

Q. Select which of are planar.

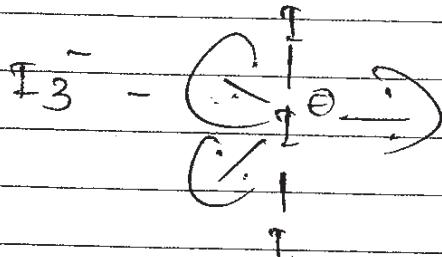
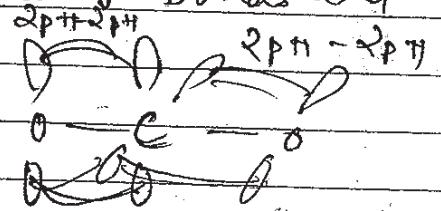
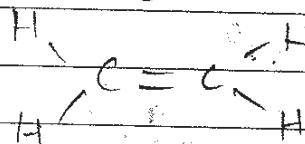
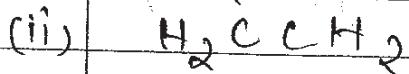
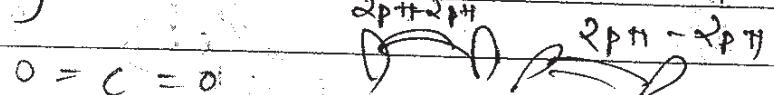
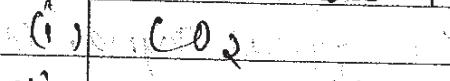
- (A) XeO_4
- (B) SF_2
- (C) TiO_3^-
- (D) ClO_2^-
- (E) ClO_2^+
- (F) XeO_2F_2

Q. Find maximum no. of atoms in a plane in
 XeF_5^+
 and also write no. of such plane.

Q. If all the atoms of COF_2 in xy plane
 find nodal plane of π -bond of COF_2 .

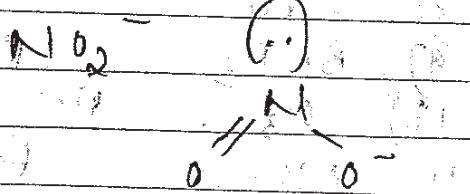
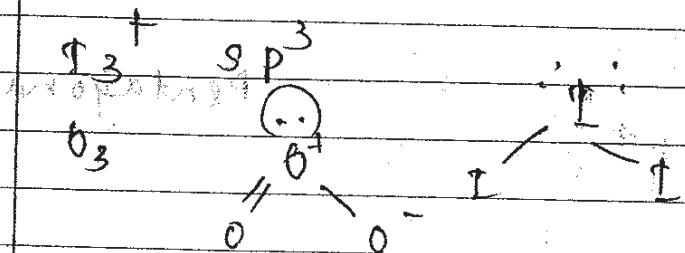
- (A) XZ
- (B) XY
- (C) YZ

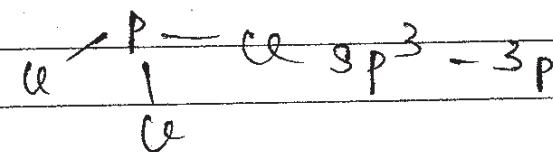
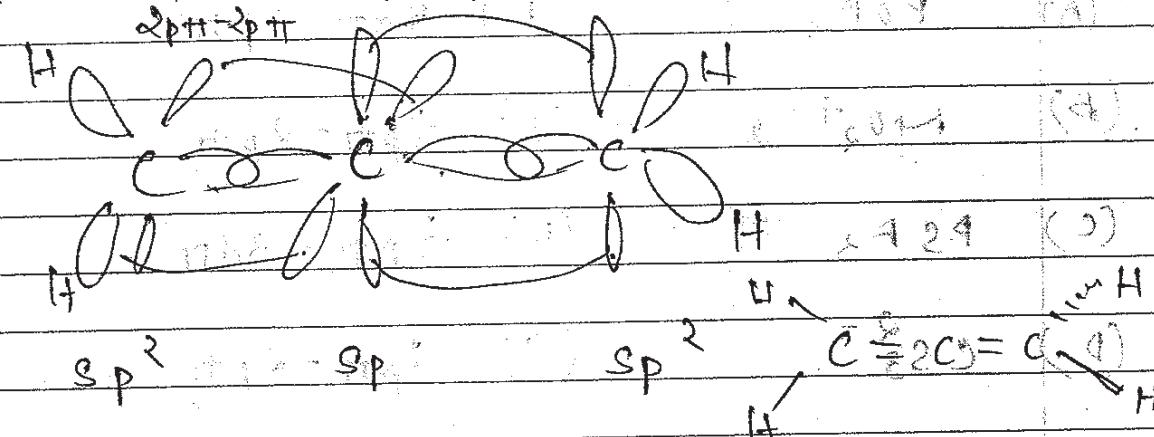
Q. Write overlapping of all the σ bonds and
 π bonds in



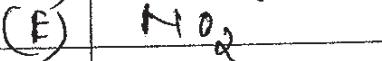
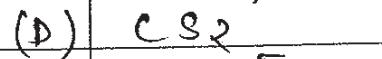
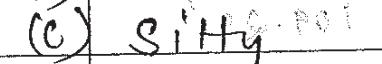
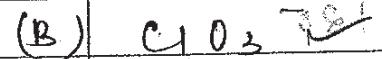
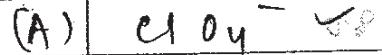
Linear
 sp^3d .

SeF

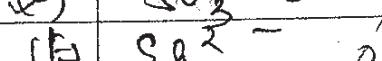
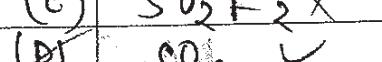
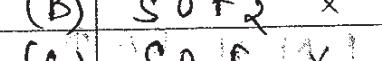
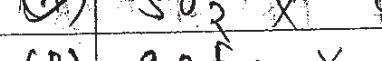
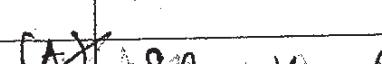


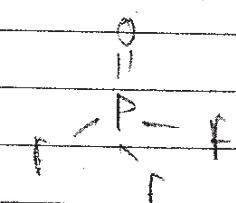
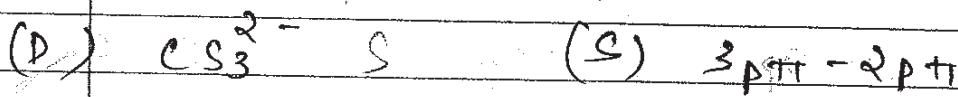
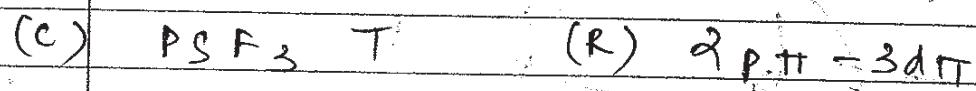
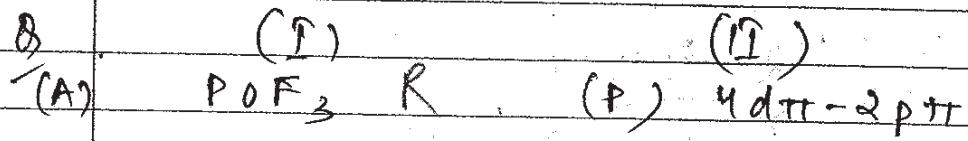


Q. Which is/are having $p\pi - d\pi$ bond?

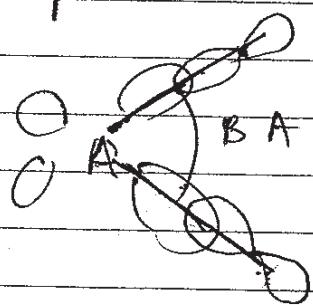


Q. Which is/are having $p\pi - p\pi$ bond and $p\pi - d\pi$ both type of bonds?



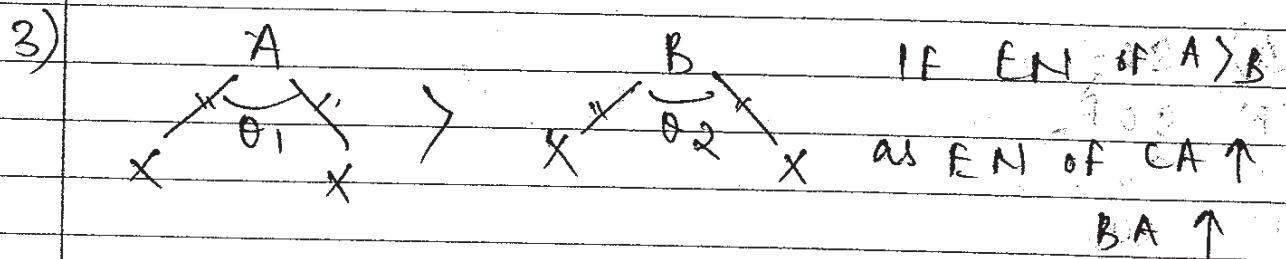
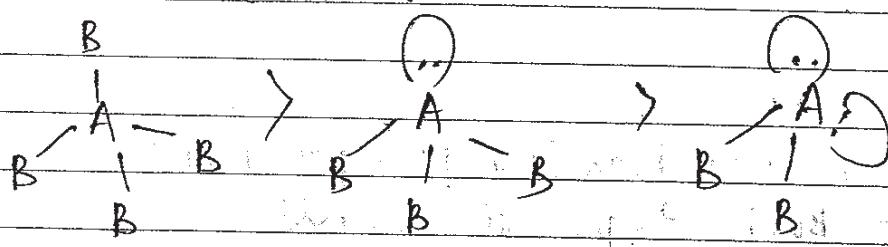


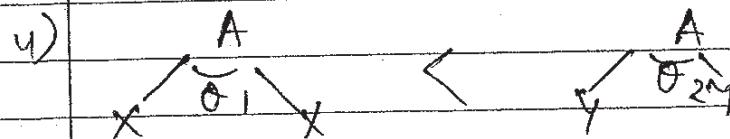
Comparison of Bond Angle:



$$\begin{aligned} 1) \text{Linear} & \quad \angle_{\text{P}} = 180^\circ \\ \text{Bent} & \quad \angle_{\text{P}} = 120^\circ \\ \text{Trigonal Pyramidal} & \quad \angle_{\text{P}} = 109.28^\circ \end{aligned}$$

2) Presence of LP

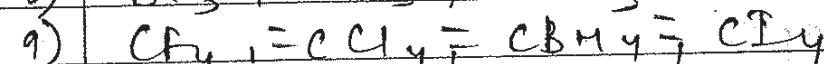
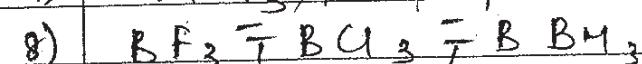
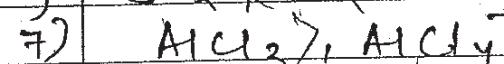
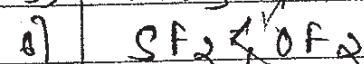
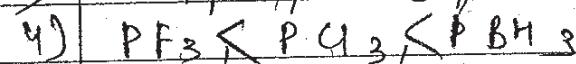
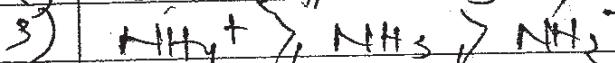
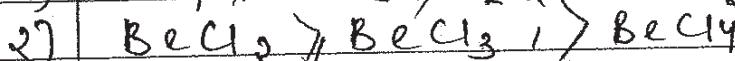
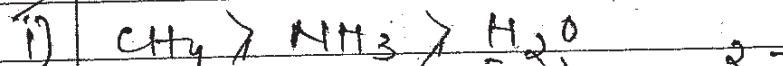




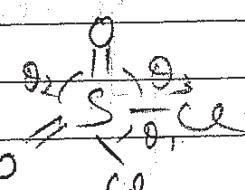
IF EN of $X > Y$

AS EN of Bond atom \uparrow BA \downarrow

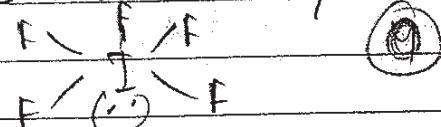
Q. Write order of BA in -



10)



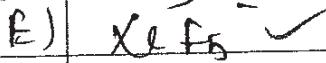
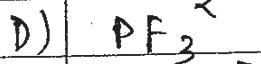
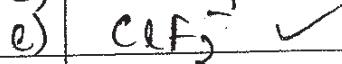
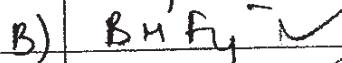
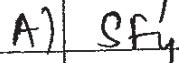
Q. Find no. of BAs which is/are at 90°
in IF_5

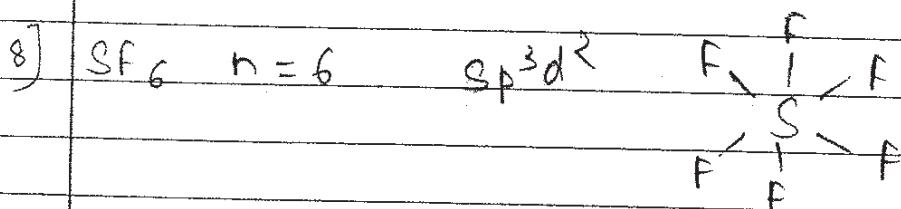
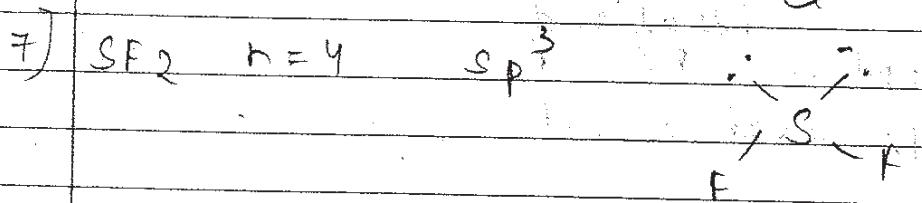
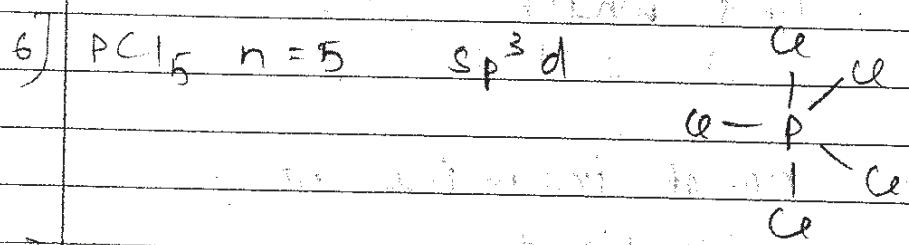
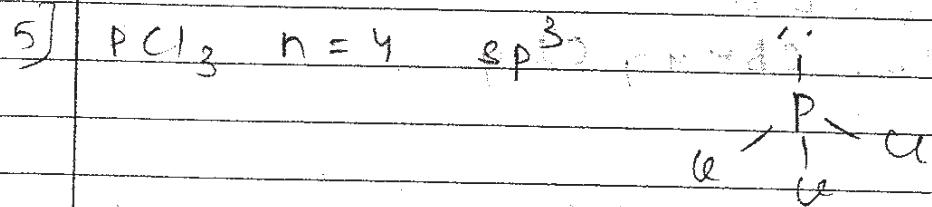
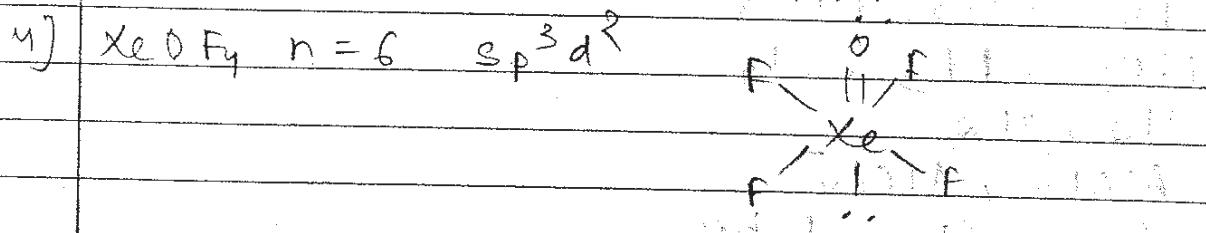
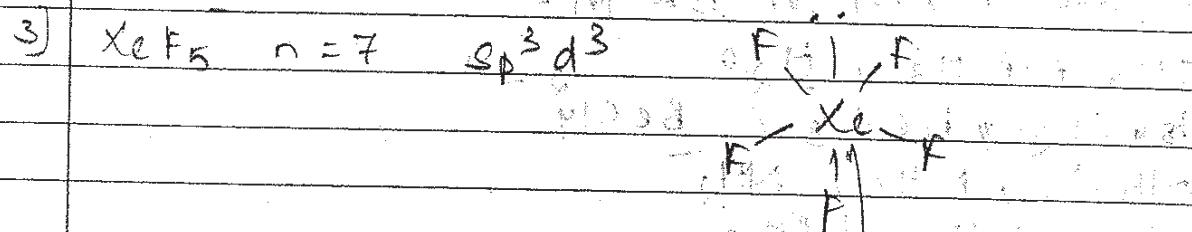
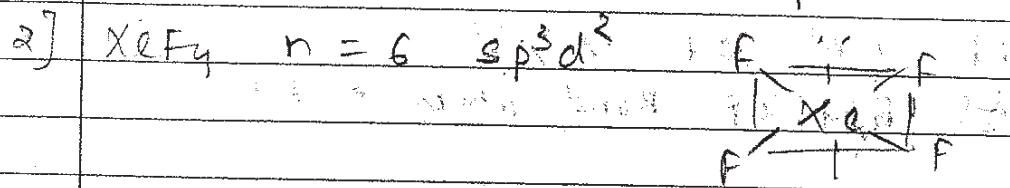
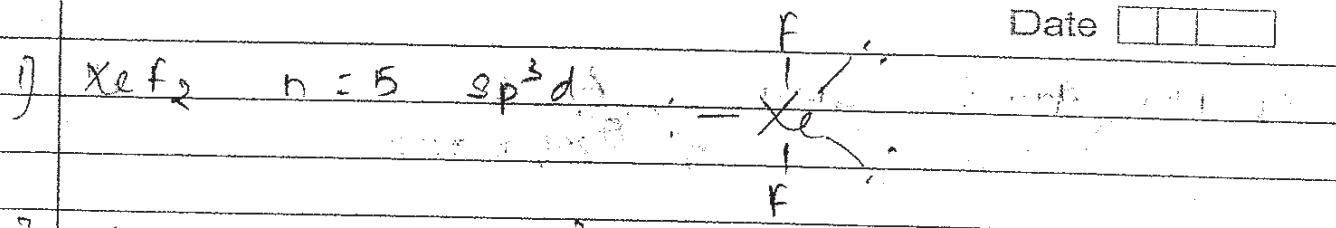


Q. Find max. no. of identical BAs in SO_2Cl_2 .

idealised

Q. In wof option BA is not affected
by the presence of lp on CA.





9) IF_3 $n=5$ sp^3d \rightarrow $\text{I}-\text{F}-\text{I}-\text{I}-\text{I}$

10) IF_5 $n=6$ sp^3d^2 \rightarrow $\text{I}-\text{F}-\text{I}-\text{F}-\text{I}-\text{F}$

11) IF_7 $n=7$

~~one type of lone pair~~
~~one pair of lone pairs~~

~~(a) 39 (b) 39 (c)~~

~~one lone pair~~

~~one lone pair~~

~~b 362~~

~~one lone pair~~

~~one lone pair~~

~~SP hybrid~~

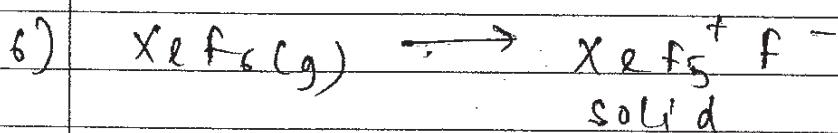
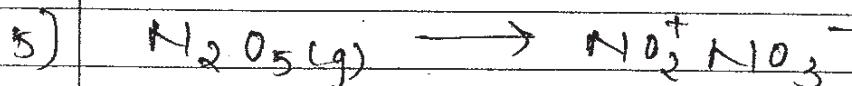
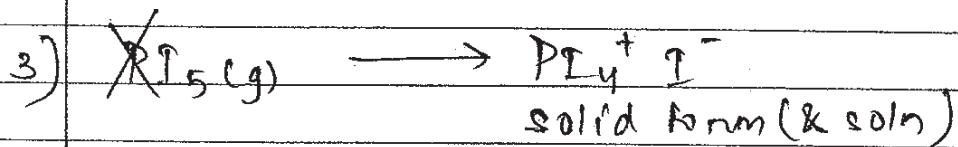
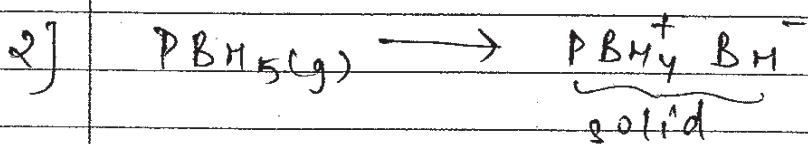
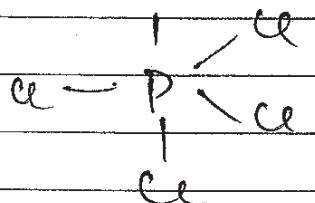
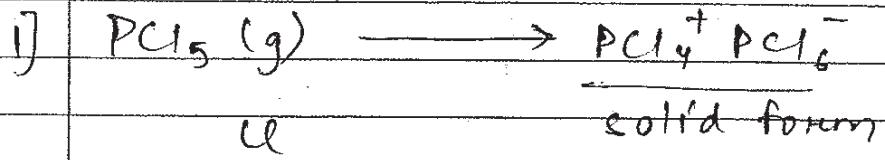
~~radical has 6 lone pairs~~

~~orbital~~

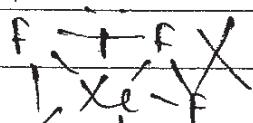
~~one lone pair~~

~~one lone pair~~

Molecules which have different hybridization in different phase.



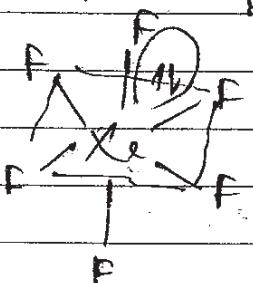
sp^3d^3



sp^3d^2 Square Pyramids

angle $< 90^\circ$

antitheme
repulsion

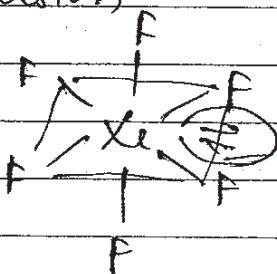


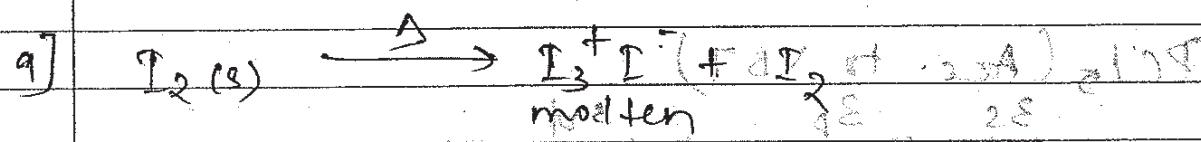
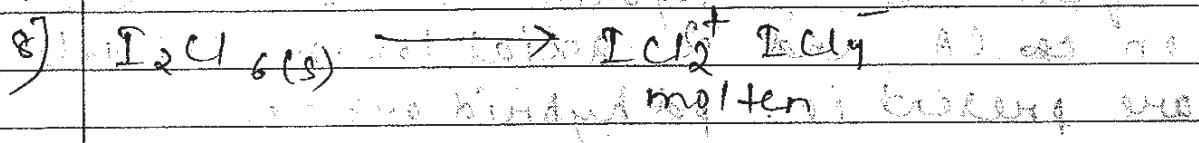
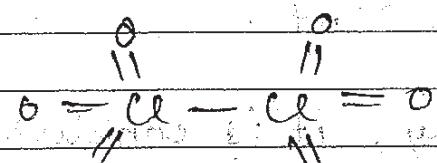
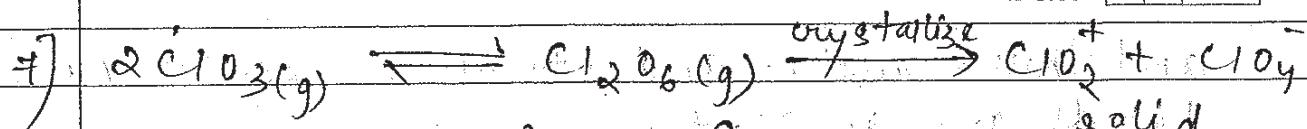
* Capped octahedra

* Distorted octahedra

* Irregular //

* Dancing molecule





Q. Set of orbitals used by central atom in the formation of PCl_5 molecule (my plane is equatorial plane)

A) $s + p_x + p_y + p_z + d_{xy}$

B) $s + p_x + p_y + p_z + d_{x^2-y^2}$

C) $s + p_x + p_y + p_z + d_{z^2}$

D) $s + s_p p_x + p_y + p_z + \text{any one d orbital}$

Bent Hypothesis

→ Most of the hybridisation produced all the equivalent hybrid orbitals. for eg - sp^3 , sp^2 , sp^3d^2 , etc.

→ In PCl_5 it is observed that there are two long or and weaker axial bonds are present

and three smaller and stronger equatorial bonds are present.

→ Experimentally, it's concluded that in sp^3d hybridisation, there are 3 equatorial sp^3 hybrid orbitals are present on CA and 2 axial longer orbitals are present i.e. pd hybrid orbitals.

PCl_5 (Ae. to VBT)

$3s \quad 3p \quad 3d$

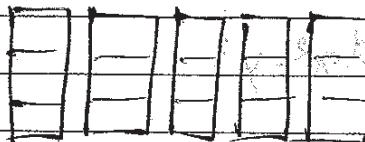
$P = [1] \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1}$

$3s \quad 3p \quad p_y \quad p_z \quad 3d$

$P = [1] \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1}$

sp^3d

$P = \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1}$



PCl_5 (Ae. to Bent)

$3s_h \quad 3p$

$P = [1] \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1}$

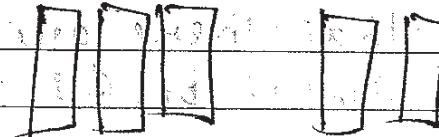
$3s \quad 3p \quad p_y \quad p_z \quad 3d$

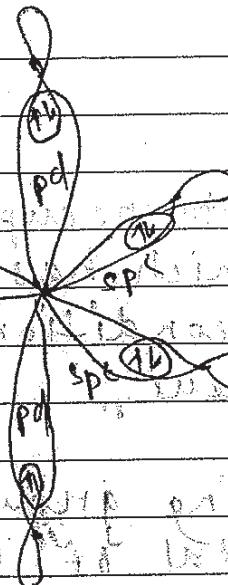
$P = \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1}$

$sp^2 \quad pd$

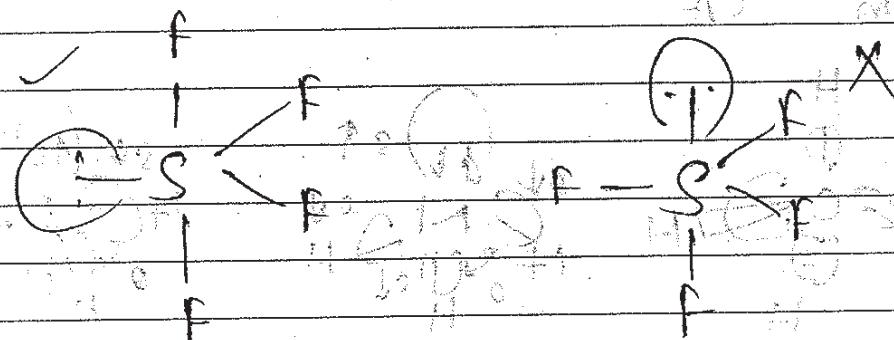
$sp \quad pg$

$P = \boxed{1} \boxed{1} \boxed{1} \boxed{1} \boxed{1}$



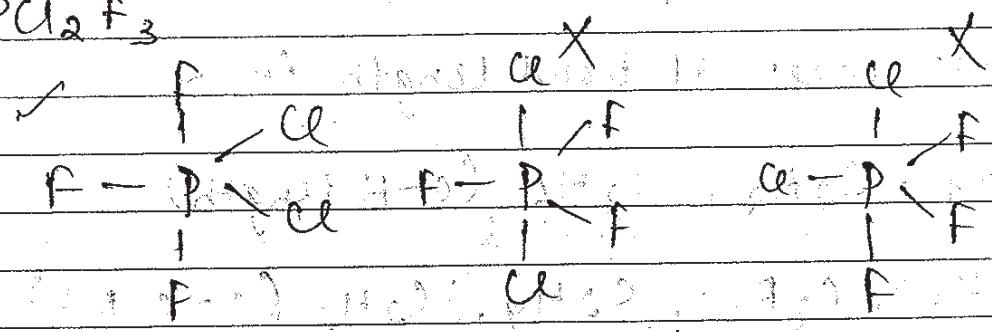


SF_4 is in equilibrium with its solid state.



More stable
bcz LP is less stable
in that orbital
which has more number of nuclei
% s character is less than % p character

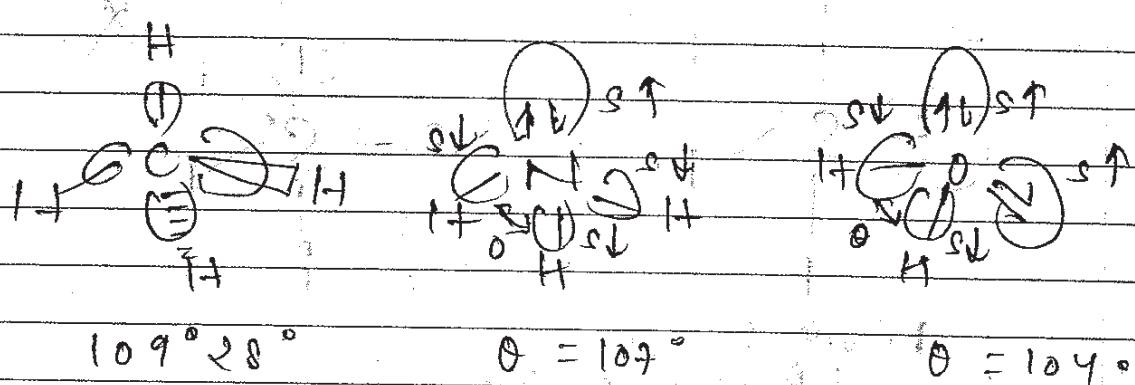
PCl_2F_3



Electron withdrawing grp is bonded
with that orbital which has less
s-character.

