# Unit-I :- P-Block :- Group-13

**Electron deficient compounds:-** The compounds containing less no. of $e^-$s than required for bonding are called as $e^-$ deficient compounds.

Ex:- Diborane ($B_2H_6$), $Al_2Cl_6$ etc..

**Diborane ($B_2H_6$)**

→ **preparation of Diborane:-**

i, From LiH & $BF_3$

$$2BF_3 + 6LiH \xrightarrow[\Delta]{450K} B_2H_6 + 6LiF \quad [BF_3 \xrightarrow{LiH} B_2H_6]$$

ii, From electric discharge

$$BCl_3 \xrightarrow[\text{electric discharge}]{H_2} B_2H_6$$

iii, From $BF_3$ and $LiAlH_4$

$$BF_3 \xrightarrow{LiAlH_4} B_2H_6$$

**Structure of Diborane**

* In $B_2H_6$ two planar $BH_2$ groups are present.
* These 2-$BH_2$ groups are linked through 2H atoms.
* The 4-hydrogens attached to 2 $BH_2$ groups are called as 'Terminal Hydrogens' ($H_t$) & the 2 hydrogens linking the 2 $BH_2$ groups are called as 'Bridge hydrogen' ($H_b$)

In Diborane, each boron atom undergoes sp3 hybridisation in its 1st excited state to form 4sp3 hybrid orbitals, out of these 4-sp3 hybrid orbitals, 3 orbitals have unpaired electrons and the 4th sp3 hybrid orbital is vacant. Now in each boron atom, two sp3 hybrid orbitals with unpaired $e^-$s overlaps with 1S orbitals of 2-hydrogen atoms overlap to form two normal 2C-2$e^-$ bonds (B-H bonds). The 3rd $sp^3$ hybrid orbital of each boron atom with unpaired $e^-$, the 1S orbital of ~~two~~ bridged hydrogen atoms ~~to form 2 normal 2C-2e⁻ bonds~~ & and the empty $sp^3$ hybrid orbital of other boron atom overlaps with each other to form B-H-B bond (bridge bonds)

* The valency $e^-$ configuration of B(Z=5) → $1s^2 2s^2 2p^1$

in ground state [↑↓] [↑ | | ]

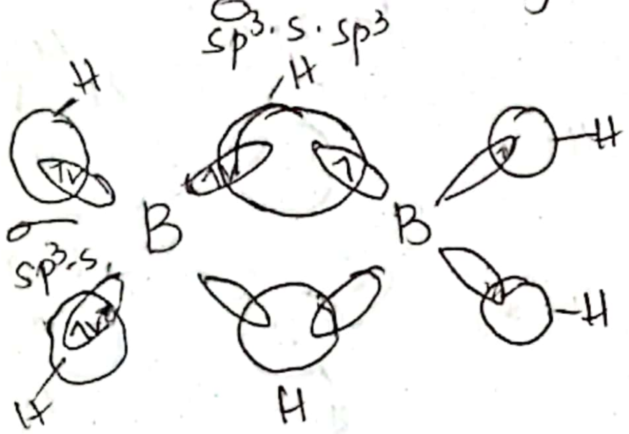
First excited state of boron - $2s^1$ $2p^2$

[↑] [↑ | ↑ | ] empty

$sp^3$ hybridisation

⇓

4 $sp^3$ hybrid orbital





→ Totally :- 4 B-H bonds (2c-electron bonds) &
2 B-H-B bonds (3C-2$e^-$ bonds)

Evidences for above structure

* IR & Raman
* Methylation of Diborane to form Tetra-methyl diborane

$B_2H_6 \xrightarrow{\text{methylation}} B_2(CH_3)_4H_2$

chemical reactions

* Reaction with oxygen

$B_2H_6 \xrightarrow{O_2} B_2O_3$ (Boron trioxide)

* Hydrolysis

$B_2H_6 \xrightarrow{H_2O} H_3BO_3$
(Boric Acid)

* Reaction with Ammonia

→ $B_2H_6 + 2NH_3 \xrightarrow{\text{low temp}} B_2H_6 \cdot 2NH_3$
(1 : 2) (Di Borane Ammonia)

→ $B_2H_6 + NH_3 \xrightarrow{\text{high temp}} (BN)_n$ (Boron nitride)
(excess)

→ $3B_2H_6 + 6NH_3 \xrightarrow{200°C} 2B_3N_3H_6 + 12H_2$
(3 : 6) (Borazole)

Borazole, Borazine (or) Inorganic benzene

~~preparatio~~ structure of borazole

→ Borazole is iso-electronic benzene. The structure of borazole is similar to that of benzene & borazole has cyclic delocalised π- electron cloud similar to benzene (Dative π-electron cloud) Due to this borazole is called Inorganic benzene.

→ Borazole is a plannar molecule in which boran and nitrogen atoms are $sp^2$ hybridis~~ation~~ed in 1st excited state.

→ The valency electronic configuration of B(z=5) in

ground state: $2s^2$ [↑↓] $2p^1$ [↑ | | ]

1st excited state: $2s^1$ [↑] $2p^2$ [↑ | ↑ | ] ← vacant
$P_x$ $P_y$ $P_z$

$sp^2 \Rightarrow 3\ sp^2$ hybrid orbitals

→ The valency $e^-$ configuration of Nitrogen

N (z=7) - G.S: $2s^2$ [↑↓] $2p^3$ [↑ | ↑ | ↑]
$P_x$ $P_y$ $P_z$

1st excited state: $2s^1$ [↑] $2p^4$ [↑ | ↑ | ↑↓] ← fully filled $P_z$ - orbital
$P_x$ $P_y$ $P_z$

$sp^2 \Rightarrow 3\ sp^2$ hybrid orbitals

→ In borazole the π bonding is dative & it arises from overlapping of empty $p_z$ orbital of B & fully filled $p_z$ orbital of N. So, the $e^{\ominus}$ in the π-electron cloud of borazole are derived from 3N-atoms

