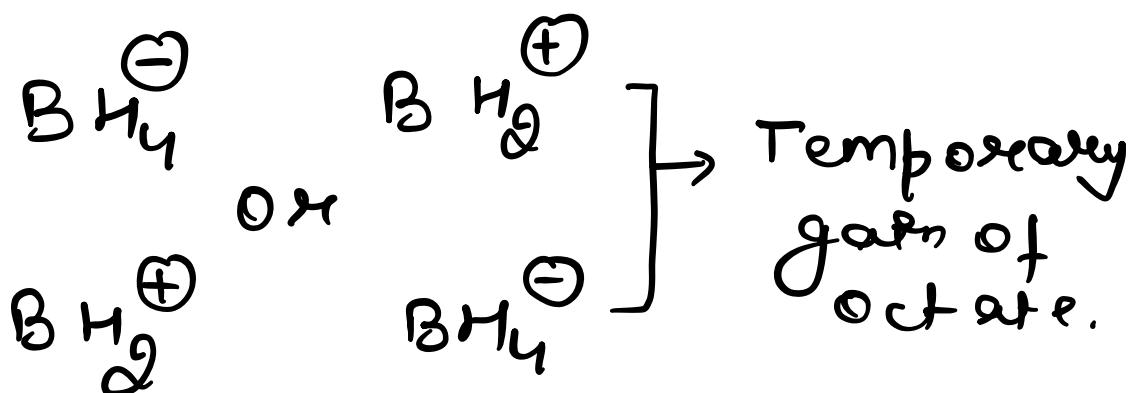
vacant
 sp^3

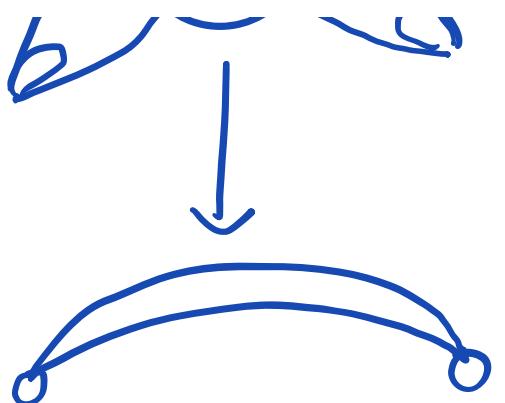


- * 4 - corner H-atoms are in same plane
- * 2 - axial H-atoms are in same plane.

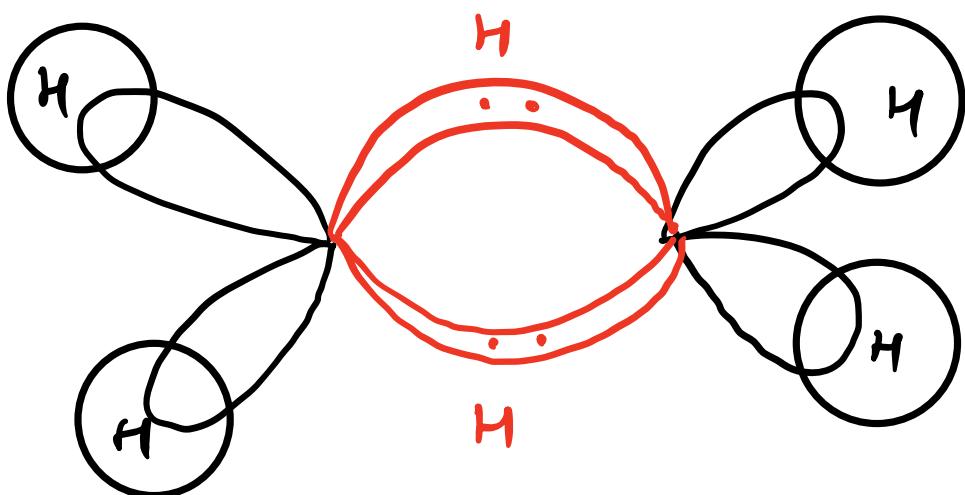


These e- keeps
on moving or shuttling





K/A Banana
hybrid orbital.



Actual st. of B_2H_6

* "3 centered electron pair bond."

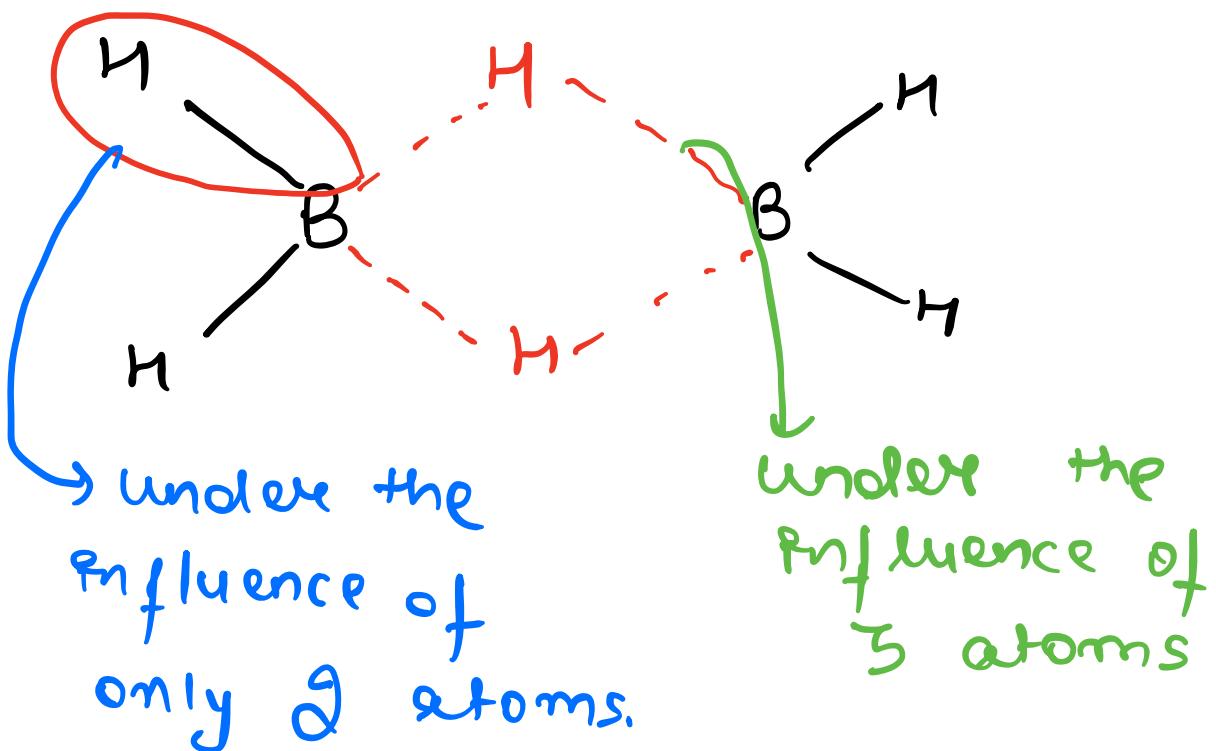
Characteristics of bonding
in $B_2H_6^-$

1.) In $B_2H_6^-$ boron is sp^3

hybridised.

2.) $(B-H)_{\text{axial}} > (B-H)_{\text{equatorial}}$
Order of bond length.

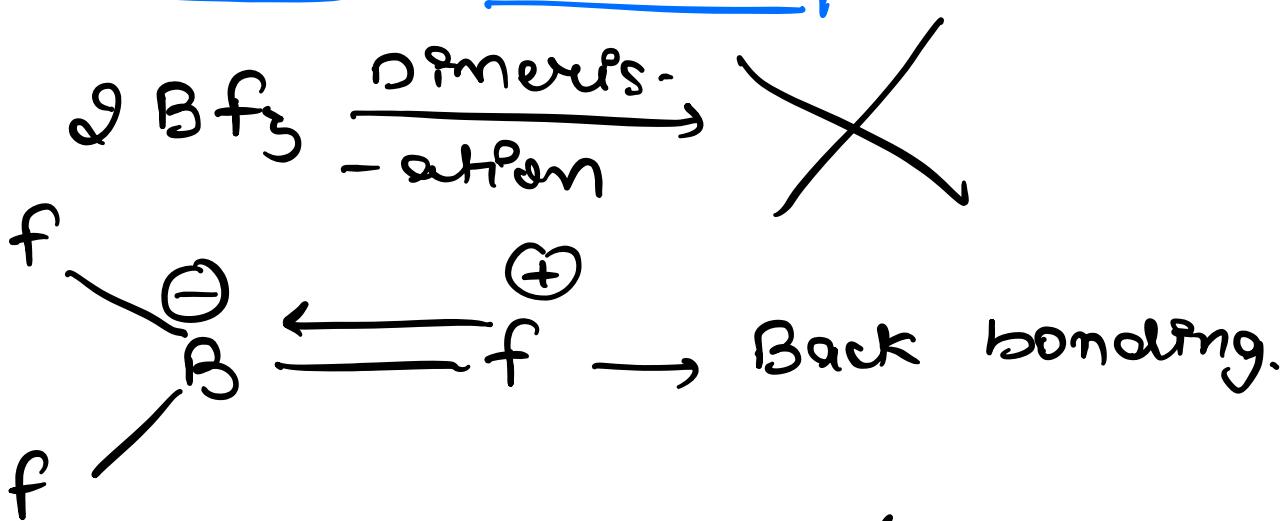
3.) $(B-H)_{\text{axial}} > (B-H)_{\text{equatorial}}$
"Order of bond
dissociation energy"



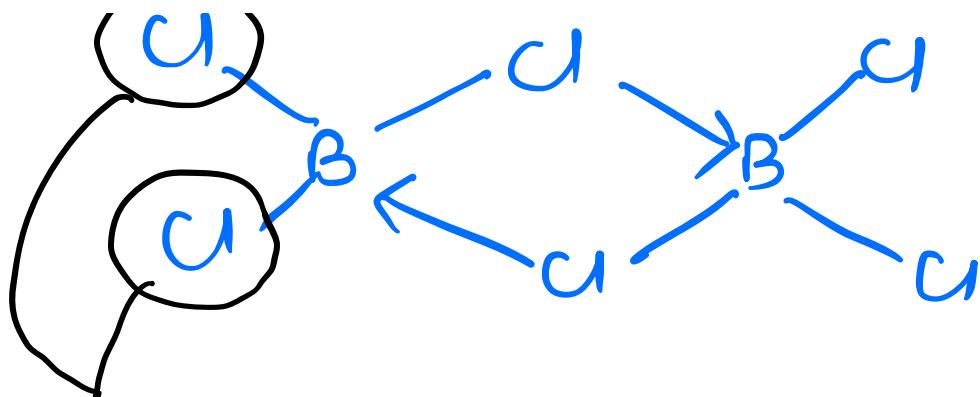
* e⁻ present in equatorial bond are under the

attractive influence of 2 nucleus whereas e^- present in axial bond P.S under the influence of 3 nucleus.

* Some other examples :-



- Due to Back bonding.
- Due to large size of Cl there will Steric repulsion.



very large steric repulsion
at equatorial position.



* Because AlF_3 is not
a covalent compound but is
an ionic compound.

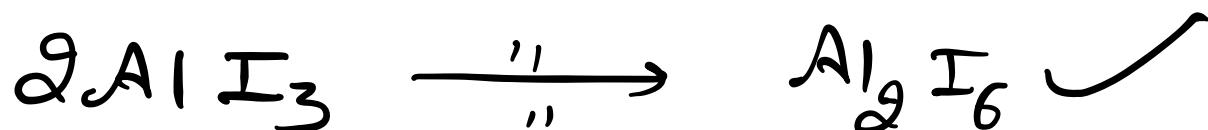


Ques:- Explain that BCl_3

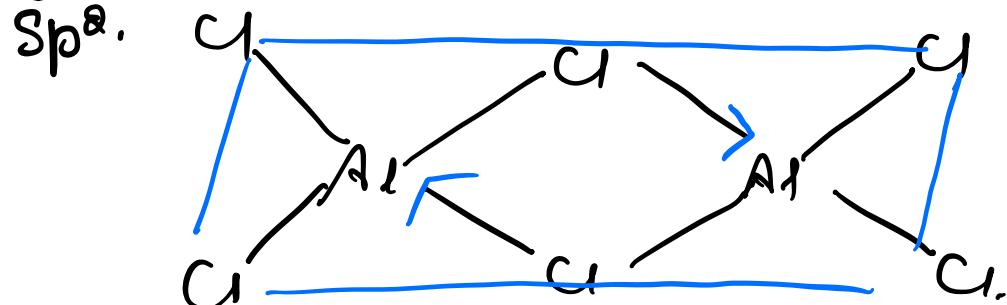
does not dimerises but
 AlCl_3 dimerises ? -

Solⁿ Due to large steric repulsion at equatorial position in case of BCl_3 .

* But Al have larger size hence it can dimerise.



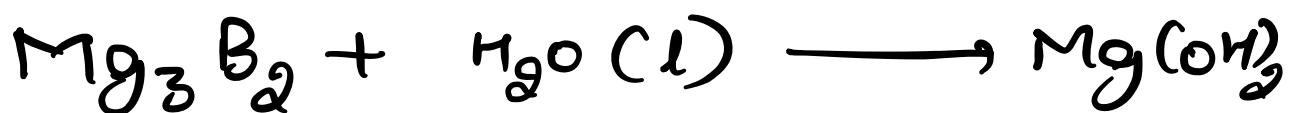
Bonding in AlCl_3 :-

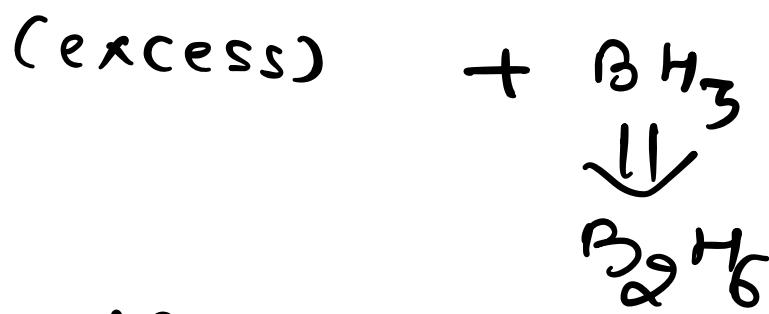


- * All Cl atoms are in same plane
- * In AlCl_3 driving force of dimerisation is just to permanent gain of octate.
- * In BH_3 driving force for dimerisation is just to temporary gain of octate.