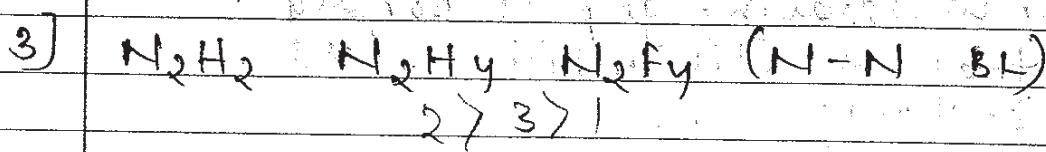
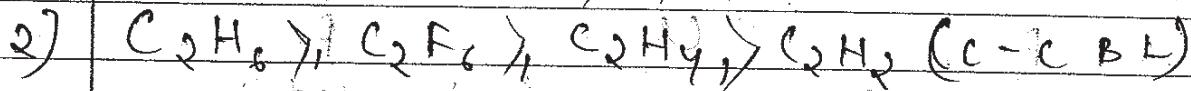
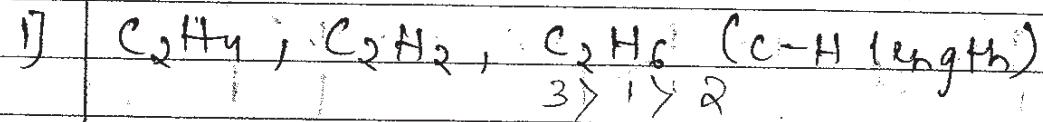
Bent's Rule.

- Lone pair prefer to occupy that hybrid orbital of CA which has more s-character, because in that condition it is closer to corresponding nucleus.
- Electron withdrawing group prefer to occupy that hybrid orbital of CA which has less s-character because in that condition withdrawing of e⁻ is easier from CA.

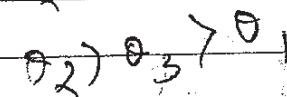
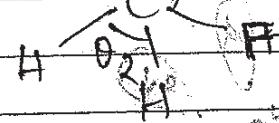
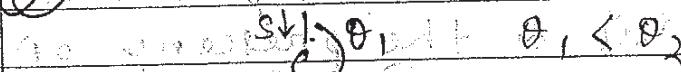


s - character decreases in hybrid orbital which are used in overlapping so that BA decreases

Q. Write order of bond length in -



Q. Compare O_1 & O_2 in



Q. Draw structure of

- (d) PCl_3F_2

- (ii) PCl_2F_2

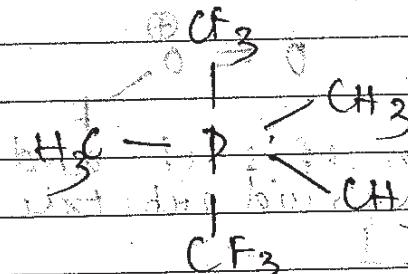
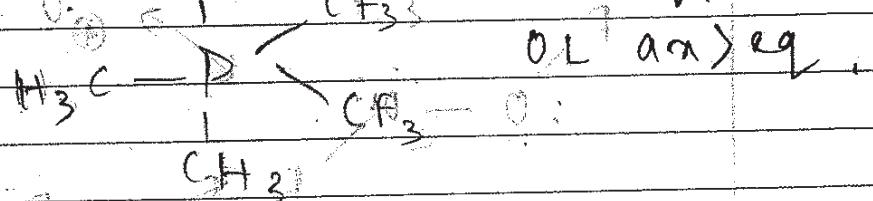
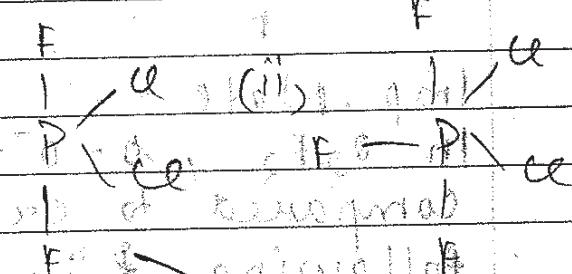
- (iii) $\text{P}(\text{CH}_3)$

- 1

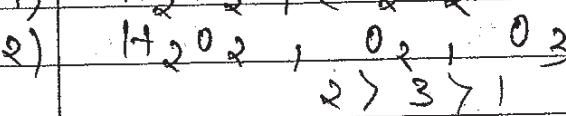
- 1

- 四

15



Q. Compare H_2O & BE in

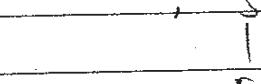
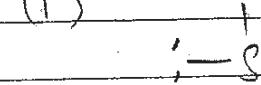
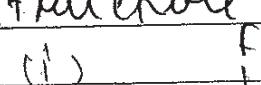


B. Draw structure of

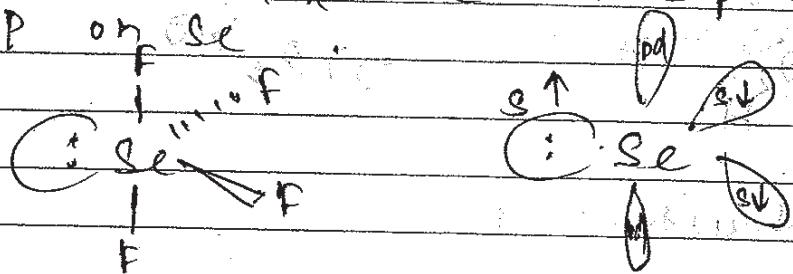
- i)

- ii) BH F₃

- (iii) XeOF_3

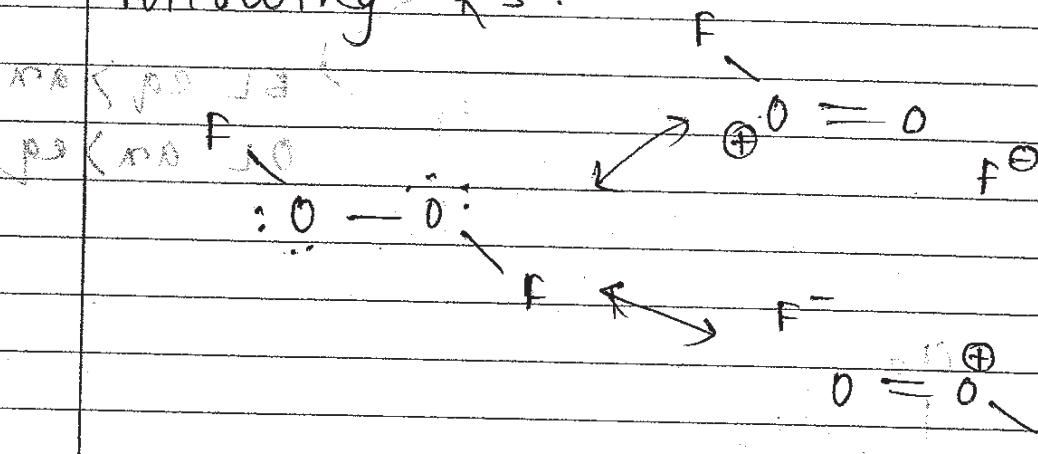


Q. In SeF_4 , $\text{Feg} - \text{S} - \text{Feg}$ Bond angle variation is higher as compared to $\text{Fax} - \text{S} - \text{Fax}$ due to the presence of LP on Se.



Imp. Note -

In O_2F_2 , O-O BL is very small as compared to expected. This is due to following RS.



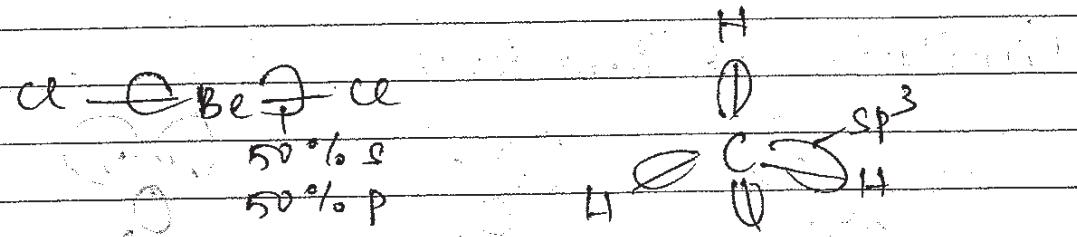
Quantitative estimation of s-ch and p-ch in hybrid orbitals

$$\cos \theta = \frac{s}{s-1} = \frac{p-1}{p}$$

s = fraction of s-character in a hybrid orbital.

p = fraction of p-character in a hybrid orbital

$$\theta = BA$$



$$\cos \theta = \frac{s}{s-1}$$

$$\cos \theta = 0.5 \rightarrow \theta = 60^\circ$$

$$\cos \theta = -0.5 \rightarrow \theta = 120^\circ$$

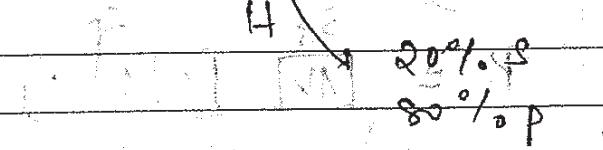
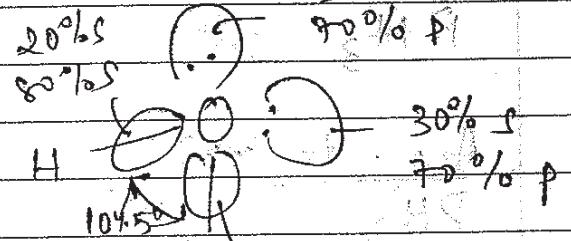
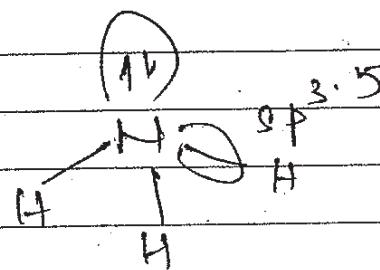
$$\cos \theta = -1$$

$$\theta = 180^\circ \rightarrow -0.33 = \frac{1}{s-1} \rightarrow s = 1.33$$

$$s = \frac{1}{4} = 25\% \text{ s}$$

$$p = 75^\circ$$

30% s



$$\cos \theta = \frac{s}{s-1} \rightarrow \text{sp}^3 \rightarrow \text{Hyb.}$$

$$\cos 104.5^\circ = \frac{s}{s-1} \text{ of a regular}$$

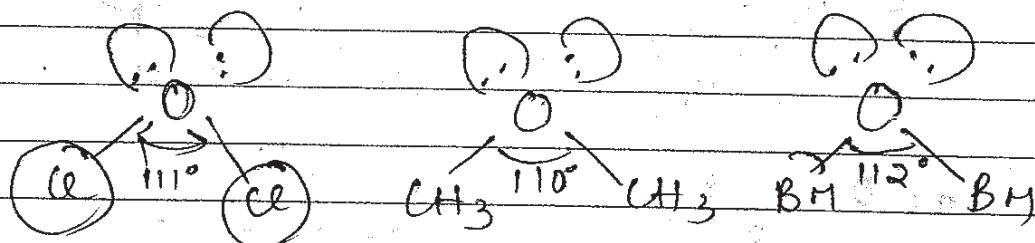
$$-0.25 = \frac{s}{s-1} \text{ used for H}_2\text{O}$$

$$s = \frac{1}{4} = 25\% \text{ s}$$

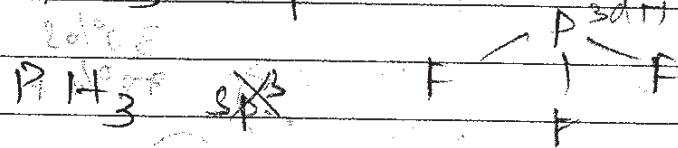
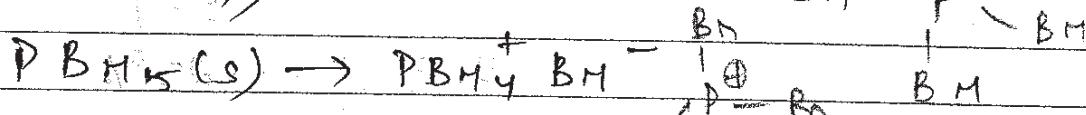
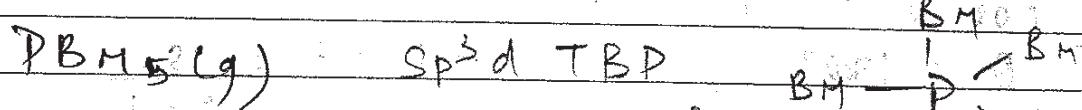
$$(2) \text{ of } s = 25\% \text{ s}$$

$$p = 75\% \text{ p}$$

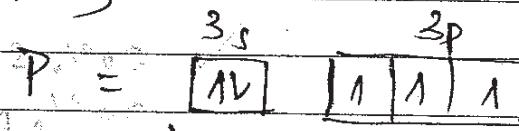
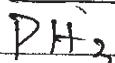
Limitation of Bent Rule.



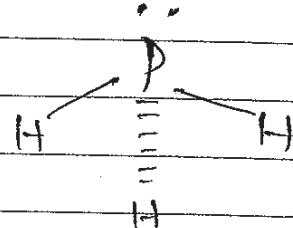
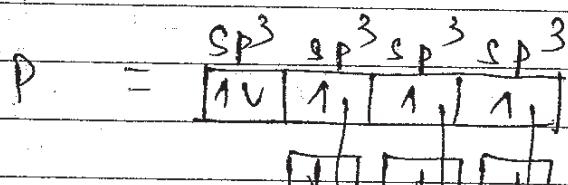
Positive deviation of BAs are not possible to correlate by Bent Rule



Ace. to VBT



sp³

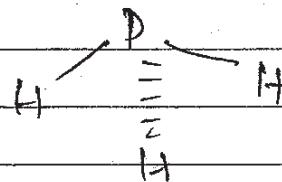
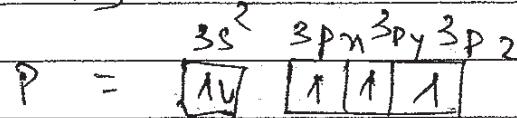
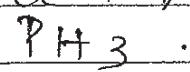


$$\text{Hyb} = \text{sp}^3$$

$$\text{Overlapping} = \text{sp}^3 - 1s(3)$$

Trigonal pyramidal
q_{3b}

Ace. to Drago



Hyb. of $\text{P} = \text{No hyb}/\text{p}^3 \text{hyb}$

Overlapping = $p_x - 1s$, $p_y - 1s$, $p_z - 1s$

Geometry = T. pyramidal

$$\text{BA} = 93^\circ$$

According to Drago, when central atom belongs to 3rd period or below 3rd period and electronegativity of bonded atom is less than or equal to 2.5 then CA use its pure p orbitals for overlapping

CH_4	NH_3	H_2O
SiH_4	PH_3	H_2S
GeH_4	AsH_3	H_2Se
SnH_4	SbH_3	H_2Te

No hyb.

$$\text{NH}_3 = 107.8^\circ$$

$$\text{H}_2\text{O} = 104^\circ$$

$$\text{PH}_3 = 93.6^\circ$$

$$\text{H}_2\text{S} = 92^\circ$$

$$\text{AsH}_3 = 91.8^\circ$$

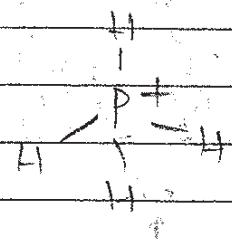
$$\text{H}_2\text{Se} = 91^\circ$$

$$\text{SbH}_3 = 91.3^\circ$$

$$\text{H}_2\text{Te} = 90^\circ$$

$\text{PH}_3 - \text{P}^3$ trigonal pyramidal

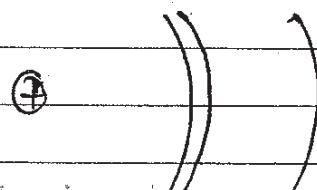
$\text{PH}_4^+ - \text{sp}^3$ tetrahedral



$\text{PH}_5 - \text{sp}^3\text{d}$ TBP DNE $^+$

Some non existing covalent species

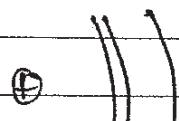
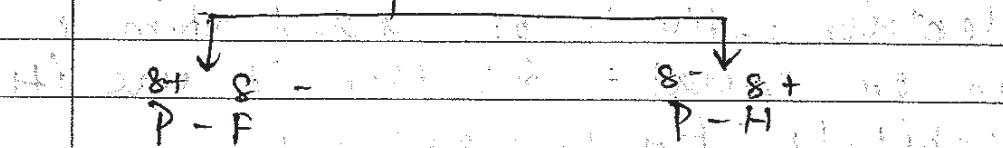
P



atomic basis functions

3s 3p 3d

but there is no d-orbitals in the valence shell of phosphorus



3s 3p 3d



3s 3p 3d

$\text{PF}_5 \checkmark$

$\text{PH}_5 X$

due to d-orbital

contraction effect.

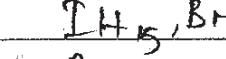
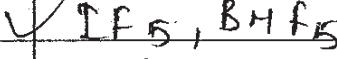
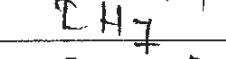
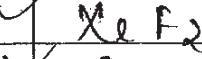
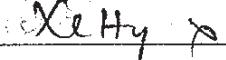
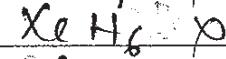
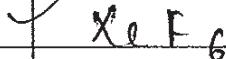
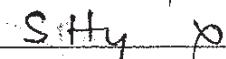
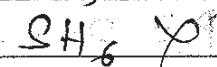
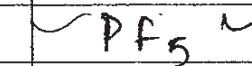
$\text{PF}_5 \checkmark$

$\text{PHF}_4 \checkmark$

$\text{PH}_2\text{F}_3 \checkmark$

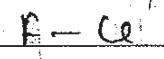
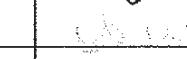
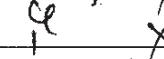
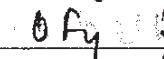
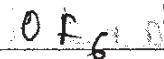
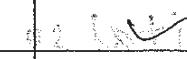
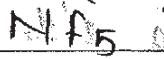
$\text{PH}_3\text{F}_2 \checkmark$

(I) Non-existence is explained by d-orbital contraction effect

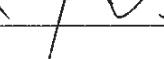
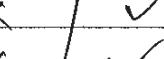
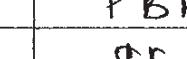
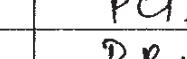


✓ $\text{ClF}_3, \text{BF}_3, \text{BH}_3, \text{CH}_3^+$ also exist

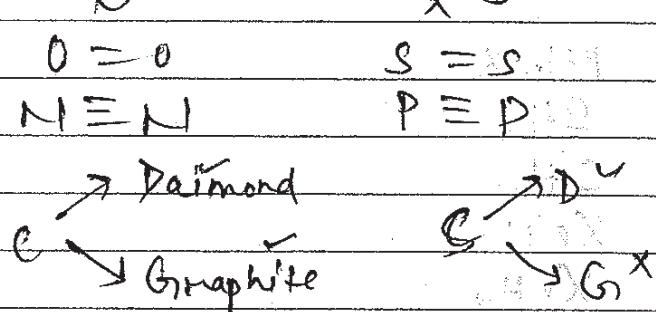
(ii) Non-existence is explained by absence of d-orbital on LCAO molecular hybrid part.



(iii) Non-existence explained by steric crowding



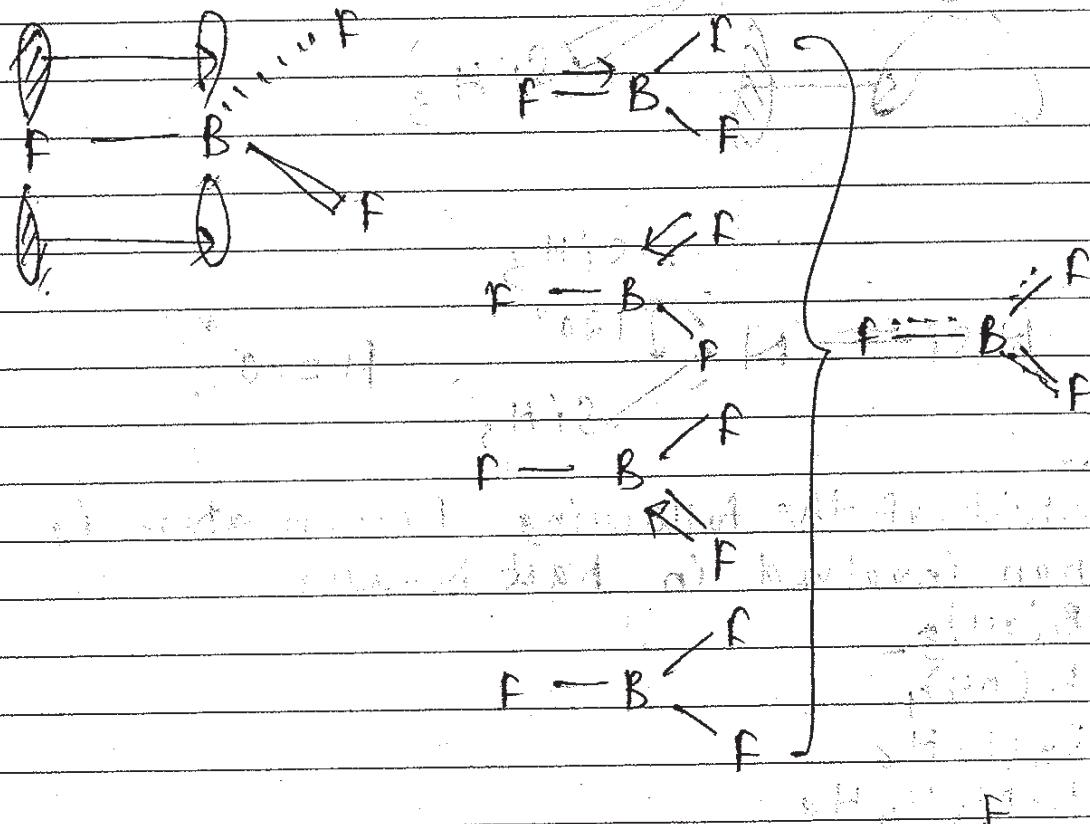
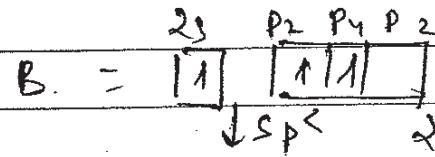
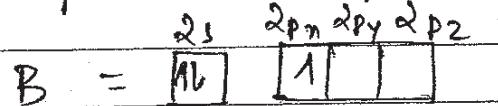
IV Non-existence explained by less non effective $3p\pi - 3p\pi$ overlapping.



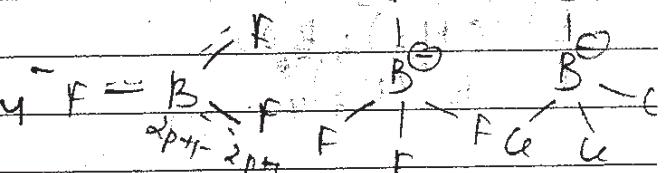
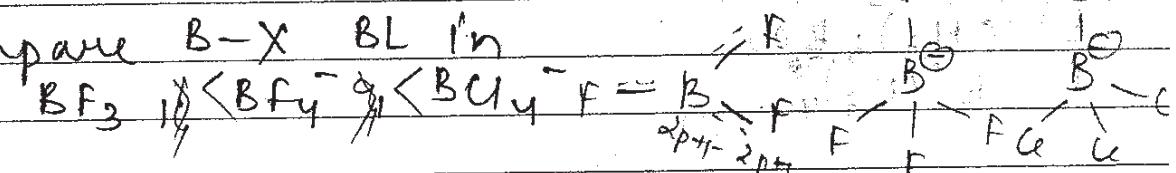
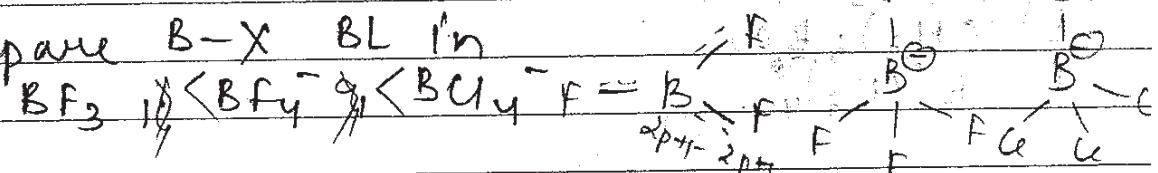
Back Bonding.

- Back Bonding is an additional interaction b/w two adjacent atoms of a molecule in which one atom has lone pair and other has vacant orbital in its valence shell.
- Back Bonding is a side wise interaction of a lone pair and vacant orbital so that it is also called coordinate π -bond.
- For back bonding in p-block compound one atom must belong to second period
- When another atom belongs to 2nd period or 3rd period then effect of back bonding is highest or most significant.

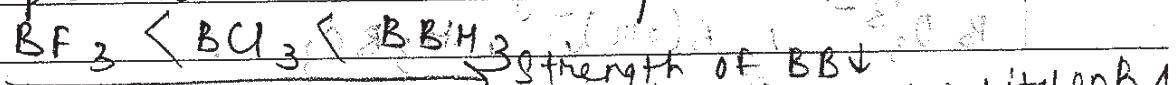
Q. B-F bond length in BF_3 is smaller than expected. Explain?



Q. Compare B-X BL in

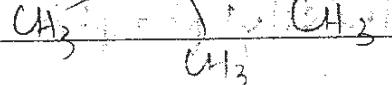
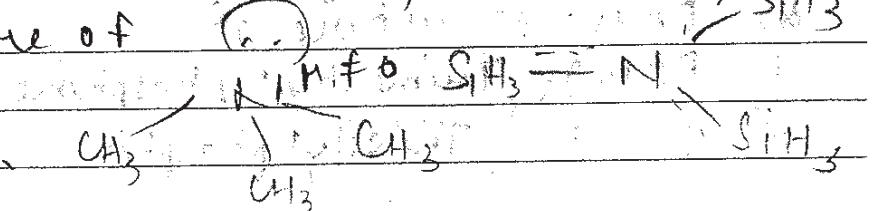
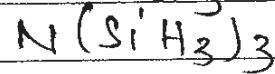
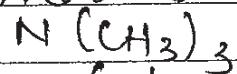


Q. Compare Lewis acidic strength of



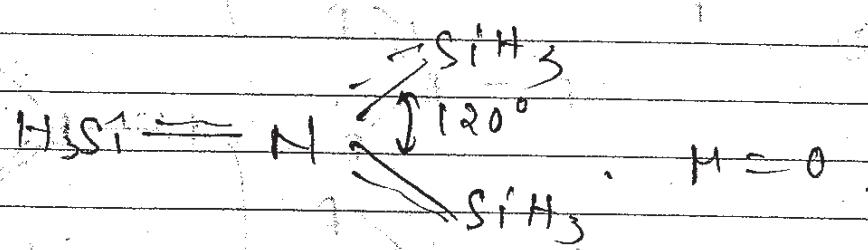
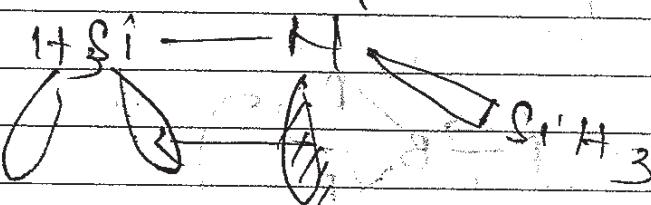
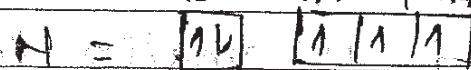
\rightarrow Strength of BB↓
Availability of vacant orbital on B↑

Q. Draw structure of

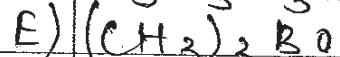
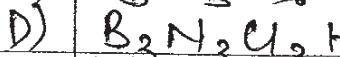
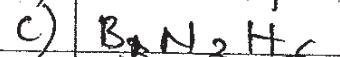


$2s$ $2p_x$ $2p_y$ $2p_z$

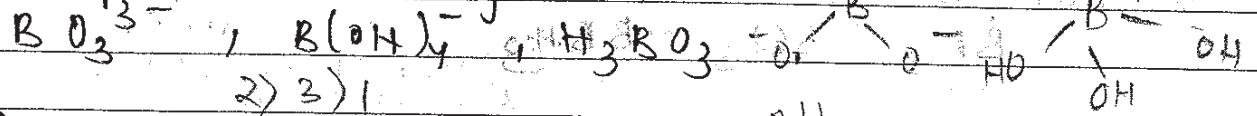
Date _____



Q) Which of the following Boron atom is non involved in back bonding



Q) Compare $\text{B}-\text{O}$ length in



2) 3) 1)

Q) Draw structure of

i) $\text{P}(\text{CH}_3)_3$ Trimethyl phosphine

ii) $\text{P}(\text{SiH}_3)_3$ Trisilyl phosphine

B. All B-O length are identical in BO_3^{3-} (T/F)

B. All B-O length are identical in $\text{B}_3\text{O}_3^{3-}$
(cyclic trimetaborate) (T/F)

Q. In wof, d-orbital is involved in $\text{B}-\text{B}$

A) CCl_4

endocyclic

B) PF_3

$\text{B}-\text{B}$ because O^-

C) SiF_4

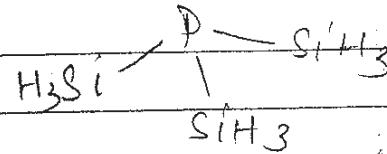
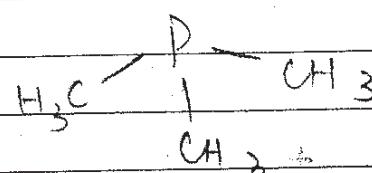
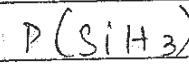
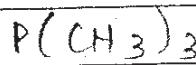
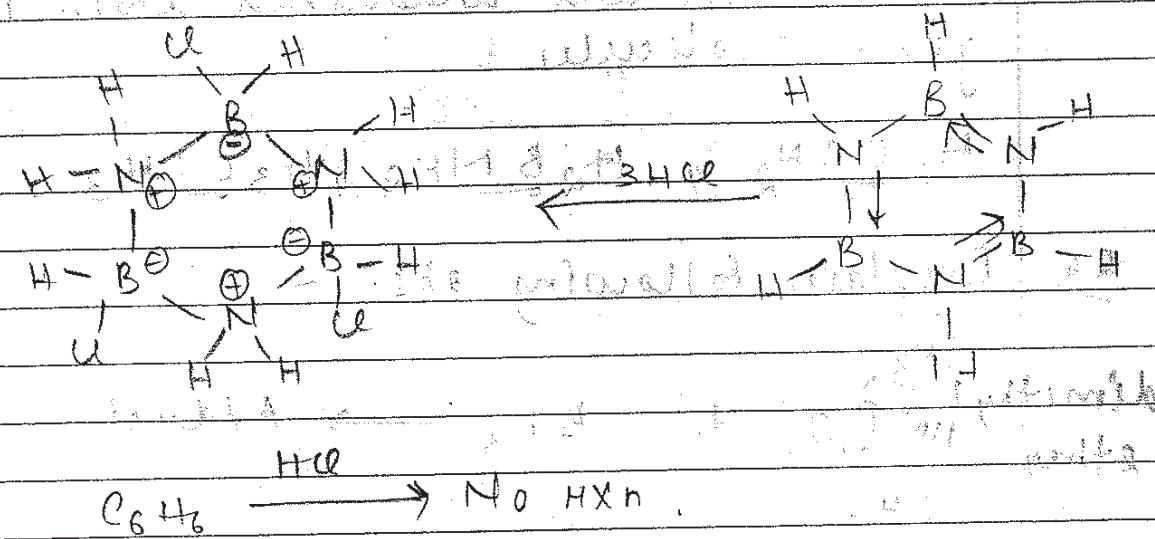
aromaticity \downarrow

D) BF_3

In this $\text{B} \rightarrow \text{O}^-$

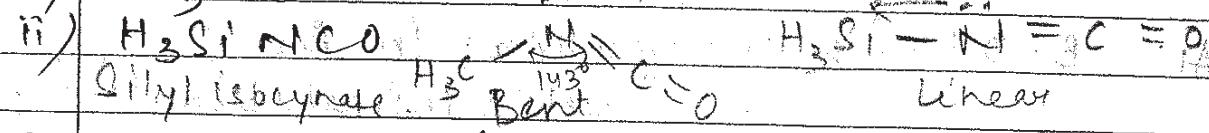
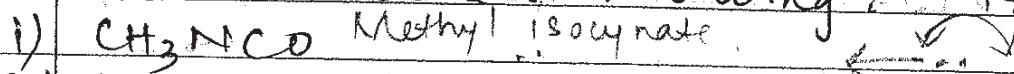
E) BCl_3

compd $\text{N}=\text{O}^-$



Both 3rd period

Q1. Draw structure of following :- (a) CH_3NCO Methyl isocyanate.