→ The function of σ & π bonds in borazole

## Evidences for structure of borazole

→ X-ray spectra

→ Electron diffraction spectra

## Group-14 Silicones

**Silicones** :- The organo silicon polymers containing -Si-O-Si- linkages are called as silicones.

Ex: silicone rubbers, silicone oils, silicone resins

**Classification of silicons** :- Based on structure silicones are classified into 3 types.

i, Linear silicones

ii, cyclic silicones

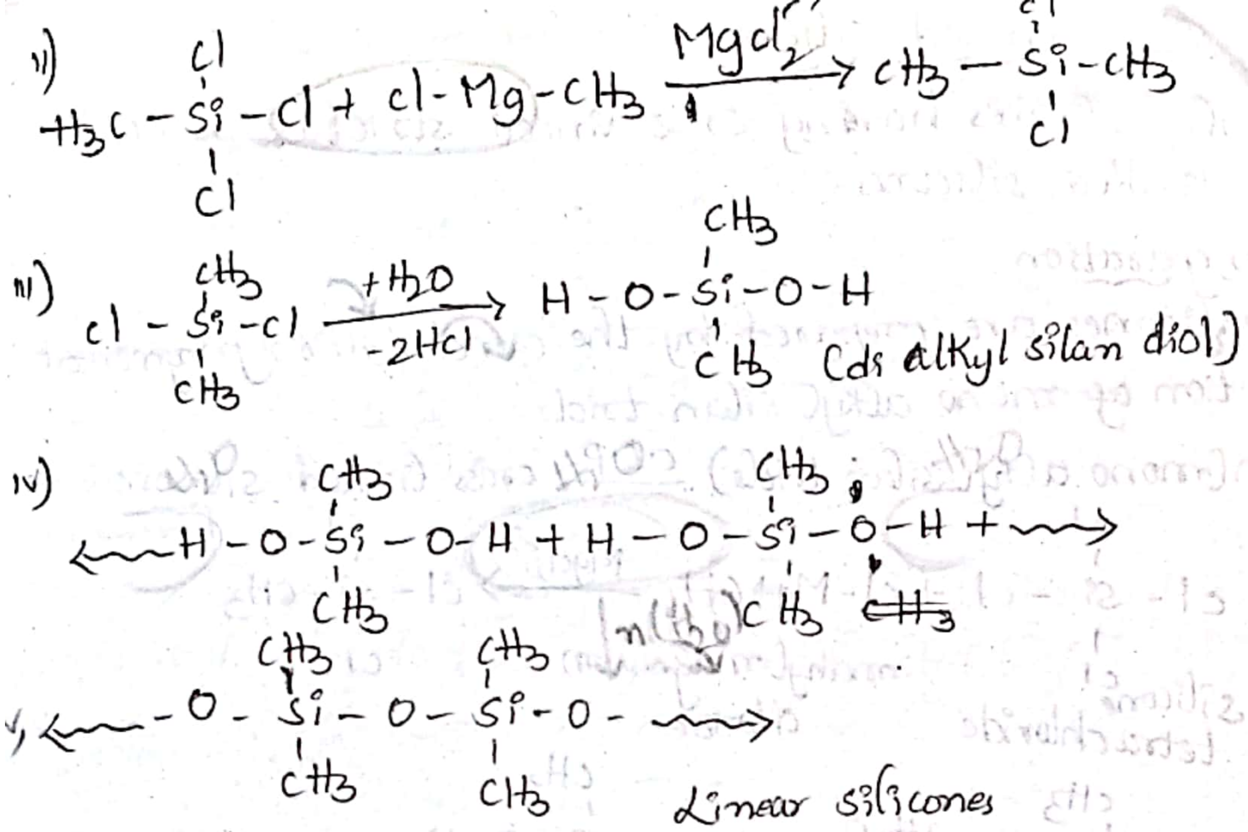
iii, cross-linked silicones

**Linear silicones** :- The silicones having linear structure are called as linear silicones.

**preparation** :- Linear silicones are prepared by the condensation polymerization of 'Di alkyl silicon diols'

n(Di alkyl silan diols) $\xrightarrow[\text{polymerization}]{\text{Linear condensation}}$ linear silicones

1, $Cl-\underset{Cl}{\overset{Cl}{|}}{Si}-Cl + Cl-Mg-CH_3 \xrightarrow{MgCl_2} Cl-\underset{Cl}{\overset{Cl}{|}}{Si}-CH_3$

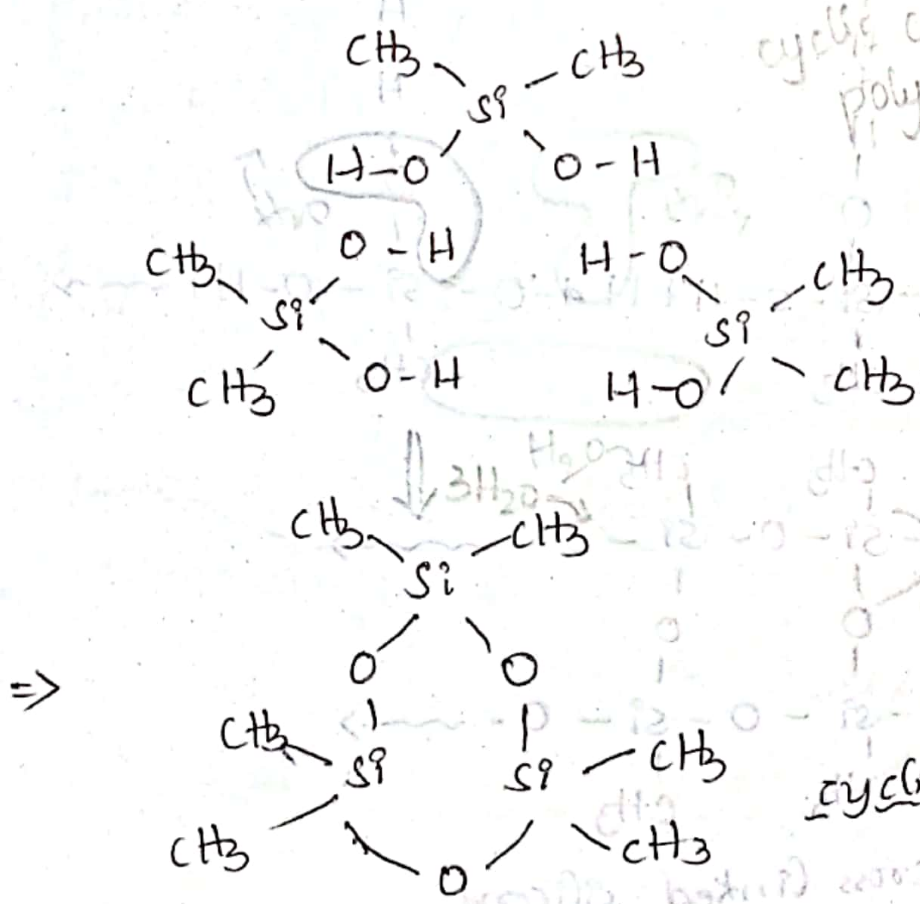



preparation of cyclic silicones

The silicones having cyclic structure is called cyclic silicones.

cyclic silicones are prepared by cyclic condensation polymerization of di alkyl silan diols

n(Di alkyl silan diols) $\xrightarrow{C.C.P}$ cyclic structure




cyclic silicone

## Cross linked silicones

The silicones having cross linked structure is called linked silicones.