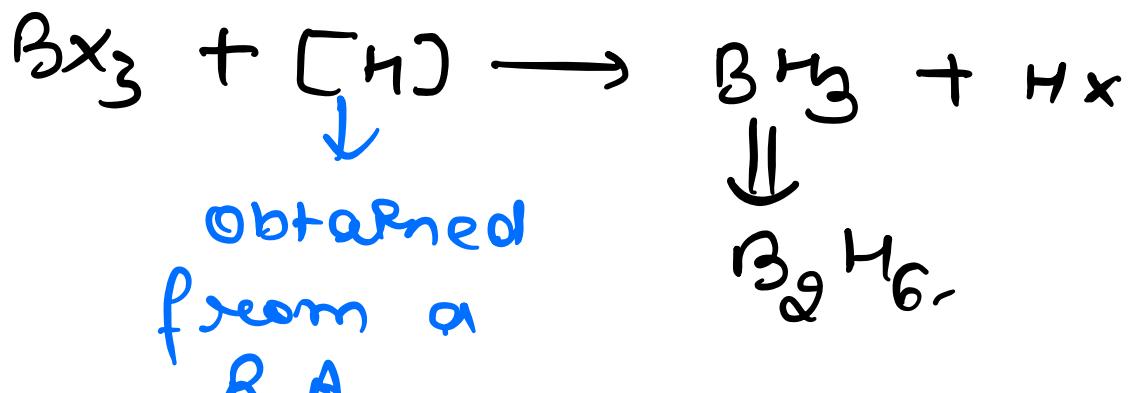
\Rightarrow Methods of preparation of B_2H_6^-

- ① By hydrolysis of metal borofiles $^-$





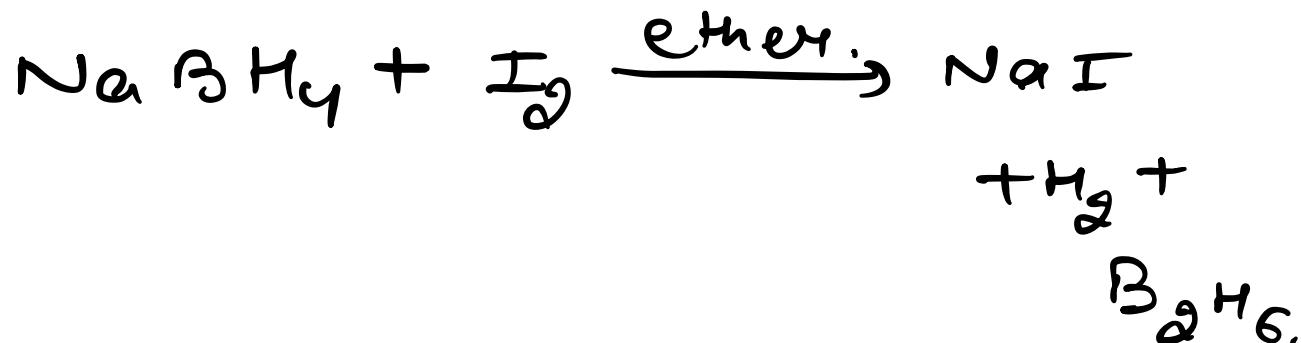
② By reduction of boron halides $\text{B}-$



(LiAlH₄, NaBH₄ etc.)

\Rightarrow Industrial method B_2H_6

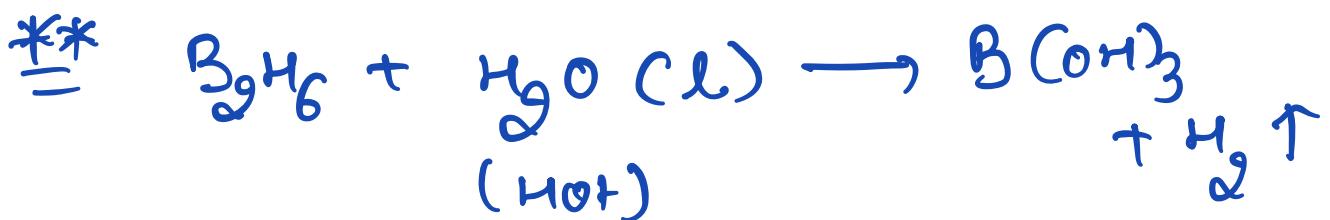
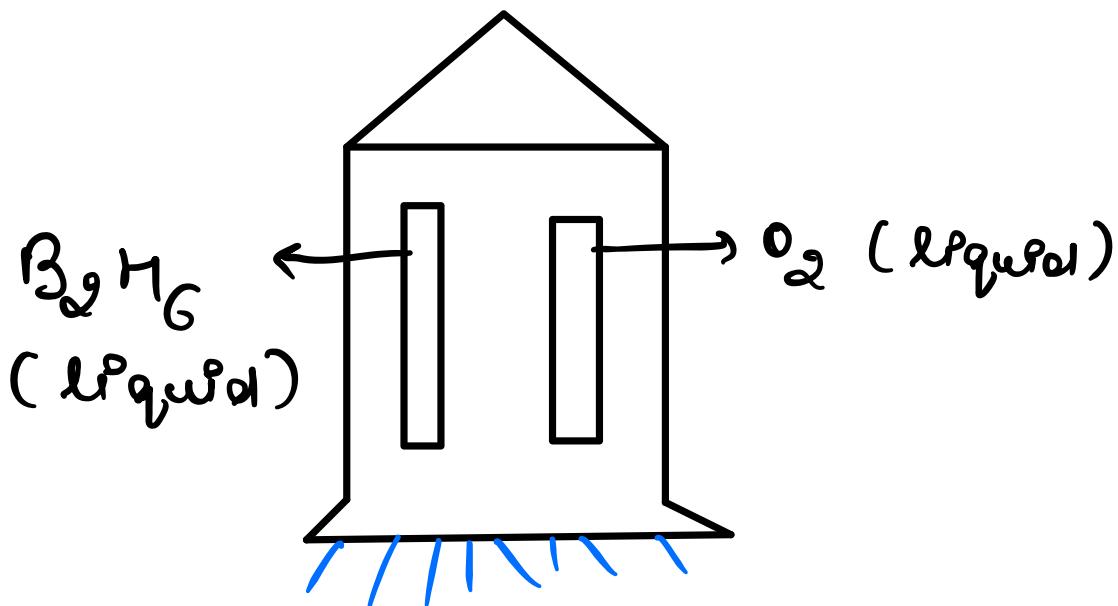
NaBH₄ treated with I₂.

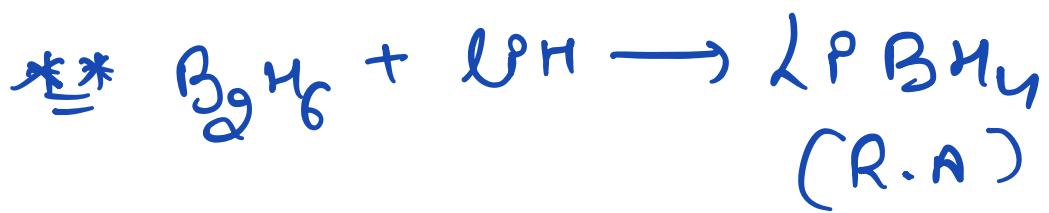




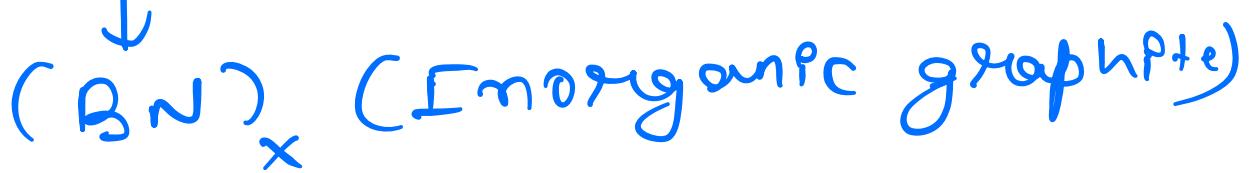
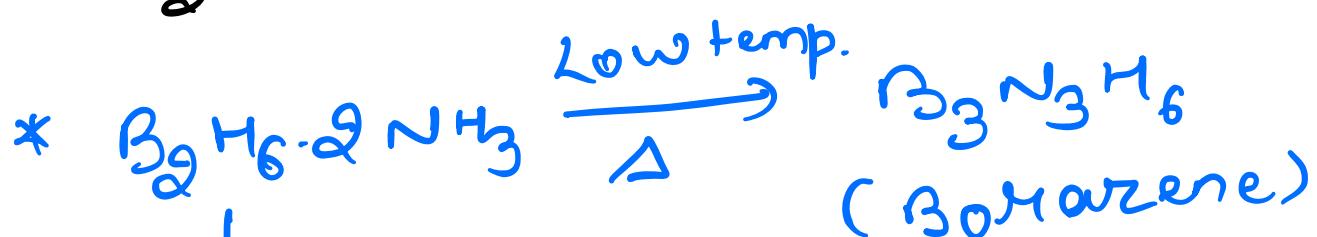
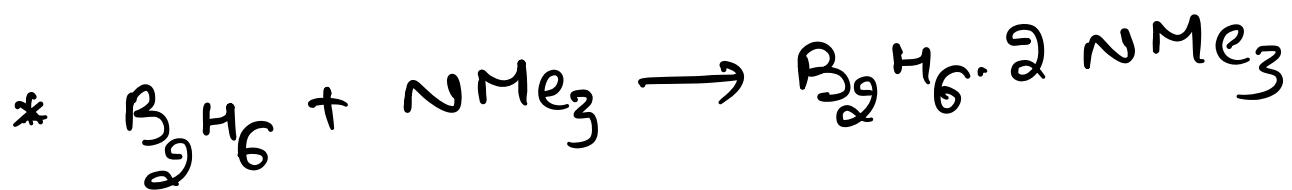
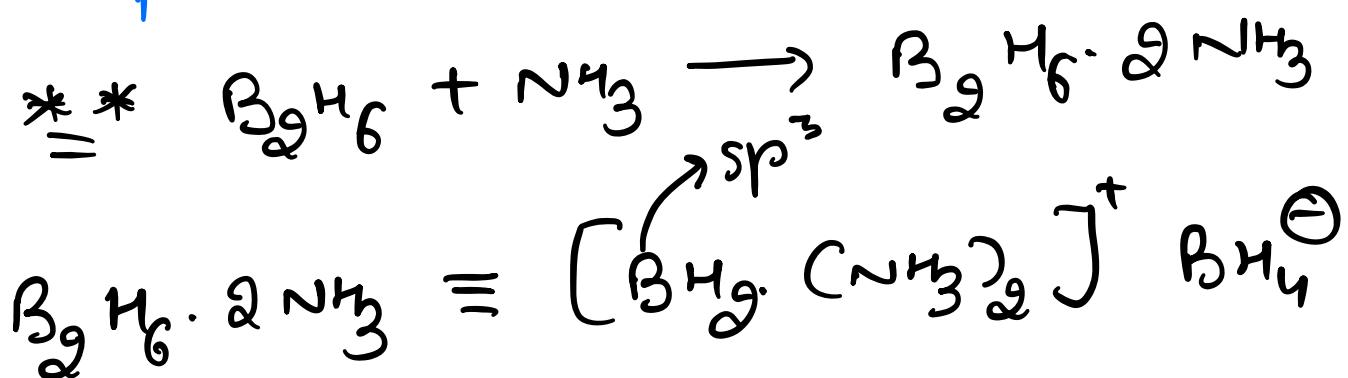
Highly exothermic

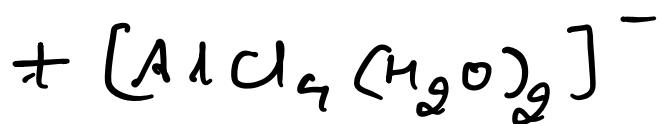
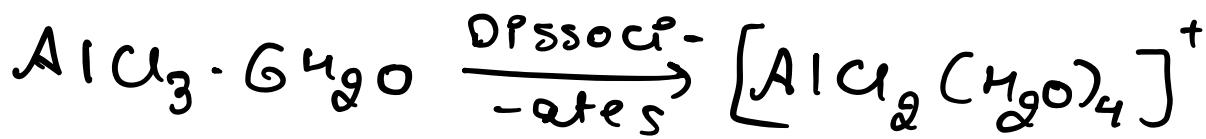
That's why B_2H_6 is used
as a Rocket propellant.





" B_2H_6 is also used in the hydroboration oxidation of alkenes"





- * Hydroxides of Al are insoluble in H_2O at Room temp.
- * AlCl_3 with water and NH_3 gives adduct with $6\text{H}_2\text{O}$.



Carbon family.

C Si Ge Sn Pb

⇒ Electronic Configuration :-

$n\text{s}^2 n\text{p}^2$

- * On moving down the group stability of +ve O.S increases

* Due to inert pair effect

⇒ Ionization energy :-

* Higher than Gr-13 elements

* On moving down the group there is not much difference in the ionization energies.

due to poor shielding effect of d and f orbitals.

" NCERT "

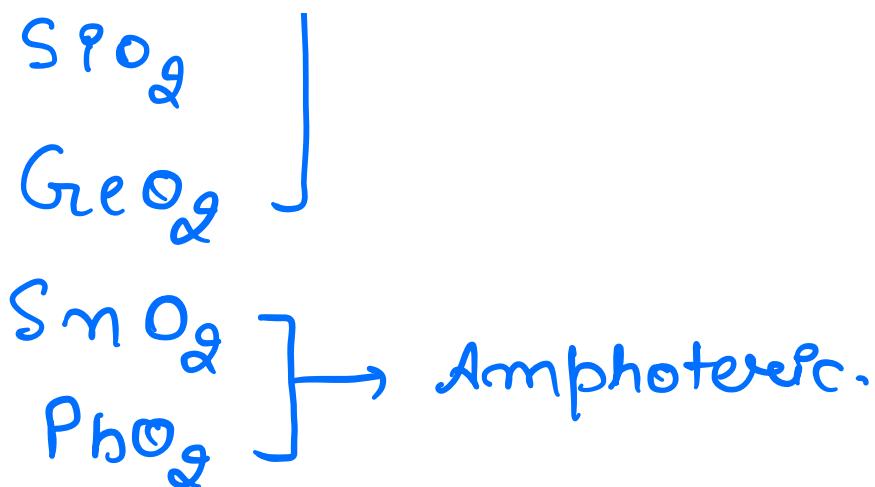
Chemical properties :-

i.) Reactivity towards oxygen :-

Mainly forms mono oxides & dioxides. e.g. CO , CO_2 .

* SFO only exist at high temp.