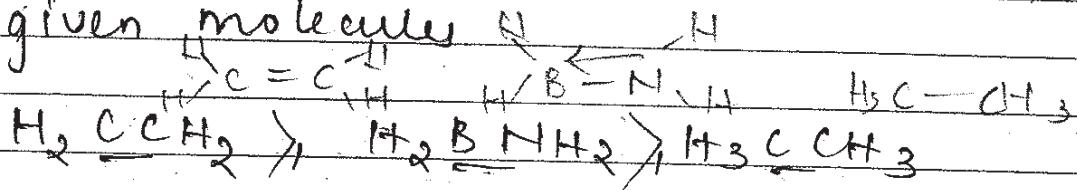


Q2. In NF_3 BA is effected by BB (TF) F

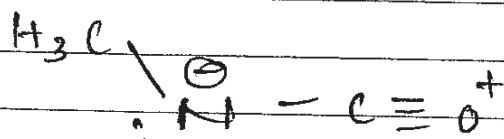
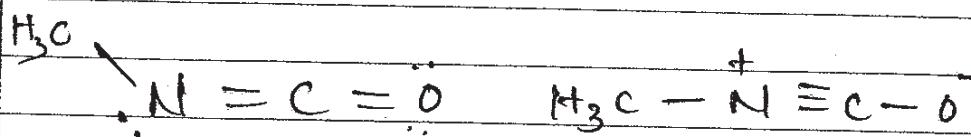
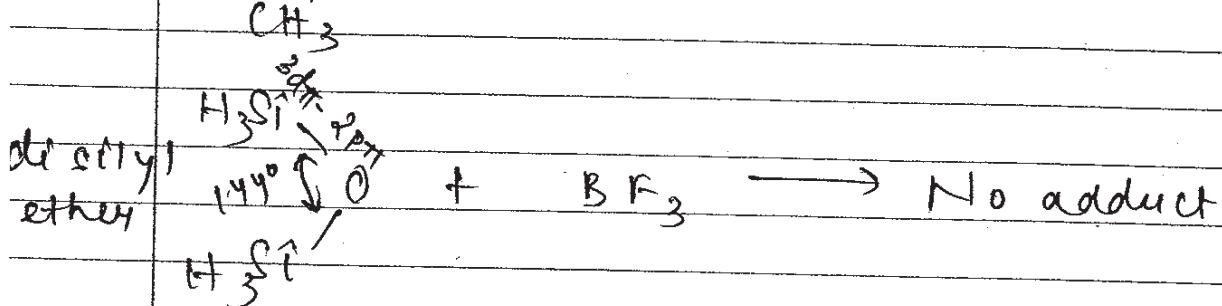
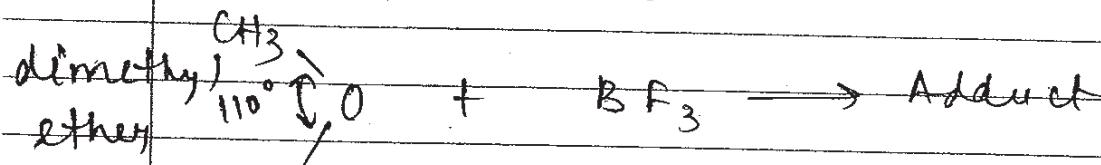
Q3. In PF_3 " " " (T/F) T

Q4. In SiF_4 " " " (T/F) T

Q5. Compare energy barrier of the rotation around underlined atom in given molecules



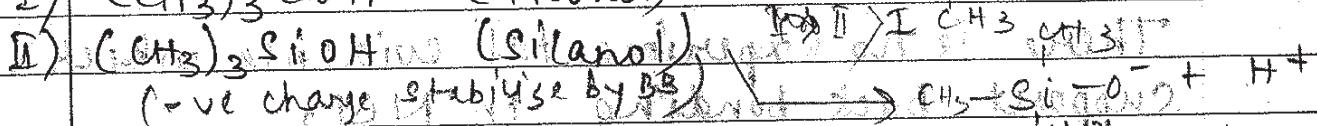
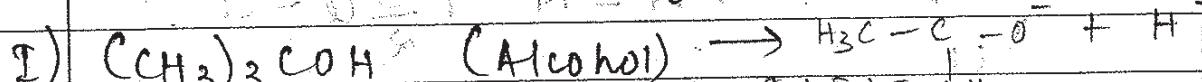
Q6. Explain following obs. -



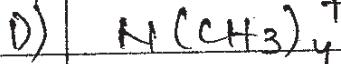
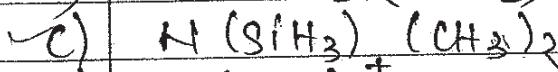
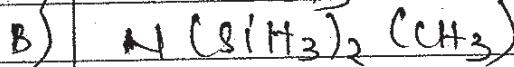
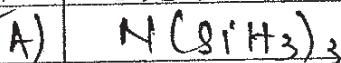
In Me_3SiAl , BA at Al is 143° which is explained by three RS. The resonance hybrid of Me have ^{main} contribution of 1st and 2nd.

(H^+ donating strength)

Q. Compare acidic strength of CH_3



Q. Which can form adduct with BF_3 most easily?



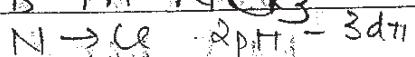
Q. In BF_3 BA change due to BB (T/F)

Q. In H_3BO_3 BA change due to BB (T/F)

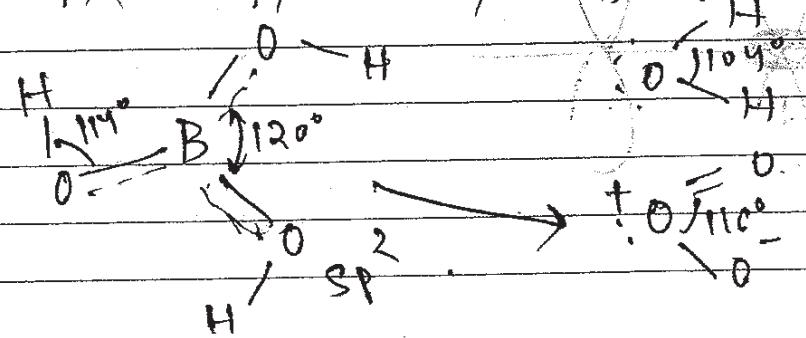
Q. Draw structure of $\text{Al}(\text{C}_2\text{H}_5)_3$



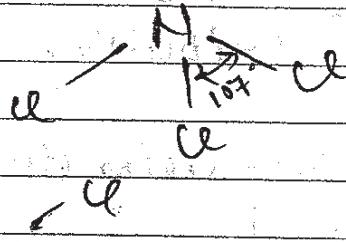
Q. What do you think about BB in NCl_3



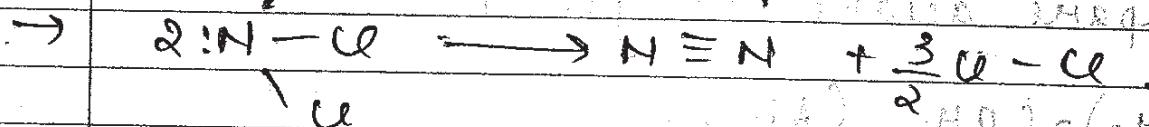
Q. Compare Lewis acidic strength of SiF_4 , SiCl_4 , SiBr_4 , SiI_4 .



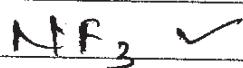
→ Expected $\angle 120^\circ$ (due to BB)



very weak N-Cl bond
explosive nature



There is no experimental evidence which support back bonding in NCl_3 .

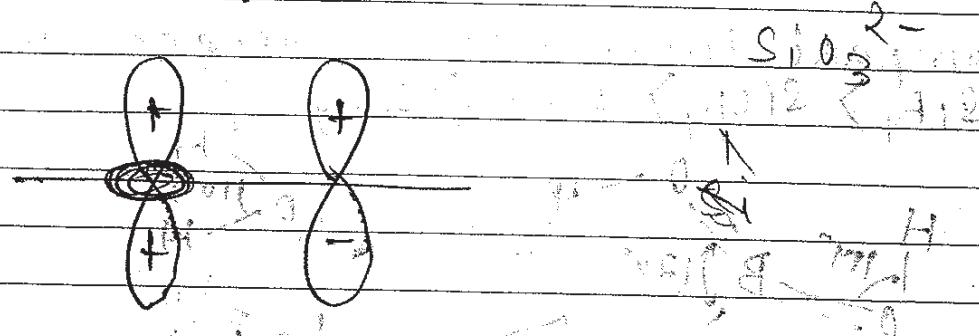


NCl_3 Explosive.

NBH_3 { Not exist}

NI_3 { In pure form

Lewis acidic strength of silicon tetrahalide is not affected by BB bcoz d_{z^2} orbital accept lone pair when new coordinate bond is formed by Si. It is well known fact that d_{z^2} orbital neither form π -bond nor back bond.



Q. What is the fundamental structural unit of Asbestos, quartz, Mica, etc?

- A) SiO_2
- B) SiO_3^{2-}
- C) SiO_4^{4-}
- D) SiO_3^-

Structures of silicate

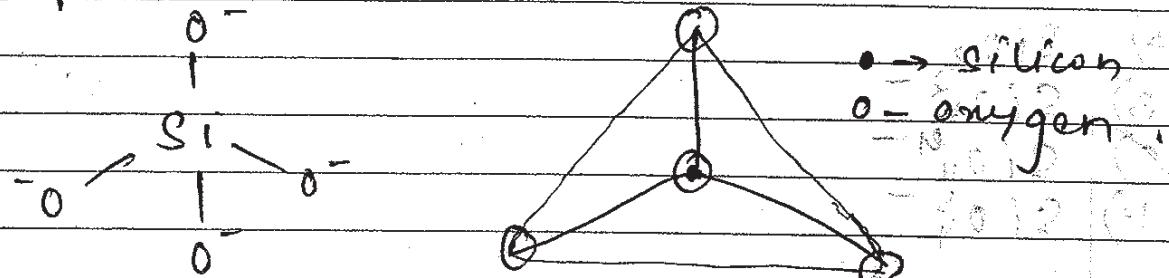
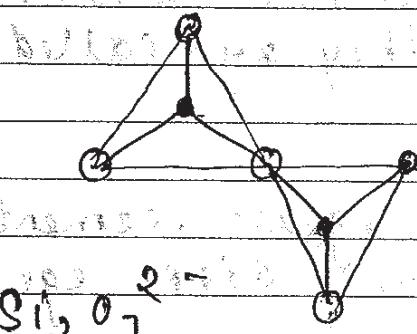
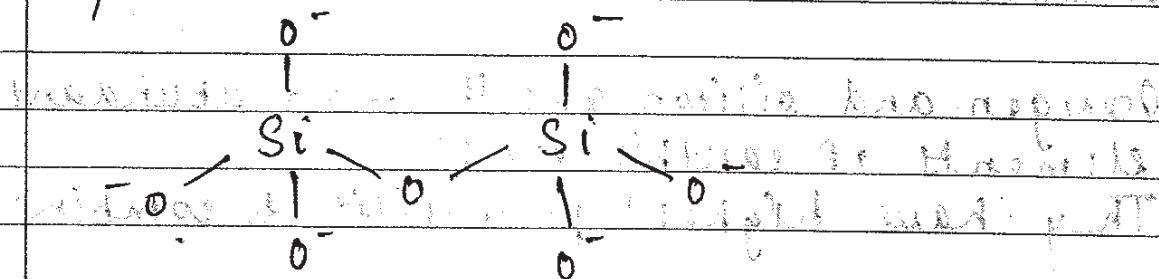
- Oxygen and silicon are the most abundant elements of earth's crust. They have highest probability to combine.
- Different types of structures are formed by silicon and oxygen. They are called silicates.
- Asbestos, quartz, mica, glass, cement, bricks, talc, etc are the different types of silicates.
- All the silicates have SiO_4^{4-} fundamental structural unit.

Top 10 abundant element in earth

O Si Al Fe Ca Mg Na K Ti > H

Orthosilicates

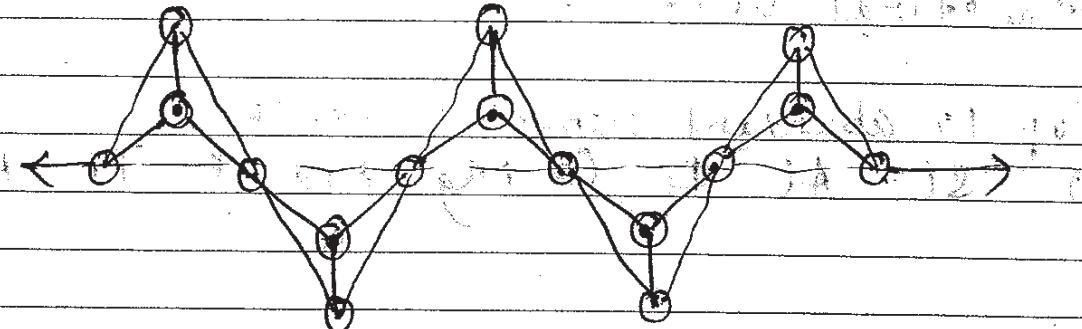
Silicate minerals in which SiO_4^{4-} unit is present.

**Pyrosilicates**

Charge on silicates?

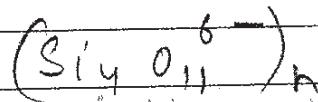
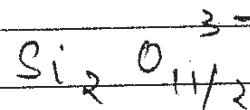
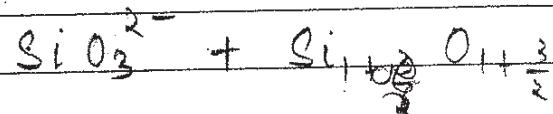
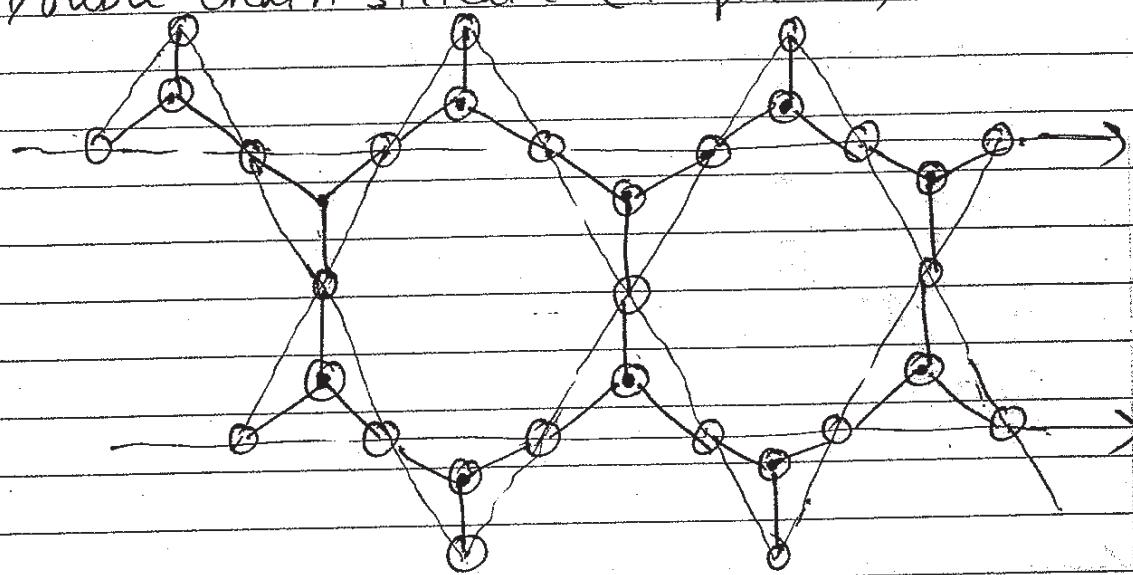
$n = \text{No. of Si}$

$(n-4)/2 = \text{No. of O}$

Single Chain Silicate (Pyroxene)

$(\text{SiO}_3^{2-})_n$

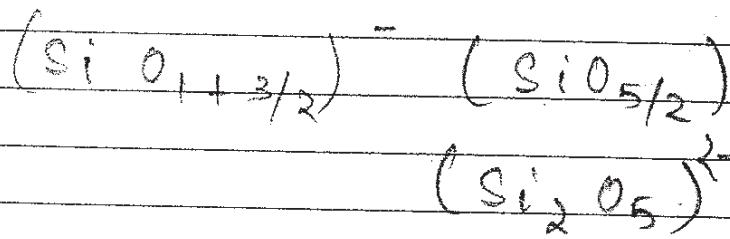
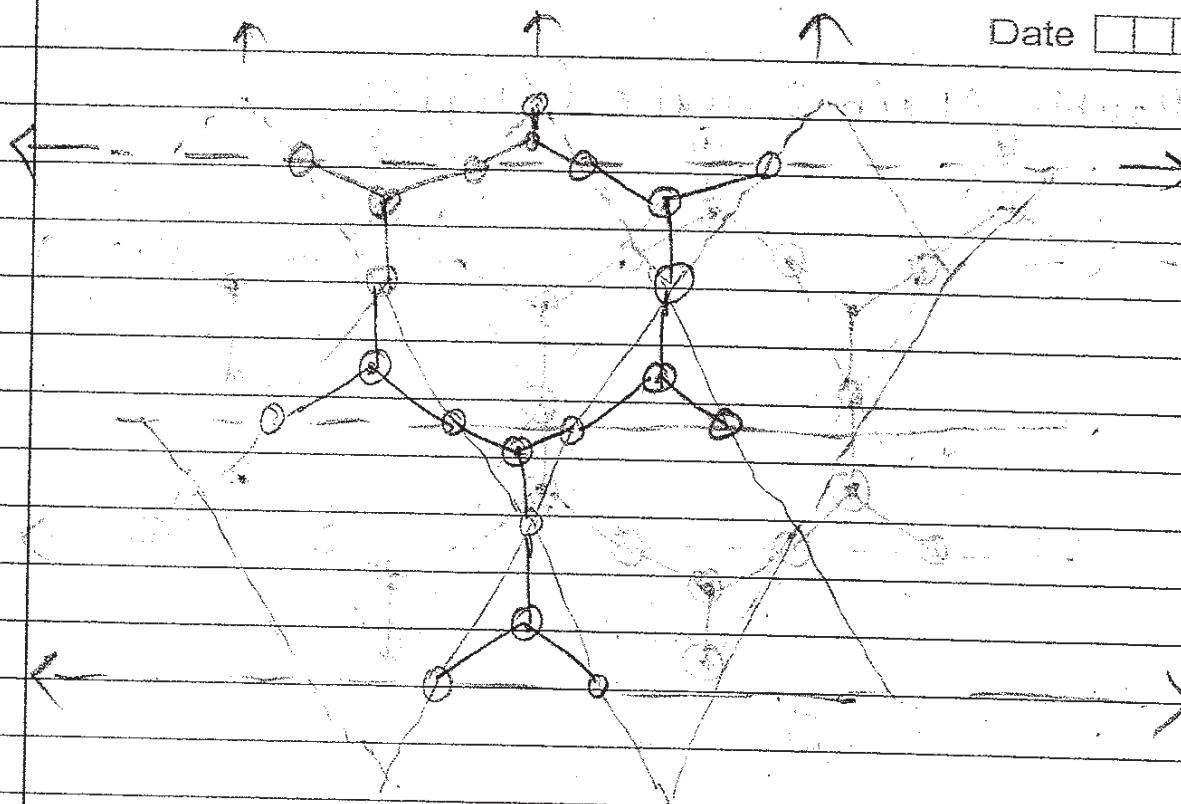
Double Chain Silicate (Amphibole)



In double chain silicate 50% tetrahedrons share its vertex with other tetrahedron and remaining tetra 50% it's 1/3 vertex with other tetrahedrons.

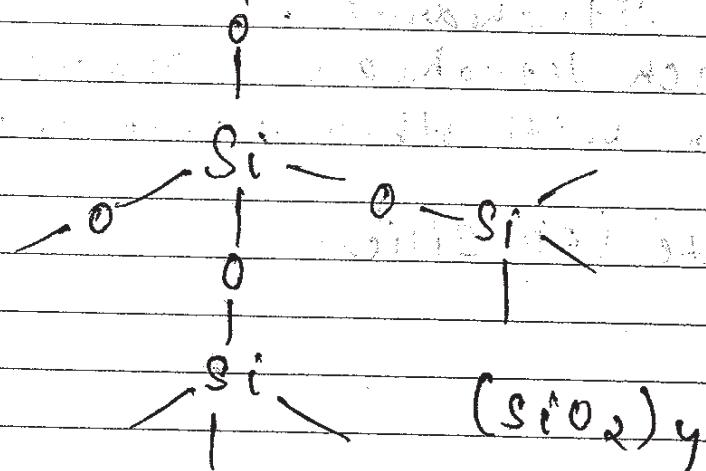
On avg each tetrahedron share its 2.5 vertex with other tetrahedron.

Sheet Silicate (2D Silicate)

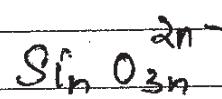


They are not planar but their growth is planar.

3D Silicate



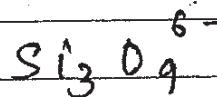
Date

Cyclic Silicate

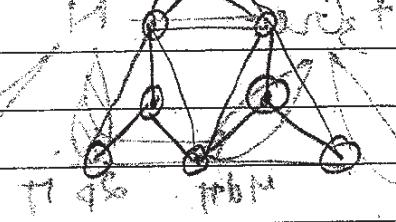
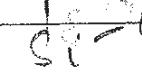
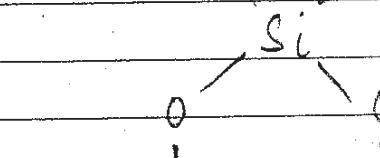
$$n = 3, -$$



~~silicate~~
silicate
silicate

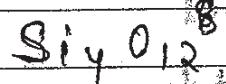


measuring 60°



28 343279

languid & sand
subtlety and



trigonal

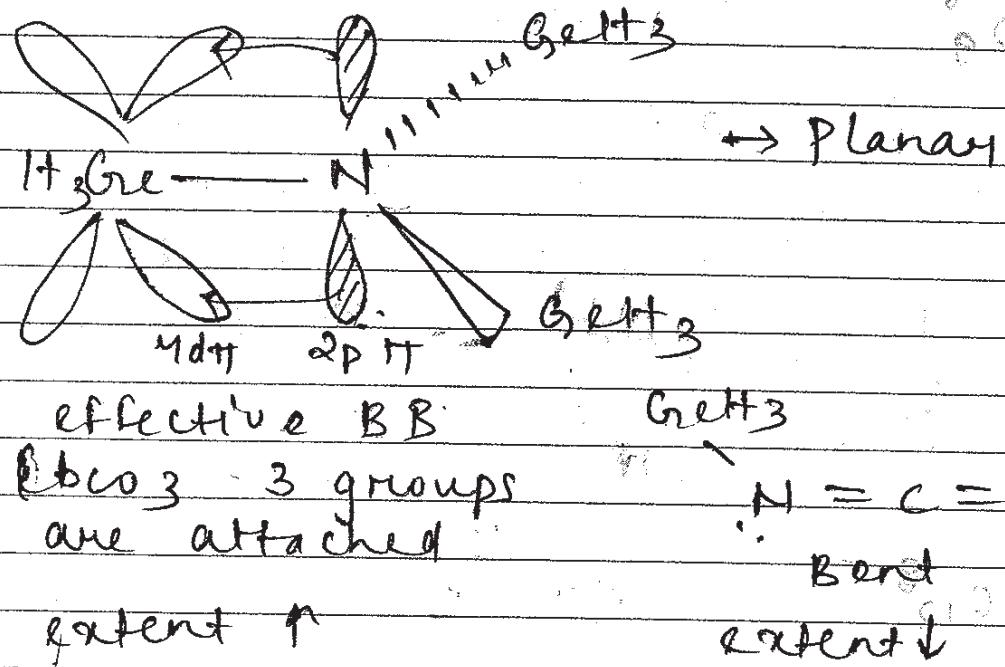
* frosty

n_{AO} = ortho

s_{MO} = pyro

phylo = sheet

lecto = 3D



Bridge Bonding

Molecules which have multicentred bond

Q. What is correct about B_2H_6

(A) It has total 12 valence e⁻'s

(B) Both Boron sp³ hybrid

(C) It has B-B bond

(D) All atoms are in same plane

(E) Two tetrahedron bonded by common edge.

(F) B-H_f length > B-H_b length

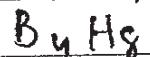
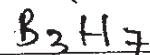
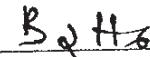
(G) H_f-B-H_f BA > H_b-B-H_b BA

(H) It has 2c-2e⁻ bond

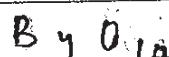
(I) It has 3c-2e⁻ bonds

Bohanes (Compds of B with H)

Nidoborane
(B_nH_{n+4})



AHchenoborane
(B_nH_{n+6})



1) B_2H_6 (dimer of BH_3)

$2s \quad 2p_x \quad 2p_y \quad 2p_z$

$B_1 = [1] \boxed{1} [1] \boxed{1} \boxed{1}$

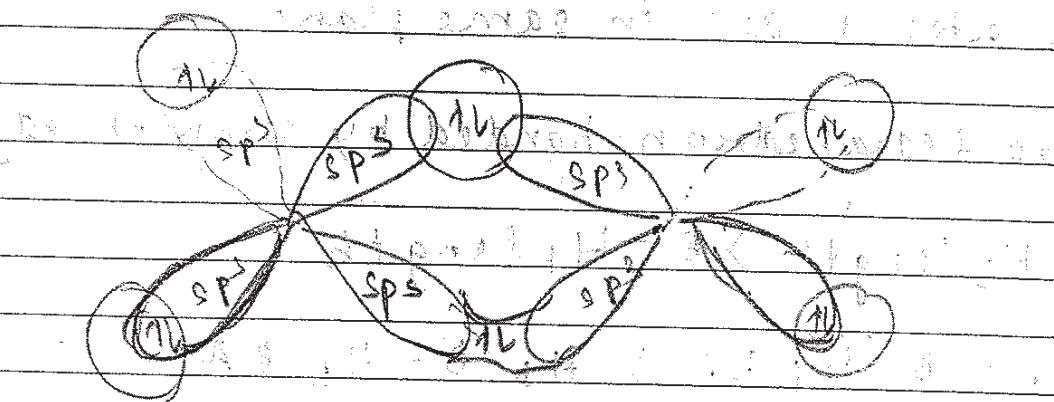
$B_1 = [1] \boxed{1} \boxed{1} \boxed{1}$

$\begin{matrix} \text{sp}^3 \\ \text{sp}^3 \\ \text{sp}^3 \\ \text{sp}^3 \end{matrix} \quad \begin{matrix} \text{sp}^3 \\ \text{sp}^3 \\ \text{sp}^3 \\ \text{sp}^3 \end{matrix}$

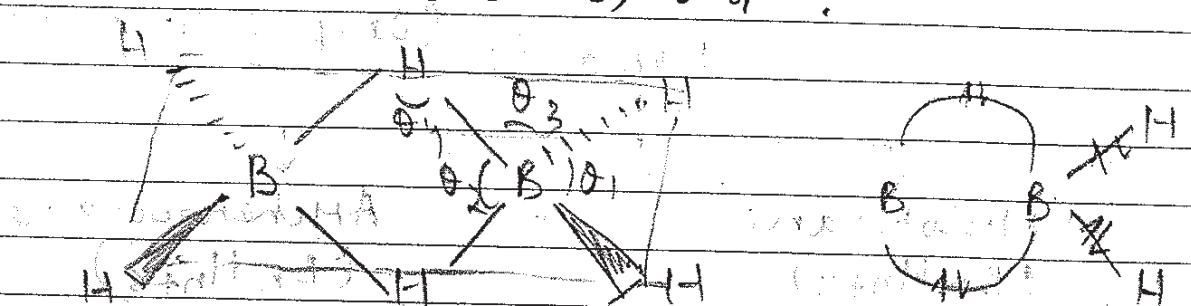
$B_1 = [1] \boxed{1} \boxed{1}$

$B_{1g} = \boxed{V} \boxed{V} \boxed{V}$

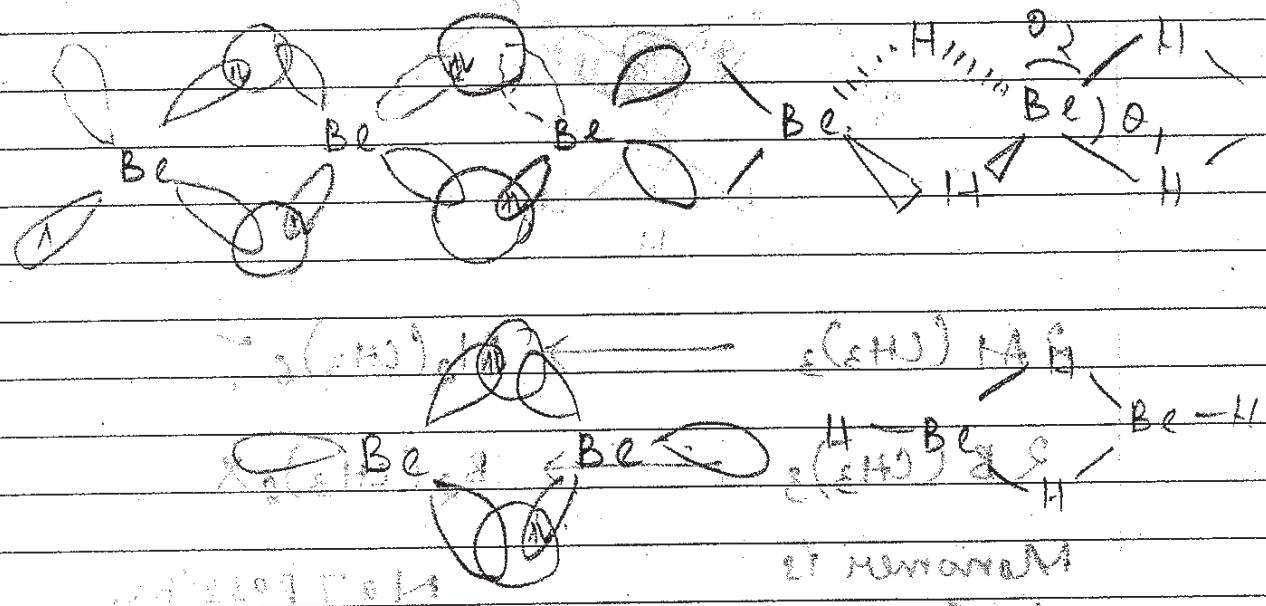
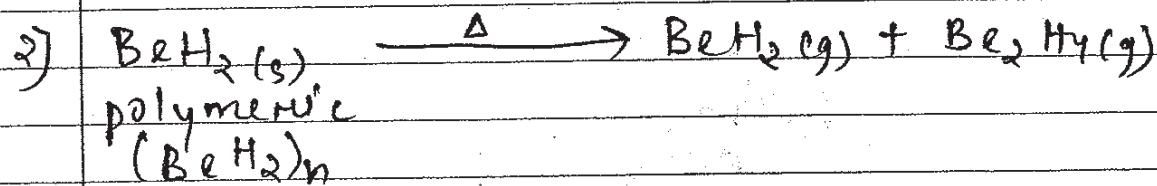
$\begin{matrix} \text{sp}^3 \\ \text{sp}^3 \\ \text{sp}^3 \\ \text{sp}^3 \end{matrix}$



↓
Banana Bond
Molecular Orbital
(3c - 2e) bond.