### Preparation

Silicones are prepared by the condensation polymerization of mono alkyl silan triols

n(mono alkyl silan triols) $\xrightarrow{C.C.P}$ cross linked silicone

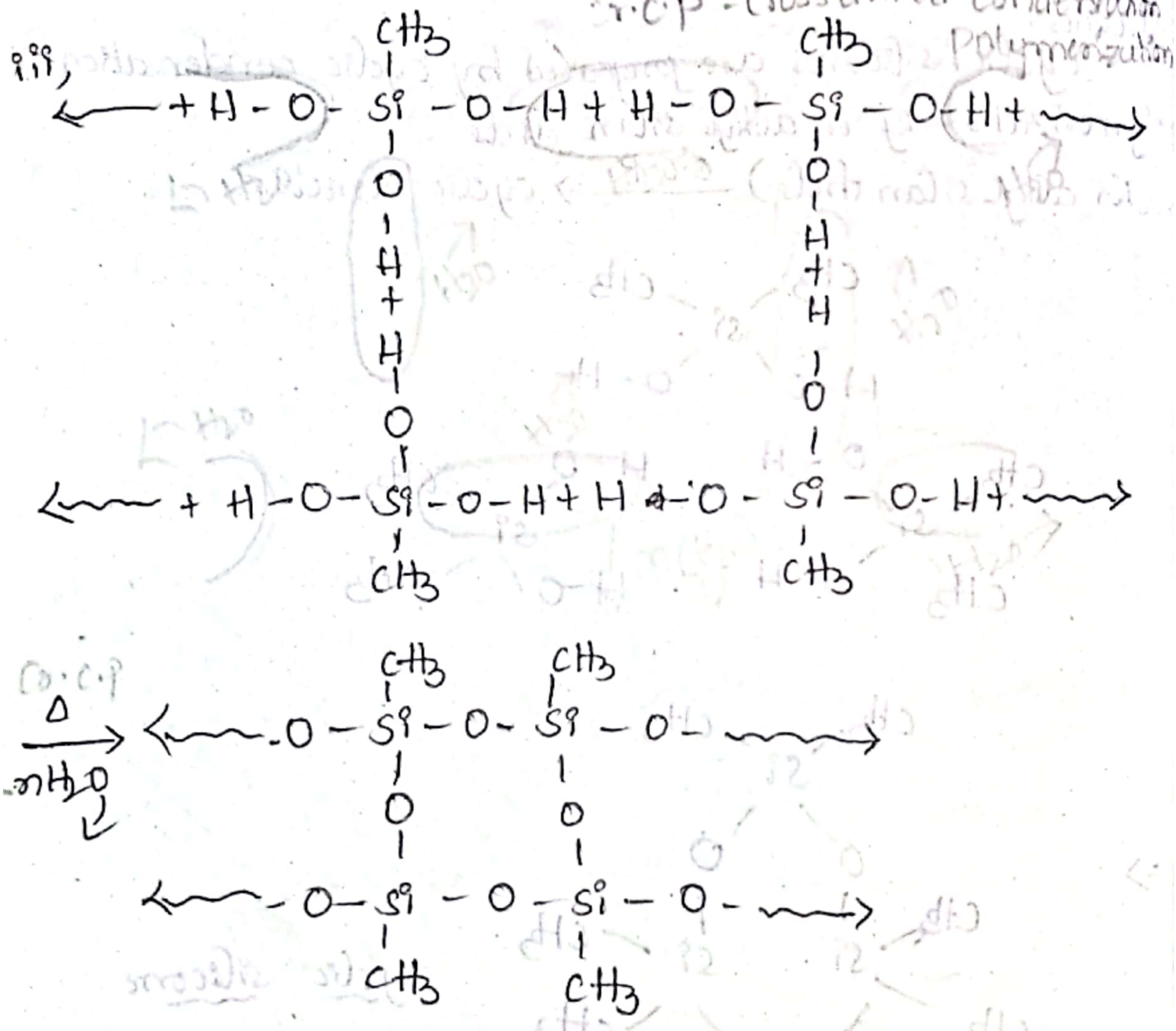
i, $Cl-Si(Cl)_2-Cl + Cl-Mg-CH_3 \xrightarrow{MgCl_2} Cl-Si(Cl)_2-CH_3$

silicone tetrachloride; methyl magnesium chloride

ii, $Cl-Si(CH_3)(Cl)-Cl \xrightarrow[3HCl]{3H_2O} H-O-Si(CH_3)(O-H)-O-H$ Mono alkyl silan triol

C.C.P - Cross linked condensation Polymerization

iii,




Cross linked silicone

Uses :- Applications of silicones

-> silicones are used in preparation of rubbers

-> silicones are used in preparation of water proof rain coats and papers

-> silicones are used as oil & greezers in air crafts (to the reason for use it doesn't freeze at 40°c)

-> silicones are used in preparation of paints and creams

-> silicones are used in preparation of insullation materials and seals due to their high thermal stability.

## p-block :- Group-15 elements

### phospho nitrilic Halides $(PNX_2)_n$

(or)

### phosphazenes

General formula for phospho nitric halides

is - $(PNX_2)_n$

where, X = Halogens

F, cl, Br, I

If n=3, X = cl → $[NPCl_2]_3 = N_3P_3Cl_6$

(Triphospho nitric chloride)

n=4, X = cl → $[NPCl_2]_4 = N_4P_4Cl_8$

(Tetraphospho Nitric chloride)

### preparations of phosphazenes

1) Heating of ammonium chloride with phosphorus pentachloride at 150°c form phosphonitrilic chlorides.

$$xNH_4Cl + xPCl_5 \xrightarrow{150°c} (PNCl_2)_x + 4xHCl$$

If $x=3$,

$$3\,NH_4Cl + 3\,PCl_5 \xrightarrow{150^\circ C} (PNCl_2)_3 + 12\,HCl$$

$x=4$,

$$4\,NH_4Cl + 4\,PCl_5 \xrightarrow{150^\circ C} (PNCl_2)_4 + 16\,HCl$$

2) Heating of $P_3N_5$ with chlorine forms phosphonitrilic chlorides.

$$P_3N_5 + nCl_2 \xrightarrow{150^\circ C} (PNCl_2)_4 \xrightarrow{330^\circ-350^\circ} \text{Helical form} \xrightarrow{500^\circ C} \text{Rubber}$$