$\text{CO}_2 \xrightarrow{\text{Acidic.}}$



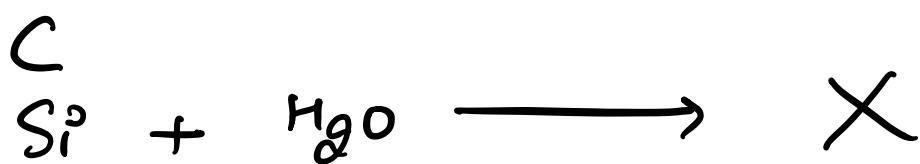
* * CO \longrightarrow Neutral

SiO \longrightarrow

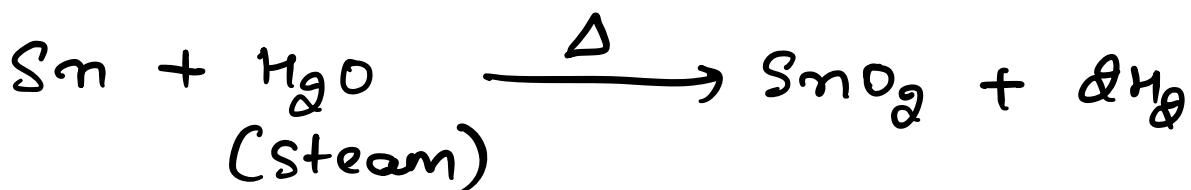
GeO \longrightarrow Acidic.

$$\begin{array}{c}
 \text{SnO} \\
 | \\
 \text{PbO} \\
 \xrightarrow{\quad} \text{Amphoteric.}
 \end{array}$$

Q) Reactivity towards water :-



Ge



Because of protective oxide film formation.

3.) Reactivity towards halogens :-



Si



Sn

Pb

MX_4 \rightarrow Covalent halides.
 $\hookrightarrow sp^3$

Exceptions :-

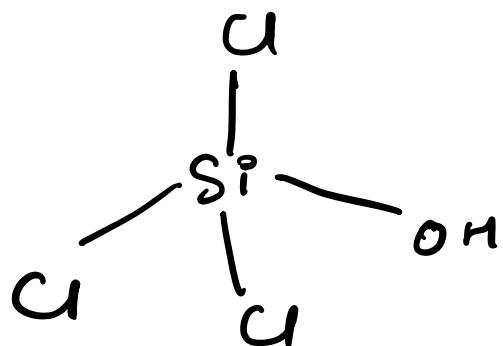
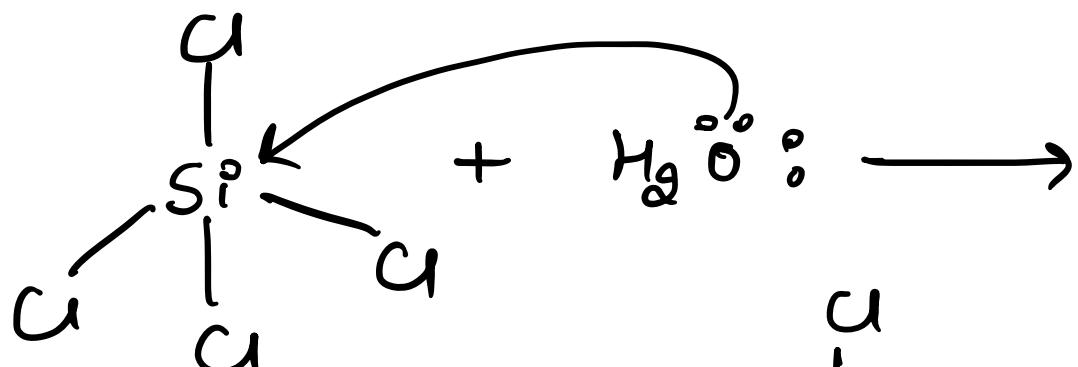
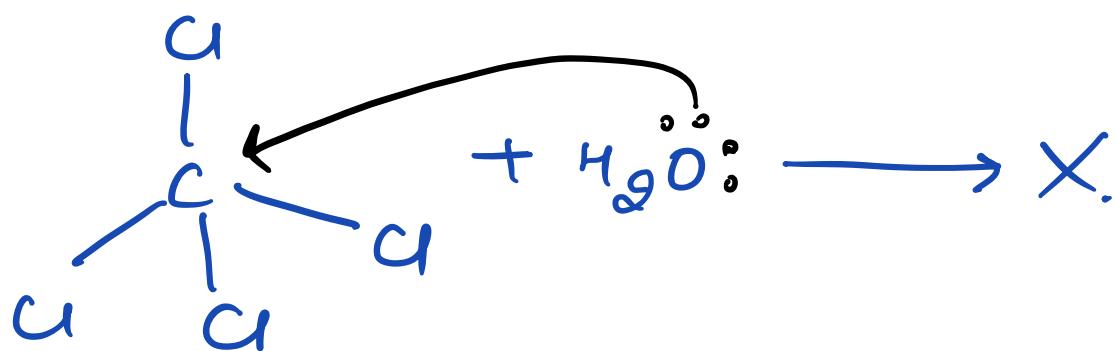


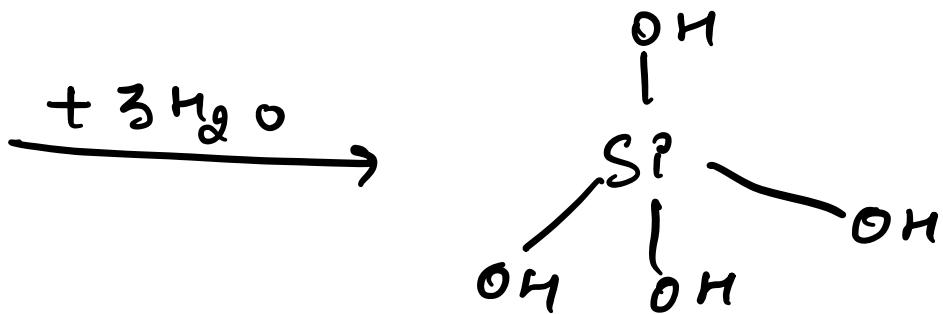
* PbI_4 \rightarrow Does not exist.

* Stability of dihalides increases down the group.



* Except for CCl_4 , all other tetrachlorides are easily hydrolysed.





Silicic acid.

Anomalous behaviour of Carbon C^{4-}

- * Due to small size
- * Absence of vacant d orbital s.
- * Tendency to form $\text{P}\pi - \text{P}\pi$ multiple bond.
- * Catenation.

$\text{C} >> \text{SP} > \text{Ge} = \text{Sn}$



Tendency to show Catenation.

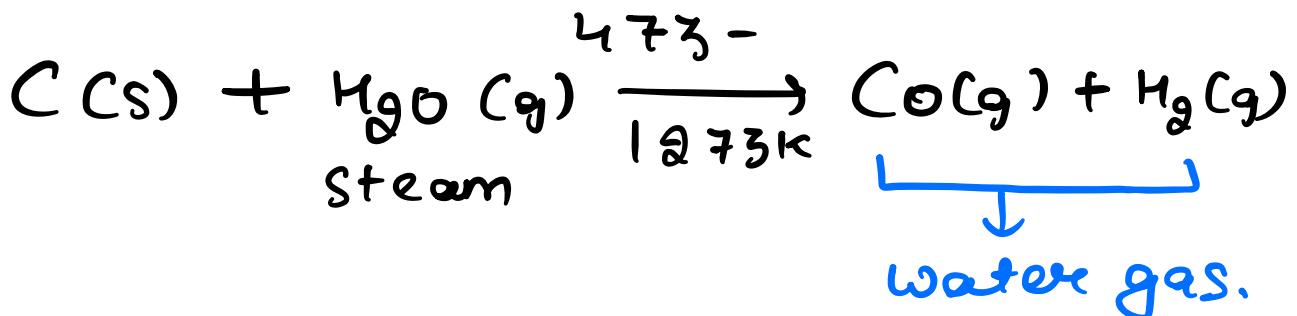
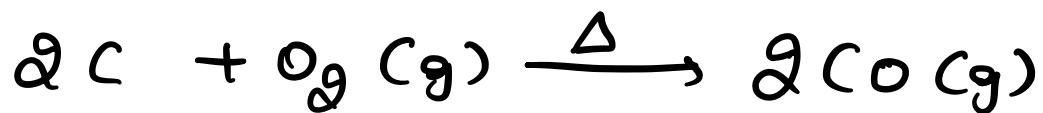
- * Pb does not shows Catenation.

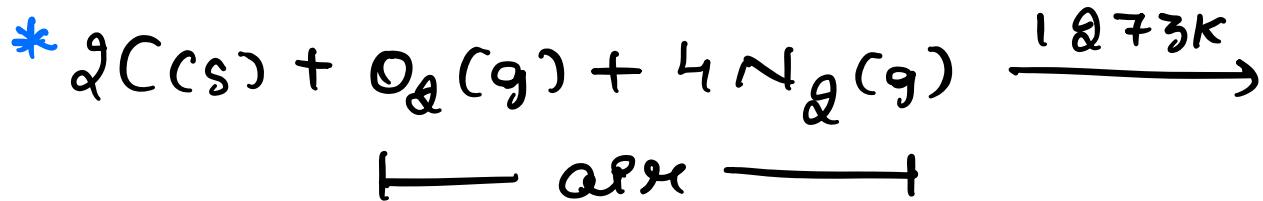
\Rightarrow Allotropes of Carbon $\text{C}^{\circ -}$

- 1.) Diamond.
- 2.) Graphite
- 3.) Fullerenes.

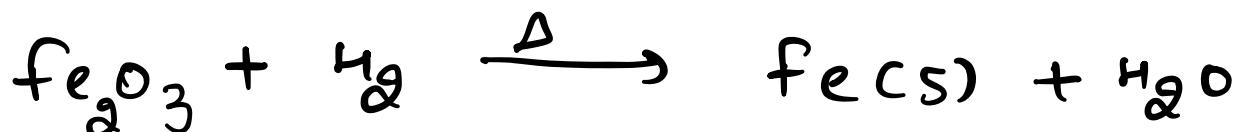
Some important Compounds
of $\text{C}^{\circ -}$ sp. $\text{C}^{\circ -}$

1.) Carbon monoxide $\text{CO}^{\circ -}$

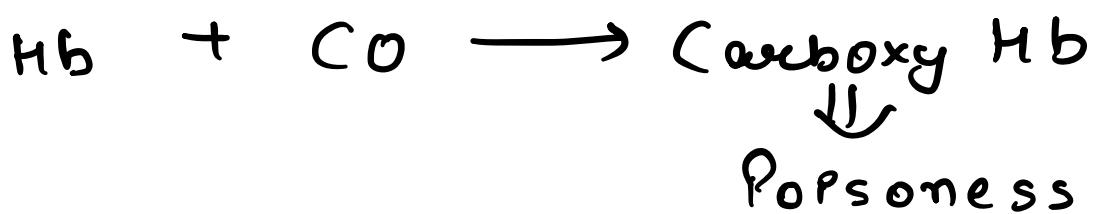
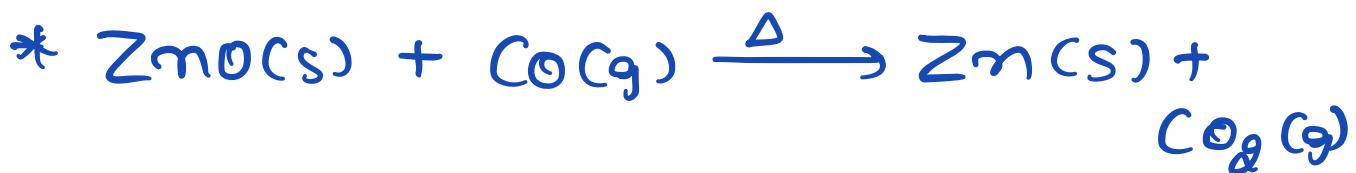




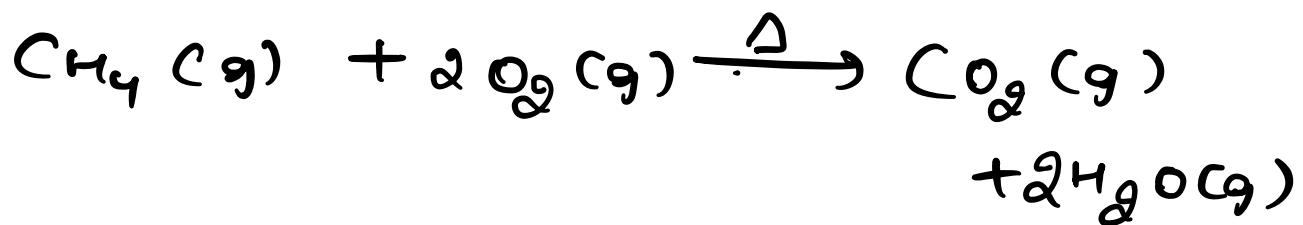
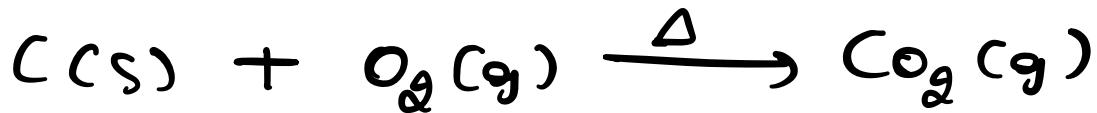
— Producer gas —



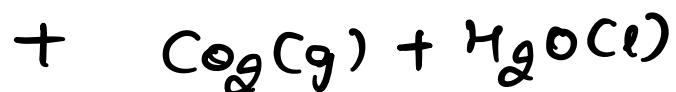
— Verification process —



2) Carbon dioxide O_2^-

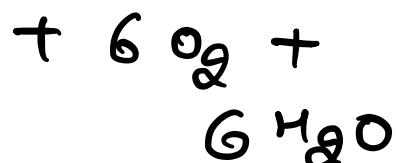
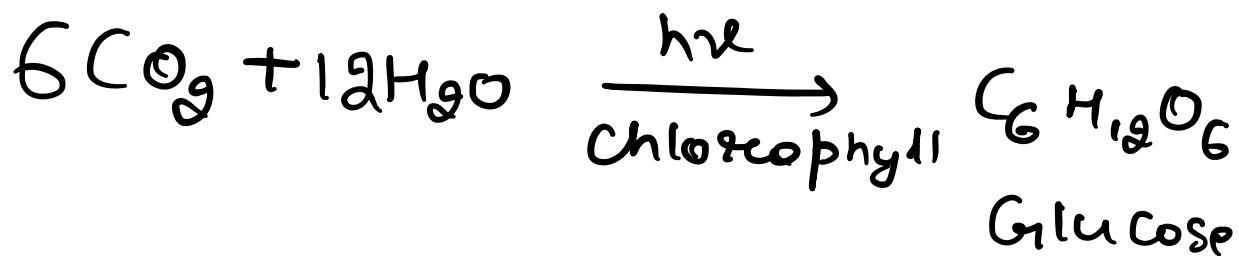


*



— lab method —

* On industrial scale Pt Ps
prepared by heating lime
Stone.



* $CO_2 \rightarrow$ Green house gas.