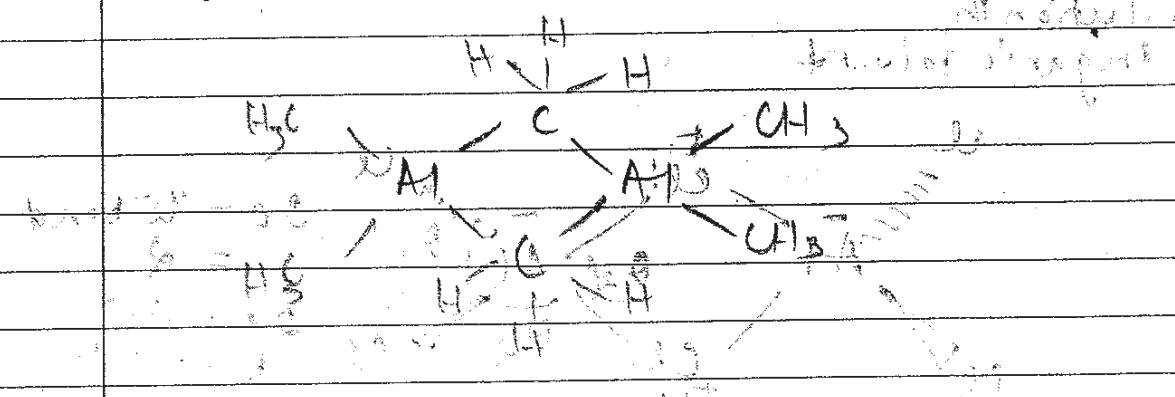
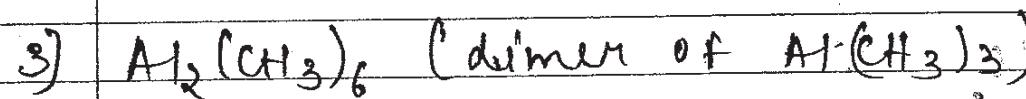


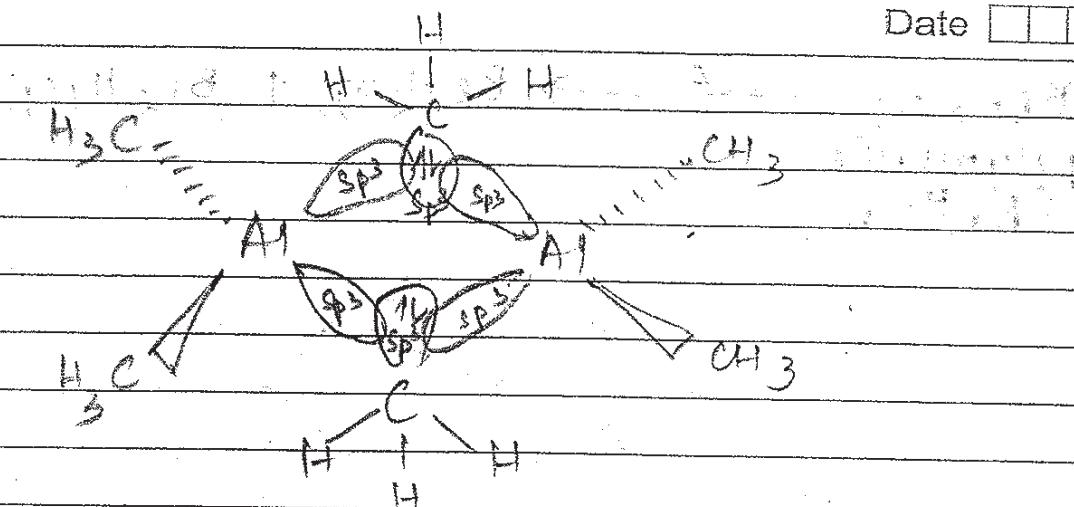
$$\theta_1 = 120^\circ, \theta_2 = 97^\circ, \theta_3 = 83^\circ$$



→ At room temperature BeH_2 exists in solid form which is polymeric form formed by banana bonding. But in vapour form it exists as monomer and dimer.

→ Composition of monomer and dimer depends on temperature



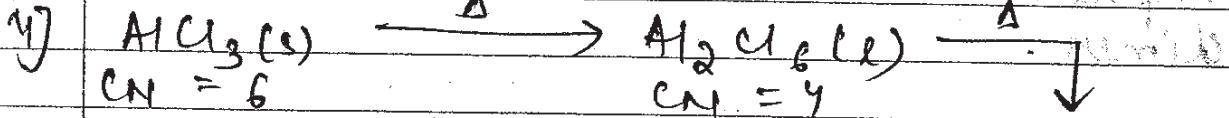


Monomer is

NOT possible

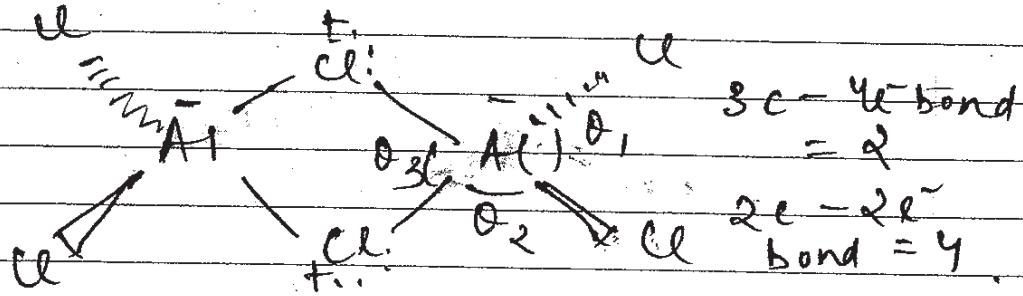
stabilized by hydrogen bonding (because dimer have hyperconjugation and steric crowding)

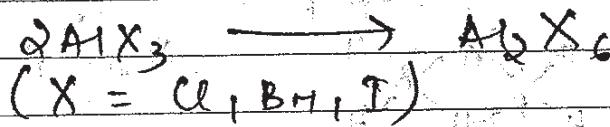
Two monomers up to 4 H



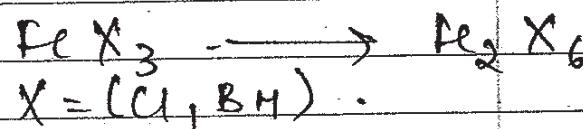
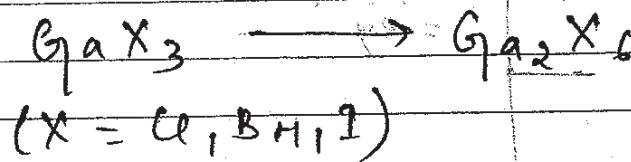
\downarrow organic solvent \downarrow organic solvent
with loss of monomer $\text{Al}_2\text{Cl}_6(g) + \text{AlCl}_3(g)$
 $\text{CN} = 6$ $\text{CN} = 4$ $\text{CN} = 3$

$\text{CN} = 4$ Al_2Cl_6 solution in
organic solvent

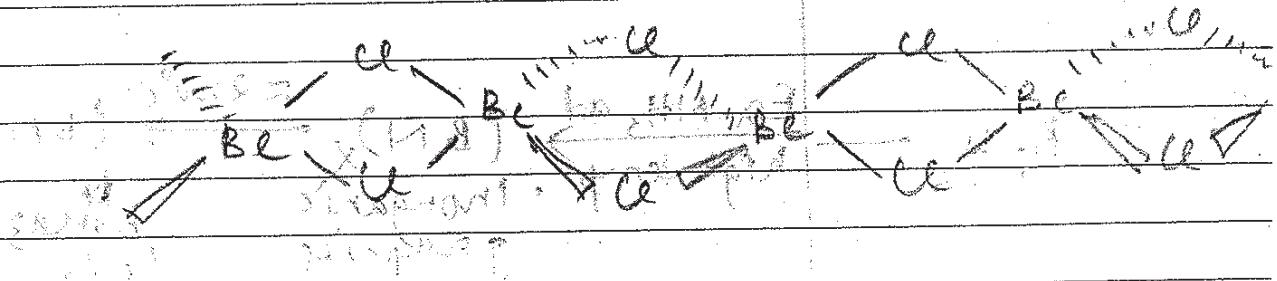
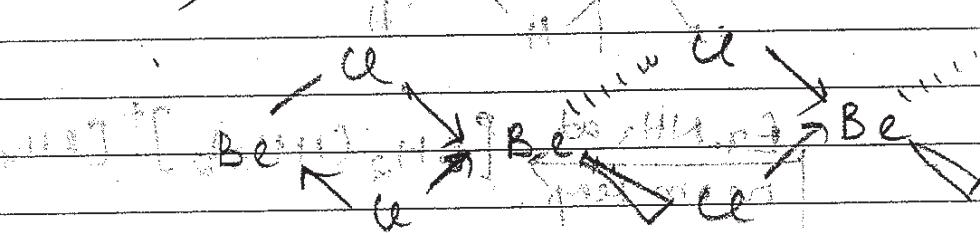
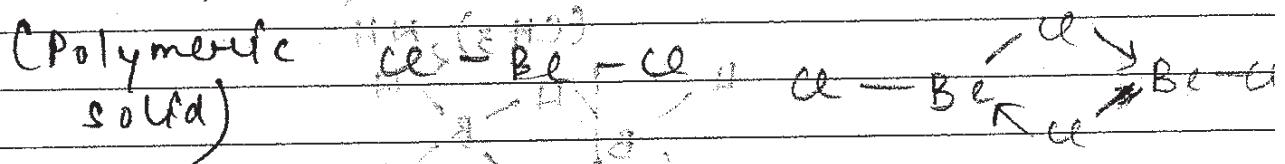




AlF_3 - Ionic.



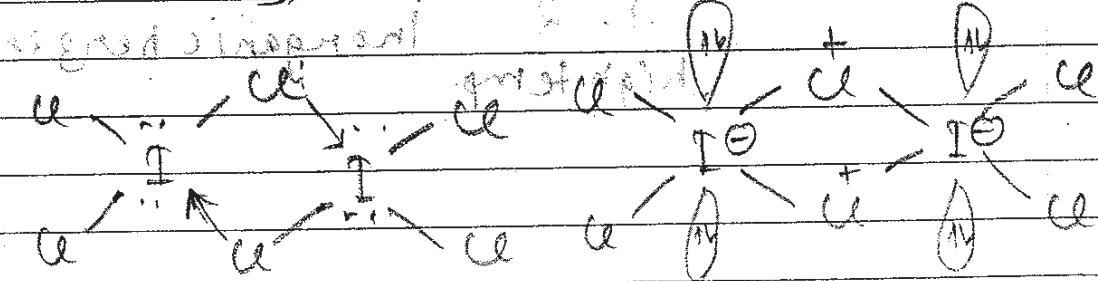
(Polymeric solid)

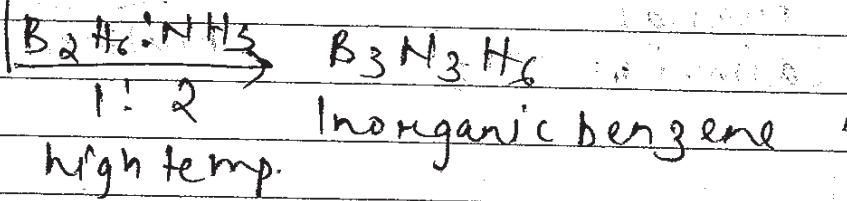
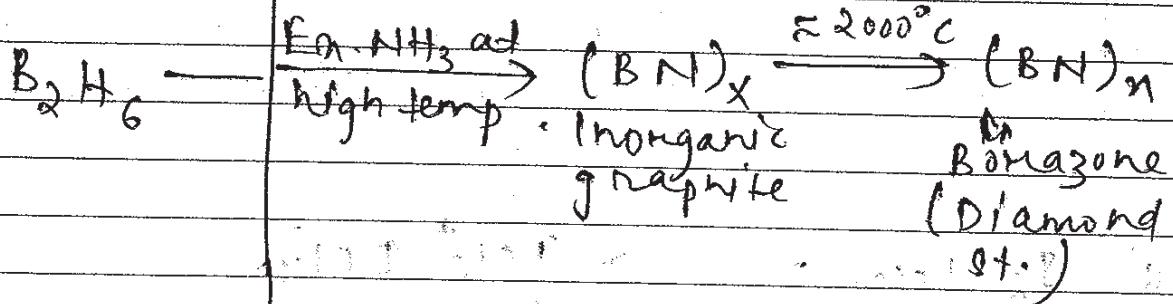
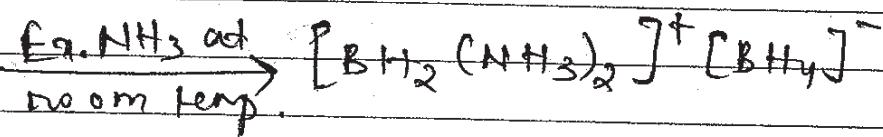
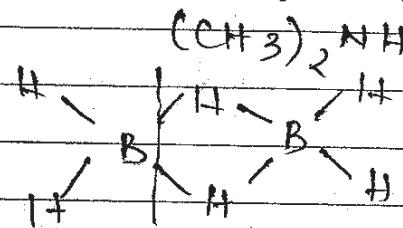
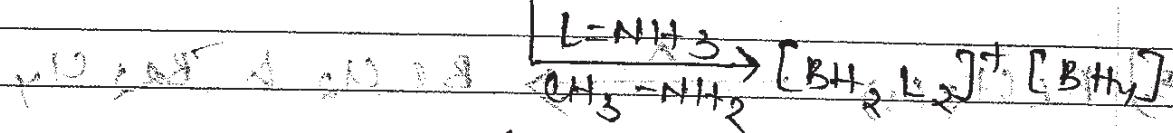
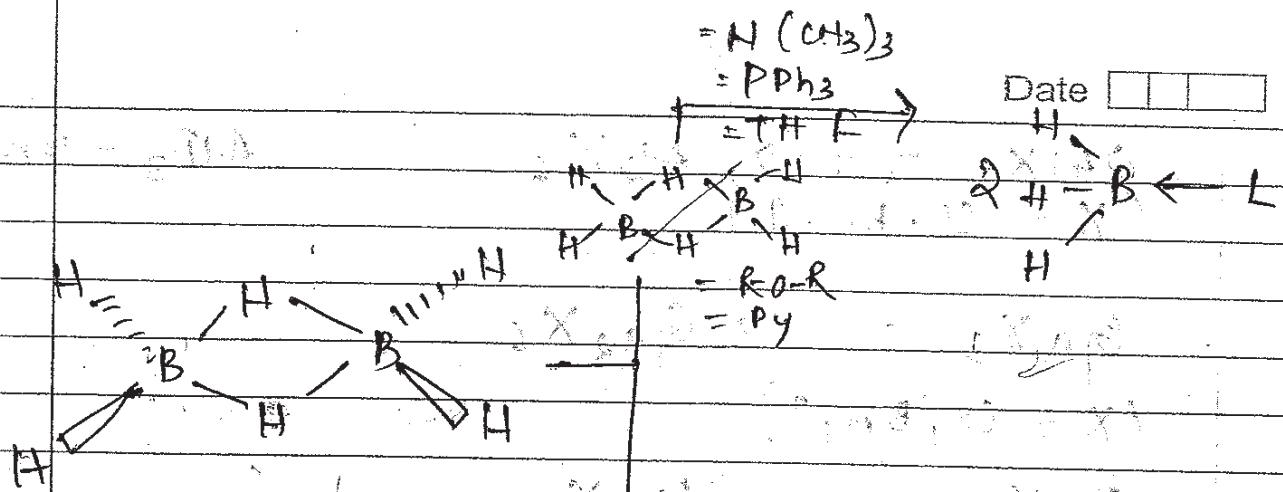


orange

Cdimer of ICl_3

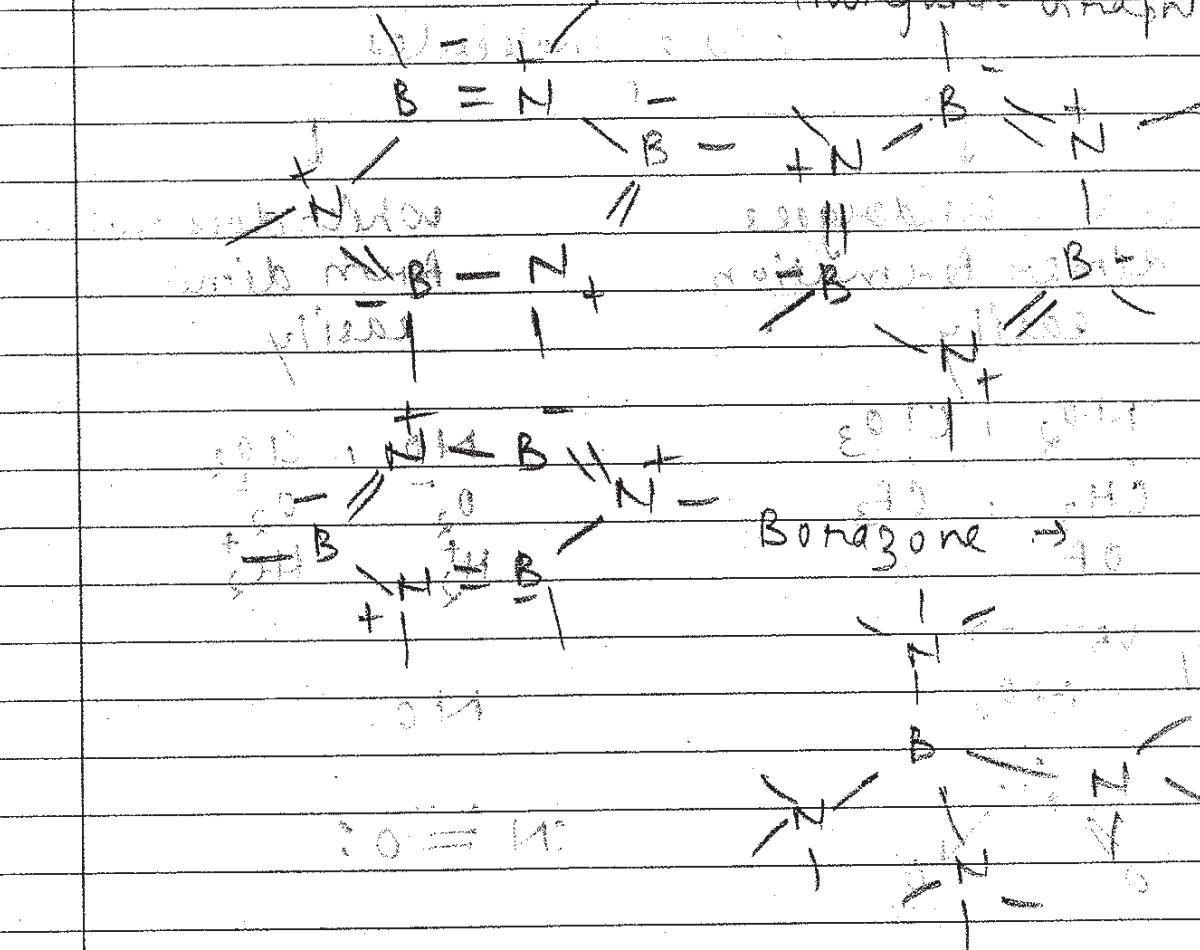
Molten





Inorganic Graphite

Date

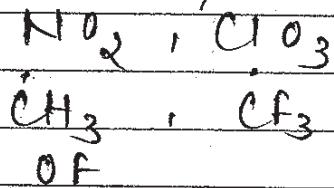


Odd Electron Molecule/Molecular Ion 19

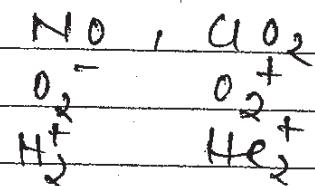
- Molecules in which total no. of e⁻'s or valence e⁻'s are odd number are called odd electron molecules.
 - All the odd electron molecules are paramagnetic because they have at least one unpaired e⁻.

odd e^- molecules

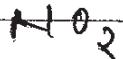
↓
which undergoes
dimer formation
easily



↓
which does not
form dimer
easily



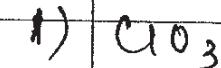
By VBT \rightarrow



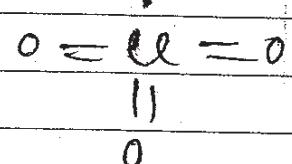
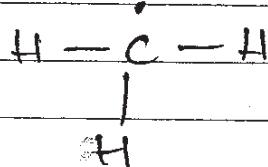
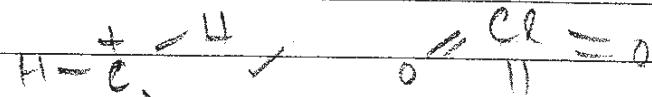
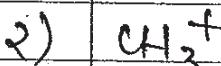
Q1. Which is/are odd e^- molecules? b.b.2

- (A) ClO_2^- (B) ClO_2^+ (C) ClO_2^{\cdot} (D) NO_2
 (E) Cl_2 (F) O_2^+ (G) Cl_2^+

Q2. Draw structure of

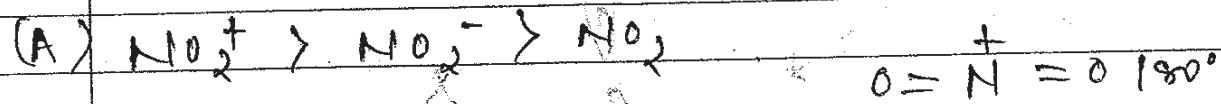


(A)

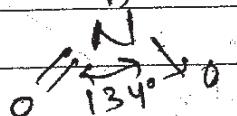
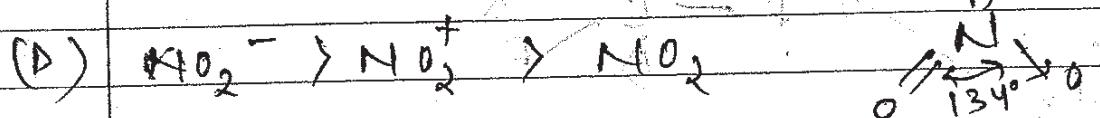
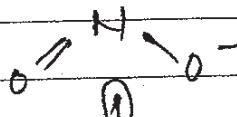
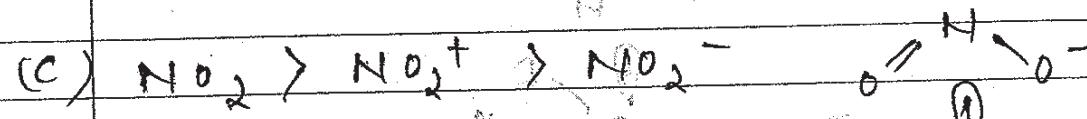


Q. CH_3 is planar but CF_3 is pyramidal. Explain?

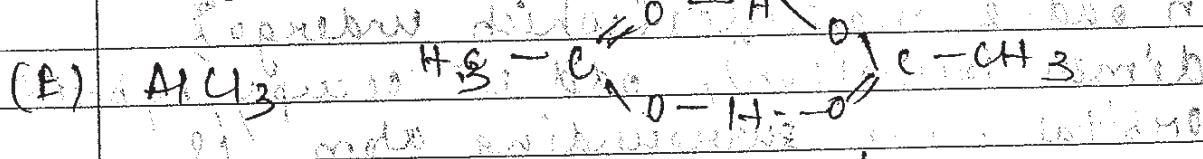
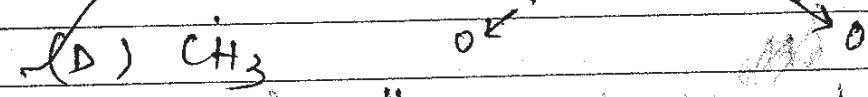
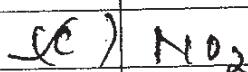
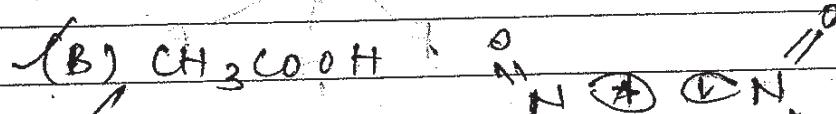
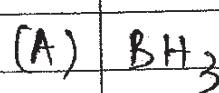
Q. Select correct order of BA



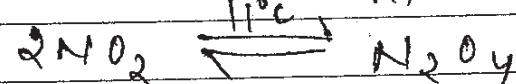
$$\text{O}=\overset{+}{\text{N}}=\text{O} \quad 180^\circ$$



Q. In which of the following vacant orbital is not required for dimer formation?



Q. In a container, NO_2 gas is present and it is allowed to cool for dimer formation.



Which change is observed on cooling?

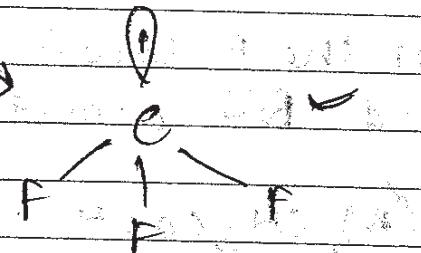
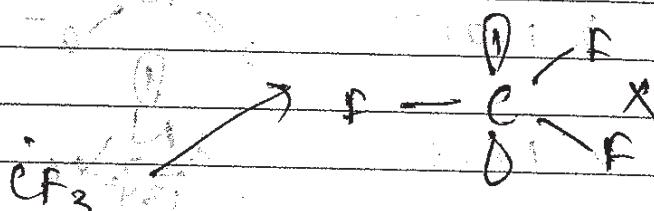
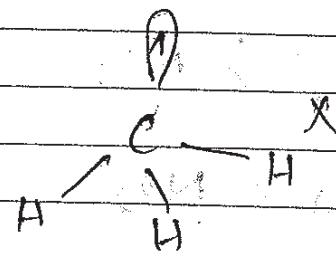
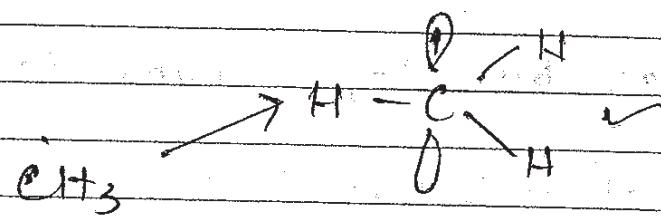
(A) Paramagnetism decreases

(B) O-O bond is formed

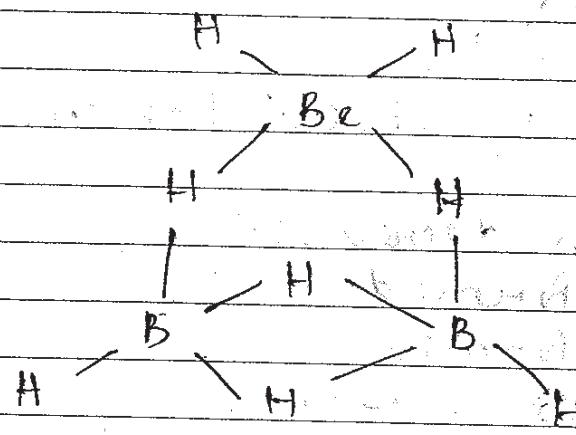
(C) N-N bond is formed

(D) No. of molecules decreases

(E) Brown colour becomes more intense

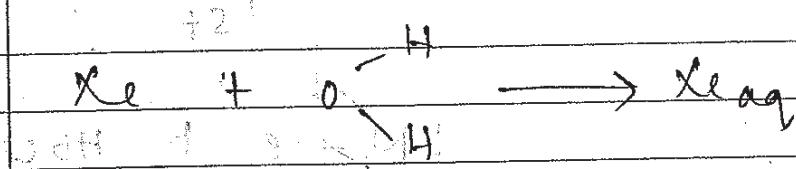
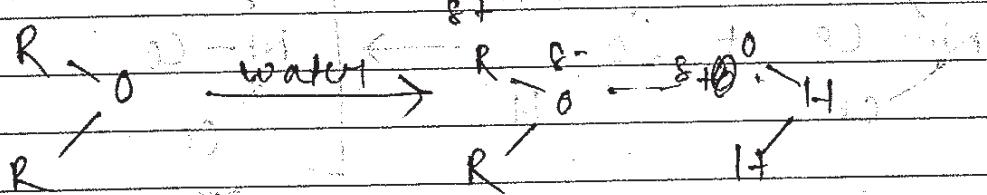
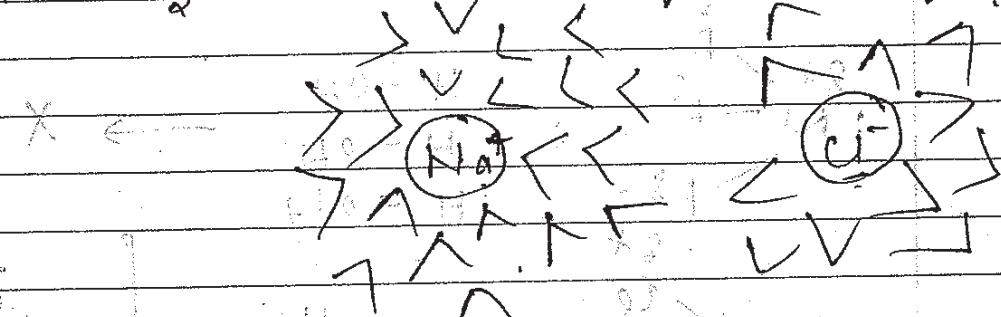
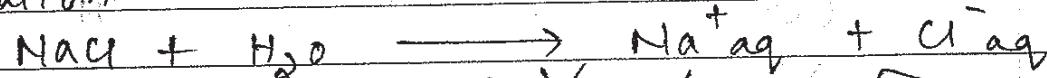


→ In odd e^- molecules (which undergo dimer formation), odd e^- occupy hybrid orbital when surrounding atom is more electronegative.