(cyclic form)

If $n=3$,

$$P_3N_5 + 3Cl_2 \xrightarrow{150^\circ C} (PNCl_2)_3 + N_2\uparrow$$

Structure of phosphazenes

$$P_3N_3Cl_6 = (PNCl_2)_3$$

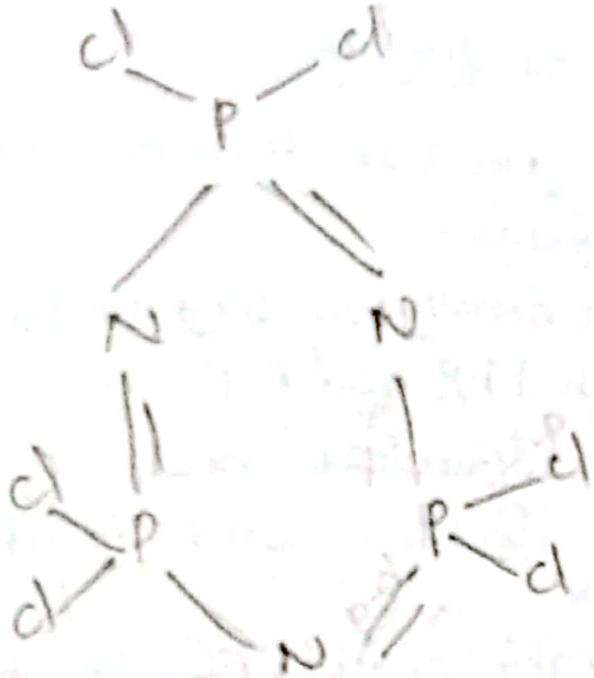
In phosphazenes, phosphorous atom undergoes $sp^3$ hybridisation in its 1st excited state.

Out of 4 $sp^3$ hybrid orbitals participate in sigma bond formation with 2 chlorine atoms and two nitrogen atoms.

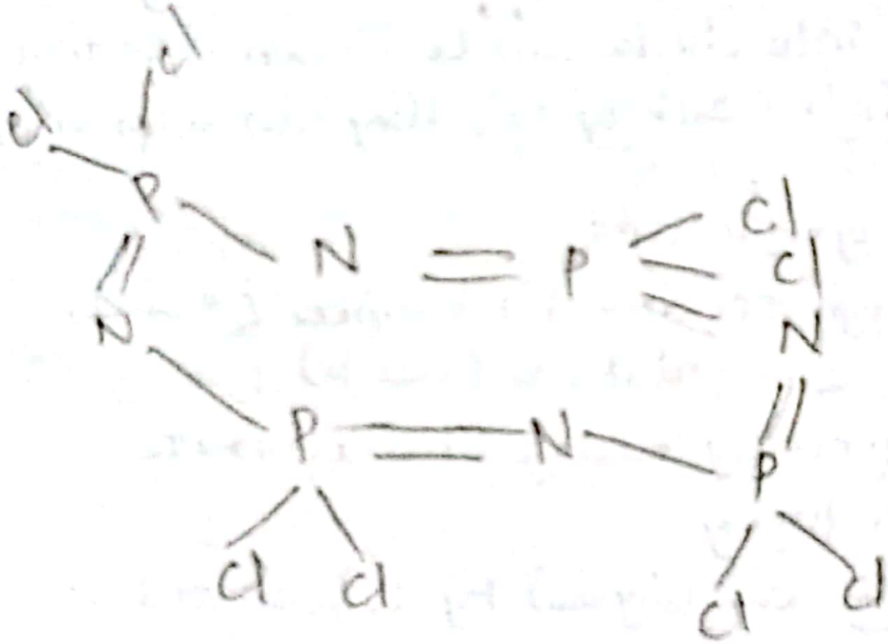
In phosphazenes, nitrogen is in $sp^2$ hybridisation in ground state. Two hybrid orbitals participate in sigma bond formation with 'p' atom. One hybrid orbital with lone pair remains on nitrogen.

The unhybridised d orbital of phosphorous and unhybridised 'p' orbital of nitrogen overlap side wise results in the formation of π bonds.

Trimer has planar type structure where as remaining polymers have puckered ring structures.



structure of $P_3N_3Cl_6$ (Trimer)



structure of $P_4N_4Cl_8$

phosphorous atom → $sp^3$ hybridisation (1st excited state)

Nitrogenation → $sp^2$ hybridisation (Ground state)

π - bond → d-p overlapping

## Orders Oxides

→ The Binary compounds of $O_2$ with the other elements are called as oxides.

→ classification of oxides based on chemical behaviour.

→ Oxides are classified into 4 types based on their chemical behaviour they are

i, Acidic oxide [Ex:- $CO_2$, $SO_3$, $N_2O_5$]

ii, Basic oxide [Ex:- $Na_2O$, CaO, BaO]

iii, Neutral oxide [Ex:- $H_2O$, NO, CO, $N_2O$...]

iv, Amphoteric oxide [Ex:- SnO, ZnO, PbO, $Al_2O_3$]

→ Basic and Amphoteric oxides are metallic oxides where as Acidic and Neutral oxides are Non-metallic oxides.

# Types of Oxides

## Acidic oxides

→ The oxides which reacts with water to form acids are called 'acidic oxides'

Ex:- $CO_2$, $SO_3$, $N_2O_5$

i, $CO_2 + H_2O \rightarrow H_2CO_3$ (carbonic acid)

ii, $SO_3 + H_2O \rightarrow H_2SO_4$ (sulphuric acid)

iii, $N_2O_5 + H_2O \rightarrow 2HNO_3$ (Nitric acid)

## Basic oxides

→ The oxides which reacts with water to form bases are called 'basic oxides'.

Ex:- $Na_2O$, $CaO$, $BaO$ etc..

i, $Na_2O + H_2O \rightarrow 2NaOH$ (sodium hydroxide)

ii, $CaO + H_2O \rightarrow Ca(OH)_2$ (calcium hydroxide)

iii, $BaO + H_2O \rightarrow Ba(OH)_2$ (Barium hydroxide)

## Neutral oxides

→ The oxides which are neither acids nor bases are called as 'Neutral oxides'.

Ex:- $H_2O$, $NO$, $CO$, $N_2O$, etc..

i, $NO$ → Nitric oxide

ii, $N_2O$ → Nitrous oxide (Laughing gas)

## Amphoteric oxides

→ The oxides which have both acidic & basic characters are called as Amphoteric oxides

Ex:- $SnO$, $ZnO$, $PbO$, $Al_2O_3$

i, $ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$ (base)

ii, $ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$ (Acid)

→ Here ZnO posses both acidic & basic characters. So 'ZnO' is an amphoteric oxide.