Silicates & Silicones :-

⇒ Silicates :-

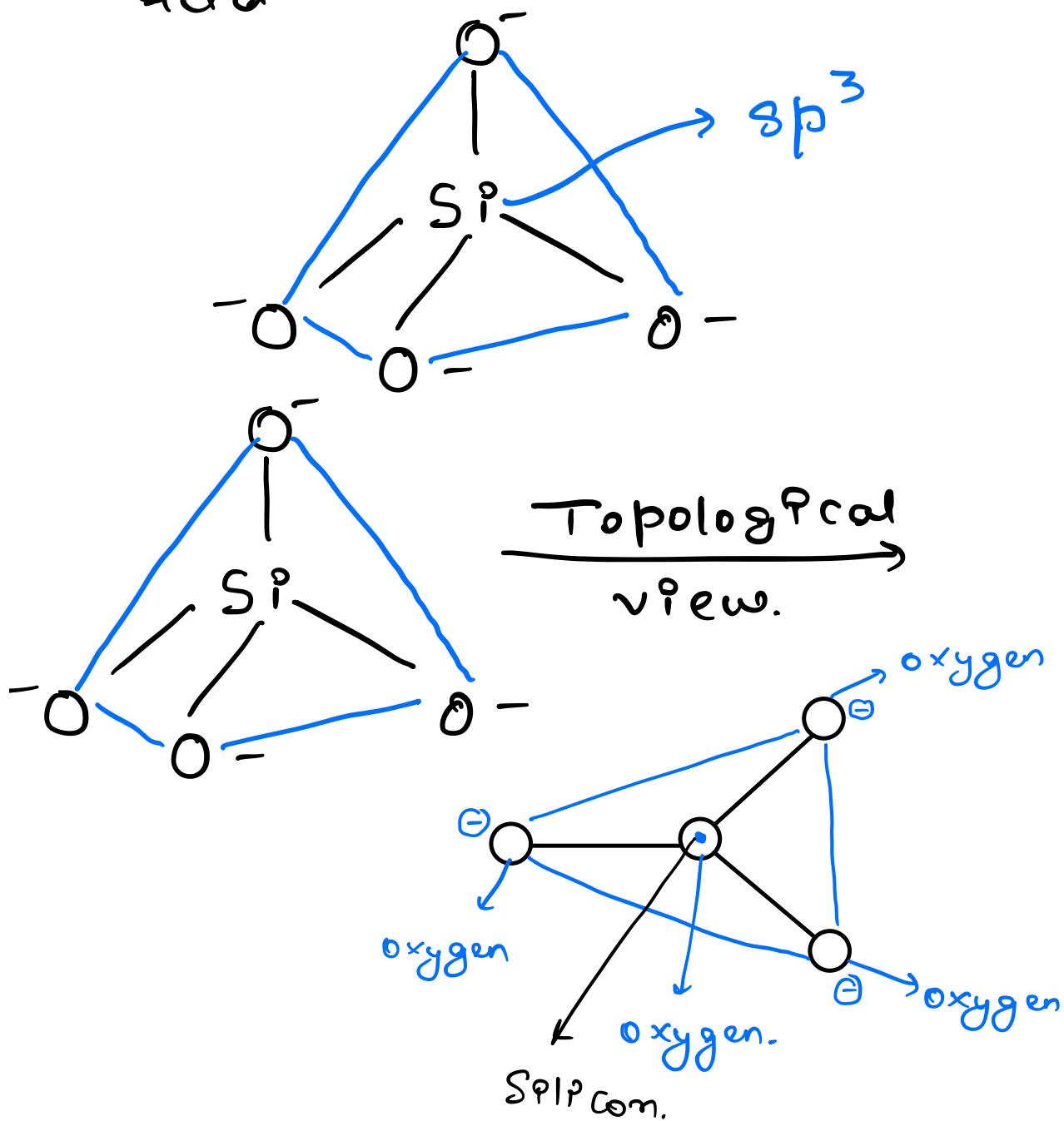
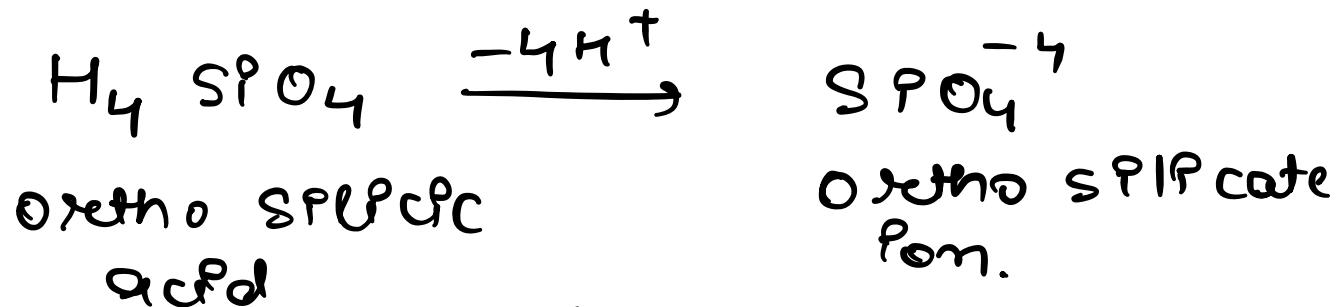
Silicates are the compounds containing SiO_4 units in which silicon is sp^3 hybridised and oxygen atom is tetrahedrally present around it and corner sharing of tetrahedral units is allowed but edge sharing is not allowed.

⇒ Types of Silicates :-

1.) Ortho Silicates :-

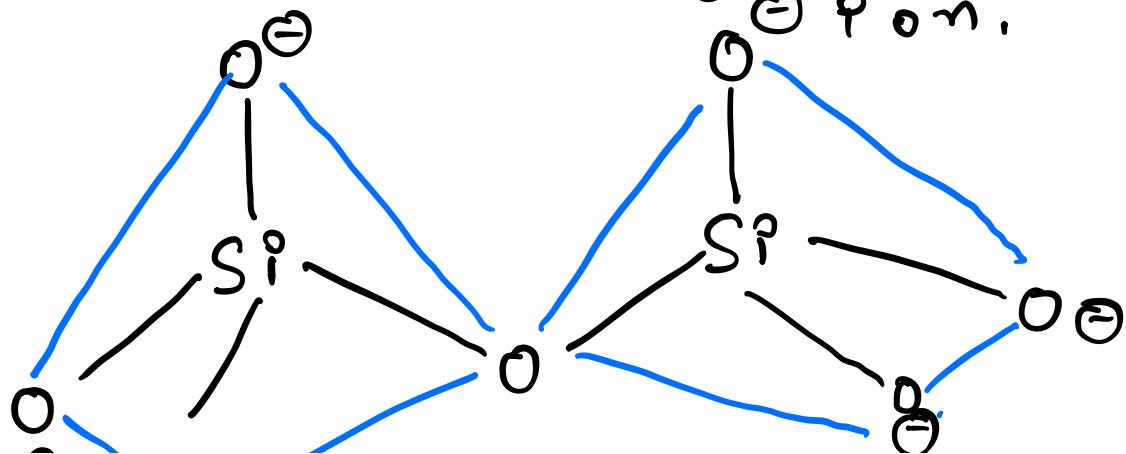
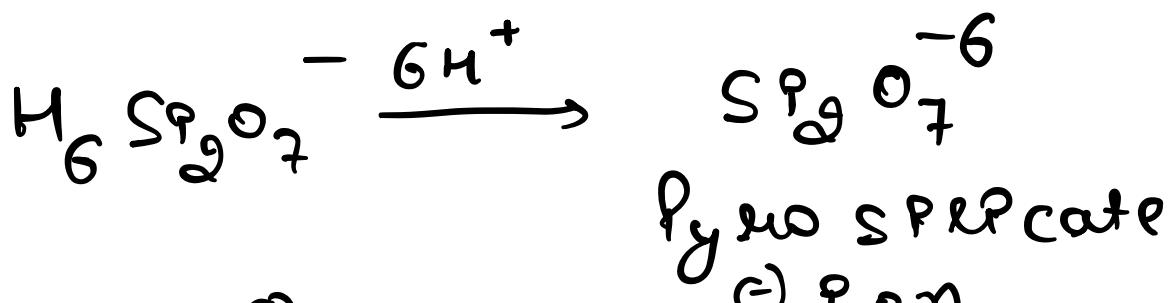
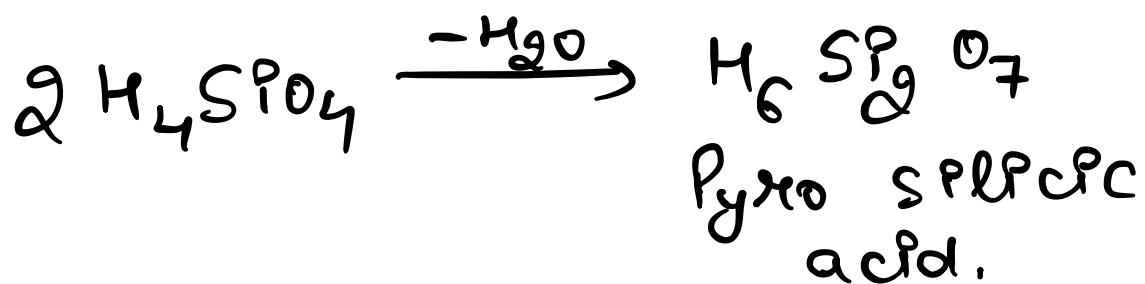
Ortho silicates consist of ortho silicate ion which is obtained from ortho

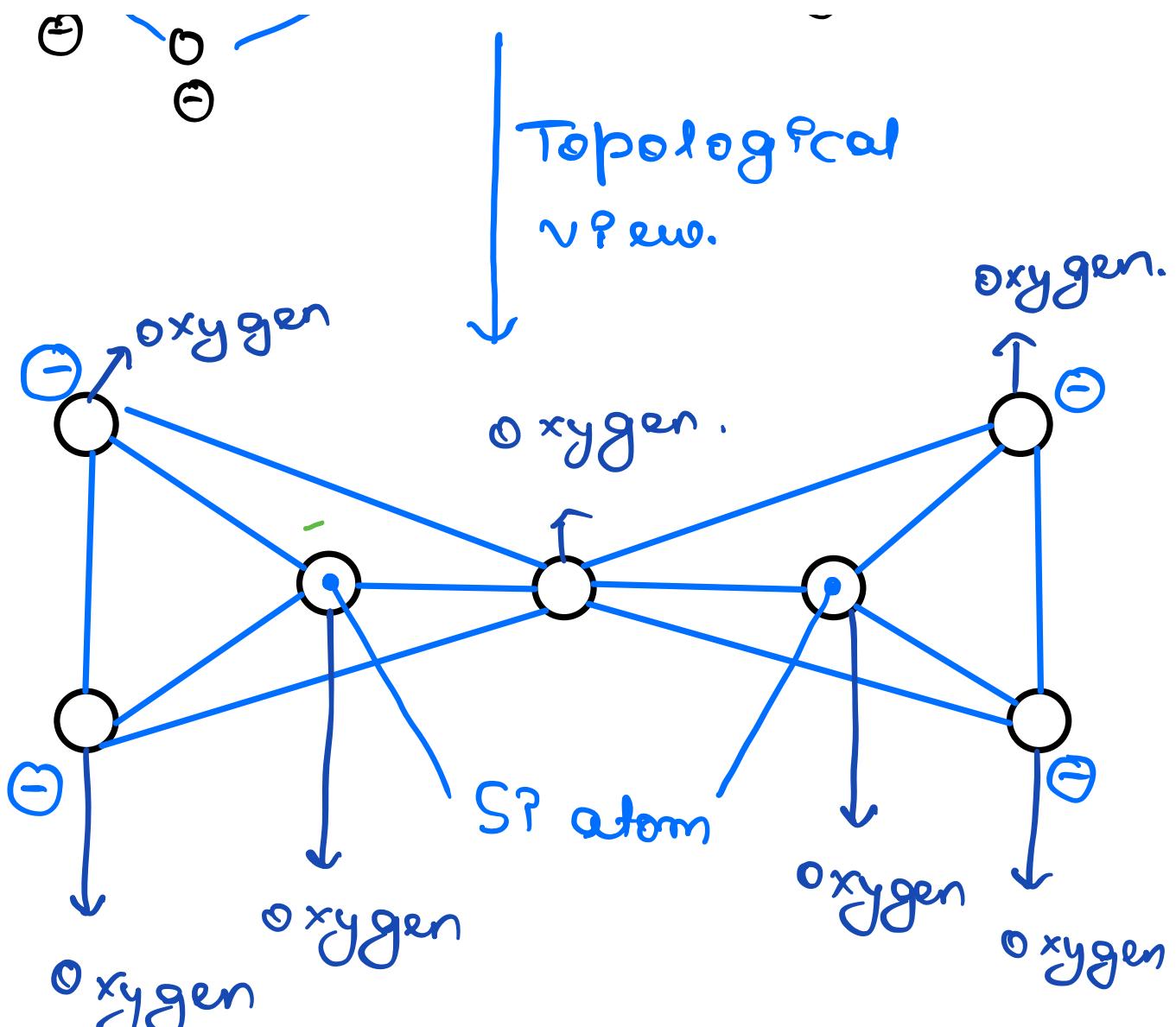
SPLCIC acid.



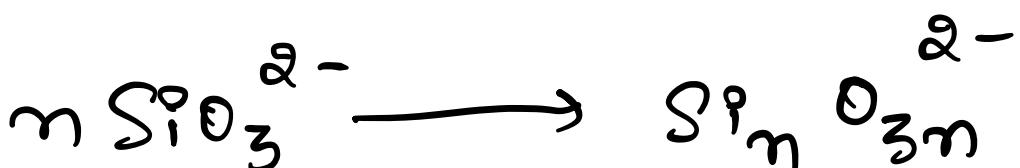
Q) Pyro silicates :-

Pyro silicates const of pyro silicate ions, obtained from pyro silicic acid.