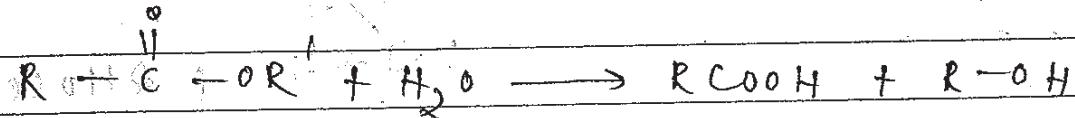
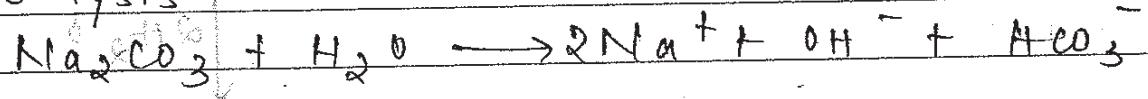


Hydrolysis of Covalent Compounds -

Hydration -

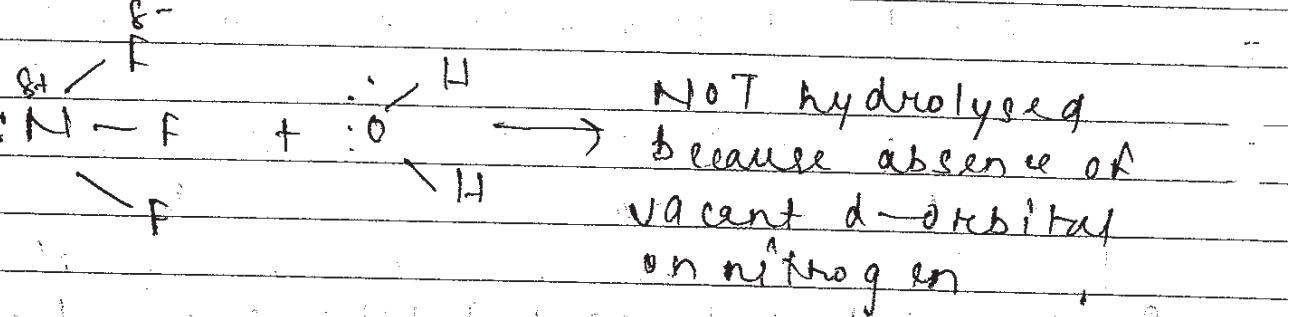
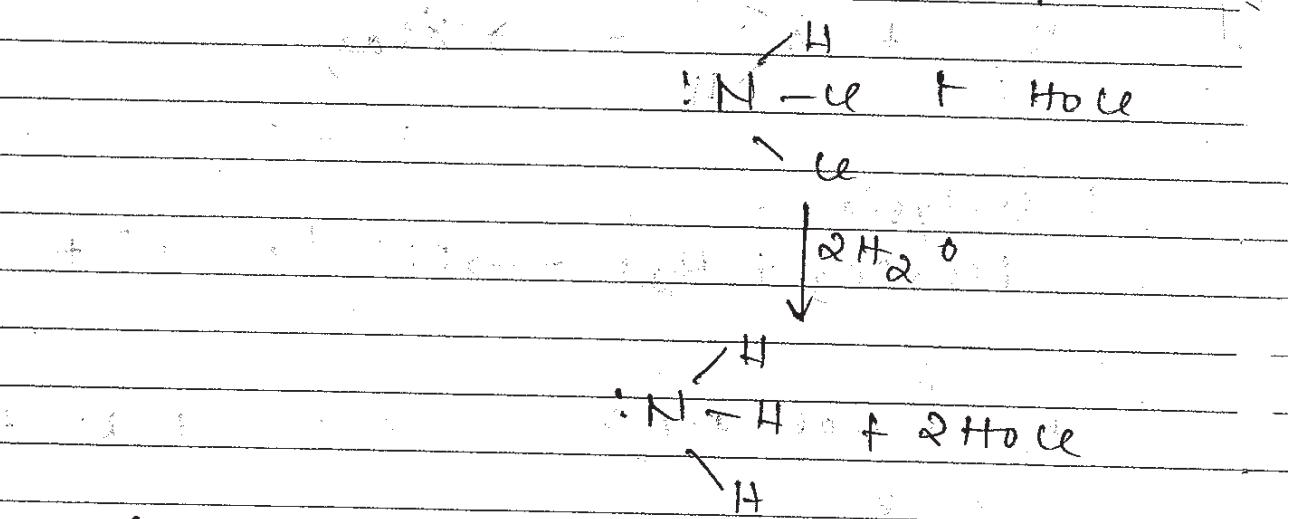
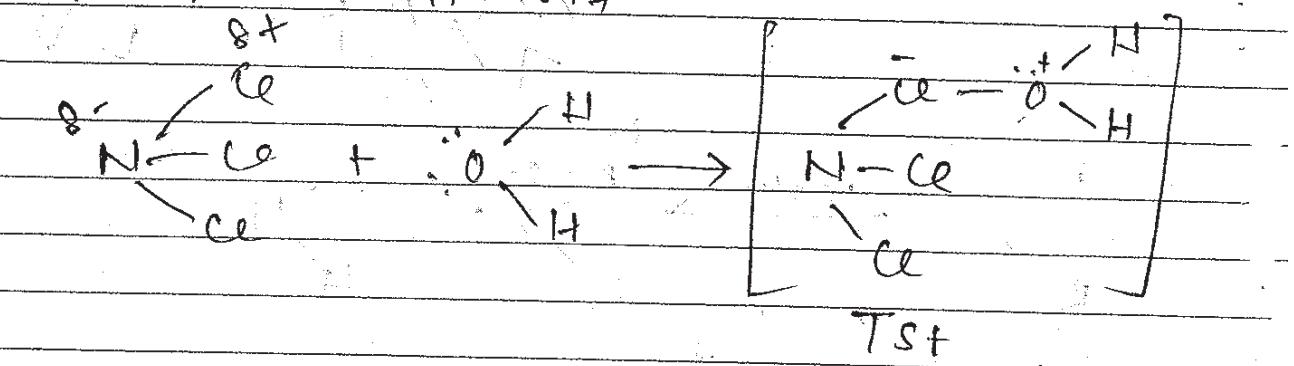
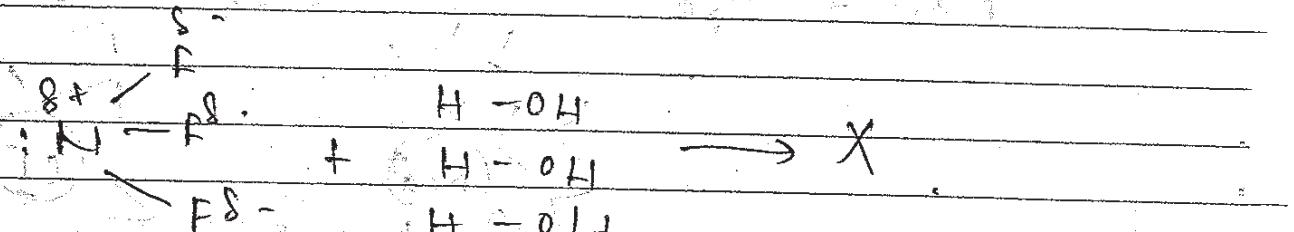
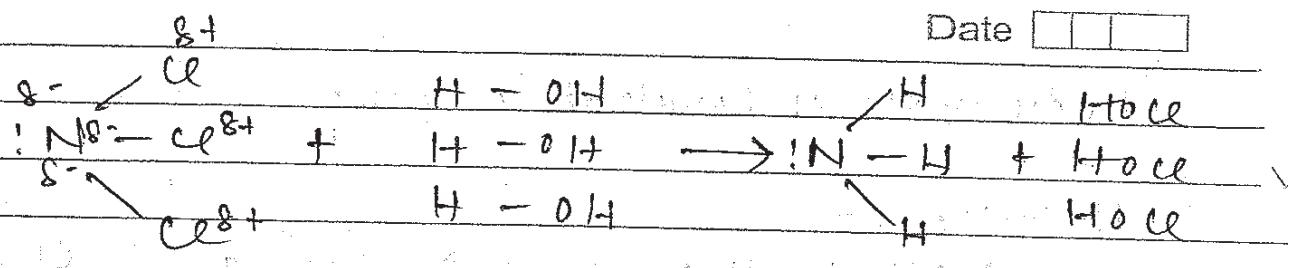


Hydrolysis -



Ionic and covalent both undergo hydrolysis and hydration

Q. NU_3 is hydrolysed but NF_3 is not Explain?

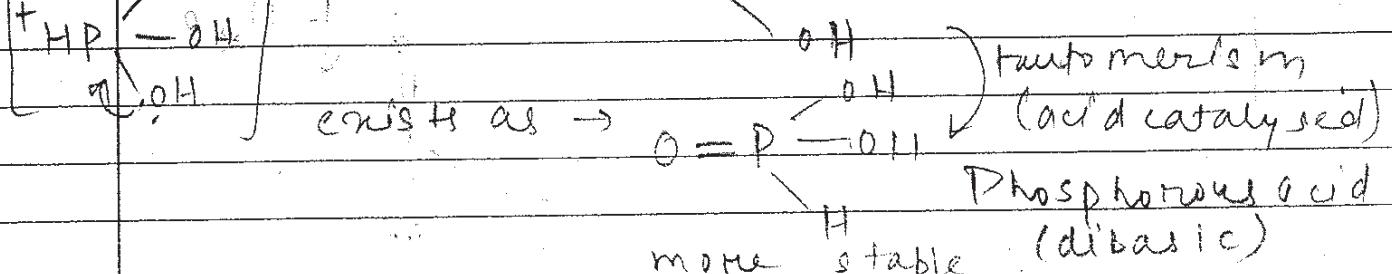
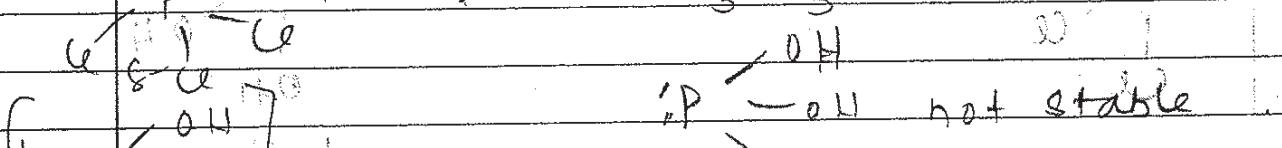
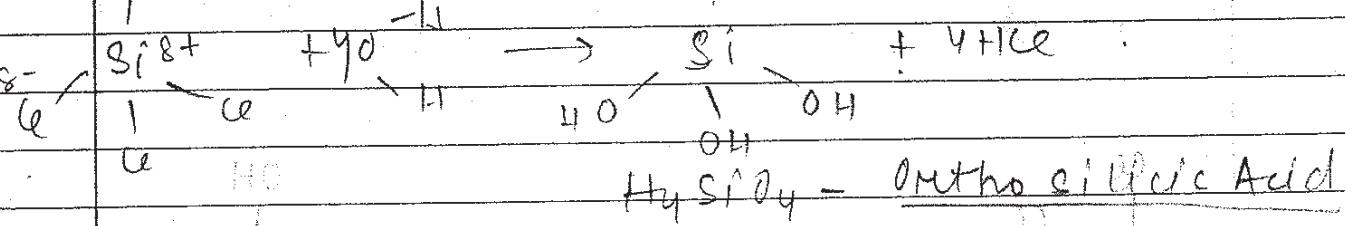
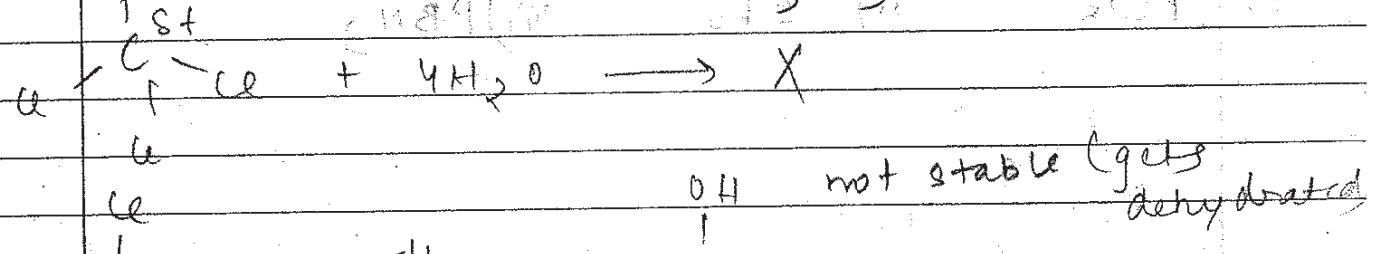
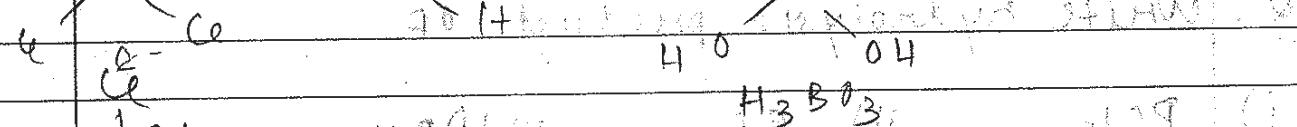
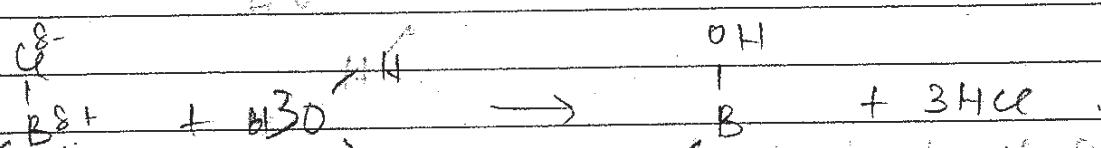
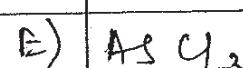
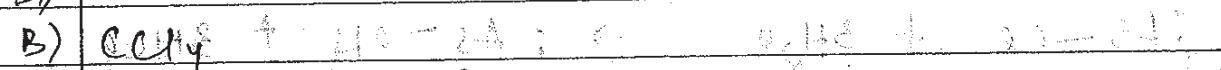


Oxygen of water attacks where there is
8+

Q. Which of the following is/are hydrolysed



B)



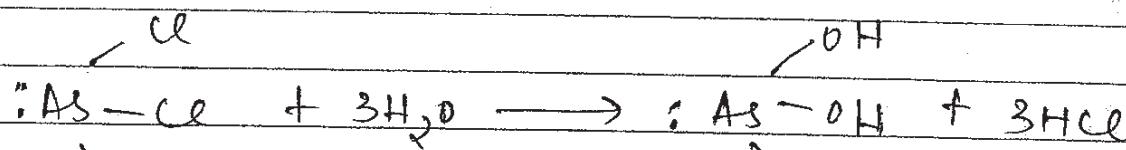
S = 2

X = 1

Date / /

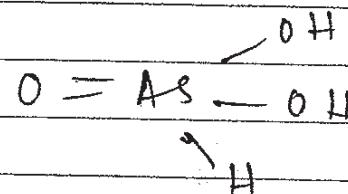
In

Final product phosphorous should be pentavalent.



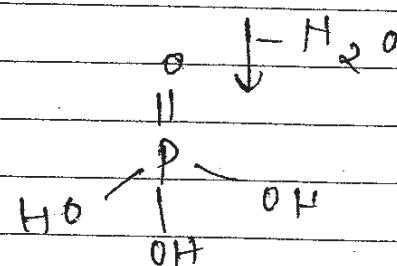
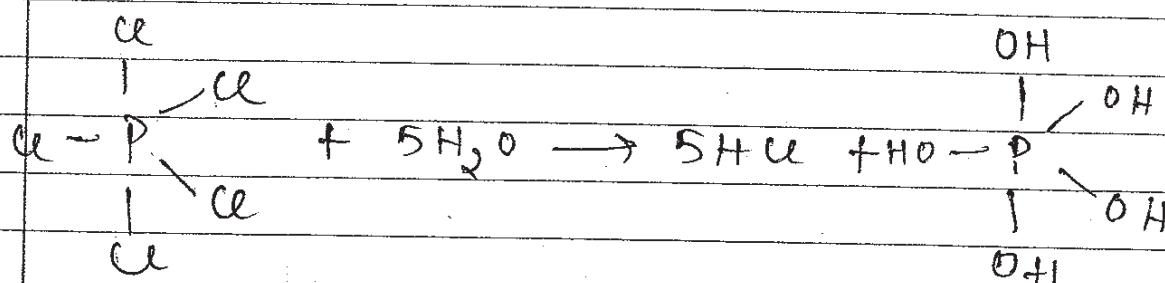
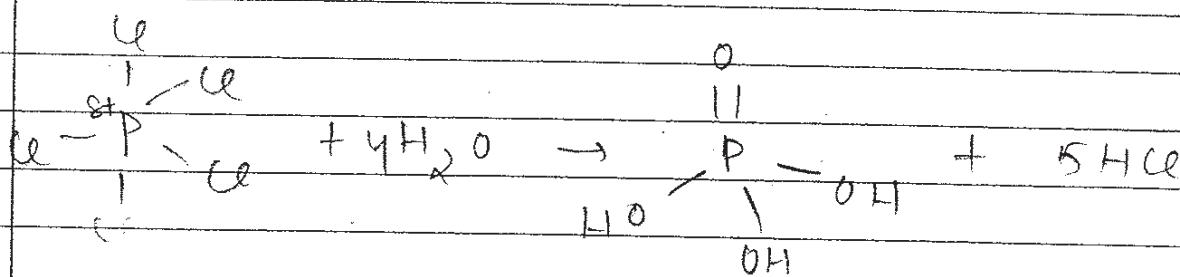
Ansénous acid product

Tribasic



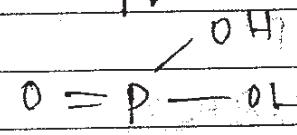
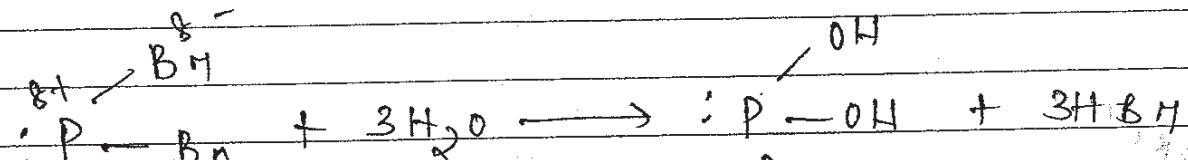
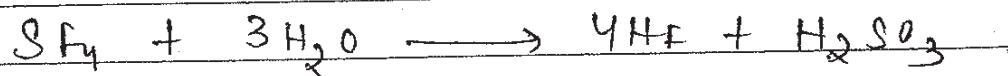
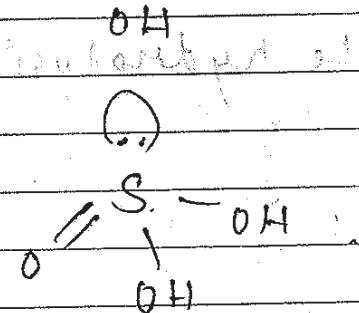
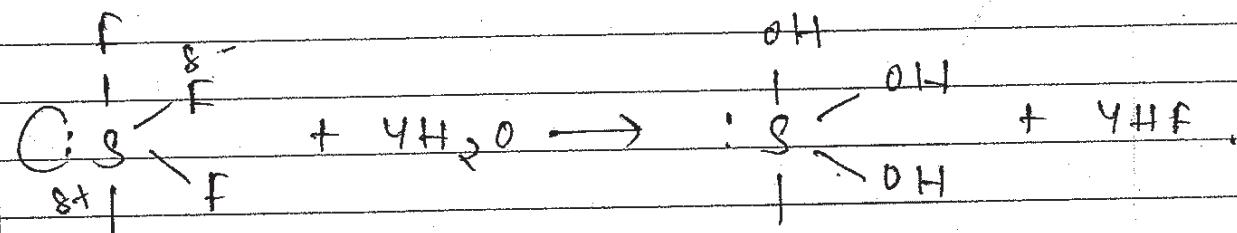
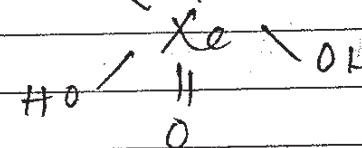
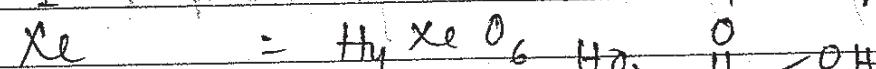
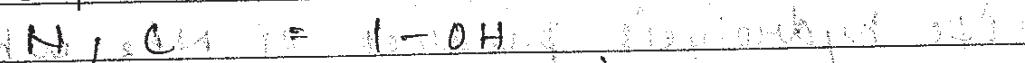
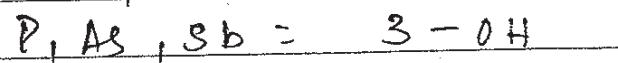
Q. Write hydrolysis product of

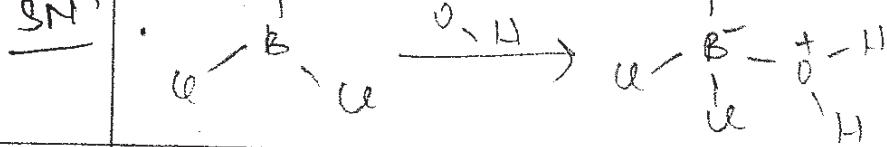
- i) PCl_5 ii) SF_4 iii) PBH_3



Date

In final product = element with 3 OH.



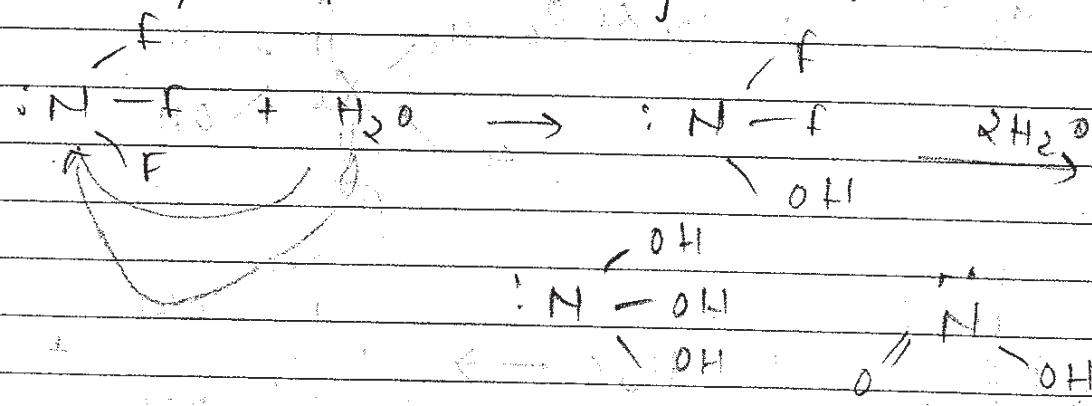


Date

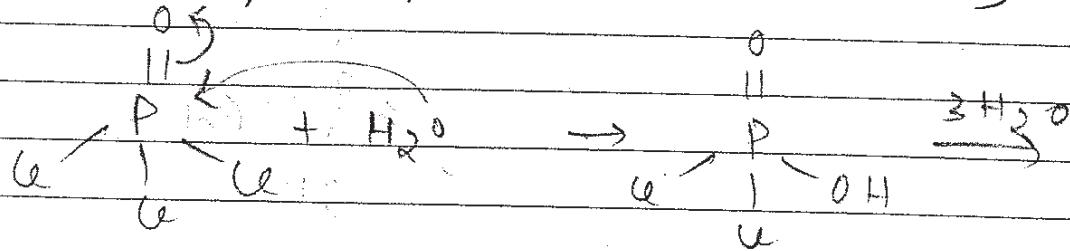
Q. What is the hybridisation state of boron when BCl_3 is hydrolysed and produces TS

- a) sp^3 b) sp^2 c) sp d) sp^3d

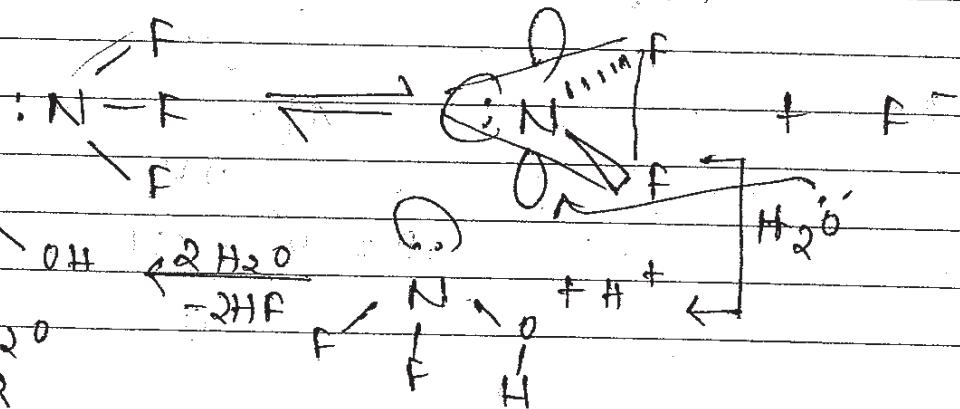
Q. Write hydrolysis product of NF_3 when it is hydrolysed at high temp.



Q. Write hydrolysis product of PO_4^3-

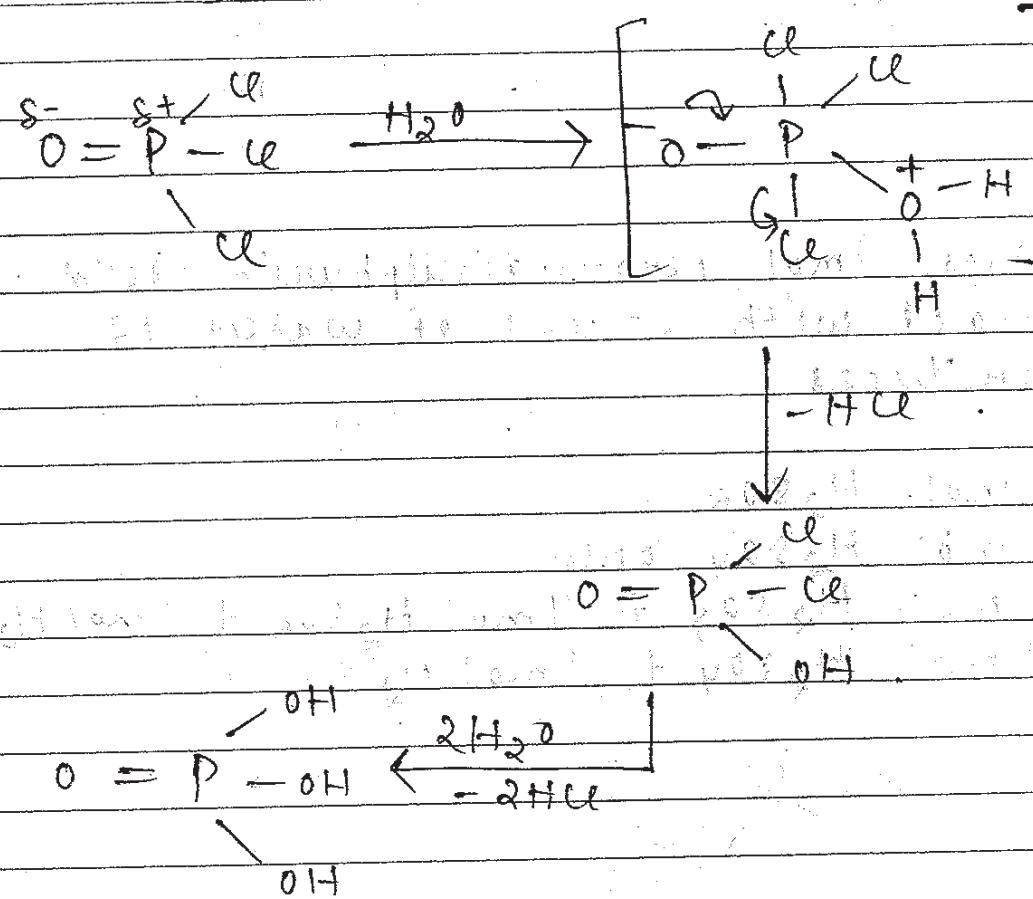


SN

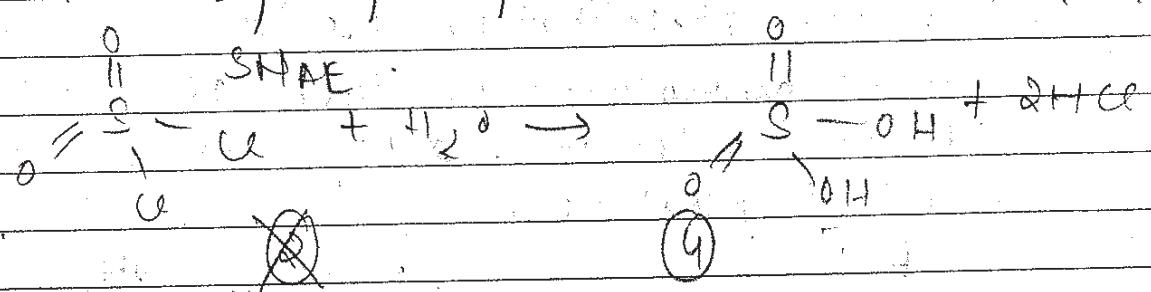


$\text{S}_{\text{N}}^{\text{I}}$ - Dissociative Mechanism

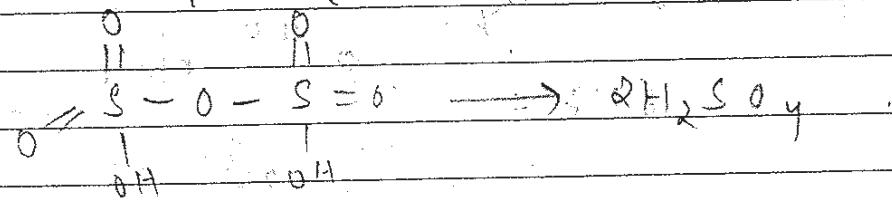
$\text{S}_{\text{N}}^{\text{2}}$ - Associative Mechanism

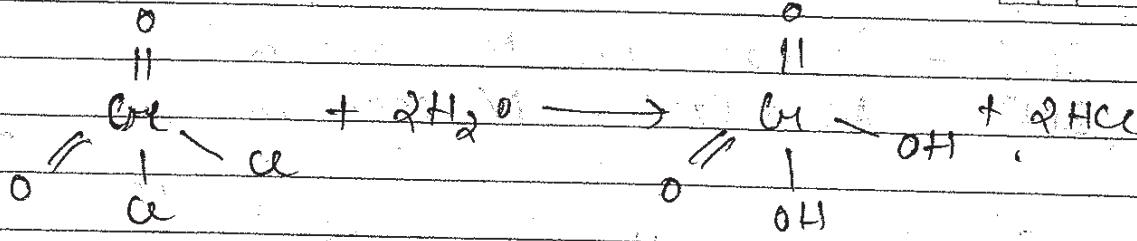


Q. How many moles of NaOH is required for complete neutralization of aqueous solution obtained by hydrolysis of 1 mole $\text{S}_2\text{O}_8^{2-}$.