# Classification of oxides based on $O_2$ content

Oxides

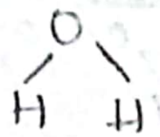
## Normal oxides

→ The oxides which have sufficient $O_2$ has permitted by the Normal valency of the other element are called as 'Normal oxides'.

Ex:- $H_2O$, $MgO$, $CaO$, etc..

→ Normal oxides have only M–O bonds

ex:-



In normal oxides the oxidation state of $O_2$ is $O^{-2}$

## polyoxides

→ oxides which have more $O_2$ has permitted by the normal valency of the other element are called as polyoxide.

→ It has both M–O & O–O bonds.

### peroxides

→ The polyoxides which have $O_2^{2-}$ ion are called as 'peroxides'

Ex:- $H_2O_2$, $BaO_2$

peroxides react with dil acids to form $H_2O_2$

$BaO_2 + \text{Dil } H_2SO_4 \rightarrow BaSO_4 + H_2O_2$

### Superoxides

→ The polyoxides which have $O_2^-$ are called as super oxides

Ex:- $KO_2$, $CsO_2$, $RbO_2$ ...

superoxides on hydrolysis gives $H_2O_2$ & $O_2$

$2KO_2 + 2H_2O \rightarrow 2KOH + H_2O_2 + O_2$

### Dioxides

→ Dioxides are also similar to peroxides but they react with dil. acids to form $H_2O$ & $O_2$

Ex:- $MnO_2$, $PbO_2$ ...

$2MnO_2 + 2H_2SO_4 \rightarrow 2MnSO_4 + 2H_2O + O_2$

## Suboxides

→ Oxides which have less oxygen has permitted by the normal valency of the other element are called as 'suboxides'.

Ex:- $C_3O_2$, $N_2O$, etc...

⇒ It has both M–O and M–M bonds

## Mixed oxides

→ The oxides formed by combination of 2/m normal oxides of an element are called as mixed oxides.

Ex:- $Fe_3O_4$ ($Fe_2O_3$ + $FeO$)

⇒ $Pb_3O_4$ ($2PbO + PbO_2$)

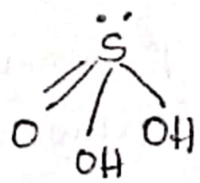
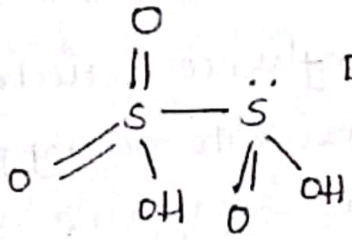
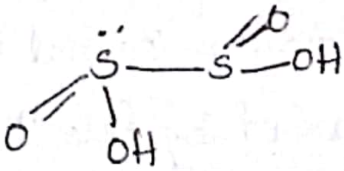
Unit - 1

## P- block elements: Group - 1

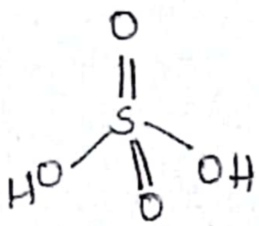
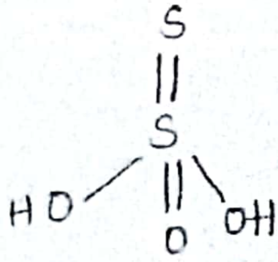
### Oxoacids of sulphur

The oxoacids of sulphur are numerous and depict strong π bonding between s and o. Most exist in solution or as crystalline salts. while a few have been isolated. The oxoanions have strong pπ-dπ bonding and have little tendency to polymerize in contrast to silicates. The oxoacids are listed in four series.

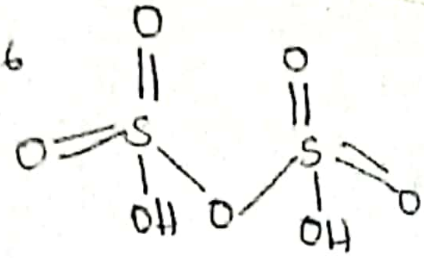
Sulphourous acid series

| Formula | Name | oxidation state | structure | salt |
|---|---|---|---|---|
| i, $H_2SO_3$ | sulphurous Acid | +4 |  | Sulphite $SO_3^{2-}$, Hydrogen sulphite $HSO_3^-$ |
| ii, $H_2S_2O_5$ | Di / pyro sulphurous acid | +5, -3 |  | Disulphite $S_2O_5^{2-}$ |
| iii, $H_2S_2O_4$ | Dithionous Acid | +3 |  | Dithionite $S_2O_4^{2-}$ |

Sulphuric acid series

| Formula | Name | oxidation state | structure | salt |
|---|---|---|---|---|
| i, $H_2SO_4$ | sulphuric Acid | +6 |  | sulphate $SO_4^{2-}$, Hydrogen sulphate $HSO_4^-$ |
| ii, $H_2S_2O_3$ | Thiosulphuric Acid | +6, -2 |  | Thiosulphate $S^2O^{3-}$ |

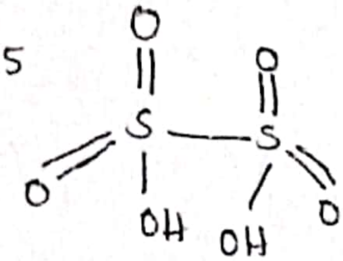
iii, $H_2S_2O_7$ — pyro Di sulphuric Acid — +6



Disulphate $S_2O_7^{2-}$

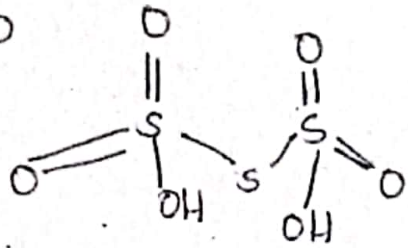
Thionic acid series

i, $H_2S_2O_6$ — Dithionic acid — +5



Dithionate $S_2O_6^{2-}$

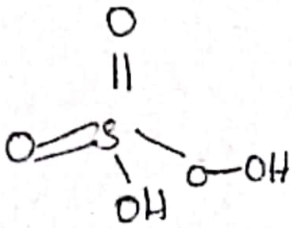
ii, $H_2S_{10}\cdot 2O_6$ — polythionic acid — +5, 0