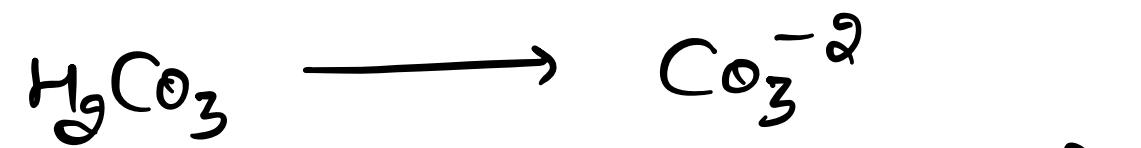


3. Cyclic Silicates O^-



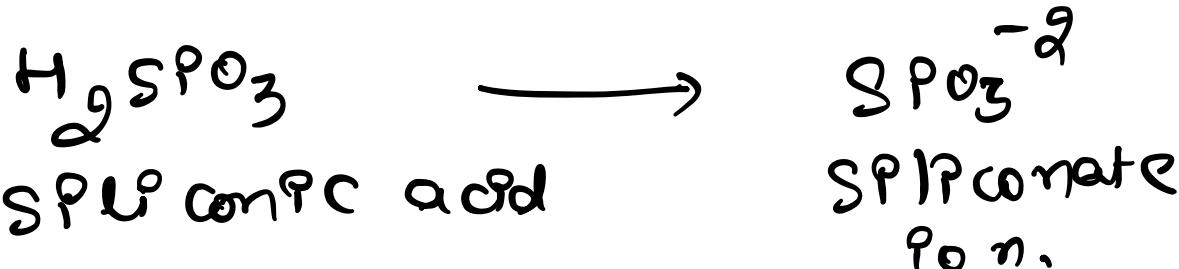
Silicate
Ion

$$n = 3, 4, 5, 6
7 (\text{rare})$$



Carbonic acid

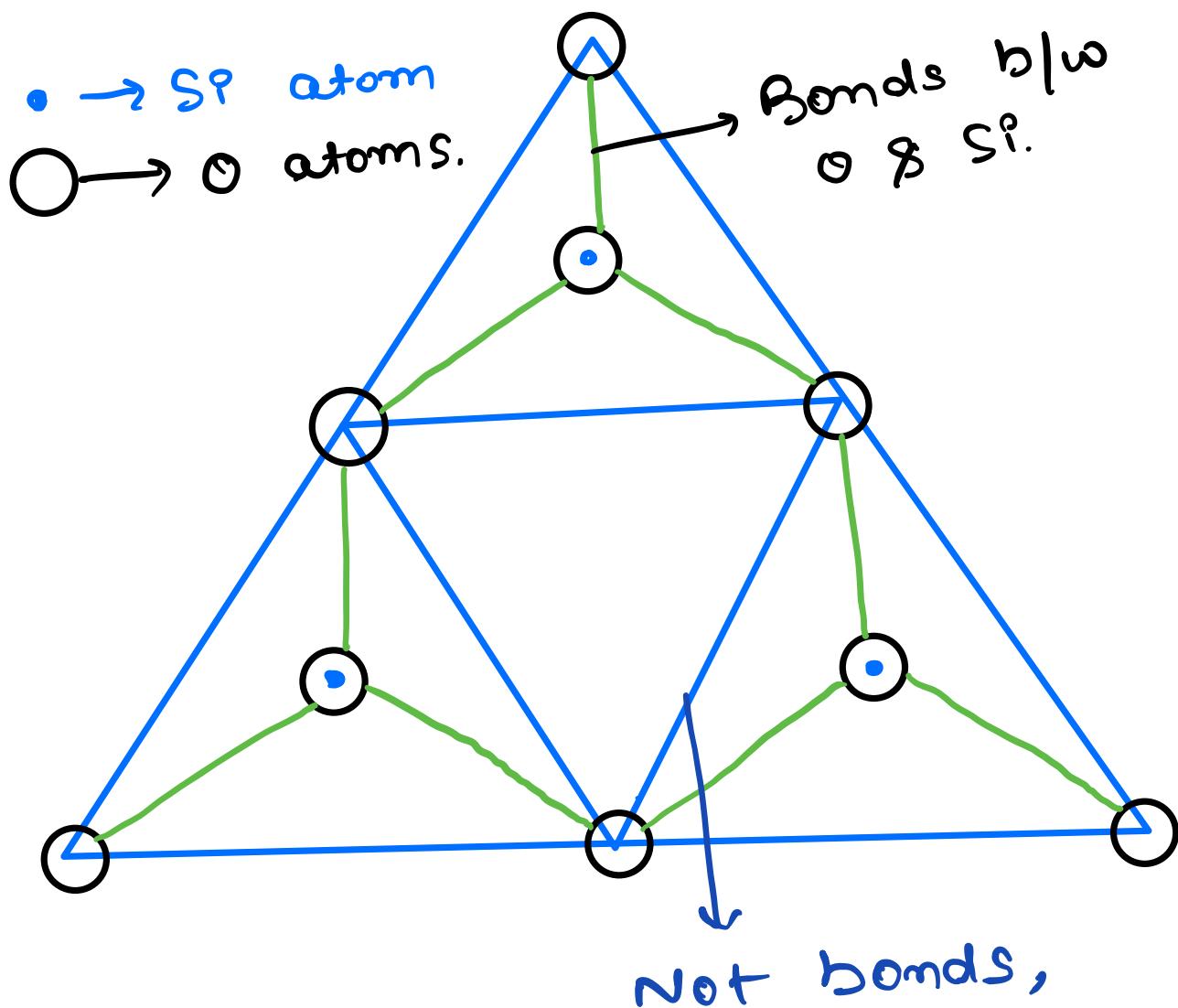
Carbo nate ion



Sulfuric acid

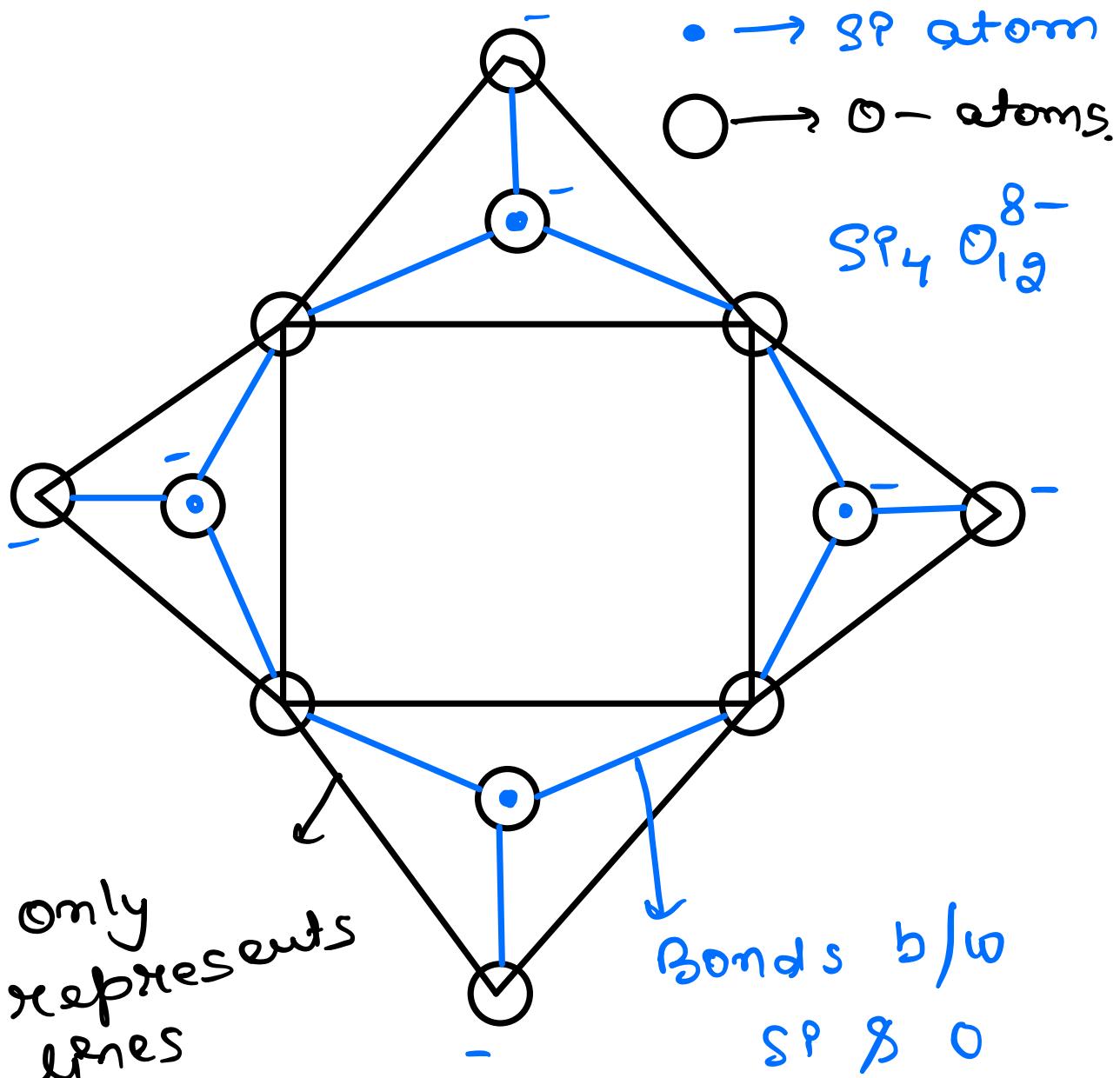
Sulfonate ion.

* When $n = 3 \Rightarrow$ Trimerisation



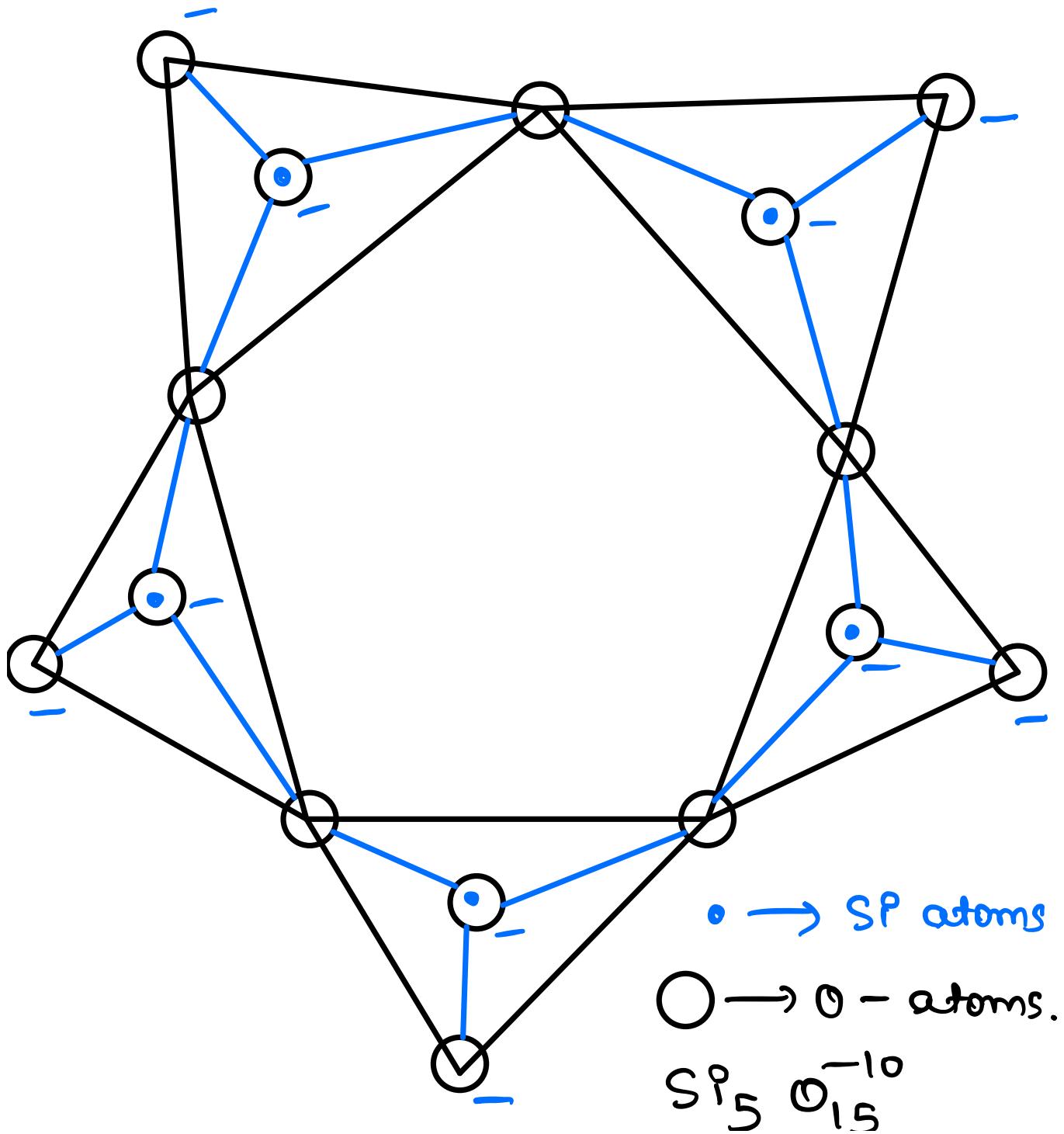
only representing
lines joining
three SP_3O_3^-
units.

* When $m = 4$



Joining
4-units.

* If $m = 5$.

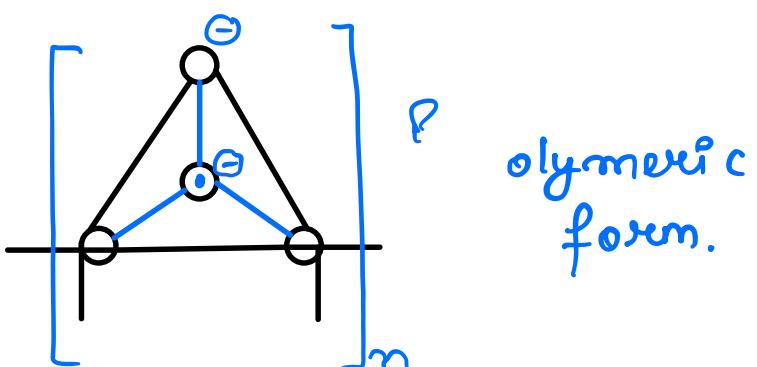
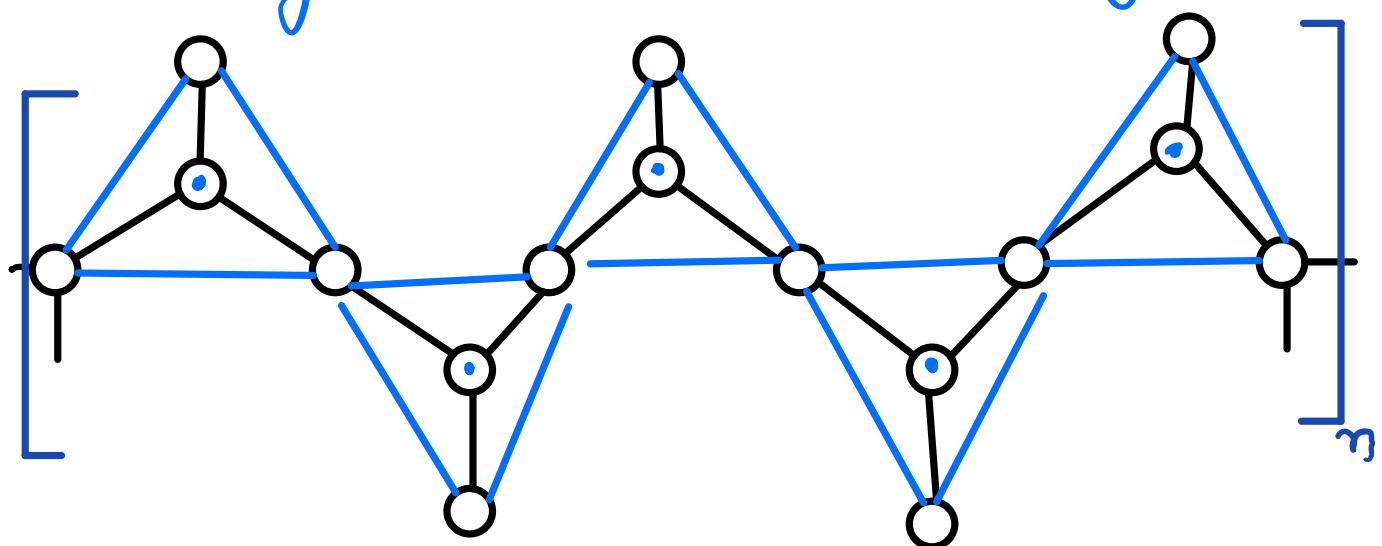


↳ Chain Silicates :-

It is polymeric form of silicate unit and there are two types of chain silicates.