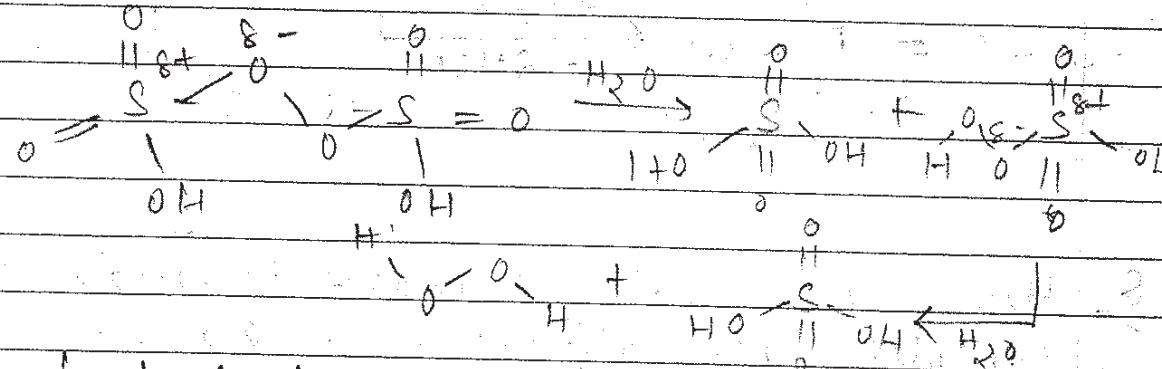
Q. Write hydrolysis product of $\text{H}_2\text{S}_2\text{O}_7$.



JEE

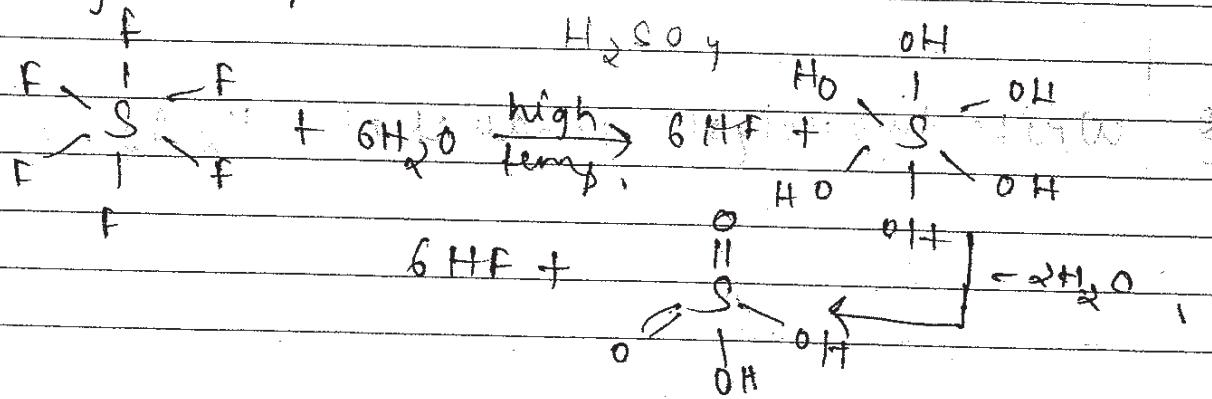
Q. When 1 mol peroxydisulphuric acid react with excess of water it produces

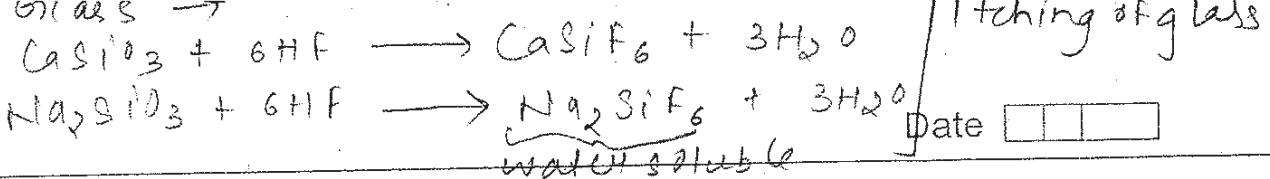
- (A) 2 mol $\text{H}_2\text{S}_2\text{O}_5$.
- (B) 2 mol $\text{H}_2\text{S}_2\text{O}_4$ only.
- (C) 1 mol $\text{H}_2\text{S}_2\text{O}_4$ + 1 mol $\text{H}_2\text{S}_2\text{O}_5$ + 1 mol H_2O_2 .
- (D) 2 mol $\text{H}_2\text{S}_2\text{O}_4$ + 1 mol H_2O_2 .



Q. SF_4 is hydrolysed but SF_6 is not. Explain. Transition state not possible (\neq coordination state).

Q. Write hydrolysis products of the hydrolysis of SF_6 when it reacts with water at high temperature.





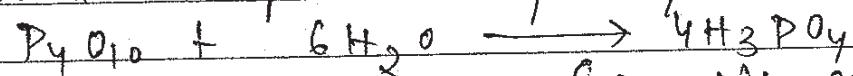
Q. SF_6 is not hydrolysed but SeF_6 is easily hydrolysed. Explain.

Q. Write ease of hydrolysis of

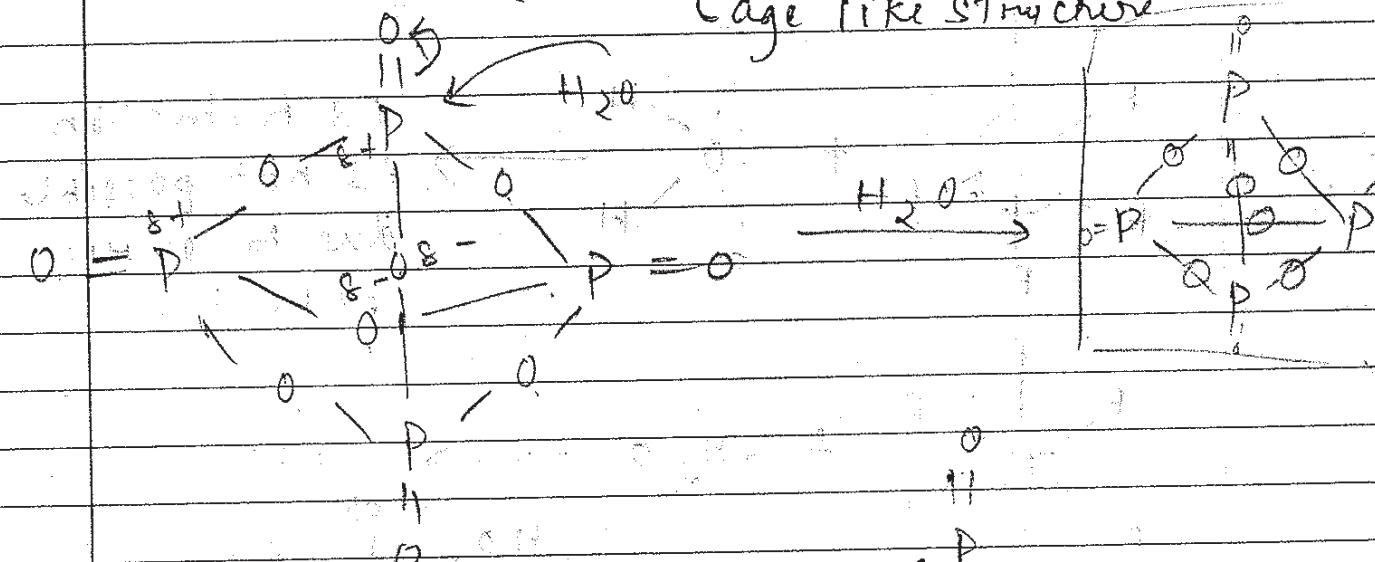
1) $\text{SF}_6 < \text{SeF}_6 < \text{TeF}_6$ (size of central atom)
because CN is already high

2) $\text{PCl}_3, \text{AsCl}_3$ BE of $\text{P}-\text{O} > \text{As}-\text{O}$

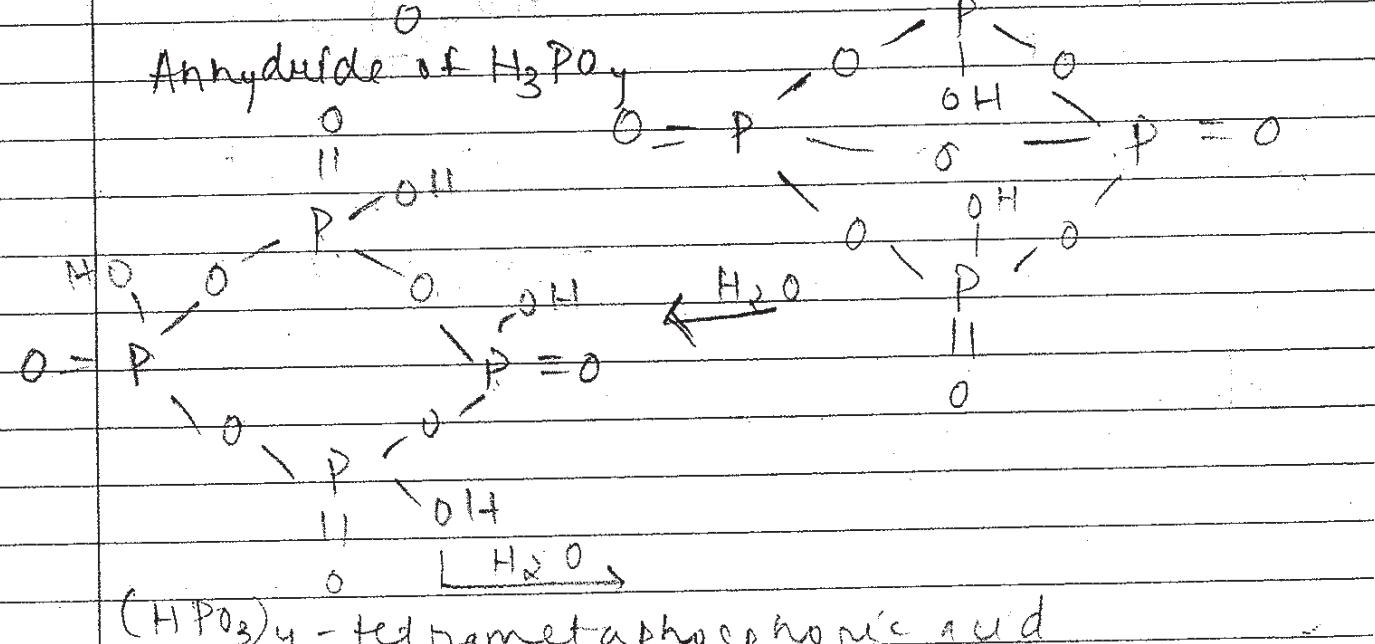
Q. Write step wise hydrolysis of PyO_{10}



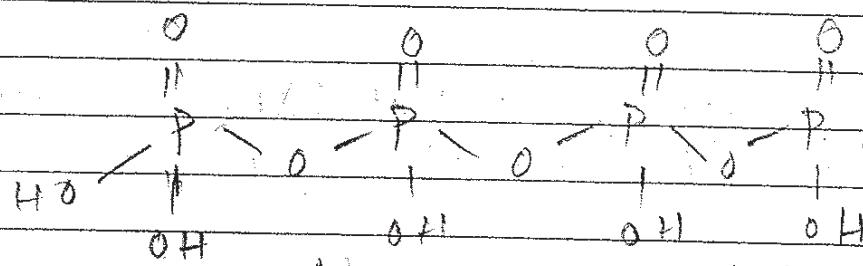
Cage like structure



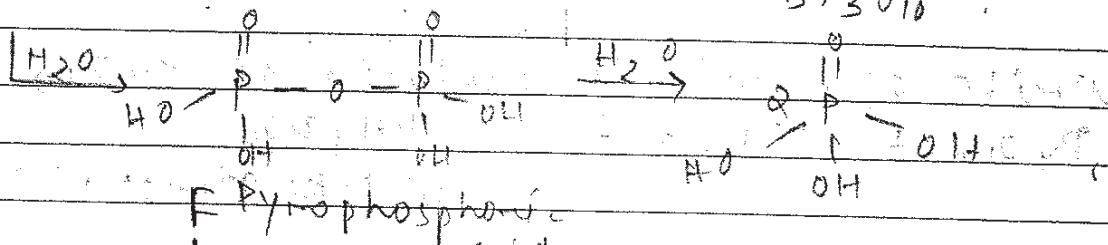
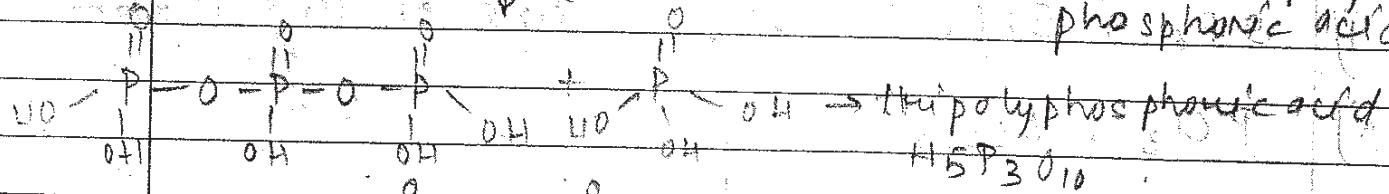
Anhydride of H_3PO_4



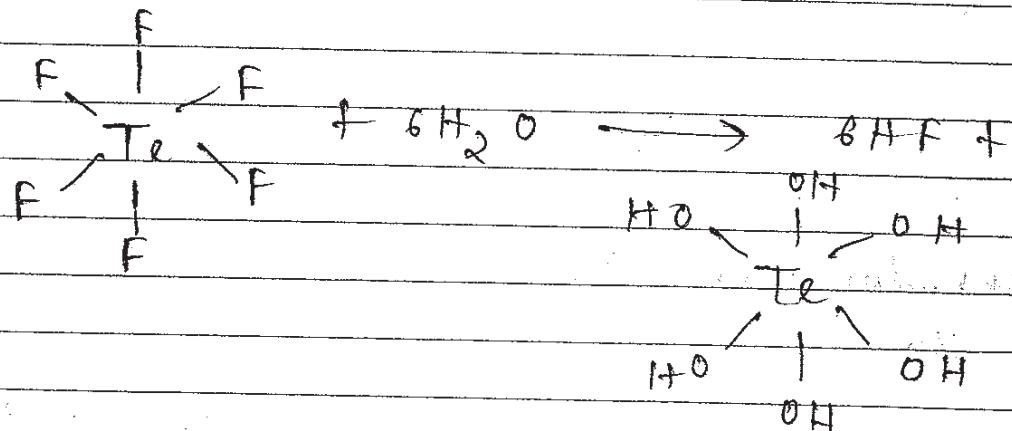
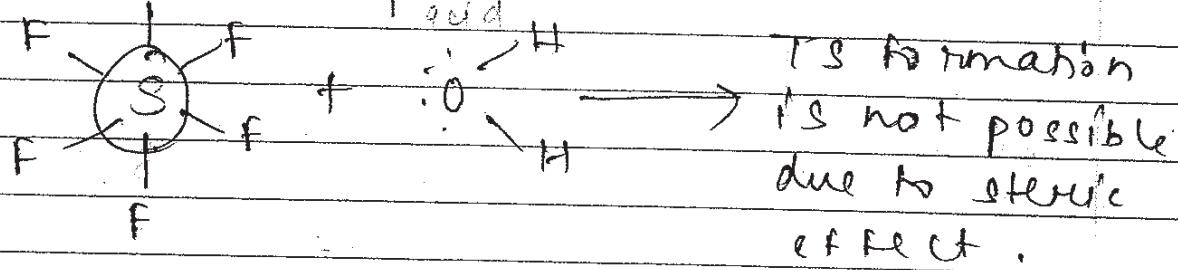
Date



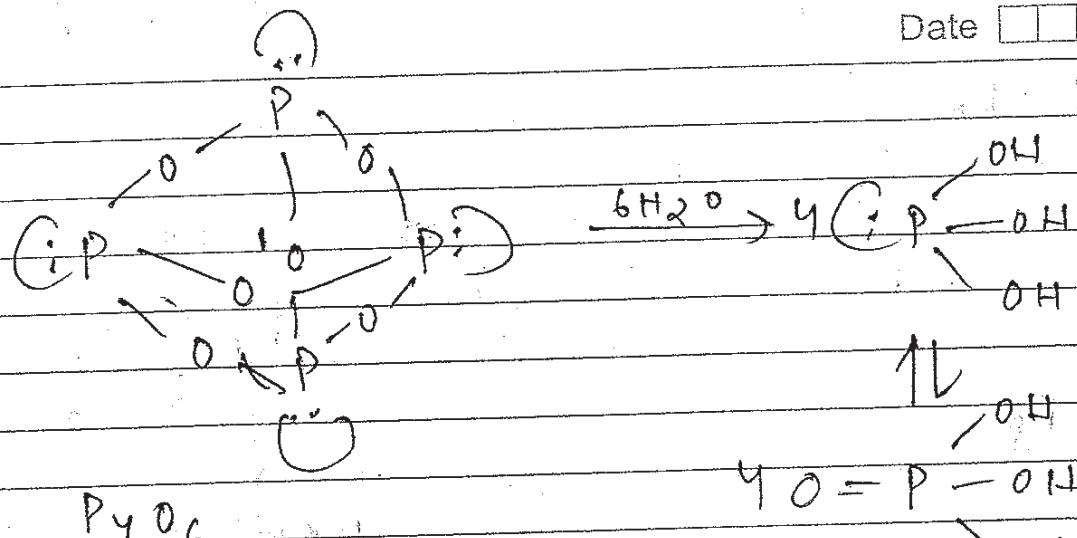
$\text{H}_6\text{PyO}_{13}$ - tetraphosphoric acid



F Pyrophosphoric acid



Telluric Acid



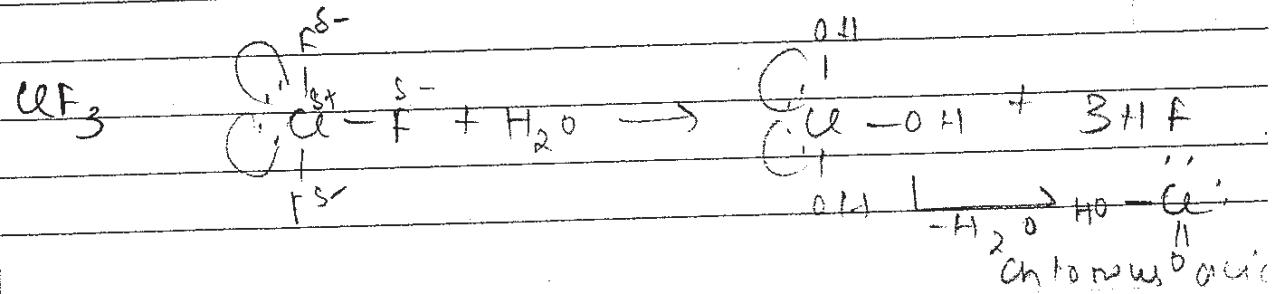
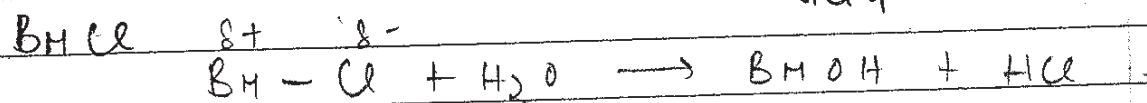
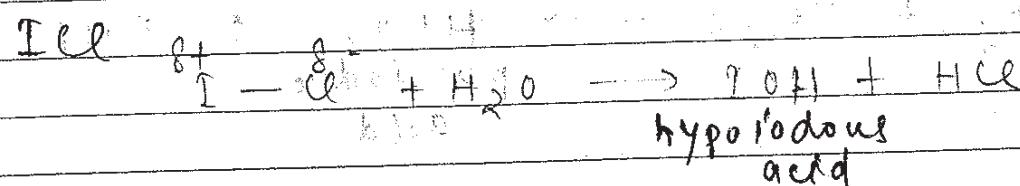
Anhydride of
phosphorous acid.

PyO_{10} is used as a dehydrating agent but PyO_6 is not because the ease of hydrolysis of PyO_6 is less than PyO_{10} and PyO_6 the hydrolysis product of PyO_6 is a reducing agent.

PyO_{10} - 2 types of BL data

PyO_6 - 1 type of BL data.

Hydrolysis of interhalogen compounds.

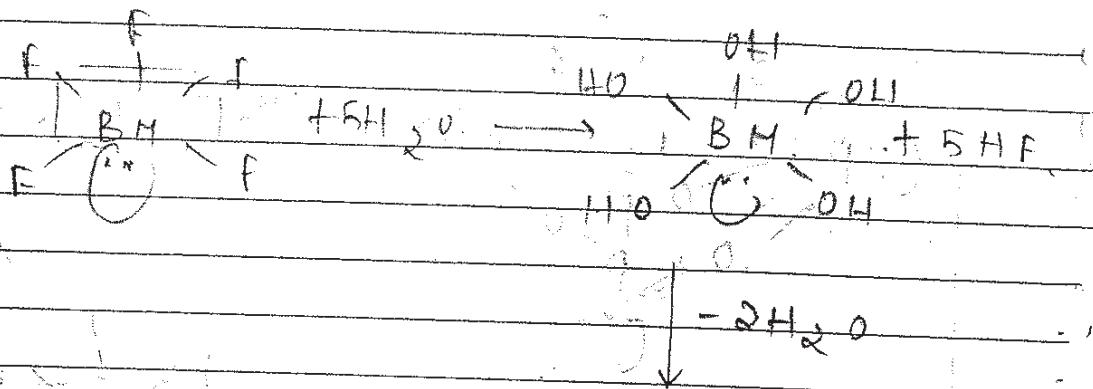


118 - class - sp a

Square antiprismatic geometry.

Date / /

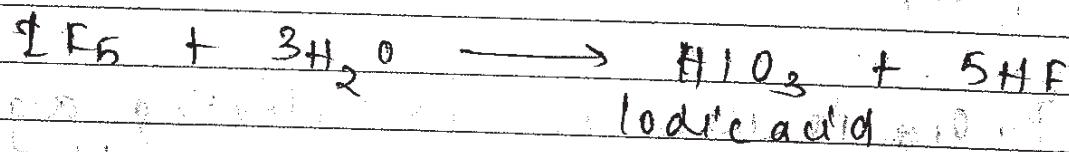
BF_5



IF_5

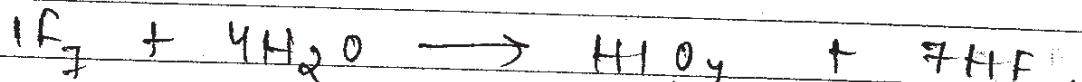
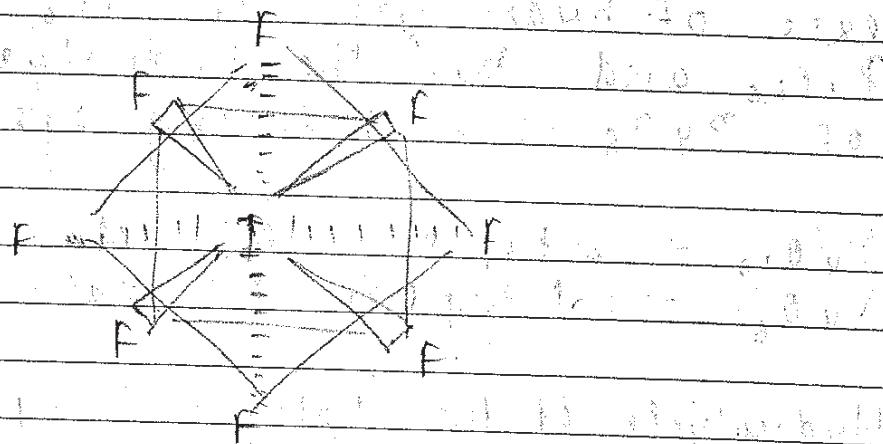


Bromic acid



Iodic acid

IF_8

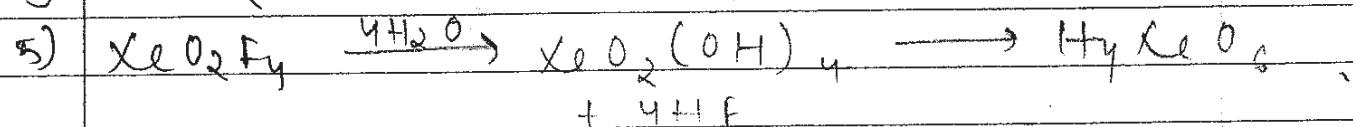
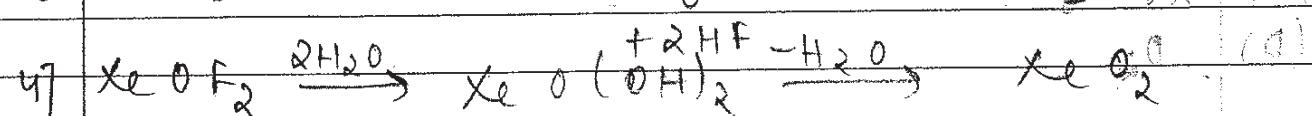
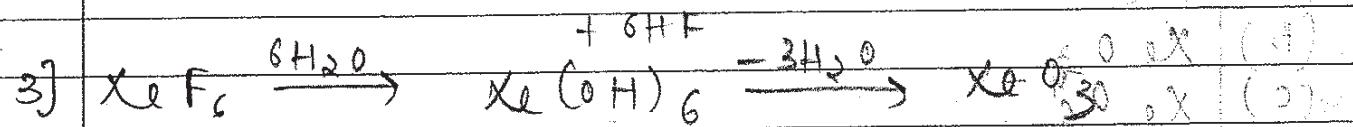
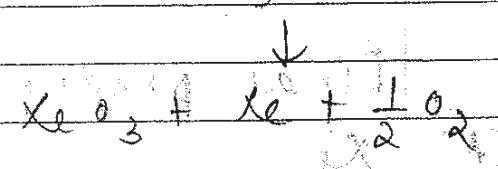
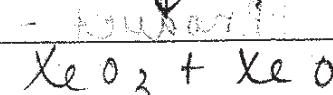
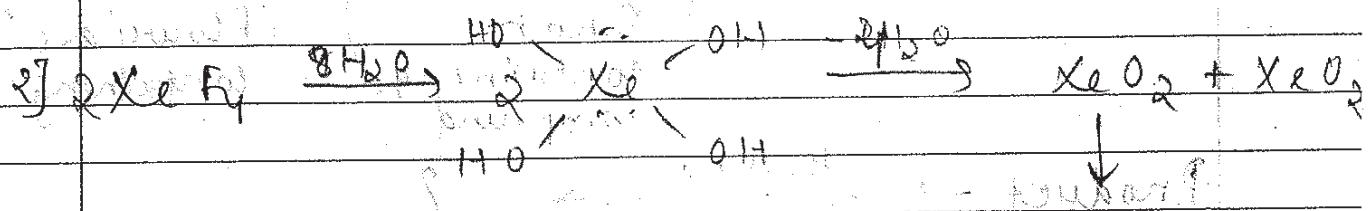
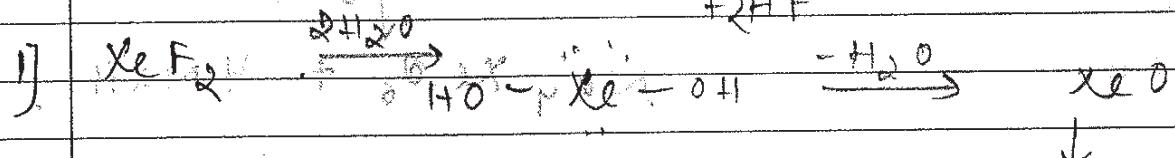
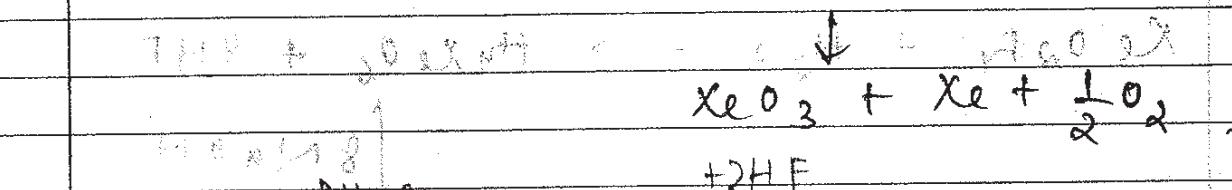
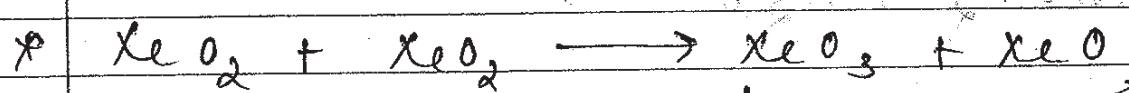


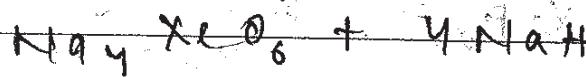
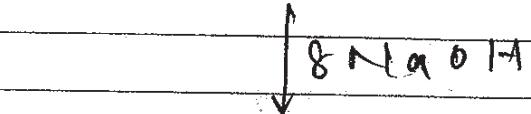
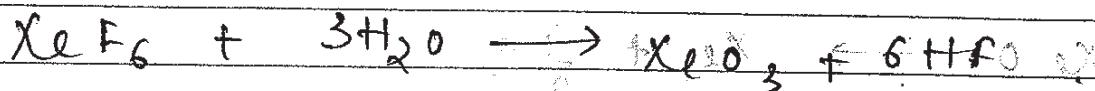
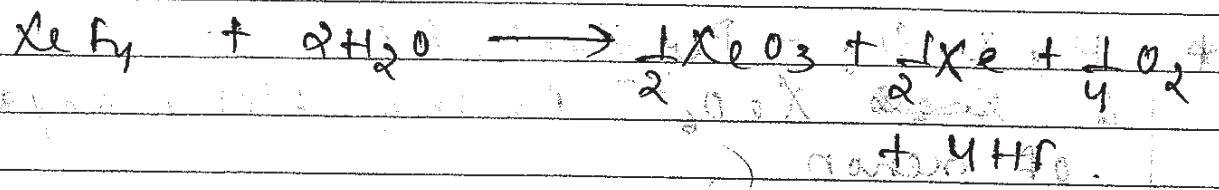
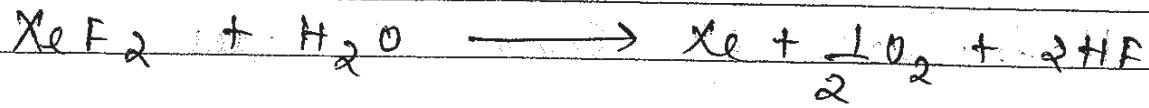
per iodic
acid

Hydrolysis of Xenon Fluorides

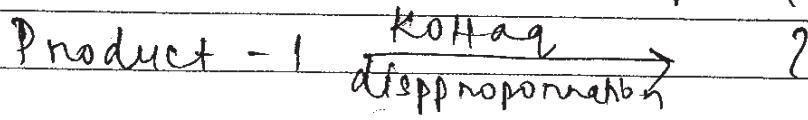
* $\text{H}_2\text{XeO}_6 \rightarrow$ Per Xenoic Acid

& ~~XeO_6^{4-}~~ XeO_6^{4-} is only stable oxyanion of xenon.