polythionate $O_3S(S_n)SO_3^{2-}$

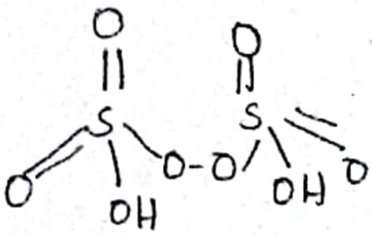
Per oxo acid series

i, $H_2SO_5$ — per oxo mono sulphuric acid — +6



per oxo mono sulphate $OOSO_3^{2-}$

ii, $H_2S_2O$ — per oxo di sulphuric acid — +6



per oxo di sulphate $S_2O_3^{2-}$

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Unit-I - P-block

Group-17 :- pseudohalogen compounds

A pseudo halogen can be defined as 'A molecule consisting of 2 or more electronegative atoms, which resemble the halogen atoms. The corresponding univalent anion which resemble the halide ion in their behaviour are called as 'pseudohalogens'

| pseudo halogens | pseudohalides |
|---|---|
| cyanogen - $(CN)_2$ | cyanide - $CN^{\ominus}$ |
| Thiocyanogen - $(SCN)_2$ | Thiocyanide - $SCN^{\ominus}$ |
| Oxycyanogen - $(OCN)_2$ | Oxycynate - $OCN^{\ominus}$ |
| Hydrozoic acid - $NH_3H$ | Azide - $N_3^{\ominus}$ |

Similarities between pseudohalogens & halogens

* Similar to halogens, pseudohalogens are also biatomic molecules.

* Similarities between pseudohalogen combines with hydrogen to form mono basic acids.

Ex :- $H_2 + Cl_2 \rightarrow 2HCl$

$H_2 + (CN)_2 \rightarrow 2HCN$

* Similar to halides, pseudo halides also form complexes.

Ex :- $[CoCl_6]^{3-}$ } complex compounds

$[Co(CN)_6]^{3-}$

Interhalogen compounds :- ($ns^2 np^5$)

→ The binary compounds formed by the combination of halogen among themselves are called as Interhalogen compounds.

→ Halogens VIIA [F, Cl, Br, I]

Ex:- $ClF_3$, $IF_7$, $BrF_5$

Types of Interhalogen compounds

→ Based on the molecular formula Interhalogen compounds are classified into 4 types

| AX | $AX_3$ | $AX_5$ | $AX_7$ |
|---|---|---|---|
| ClF | $ClF_3$ | $IF_5$ | $IF_7$ |
| BrF | $BrF_3$ | $BrF_5$ | |
| BrCl | $ICl_3$ | | |
| ICl | | | |
| IBr | | | |

Total no. of stable inter halogen compounds are - 11

→ The main reason for the formation of interhalogen compounds is the large electro negativity and size differences among the different halogens.

Methods for preparation of Inter halogen compounds

→ Method - I (By direct combination of halogen)

i, AX :- Type (1:1 ratio)

Ex:- $A_2 + X_2 \xrightarrow{\Delta} 2AX$

$Cl_2 + F_2 \xrightarrow{\Delta} 2ClF$

ii, $AX_3$ type :- (1:3 ratio)

Ex:- $A_2 + 3X_2 \xrightarrow{\Delta} 2AX_3$

$Cl_2 + 3F_2 \xrightarrow{\Delta} 2ClF_3$

(1 : 3)

iii, $AX_5$ type :- (1:5 ratio)

Ex:- $A_2 + 5X_2 \xrightarrow{\Delta} 2AX_5$

$Br_2 + 5F_2 \xrightarrow{\Delta} 2BrF_5$

(1 : 5)

iv, $AX_7$ type :- (1:7 ratio)

$A_2 + 7X_2 \xrightarrow{\Delta} 2AX_7$

$I_2 + 7F_2 \xrightarrow{\Delta} 2IF_7$

(1 : 7)

→ Method - II : preparation of bigger inter halogen compounds from smaller inter halogen compounds

Ex:- $BrF_3 + F_2 \xrightarrow{\Delta} BrF_5$ (bigger)
(smaller)

$IF_5 + F_2 \xrightarrow{\Delta} IF_7$

Structures of Interhalogen compounds

i, Structure of AX type Interhalogen compounds :-

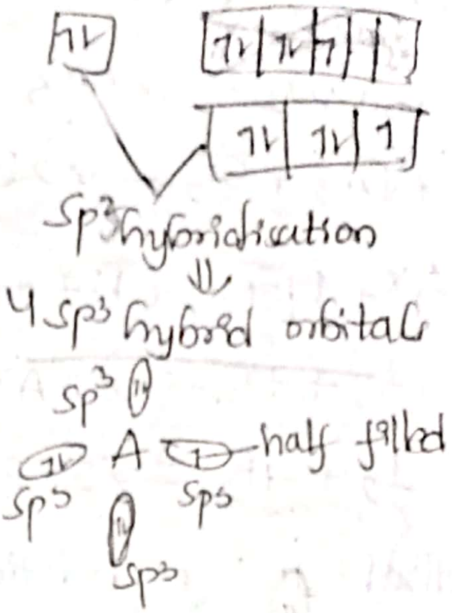
→ In AX-type Interhalogen compounds, the central halogen atom 'A' undergoes $sp^3$ hybridisation in ground state to form $4sp^3$ hybrid orbitals.

→ out of these $4sp^3$ hybrid orbitals, 3 hybrid orbitals are fully filled and the remaining $sp^3$ hybrid orbital is half -filled.

→ Now the half-filled $sp^3$ hybrid orbital of central halogen atom 'A' overlaps with the half filled $P_x$ orbital of halogen 'X' to form 1 $\sigma_{sp^3-p}$ (A-X) bond.

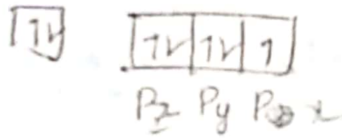
→ So, AX type Inter halogen compound have linear shape, and the bond angle is – 180°.

→ The valency electronic configuration of central halogen atom - 'A' in ground state – $ns^2$ $np^5$

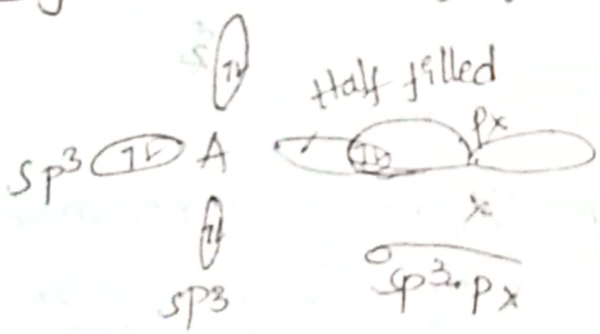



Hybridisation :- Inter mixing of 2 atomic orbitals is called as hybridisation

→ The valency electronic configuration of halogen - 'X' in ground state – $ns^2$ $np^5$




Bonding




⇒ :Ä — X: Linear shape, Bond angle – 180°

Bond pair = 1
Lone pair = 6 } = 7

ii, Structure of $AX_3$ type of Inter halogen compound ($ClF_3$):

→ In $AX_3$ type of Inter halogen compounds the central halogen atom – 'A' under goes $sp^3d$ hybridisation in 1st excited state to form 5 $sp^3d$ hybrid orbitals.