- Single chain silicates (Pyroxenes)
- Double chain silicates (Amphiboles)

⇒ Single Chain Silicates (Pyroxenes)

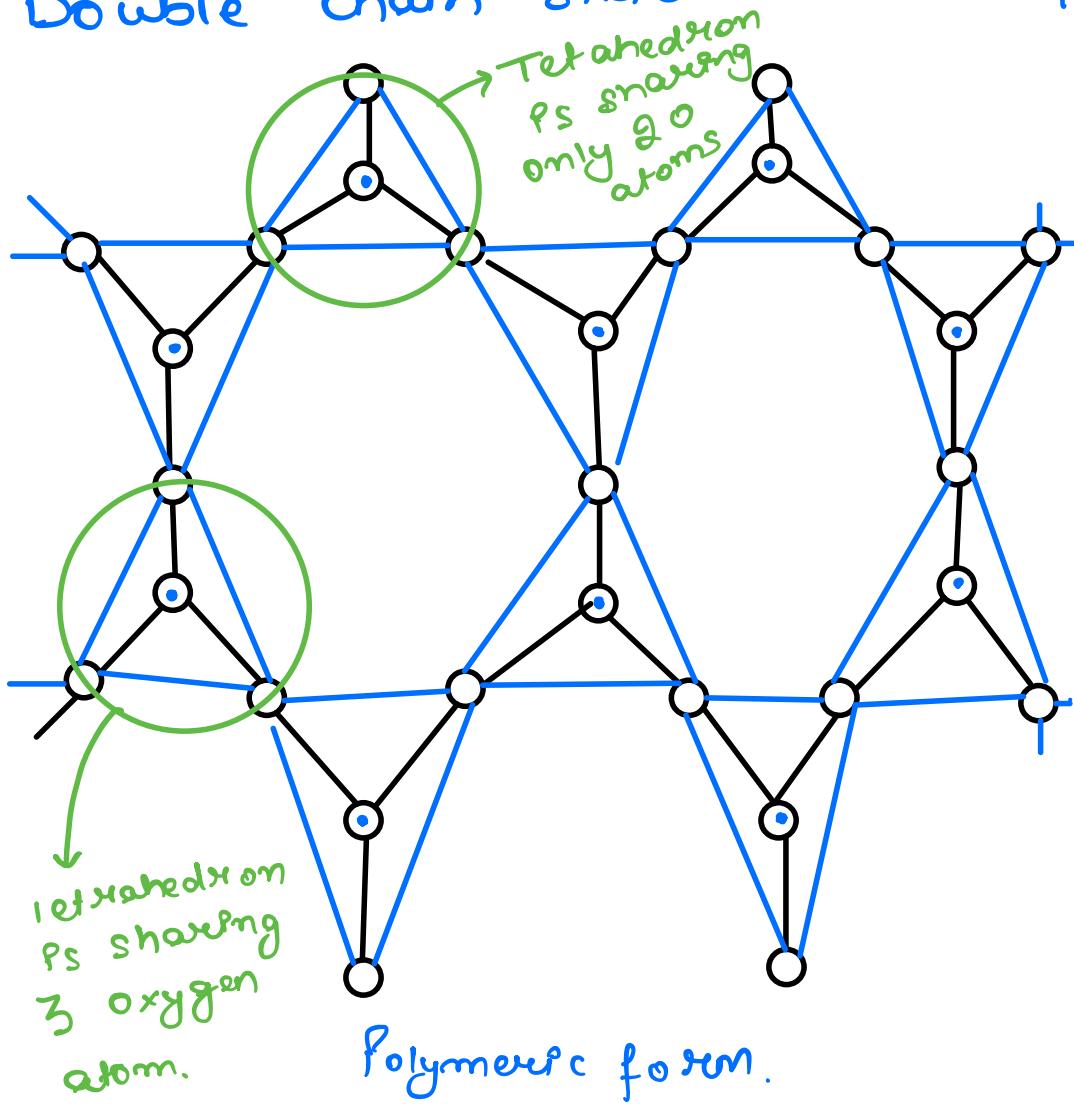


Hence formula of unit = $[SiO_3]_n^{-2}$

OH
Single chain silicate = $[SiO_3]_n^{-2}$.

- * Two oxygen atoms are being shared per tetrahedron.

→ Double chain silicates :- (Amphiboles)



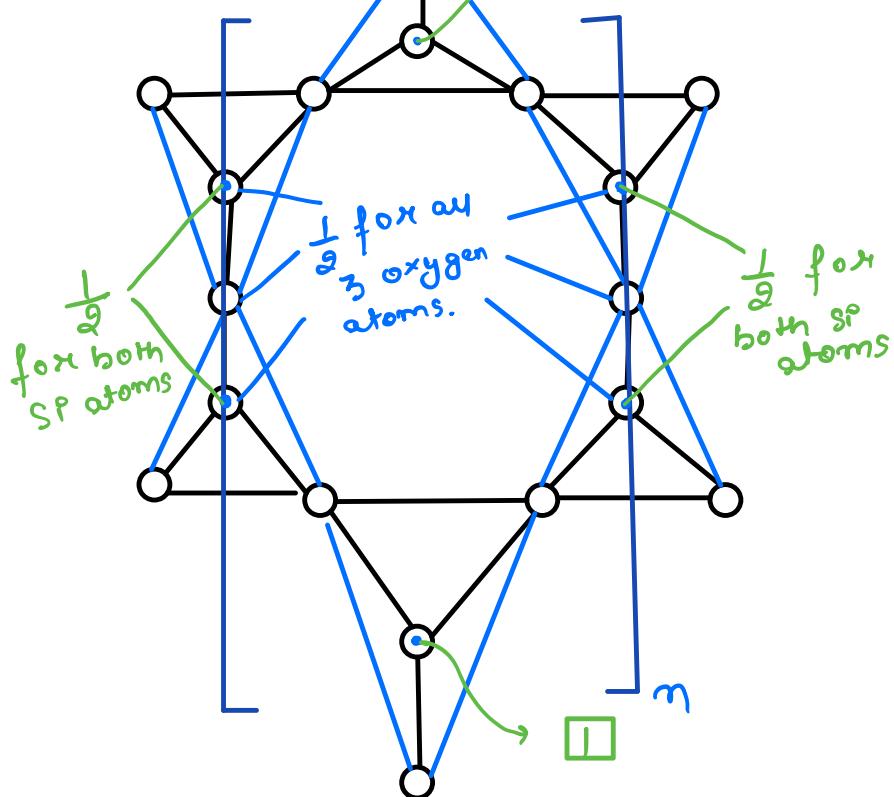
Total oxygen shared per tetrahedron

$$= \frac{2+3}{2}$$

$$= 2.5$$

Imp.

General formula = $(\text{Si}_4\text{O}_{11})_m^{6m-}$



General monomer unit
of double chain SPlPcate.

* Total SPlcones in thPs
monomer unit = 4

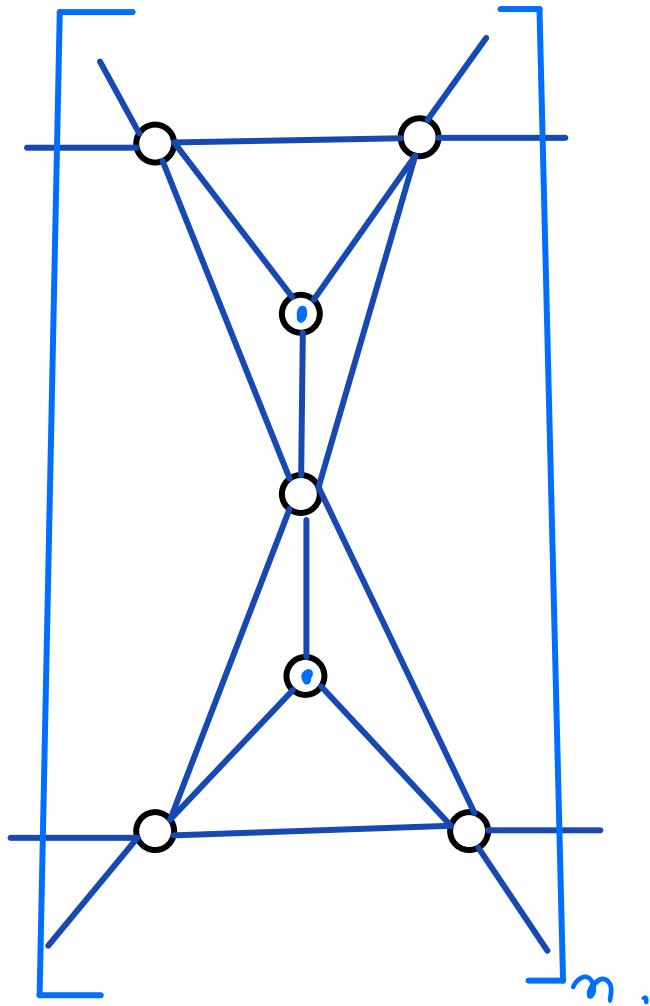
* Total oxygen shared = 11

* Total charge = -6

Hence General formula = $(SPl_4O_{11})_n^{-6n}$

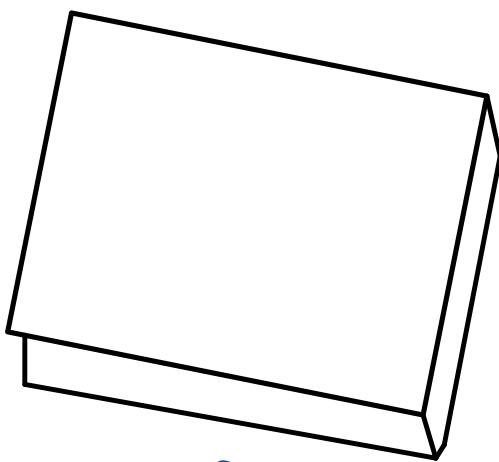
5.) Sheet SPlPcates or 2 D SPlPcates:

It consists of infinite single
chain SPlPcate structure.



3 oxygen atoms are being shared per tetrahedron.

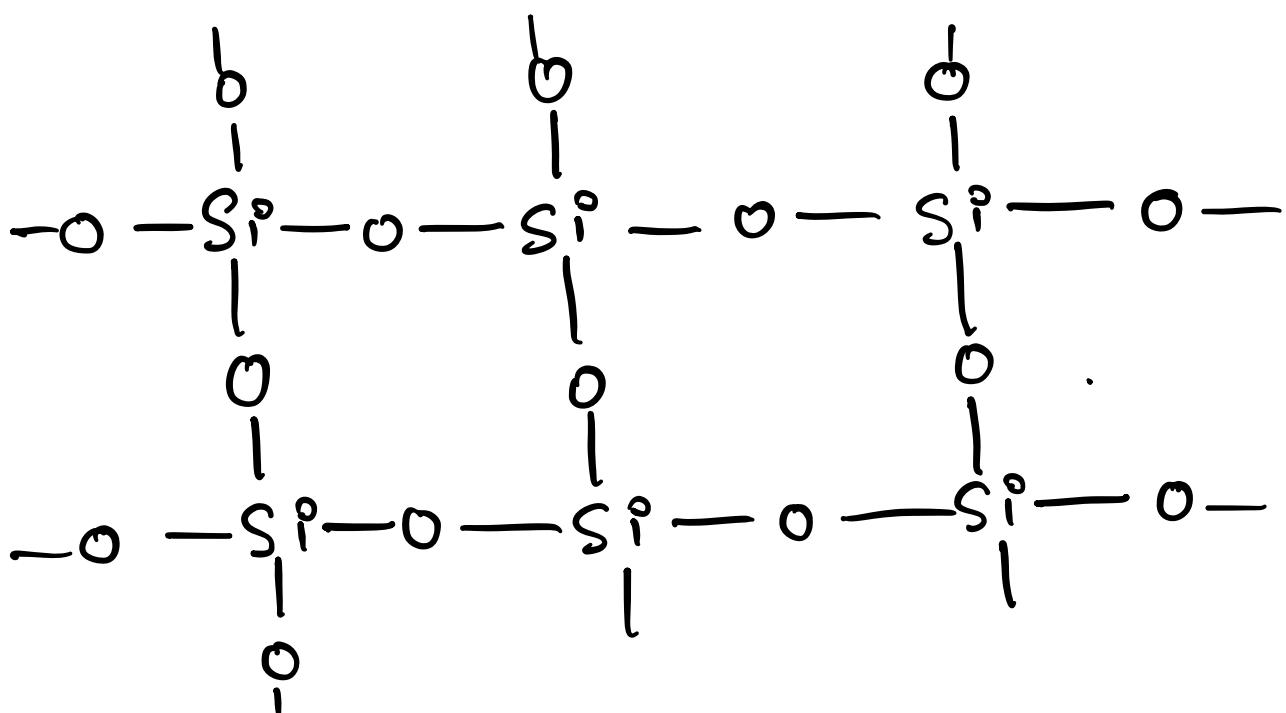
General formula = $[SP_2O_5]^{\alpha-}_m$



6) 3-D Silicates :-

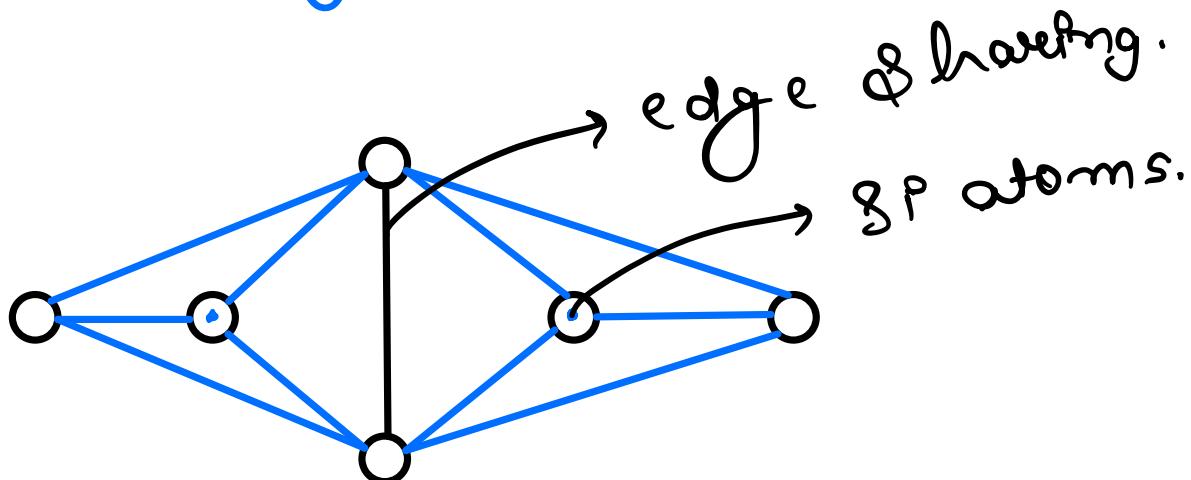
In this type of silicates all four oxygen atoms are shared per tetrahedron.