Q. $\text{XeF}_6 \xrightarrow{\text{hydrolysis}}$ (Product-1) + Product-2
 (Xenon containing compound) (Fluoride containing)



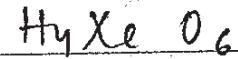
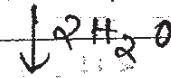
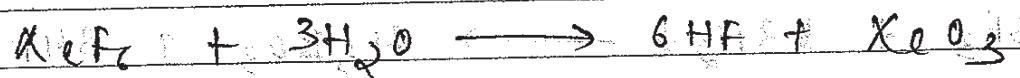
Final product contain

- (A) Xe
- (B) XeO_3
- (C) XeO_6^{4-}
- (D) O_2



Si-F bond is very strong
 BF_3 - Slow hydrolysis (BB)

Date []

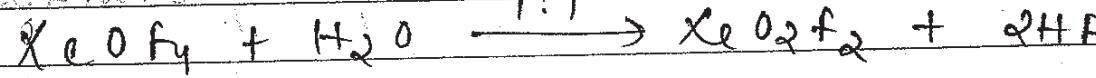


PARTIAL HYDROLYSIS

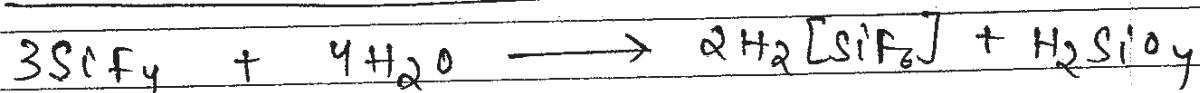
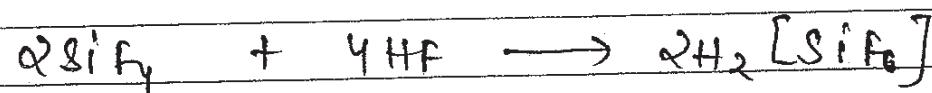
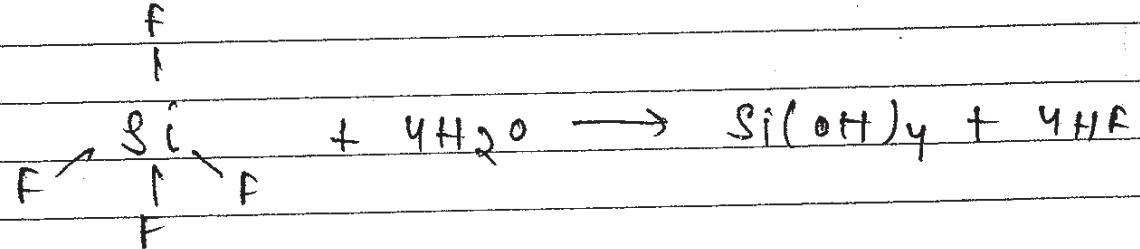
I] Because of less water.



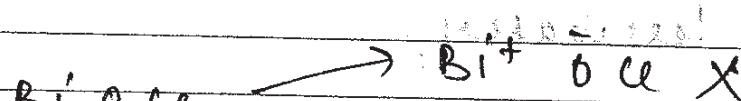
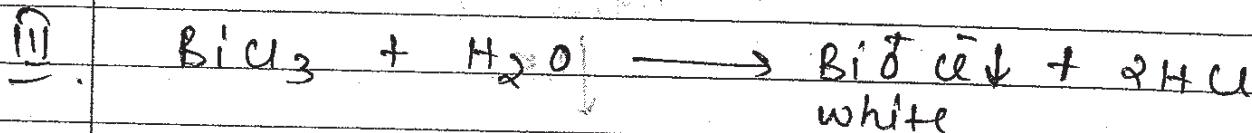
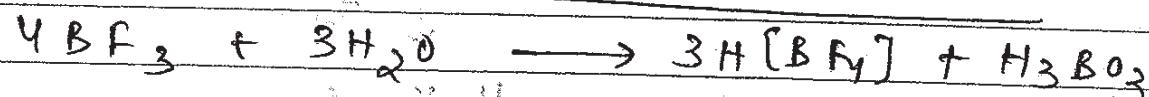
Inhalation



II] Personal Problem



Date

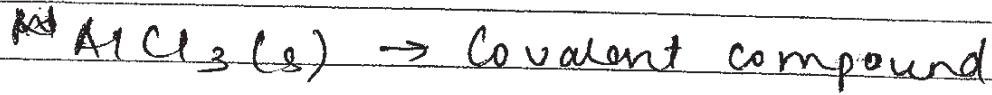


Bismuth oxy chloride
Antimony oxy chloride.

metathesis

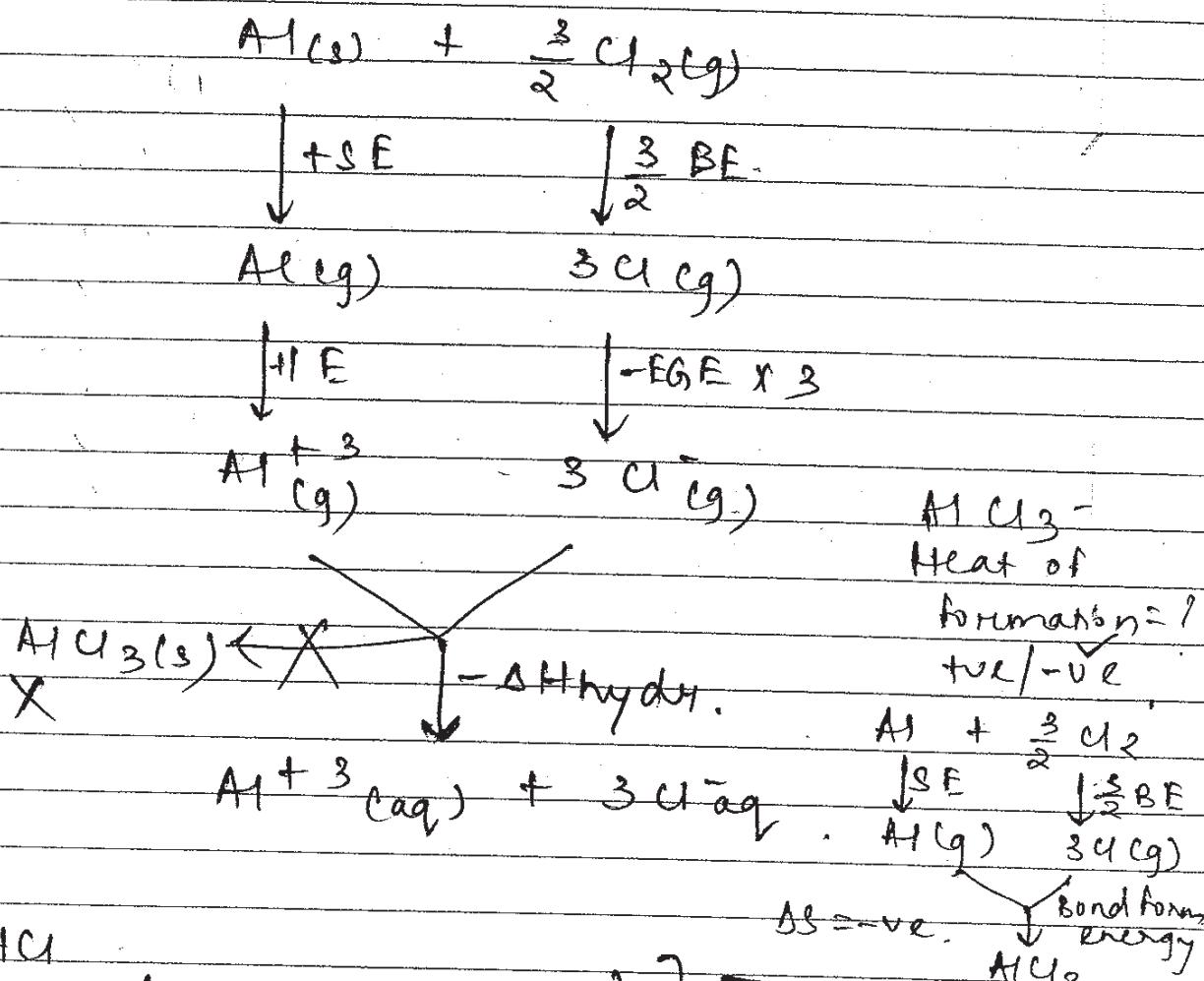
IONIC BOND

Date



$$\Delta G^\circ = \Delta H - T\Delta S$$

During formation of bond ΔS is always
-ve, so ΔH should be sufficiently
negative.

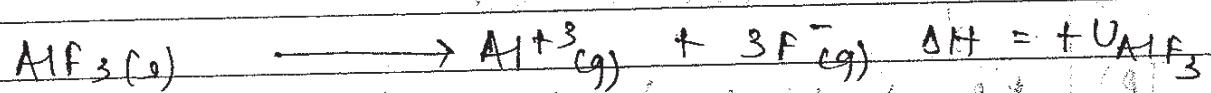
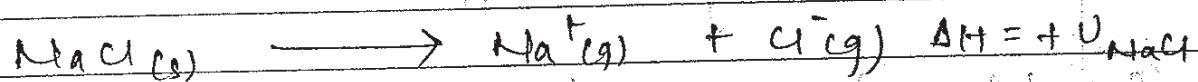
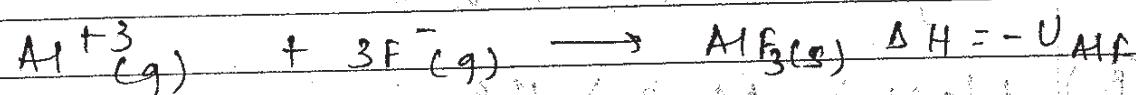
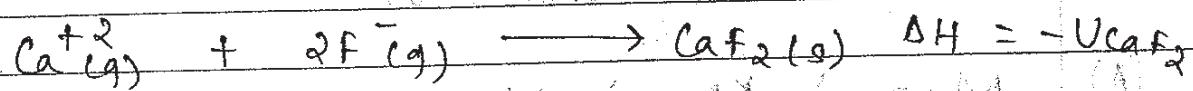


HCl
 AlCl_3 ($X = \text{Cl, Br, I}$)
 GaX_3 ($X = \text{Cl, Br, I}$)
 GeX_3 ($X = \text{Cl, Br}$)
 CuX_2 ($X = \text{Cl, Br}$)
 SnCl_2
 MgCl_2

These compounds
are covalent in
anhydrous state
and ionic in
aqueous state.

Lattice Energy

Amount of energy released when 1 mol of ionic lattice is formed from constituent gaseous ions.



Amount of energy required to dissociate 1 mol ionic lattice to constituent gaseous ions is called lattice energy.

Lattice energy depends on

- charge on ions
- size of the ions
- repulsive forces b/w similar charged ions
- packing style.

Q Write order of lattice energy in

1) $\text{LiF} > \text{NaF} > \text{KF} > \text{RbF} > \text{CsF}$

2) $\text{NaF} > \text{NaCl} > \text{NaBr} > \text{NaI}$

3) $\text{BeO} > \text{MgO} > \text{CaO} > \text{SrO} > \text{BaO}$

4) $\text{CaSO}_4 \rightarrow \text{MgSO}_4 \rightarrow \text{BaSO}_4$

5) $\text{AlF}_3 \rightarrow \text{MgF}_2 \rightarrow \text{NaF}$

6) $\text{TiF}_2 < \text{TiF}_3$

7) $\text{CaO} > \text{CaS} < \text{CaF}_2$

8. Select correct order of LE

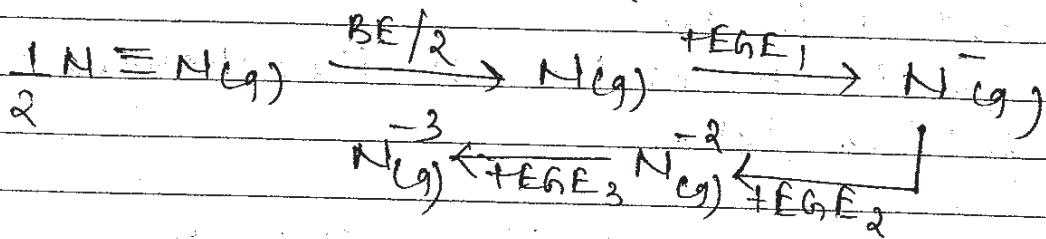
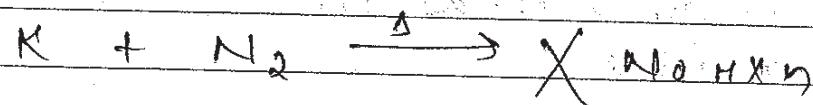
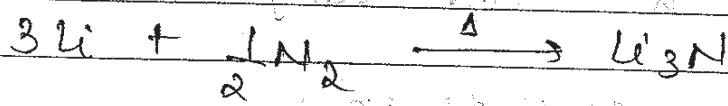
(A) $\text{MgO} > \text{KBr} > \text{NaCl}$

(B) $\text{NaCl} > \text{MgO} > \text{KBr}$

(C) $\text{MgO} > \text{NaCl} > \text{KBr}$

(D) $\text{KBr} > \text{NaCl} > \text{MgO}$

9. Explain given observation



Only lithium reacts among the alkali formation of nitride ion from N_2 is a highly endothermic process. Large energy consumed during the formation of N_3^- ions is compensated by lattice energy when it combine with Li^+ but not.

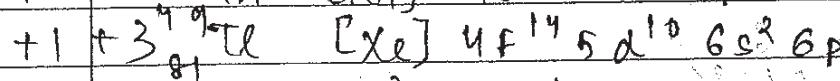
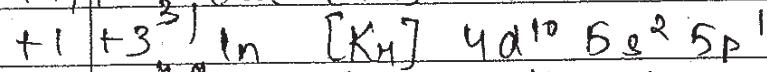
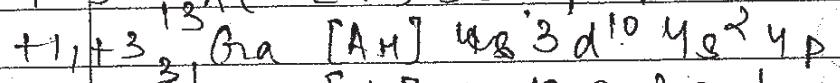
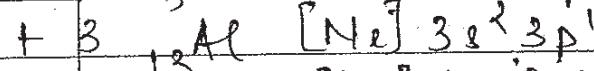
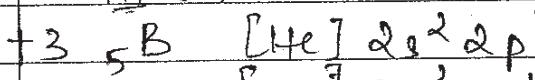
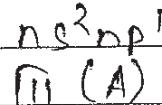
compensated by lattice energy when it combine with K^+ so that Li can form LiN with N_2 but K does not.

Out of all alkali metals only Li form nitride with N_2 .

All alkali earth metals (IIA) can form nitride with N_2 .

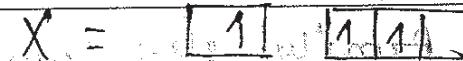
Electrovalency

- No. of electrons lost or gained by an atom to form ionic bond is called electrovalency.
- d-block elements and heavy elements of p-block can show variable electrovalency.



An element

of B-family



$\text{COV} = 3 - (n_s + n_p)$ with respect to other elements



In next pair

Shielding effect : $s > p > d > f$

$ns^2 np^2$
c

Cr +4, +2

Sn +4, +2

Pb +4, +2

$ns^2 np^3$

As +5, +3

Sb +5, +3

Bi +5, +3

$ns^2 np^4$

O 2

S (2, 4, 6)

Se (2, 4, 6)

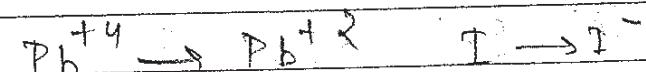
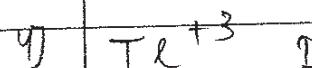
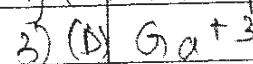
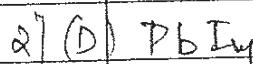
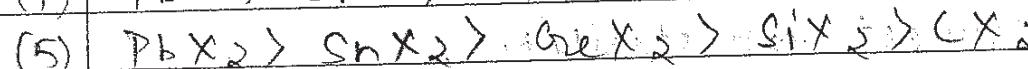
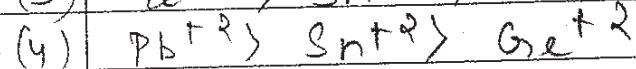
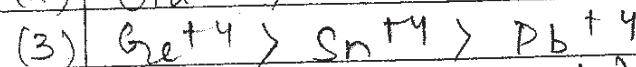
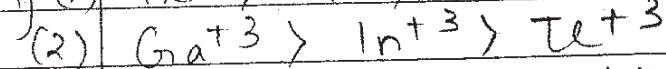
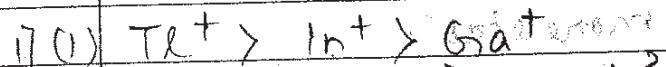
Te (2, 4, 6)

Po (2, 4, 6)
rare

→ Most common oxidation no. of B family
is +3 due to participation of outermost
ns and np electrons in bond formation

→ Heavier elements of B family also show
+1 oxidation state due to participation of
only np e⁻'s in bonding.

- When no e⁻'s are not involved in bonding and remain as a pair it's called Inert pair and this effect is called Inert pair effect.
- Inert pair effect is due to poor shielding of inner e⁻s.
- Inert pair effect is also observed in other families of p-block.
- Inert pair effect become more dominant on moving down the group in p-block due to increasing poor shielding e⁻s in inner shells.
- Variable oxidation state, arise due to Inert pair effect, have difference of two.



Oxidising



Oxidising



18⁻ in outermost shell
(only)

Date

Q

(I)

Configuration in cation

P

Cation

(A) Octet config R^8

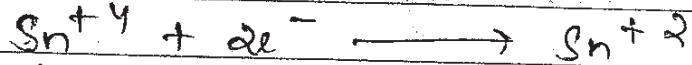
(P) Be^{+2}

(B) Pseudo inert gas config $\text{R}, \text{ST}(8), \text{Al}^{+3}$
18⁻ in outermost shell

(C) (18+2) config $\text{R}, \text{S}, \text{O}^{2-}$ (R) Zn^{+2}

(D) Duplet config P. (S) Ga^{+3}

(T) Ga^{+3}



stable with given, less stable
reducing agent



less stable
oxidising
agent.

Q

Select correct for stability.

✓ (A) $\text{Sn}^{+2} < \text{Sn}^{+4}$

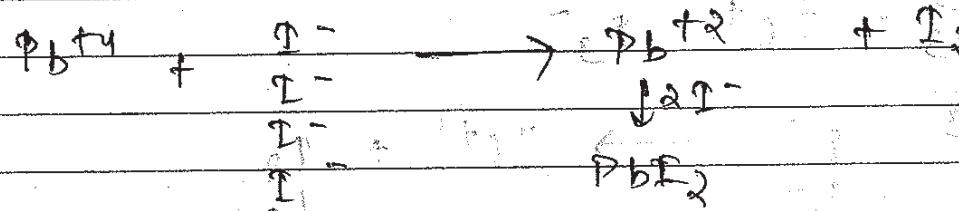
✓ (B) $\text{Sn}^{+2} < \text{Pb}^{+2}$

✓ C) $\text{Sn}^{+4} > \text{Pb}^{+4}$

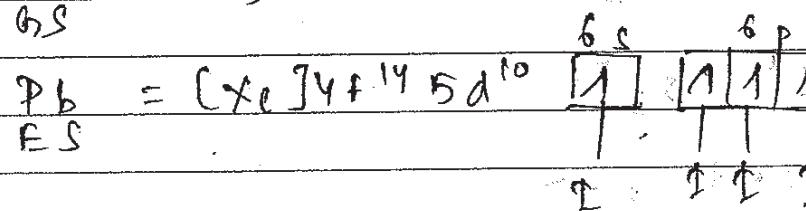
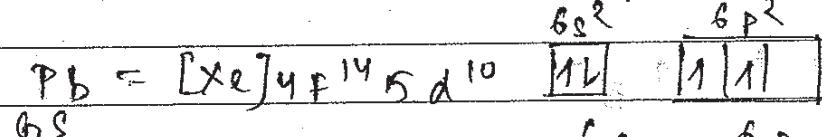
✓ D) $\text{Pb}^{+2} > \text{Pb}^{+4}$

Oxidising Agent $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$

Reducing Agent $\text{F}^- < \text{Cl}^- < \text{Br}^- < \text{I}^-$



Oxidising power of Pb^{+4} is sufficient to gain electrons from strong reducing I^- . But not sufficient to gain electrons from other halide ions under ordinary conditions so that PbCl_4 does not exist.



(Excitation energy \gg Bond energy)
so PbI_4 is not formed



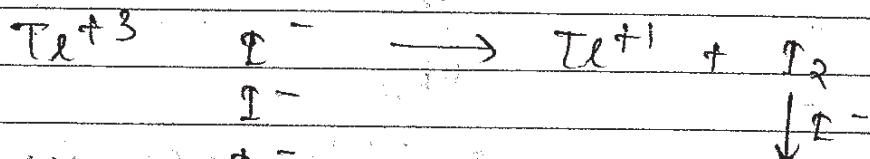
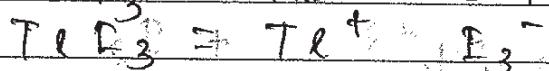
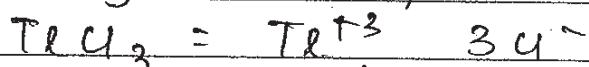
~~Any compound of Bi, Al, Pb, and Sb~~

BiF_5 , Bi_2O_5 , NaBiO_3

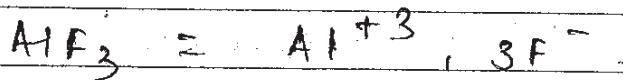
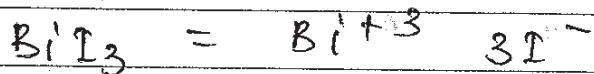
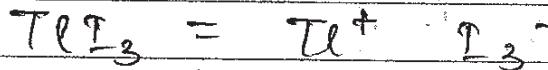
Date

which is/are not existing

- A) BiF_5
- B) BiCl_5
- C) BiBH_5
- D) BiI_5



(OA) (RA).



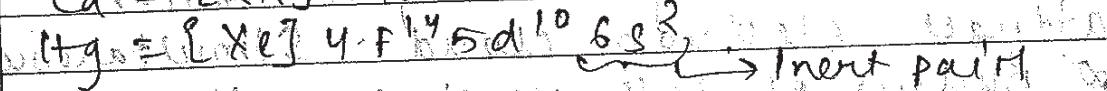
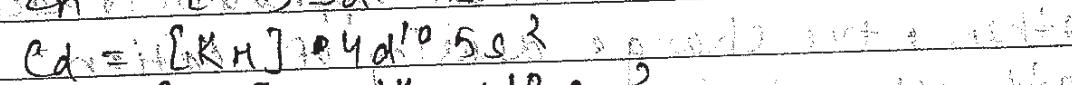
GaCl_2



Date

--	--	--

B	C	N
Al	Si	P
Zn	Gra.	Gre
Hg	In	As
	Sn	Sb
Hg	Tl	Pb
		Bi



→ Inert pair



Yellowish, black solid is Black in colour

DNE

PH₅

NH₅ Malachite green is white

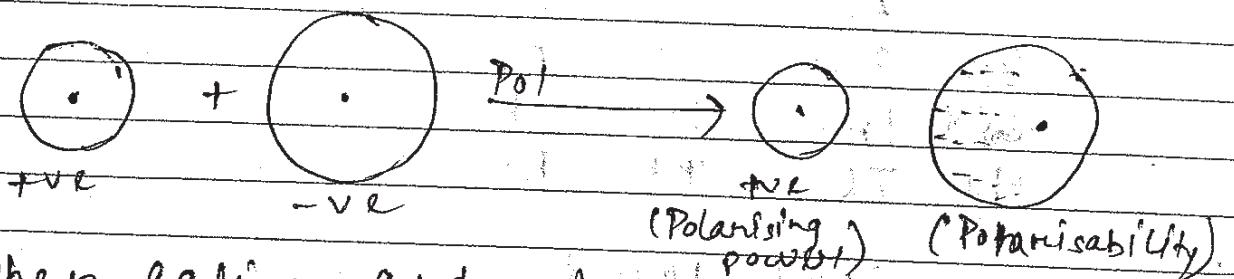
Ph₆ Blue of toffy of malachite is blue

K₃N

PbI₄ Yellow-green colour is yellow

C

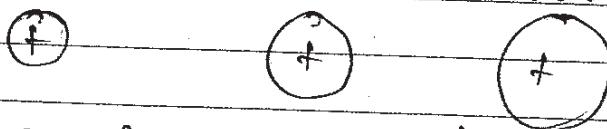
Covalent Character In Ionic Compounds.



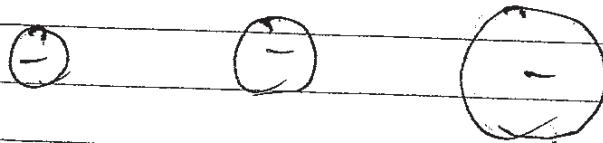
When cation and anion approach to each other, +ve charge density of cation attract electron cloud. Simultaneously, + nucleus of both repel each other. Due to unequal attractive and repulsion forces, shape of anion is distorted. It is called polarisation of anion.

Higher the polarisation greater will be the covalent character in that ionic compound.

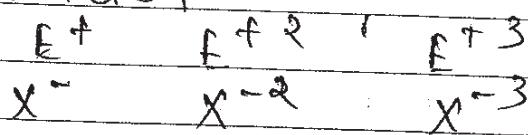
1) Smaller cation favours covalent character.



2) Larger anion favours covalent character.



3) Charge on either ion favours covalent character.



4) Two cations with same charge and comparable size then polarising power is high to that cation which has pseudo inert gas.

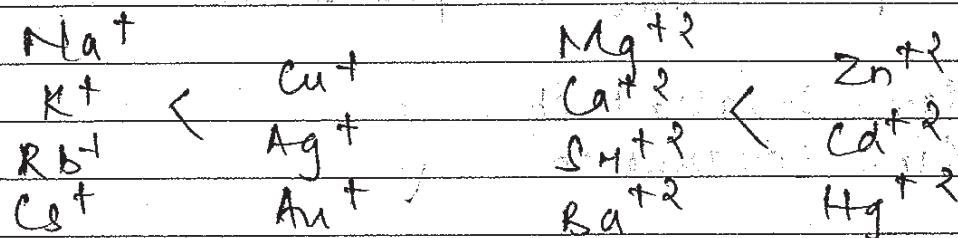
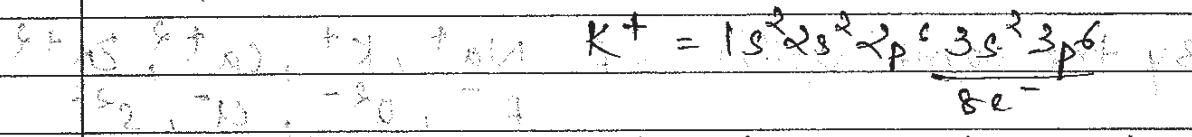
non-polar covalent bond, polar covalent bond, ionic bond.

of ionic compound in water.

Date

configuration as compared to other cation which have inert gas configuration?