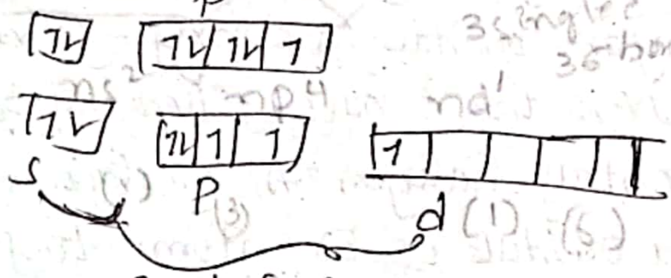
→ out of these 5 $sp^3d$ hybrid orbitals 2 hybrid orbitals are fully filled. and the remaining 3 hybrid orbitals are half-filled.

→ Now, the 3 half filled $sp^3d$ hybrid orbitals of halogen 'A' overlaps with the 3 half filled $P_x$- orbitals of 3-X halogen atoms to form 3 $\overline{sp^3d\,p_x}$ (A-X) bonds.

→ So $AX_3$ type Inter halogen compounds have T-shape, and the bond angle is $\simeq 87.5°$.

→ The valency E.C of central halogen atom 'A' in ground state is equal to $ns^2\ np^5$

First excited state

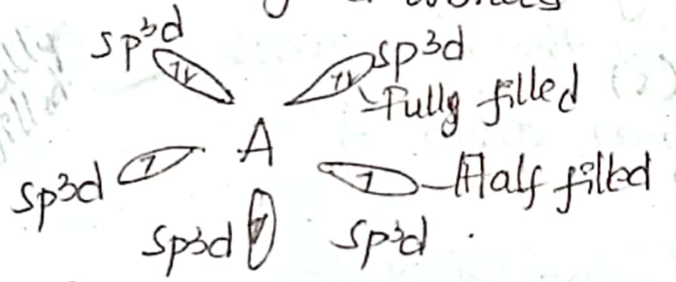



$sp^3d$ hybridisation

↓

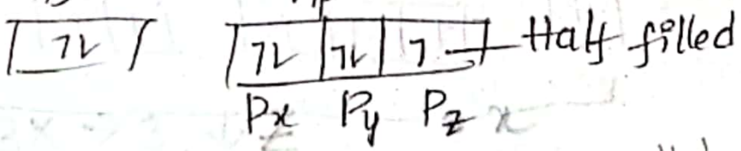
5 $sp^3d$ hybrid orbitals

5 $sp^3d$ hybrid orbitals

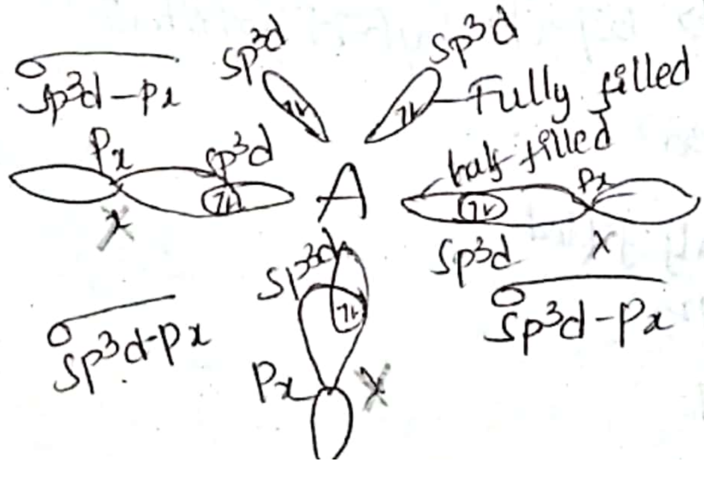


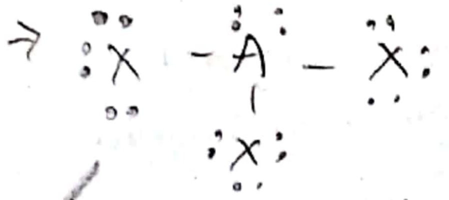

→ The valency E.C of halogen 'X' in ground state

E.C of X $ns^2$ $np^5$




Bonding





T-shape, Bond angle $\simeq 87.5°$ (equal to 90° right L)

Bond pairs - 3

lone pairs - 11

## Structure of $AX_5$ type of Inter halogen compound

→ In $AX_5$ type Inter halogen compound. The central halogen atom A undergoes $sp^3d^2$ hybridisation in 2nd excited state to form 6 $sp^3d^2$ hybrid orbitals.

→ Out of these 6 $sp^3d^2$ hybrid orbitals 1 hybrid orbital have a pair of electrons and remaining 5 $sp^3d^2$ hybrid orbitals are half-filled.

→ Now the 5 half-filled $sp^3d^2$ hybrid orbitals of central halogen A overlaps with the 5 half-filled $p_x$ orbitals of 5X - atoms to form 5 $sp^3d^2 - p_x$ (A-X) bonds.

→ So, $AX_5$ type Inter halogen compounds have 'square pyramidal' shape and the bond angle is $\simeq 90°$.

→ The valency E.C of central atom 'A' is

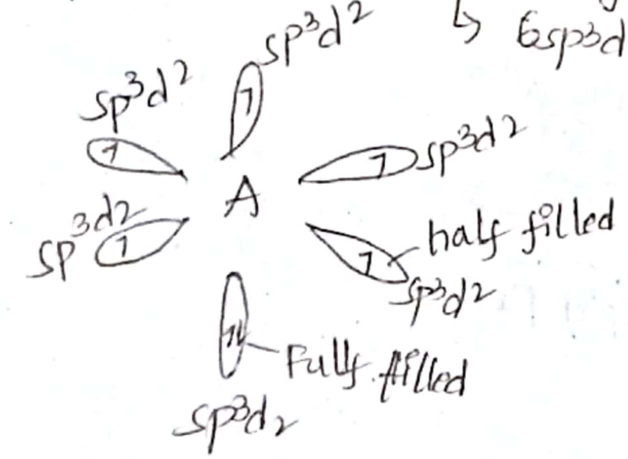
A = $ns^2$ [↑↓] $np^5$ [↑↓ | ↑↓ | ↑] - Ground state

A = s [↑↓] p [↑ | ↑ | ↑] d [↑ | ↑ | | | ] → In 2nd excited state

↓

$sp^3d^2$ hybridisation

↳ 6 $sp^3d^2$ hybrid orbitals.