General formula = $(SiO_4)_n$.

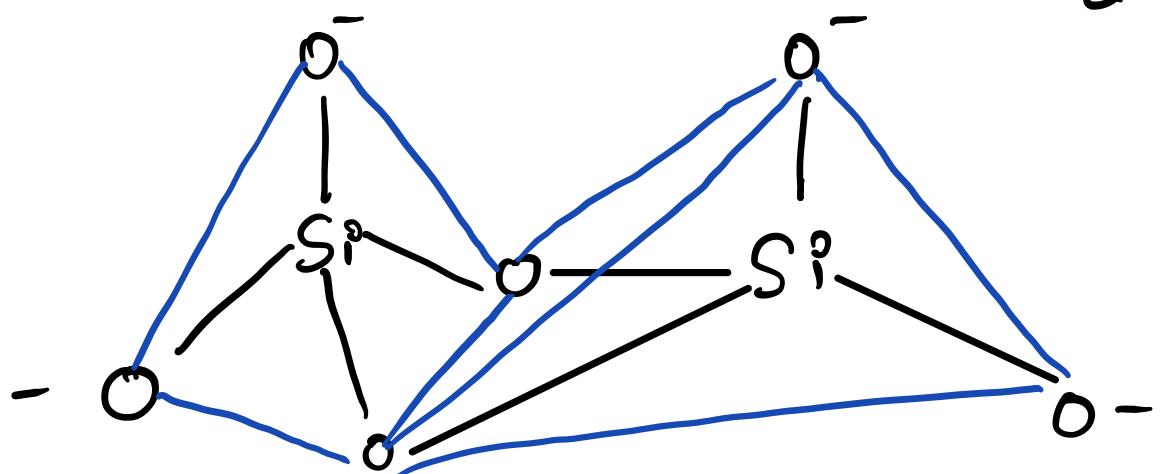


4 O atoms are shared
per tetrahedron.

All 4 oxygen atoms are
being shared therefore
no charge on the molecule.

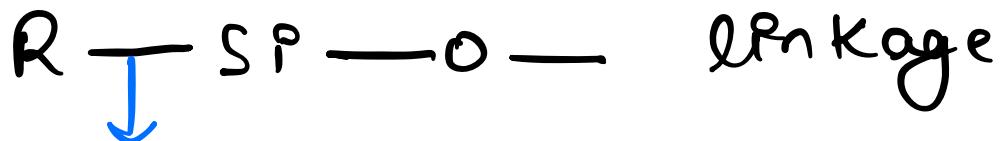


formula of above unit =
 $\text{Si}_2\text{O}_6^{4-}$



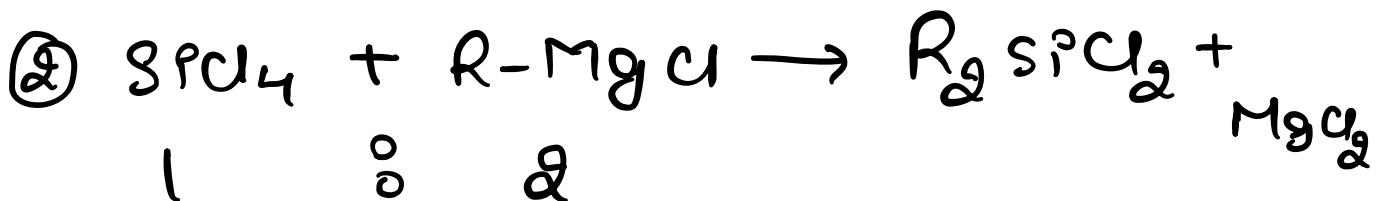
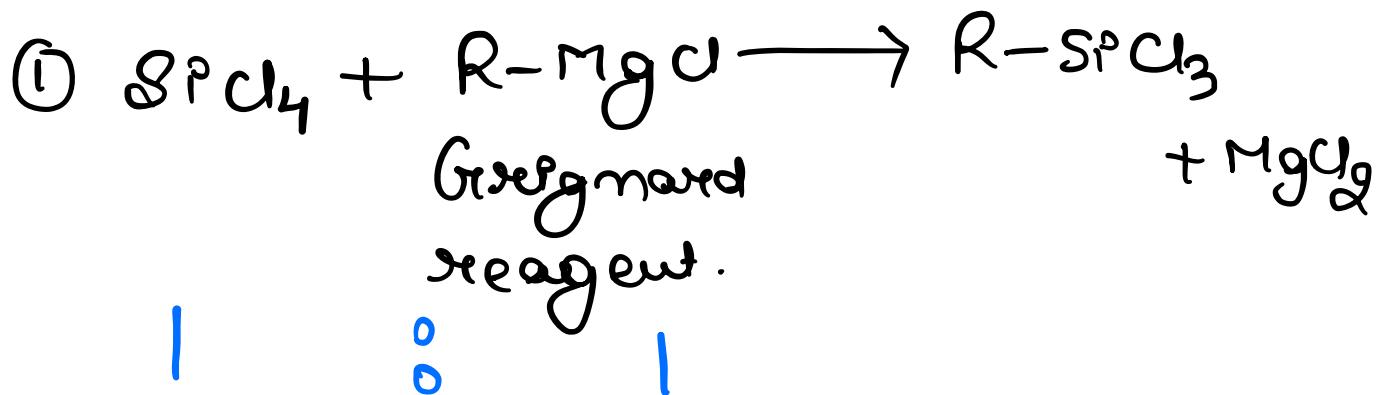
Silicones :-

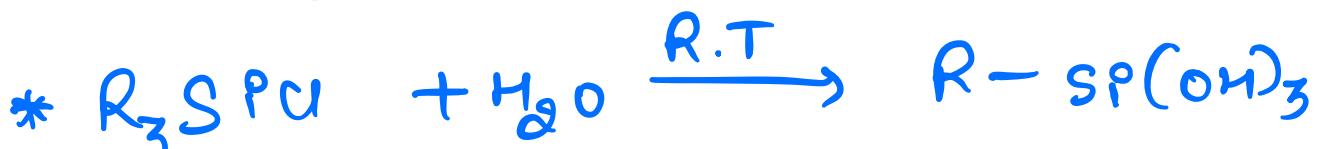
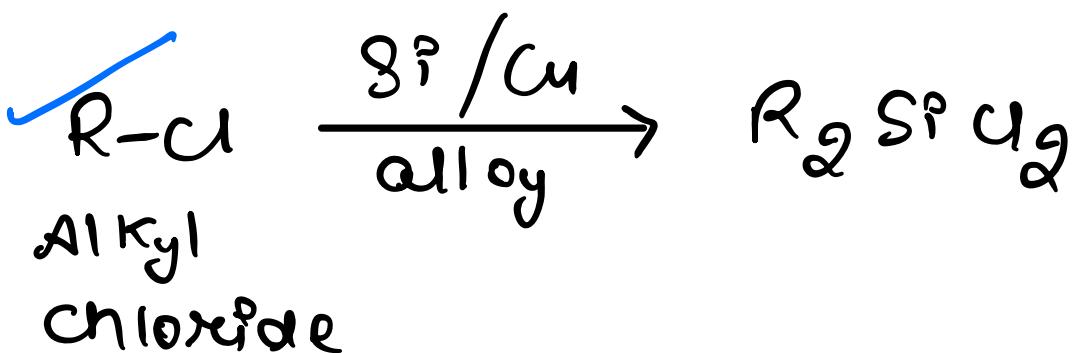
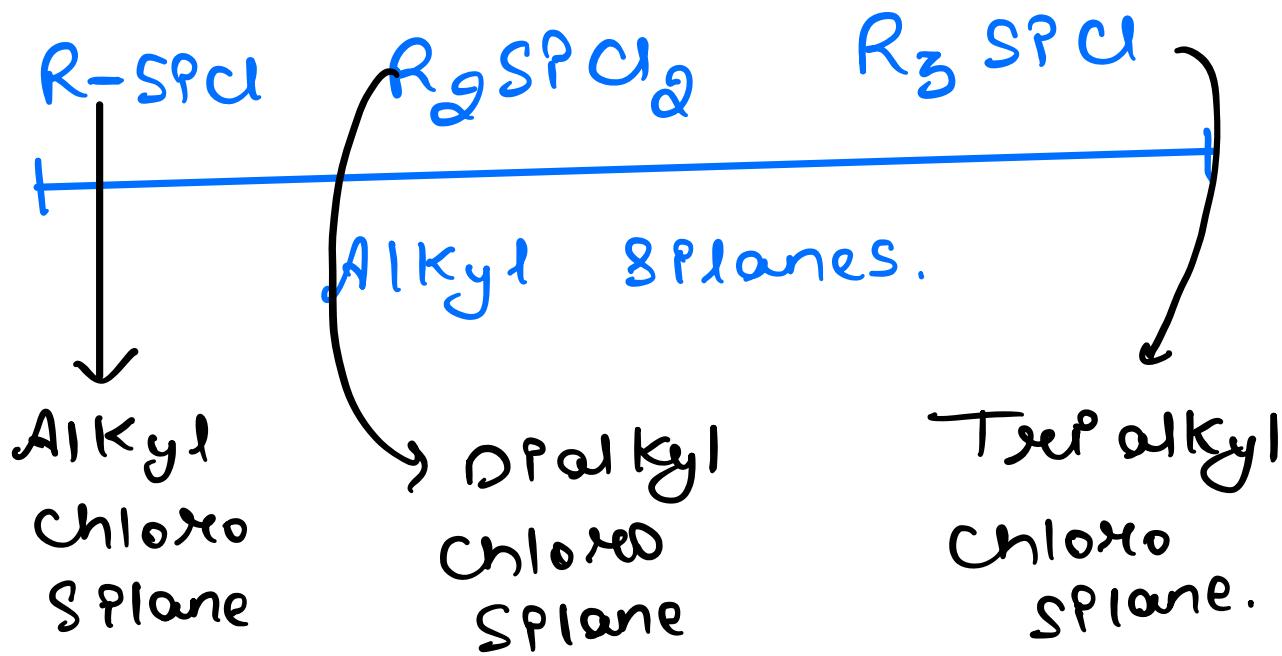
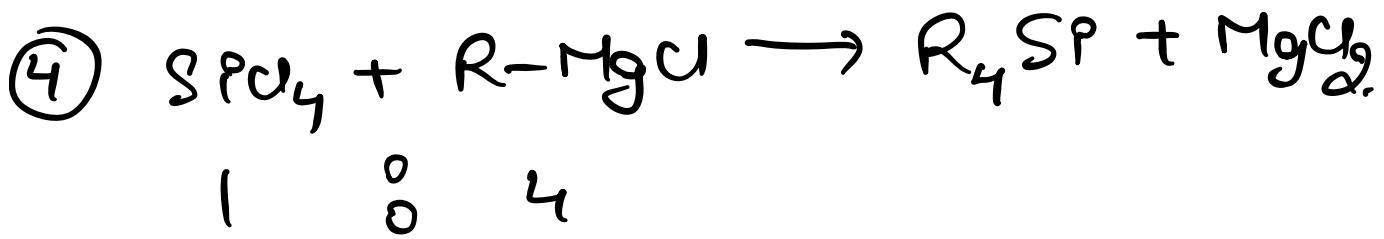
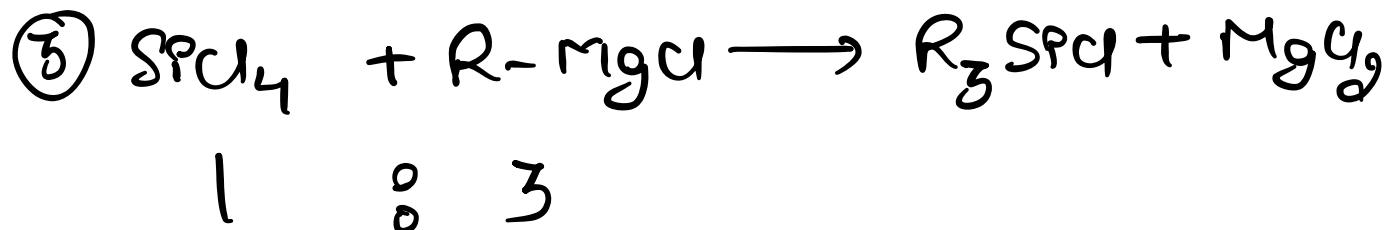
* Silicones are the organo silicon polymer having

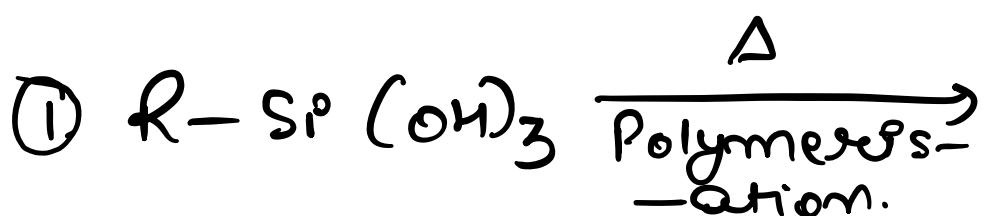
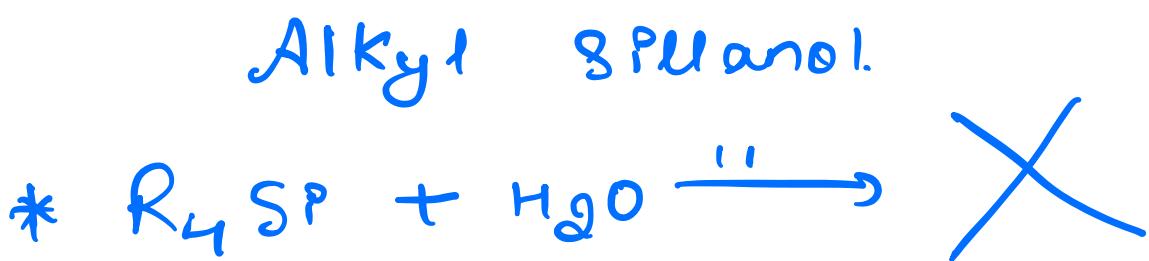
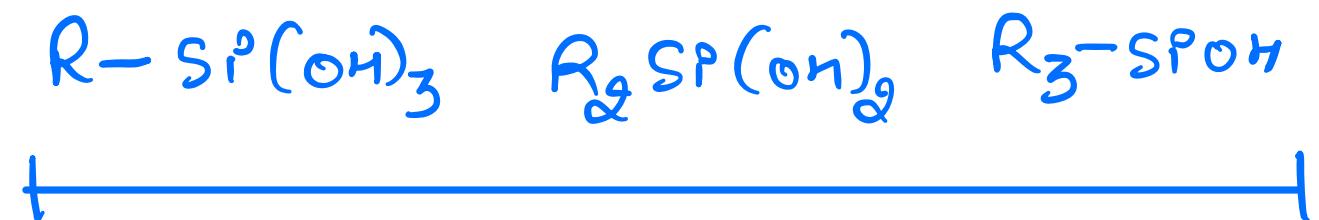
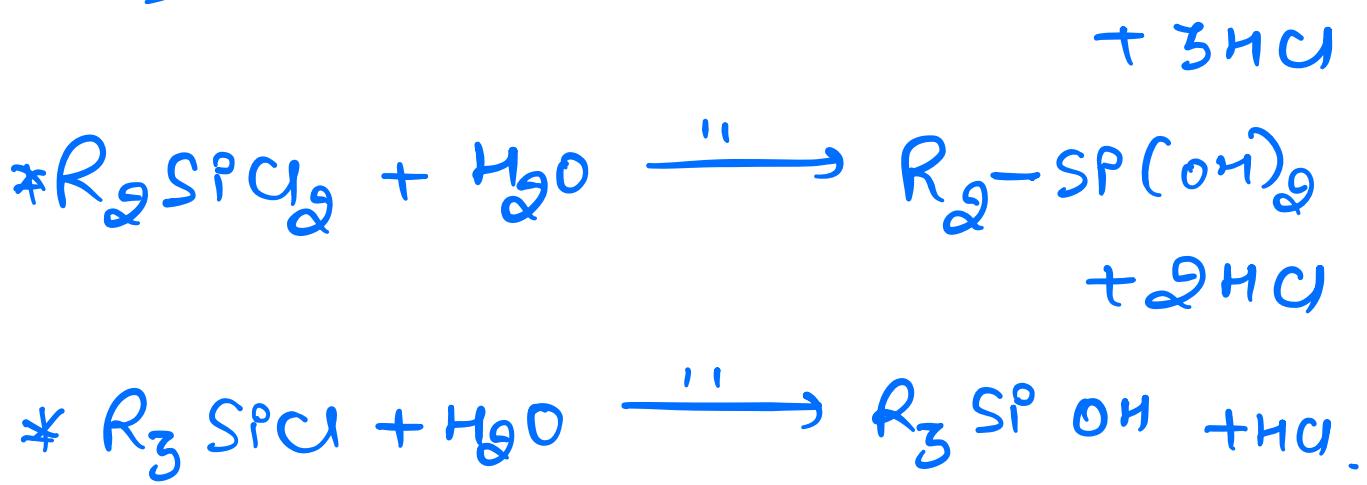


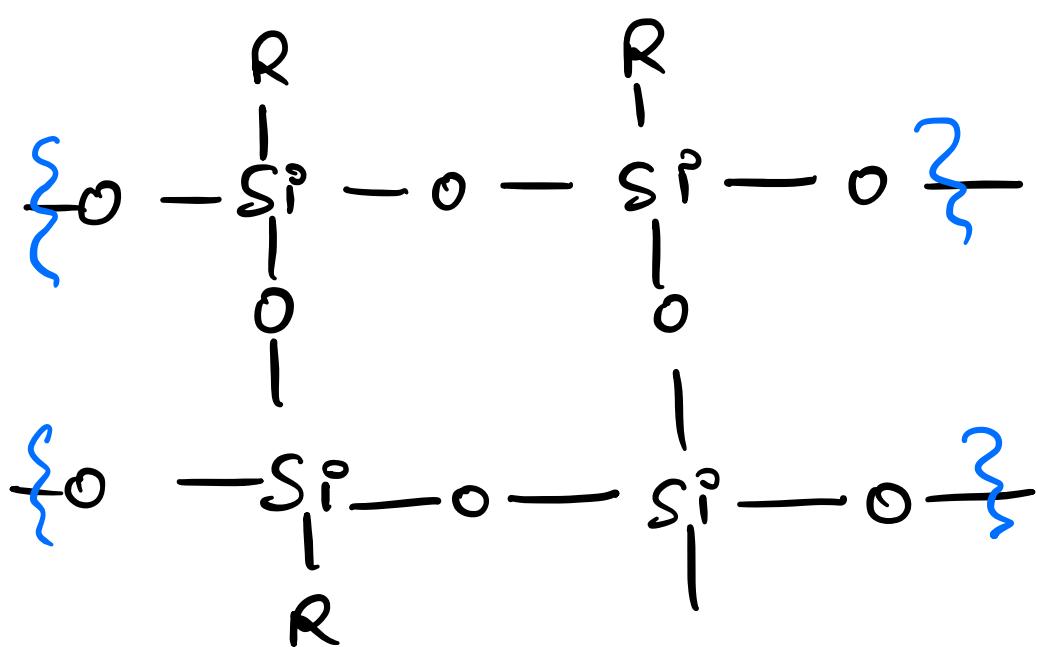
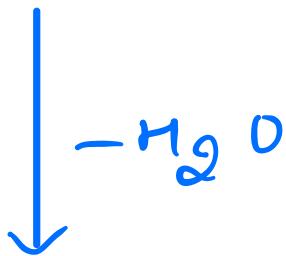
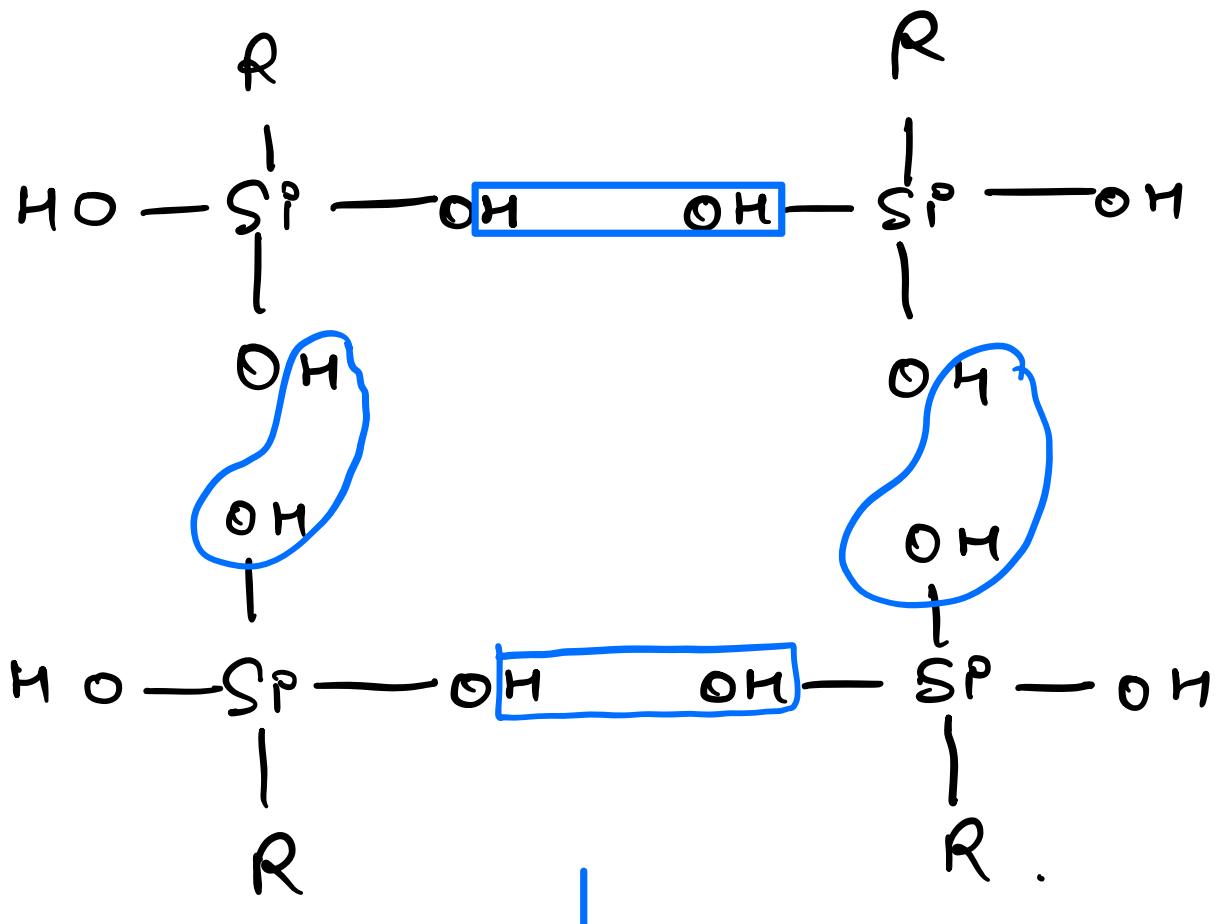
Organosilicon linkage

* These polymers are obtained by hydrolysis of alkyl chlorosilanes.

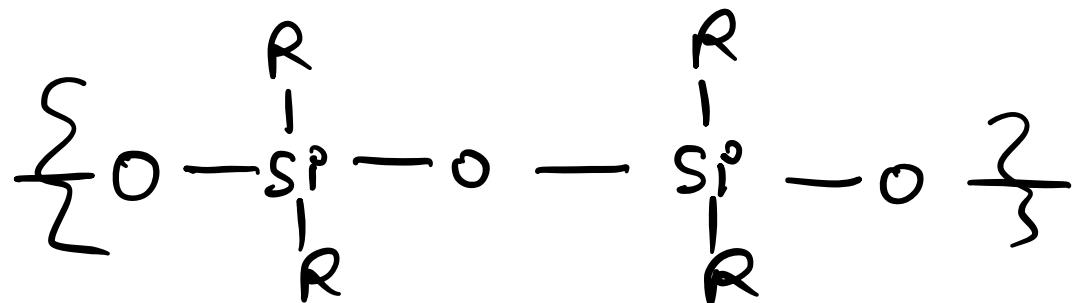
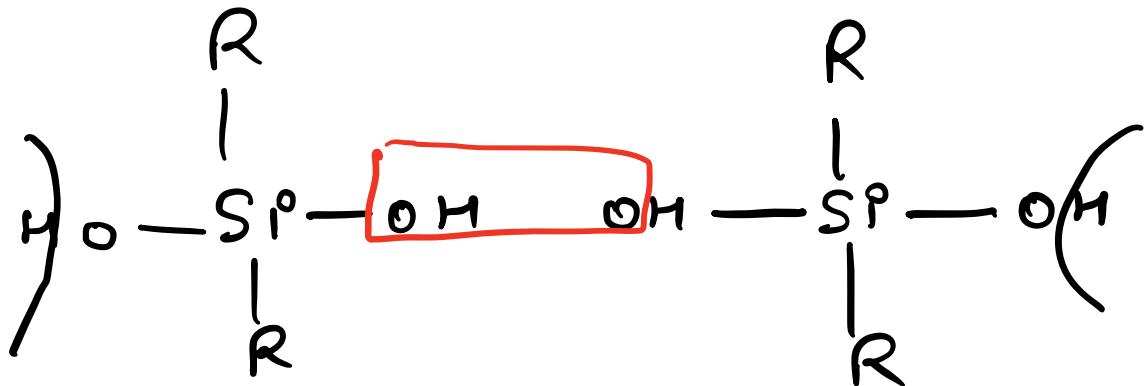
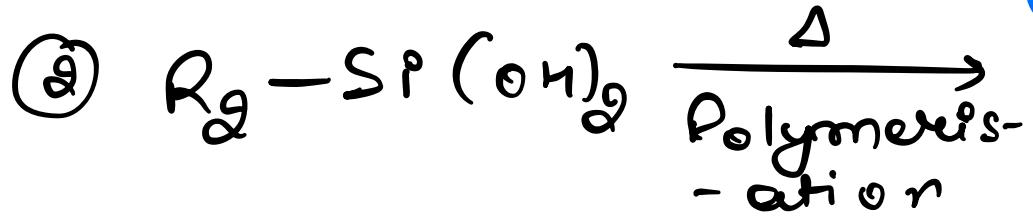




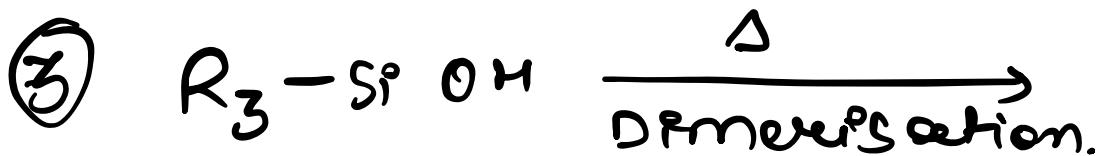


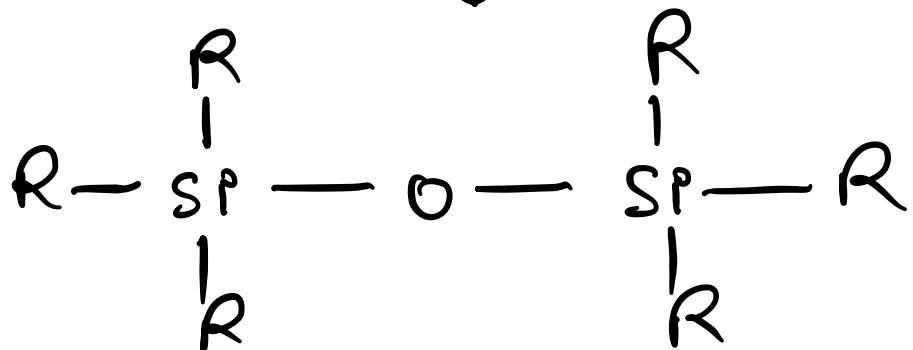
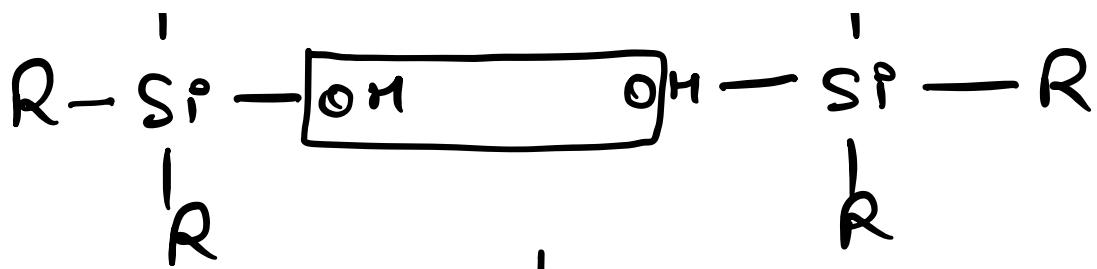


Crossed linked S_PL_PCom.
(Polymer)



Linear S_PL_PCom. (Polymer)





Dimer



It is not a silicone
because it is not a
polymer.

* $R_3\text{-SiCl} \rightarrow$ It is K/A
Chain Terminator

i.e. it controls

the extent of
polymerisation.