→ 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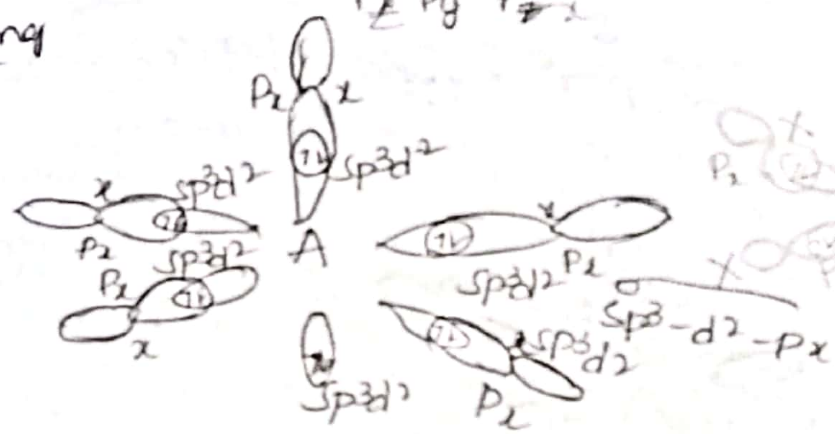
→ The valency E.C of halogen 'X' is $ns^2\ np^5$

$X - ns^2 \quad np^5$ (G.S)

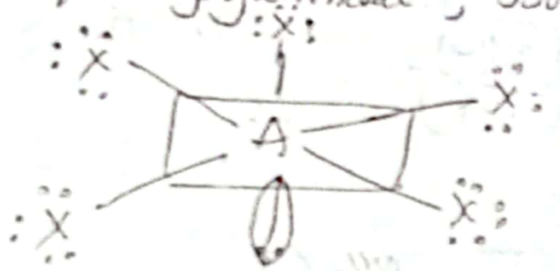
[⇅] [⇅|⇅|↑] half filled

$P_x\ P_y\ P_z$

Bonding




→ shape - square pyramidal ; Bond angle ≃ 90°




Structure of $AX_7$ type inter halogen compound

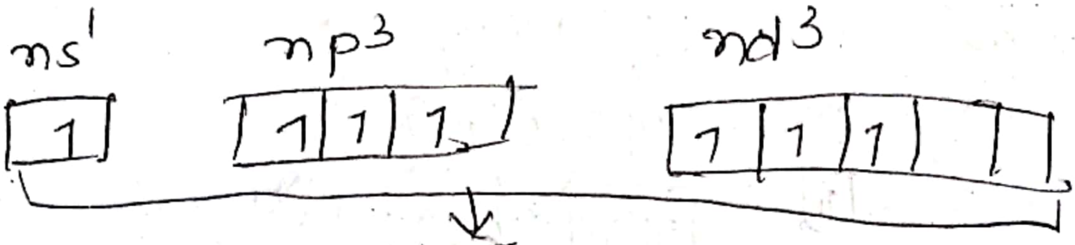
→ In $AX_7$ type of inter halogen compound the central atom 'A' undergoes $sp^3d^3$ hybridisation, in 3rd excited state to form 'seven $sp^3d^3$ hybrid orbitals having unpaired electrons overlap directly with the 7 p-orbitals of seven other halogen atoms forming seven 'σ' bond. The shape of the molecule is 'pentagonal bi-pyramidal'.

→ The central atom 'A' electronic configuration of valency electronic configuration in ground state.

$ns^2 \quad np^5$

[⇅] [⇅|⇅|↑]

The valency electronic configuration of central atom - A in 3rd excited state.

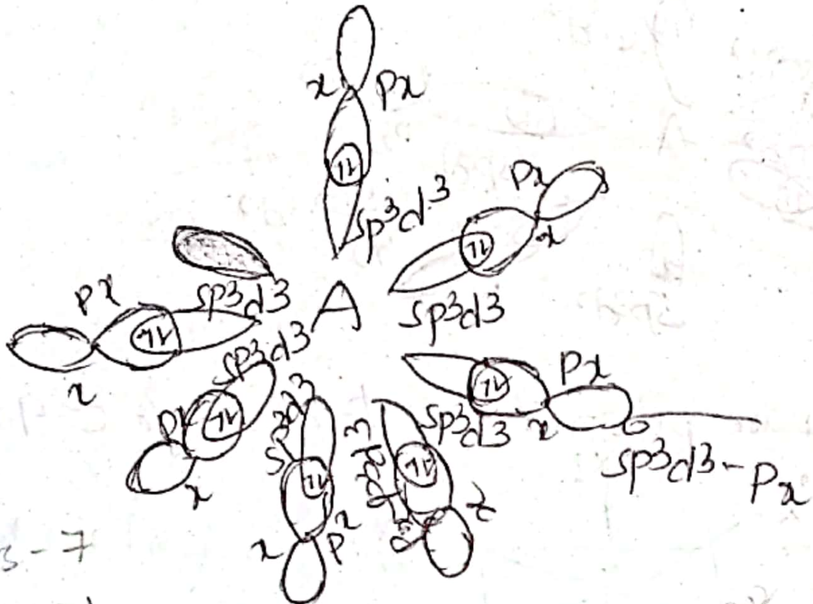



$sp^3d^5$

⇓

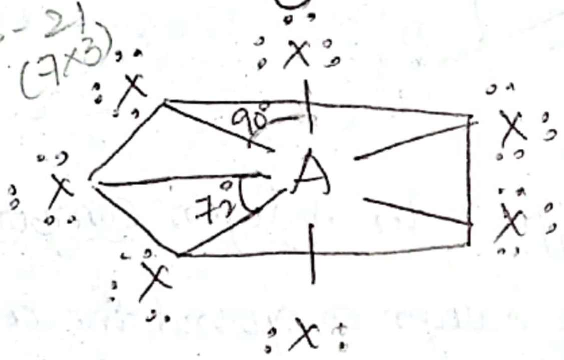
7 $sp^3d^5$ hybrid orbitals

**Bonding**




Bond pairs - 7

Lone pairs - 21 (7×3)




→ shape pentagonal bipyramidal & bond angle is 72° & 90°