Covalent $KCl < AgCl$
character



Rank 13

1) $NaF < NaCl < NaBr < NaI$

2) $LiCl > NaCl > KCl > RbCl > CsCl$ Ionic state

3) $\underset{\text{Ionic}}{NaCl} < \underset{\text{Ionic}}{MgCl_2} < \underset{\text{Ionic}}{AlCl_3}$ Intermediate state

4) $AgF > KF > RbF > CsF$ Ionic state

5) $K_2S > K_2O$ Ionic state

6) $CaF_2 < CaO < Ca_3N_2$ Ionic state

7) $KCl < CaCl_2 < ZnCl_2$ Covalent state

8) $BeCl_2 < MgCl_2 < LiCl < RbCl$ Covalent state

9) $UF_6 > UBr_4 > UCl_4 > UFA$ Covalent state



Q. Polarising power of Mg^{+2} is higher as compared to

- (A) Mg^{+3} (B) Al^{+3} (C) Na^+ (D) Be^{+2} (E) SiH^{+2}

Q. By the combination of $Na^+, K^+, Ca^{+2}, Zn^{+2}$
 $F^-, O^{2-}, Cl^-, S^{2-}$

Prepare ionic compound with

- (i) Max. Covalent ch. ZnS
(ii) Min. Covalent ch. KF

Q. Which has max. ionic potential

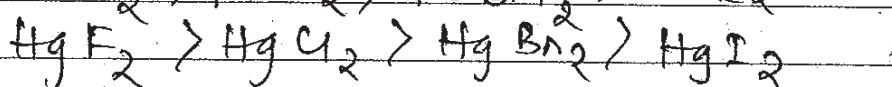
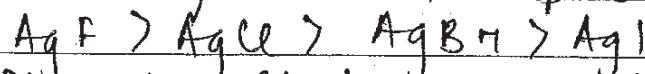
- (A) Be^{+2} (B) Mg^{+2} (C) Ca^{+2} (D) K^+

Ionic potential is the best criteria to compare polarising power of cations which have diff. size and charge.

Diagonal similarity of Be and Al is explained by same ϕ of their cations

$$\text{Ionic potential} = \frac{q}{r} = \frac{\text{charge}}{\text{size (A)}}$$

Solubility in water explained by Fajan's rule



Solubility in $\text{LiI} > \text{LiBr} > \text{LiCl} > \text{LiF}$
 organc
solvent. Always ionlc

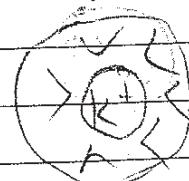
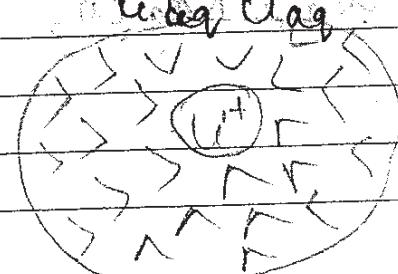
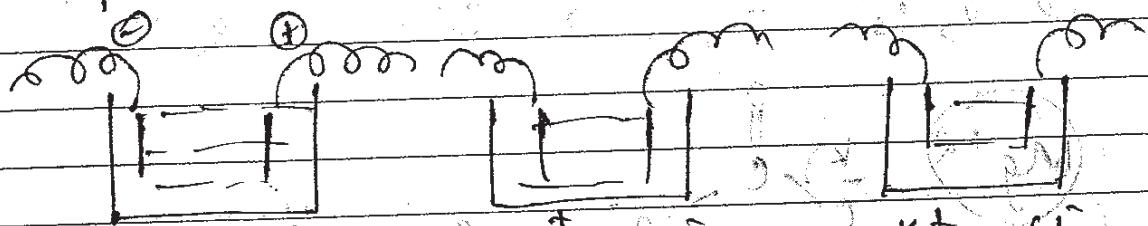
$\text{LiCl}, \text{LiBr}, \text{LiI}$ are predominantly covalent in solid form and in molten form but in aqueous form and in vapour form they dissociate into ions.

Conductivity

→ Ionic Compound does not conduct electricity in solid form but they are good conductor of electricity in molten state and in aqueous solution.

→ Conductivity of Ionic compounds depends on various factors - Concentration, Mobility of the ions, Charge on the ions, etc.

→ Mobility of H^+ ions is extremely high because of H^+ switching mechanism. Mobility of H^+ ion is better in ice as compared to $\text{H}_2\text{O}(\ell)$.



Size- $\text{Li}^+(\text{aq}) < \text{Na}^+(\text{aq}) < \text{K}^+(\text{aq}) < \text{Rb}^+(\text{aq}) < \text{Cs}^+(\text{aq})$

Size- $\text{Li}^+(\text{aq}) > \text{Na}^+(\text{aq}) > \text{K}^+(\text{aq}) > \text{Rb}^+(\text{aq}) > \text{Cs}^+(\text{aq})$

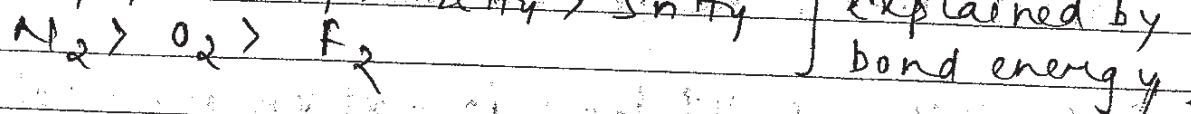
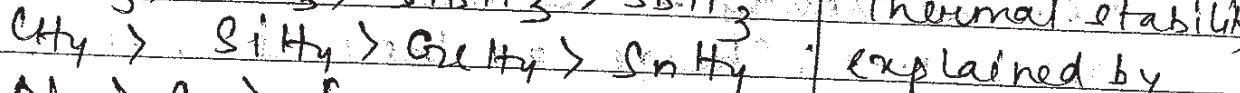
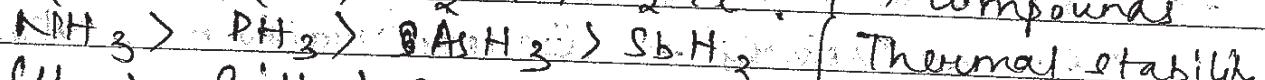
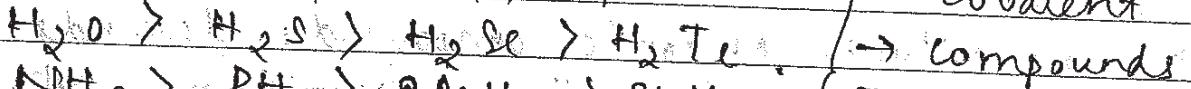
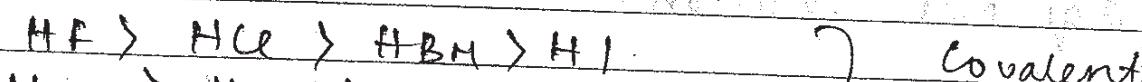
Mobility- $\text{Li}^+(\text{aq}) < \text{Na}^+(\text{aq}) < \text{K}^+(\text{aq}) < \text{Cs}^+(\text{aq})$

Δ Conduction- $\text{Li}^+(\text{aq}) < \text{Na}^+(\text{aq}) < \text{K}^+(\text{aq}) < \text{Cs}^+(\text{aq})$
 \approx dilute soln

Mobility $\text{Be}^{2+}(\text{aq}) < \text{Mg}^{2+}(\text{aq}) < \text{Ca}^{2+}(\text{aq}) < \text{Sr}^{2+}(\text{aq}) < \text{Ba}^{2+}(\text{aq})$

Mobility $\text{F}^-(\text{aq}) < \text{Cl}^-(\text{aq}) < \text{Br}^-(\text{aq}) < \text{I}^-(\text{aq})$

Thermal Stability



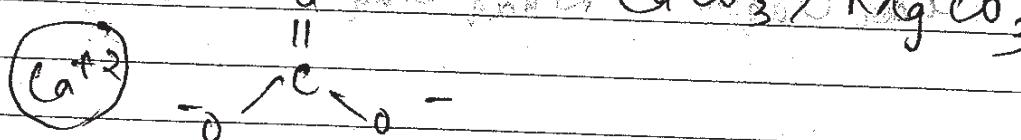
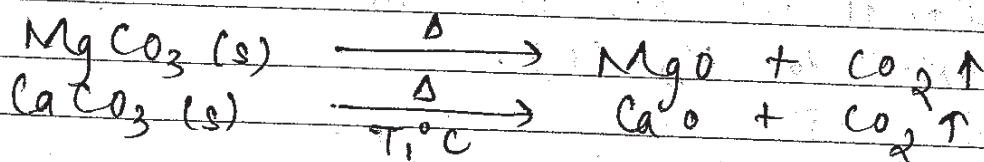
Covalent

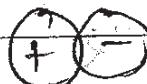
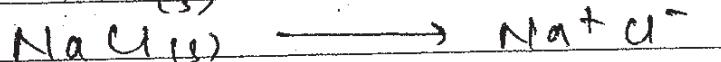
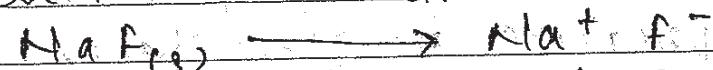
compounds

Thermal stability

explained by
bond energy.

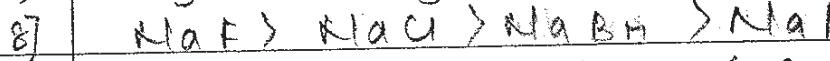
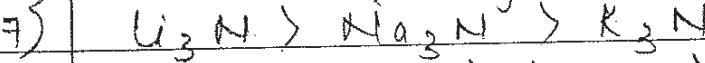
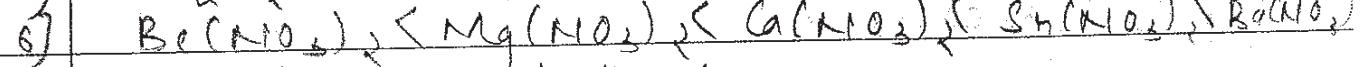
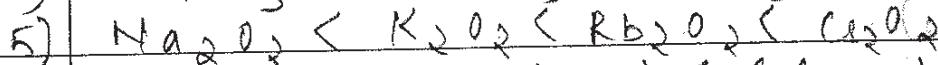
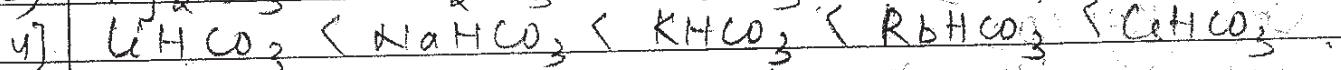
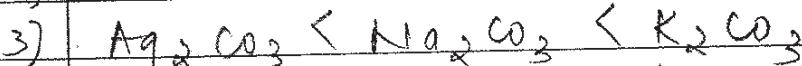
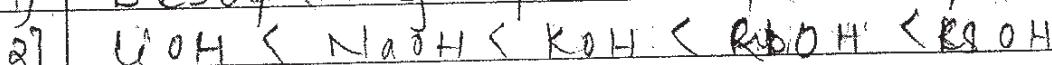
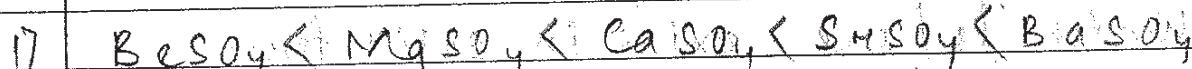
Case 1 - Polyatomic c. And an



Case 2 - Monoatomic Anion

→ Ionic compounds with polyatomic anions are thermally more stable when covalent character is high in that ionic compound.

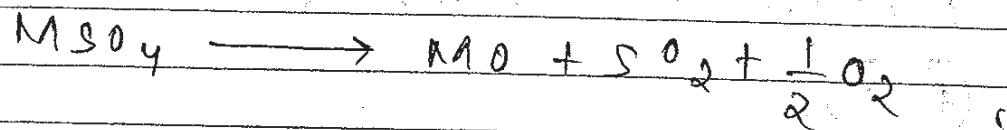
→ Ionic compounds with monoatomic anion are thermally stable when lattice energy is high.

Thermal Stability - Race

→ BeCO_3 is stored in a container already containing CO_2 .

Decomposition
temp: 1000°C

Q. Which alkali earth metal sulphate requires highest temperature for given change?



- (A) BeSO₄ (B) MgSO₄
 (C) BaSO₄ (D) CaSO₄

Q. Select correct statement.

- (A) Gypsum is obtained by heating POP
 (B) POP is obtained by hydration of gypsum
 (C) POP is obtained by partial oxidation of gypsum
 (D) Gypsum contain more % of water as compare to POP.

Q. Which of / are exist in solid form

- (A) NaHCO₃
 (B) KHCO₃
 (C) Mg(HCO₃)₂
 (D) Ca(HCO₃)₂

Q. NaNO₃ on 800°C produce

- (A) NO₂ (B) N₂O₅ (C) N₂ (D) O₂.

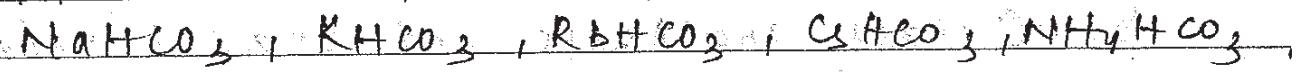
Q. Anhydrous sodium carbonate on heating produce

- (A) Na₂CO₃ + H₂O (B) Na₂O + CO₂.
 (B) Na₂O + CO₂ + H₂O (D) Na₂CO₃.

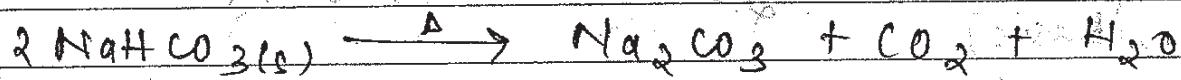
are most stable.

Date / /

NOTE: There are five bicarbonates existing in solid form -

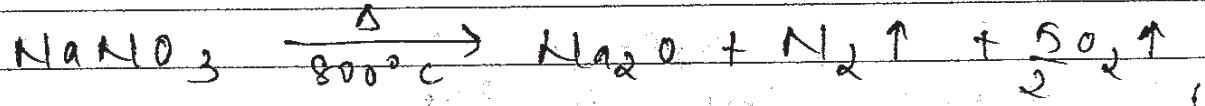
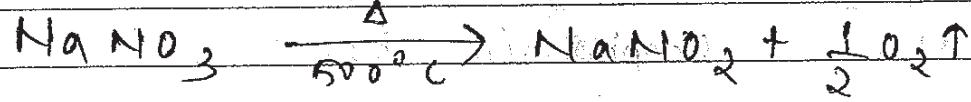
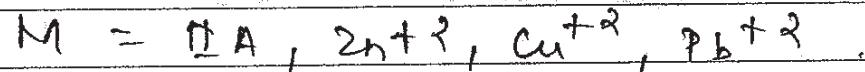
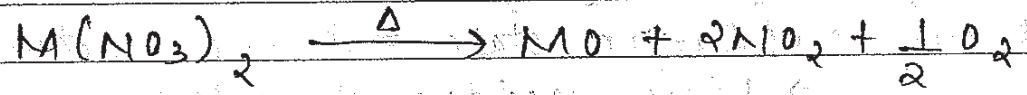


None of the alkali metal carbonates decompose on heating except lithium carbonate.



Out of D(A) carbonates BaCO_3 is not decomposed on bunsen burner flame because of high thermal stability.

BeCO_3 is required to store in the atmosphere of CO_2 because of its low thermal stability.



All metal nitrates form brown coloured gas on decomposition but alkali metals (except Li) do not form NO_2 .

TlI_3 exist as $\text{Tl}^+ \text{I}_3^-$ but $\text{Pb}_2^+(\text{I})$

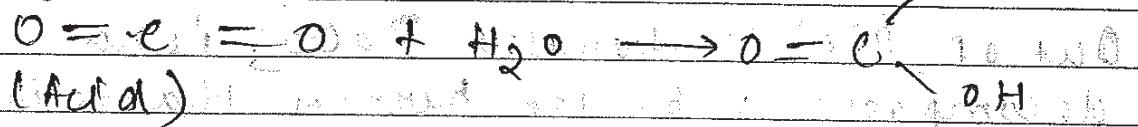
Nature of Oxides

Ionic Oxides are basic and covalent oxides are acidic. As covalent character increases in oxides acidic strength of oxide increases.

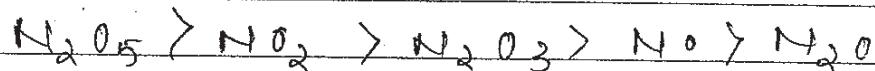
Ionic Oxide



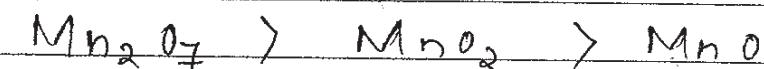
Covalent Oxide



Fajan's Rule is not used to compare covalent character in covalent compounds.



More oxidation state \Rightarrow More electronegativity
 \Rightarrow More acidic character



acidic amphoteric basic



Acidic Amphoteric Basic



Anhydride of permanganic acid Permanganic acid
 permanganic acid Acid



Anhydride of chromic acid

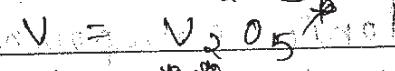
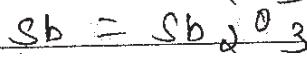
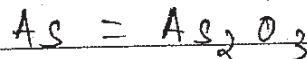
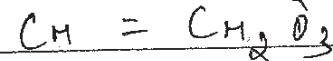
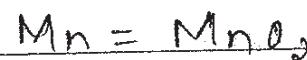
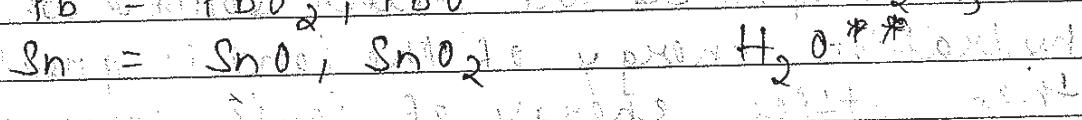
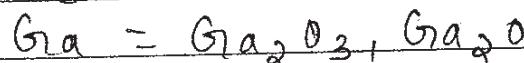
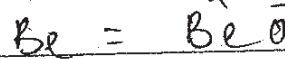
ϕ = Charge
Size (in Å)

If $\sqrt{\phi}$ of cation > 3.2 oxide will be acidic.

If $\sqrt{\phi}$ of cation b/w 2.2 to 3.2 oxide will be amphoteric.

If $\sqrt{\phi}$ of cation < 2.2 oxide will be basic.

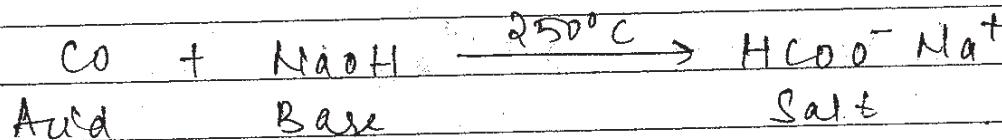
Amphoteric Oxide



Neutral Oxide (At room temperature)

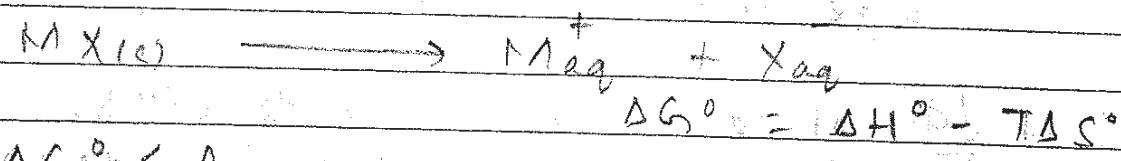


→ Jaise jiska oxide wala uska hydroxide



- * V_2O_5 is amphoteric but predominantly acidic.
- ** H_2O is neutral to litmus but it is amphiprotic.

Solubility in Water

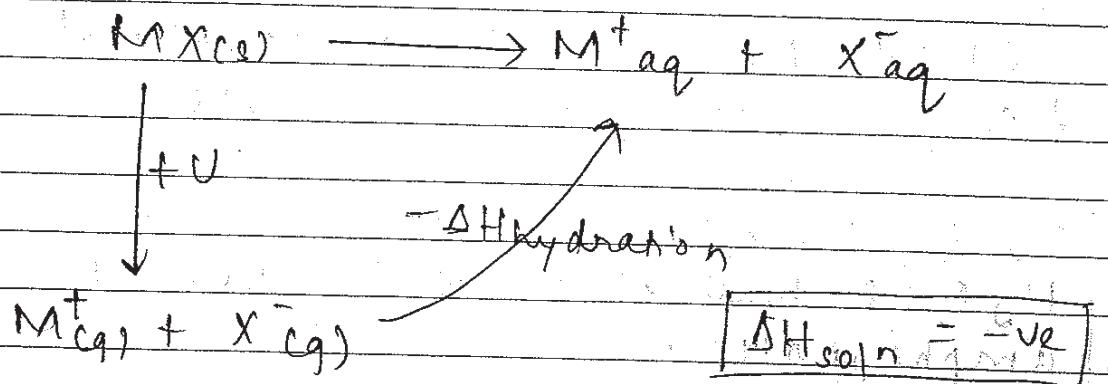


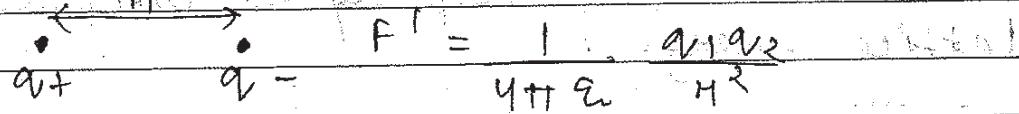
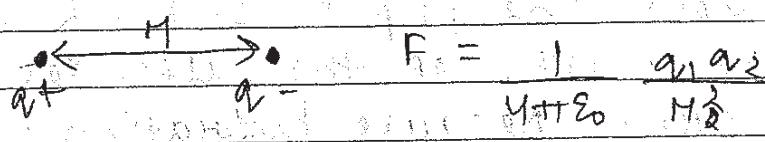
Solubility is decided by ΔH° because ΔS° is very less as entropy is increased due to formation of ions but decreased due to hydration.

Normally temp. is increased when ionic compounds are dissolved in water bcoz it is exothermic but temp. decreased when NaCl is dissolved in water.

Ionic compounds are water soluble when hydration energy of the ion is greater than lattice energy of ionic compounds.

(Solubility of NaCl and solubility of PbCl₂ in hot water is explained by entropy)





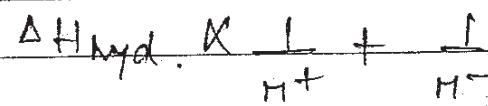
$$\text{Water} \quad \epsilon_r = 80 \quad (\epsilon_r = 80 \epsilon_0)$$

actual dielectric constant of water $= 80$ (Dielectric constant of water) $\epsilon_r = 80$ (water)

Li^+	Be^{+2}
Na^+	Mg^{+2}
K^{+}	Ca^{+2}
Rb^{+}	Sr^{+2}
Cs^{+}	Ba^{+2}

Lattice energy decreases (which favours solubility increases)

Hydration energy decreases (which favours solubility decreases)



U_X 500 unit

880 unit

G_X 300 unit

350 unit

- On moving down the group in s-block, solubility of most of the salts decreases down the group because hydration energy decreases more rapidly as compared to lattice energy.
- Exceptionally in I(A) solubility of F^- , OH^- , HCO_3^- , CO_3^{2-} increases down the group because lattice energy decreases more rapidly as compared to hydration energy.
- Exceptionally in II(A) solubility of F^- , OH^- , HCO_3^- , CO_3^{2-} increases down the group because lattice energy decreases more rapidly as compared to hydration energy.

Solubility - Rule

- 1) $\text{BaSO}_4 > \text{MgSO}_4 > \text{CaSO}_4 > \text{SrSO}_4 > \text{BaSO}_4$
- 2) $\text{BaX}_2 > \text{MgX}_2 > \text{CaX}_2 > \text{SrX}_2 > \text{BaX}_2$
- 3) $\text{BaCO}_3 > \text{MgCO}_3 > \text{CaCO}_3 > \text{SrCO}_3 > \text{BaCO}_3$
- 4) $\text{BaS}_2\text{O}_3 > \text{MgS}_2\text{O}_3 > \text{CaS}_2\text{O}_3 > \text{SrS}_2\text{O}_3 > \text{BaS}_2\text{O}_3$
- 5) $\text{BaSO}_3 > \text{MgSO}_3 > \text{CaSO}_3 > \text{SrSO}_3 > \text{BaSO}_3$
- 6) $\text{LiBr} > \dots > \text{CsBr}$
- 7) $\text{LiCO}_3 < \dots < \text{Cs}_2\text{CO}_3$
- 8) ~~$\text{LiHCO}_3 < \dots < \text{Cs}_2\text{HCO}_3$~~
- 9) $\text{LiOH} < \dots < \text{CsOH}$
- 10) $\text{Be(OH)}_2 < \dots < \text{Ba(OH)}_2$
- 11) $\text{LiF} < \dots < \text{CsF}$

- X) $\text{BeF}_3 < \text{LiF} < \text{BaF}_2$
 13) $\text{LiCl} > \text{NaCl} > \text{CsCl}$

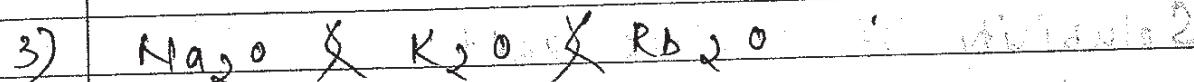
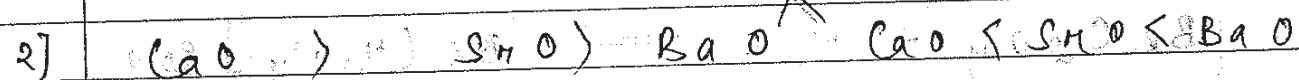
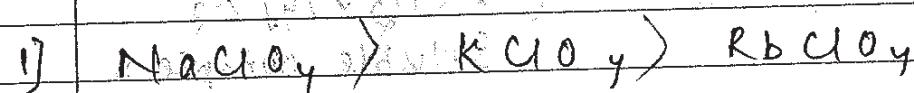
Q. What is most soluble sulphate of alkali earth metal?

- (A) BaSO_4 (B) SrSO_4 (C) MgSO_4 (D) BeSO_4

Q. Saturated solution of which salt have max. conc. of CrO_4^{2-} ions

- (A) CaCrO_4 (B) SrCrO_4
 (C) BaCrO_4 (D) All have same

Q. Write order of solubility.



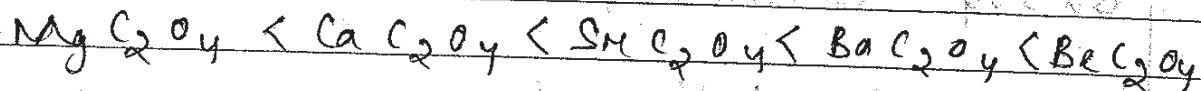
Q. Electrostatic forces b/w ions in water decreases to

- (A) 1% (B) 99%
 (C) 82% (D) 18%

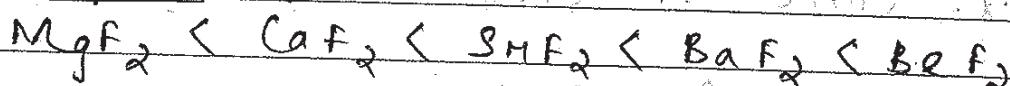
$$\frac{\text{f}_{\text{dist}}}{\text{f}_{\text{dist}}} = \frac{\sin F - F}{\sin F + F} = \frac{81F}{81F + 18F} = \frac{81}{99} = 10.2 \times 100 = 10.2\%$$

Solubility trends of s-block oxides and sulphides are same as hydroxides because sulphide and oxide react with water and produce corresponding hydroxide

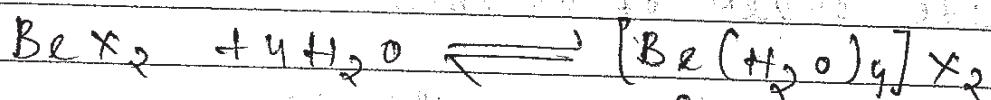
8) Exception



12) Exception



13) Exception



Soluble complex



Solubility of s-block salt

→ Regular trends

→ Exceptions of IA (F^- , OH^- , HCO_3^- , CO_3^{2-})

II A (F^- , OH^- , HCO_3^- , $\text{C}_2\text{O}_4^{2-}$)

→ Solubility trends of oxide, sulphides are same as hydroxide.

→ BeX_2 & BeC_2O_4 are fairly soluble.

→ $\text{LiF} < \text{NaF} < \text{KF} < \text{RbF} < \text{CsF}$ OK

$\text{LiCl} > \text{NaCl} \rightarrow \text{CsCl} \times$

$\text{LiCl} > \text{CsCl} > \text{RbCl} > \text{KCl} > \text{NaCl}$ OK

$\text{LiB}_4 > \text{NaB}_4 > \text{KB}_4 > \text{RB}_4 > \text{CB}_4$ OK

$\text{Li}^+ > \text{Na}^+ > \text{K}^+ > \text{Rb}^+ > \text{Cs}^+$

$\text{Na}^+ > \text{Li}^+ > \text{K}^+ > \text{Rb}^+ > \text{Cs}^+$ OK.

\rightarrow ionic.

$\text{MP} = \text{NaCl} > \text{KCl} > \text{RbCl} > \text{CsCl} > \text{LiCl}$

$\text{Th. Stability} = \text{LiCl} > \text{NaCl} > \text{KCl} > \text{RbCl} > \text{CsCl}$

\downarrow
covalent.

Molecular Orbital Theory (MOT)

$\text{Zn}^{+2} = [\text{Ar}] 3d^10$ Zn S white

$\text{Cd}^{+2} = [\text{Kr}] 4d^10$ Cd S yellow

$\text{Hg}^{+2} = [\text{Xe}] 4f^14 5d^10$ Hg S black

orange.

real ionic radius of Zn^{+2}

real ionic radius of Cd^{+2}

Cd^{+2} = most?

Hg^{+2} - most of HgCl_2

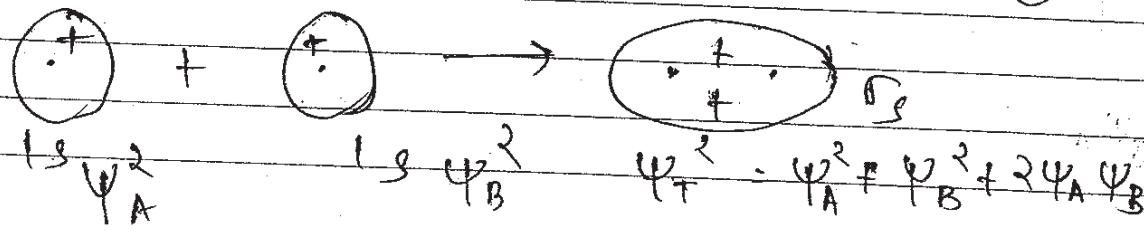
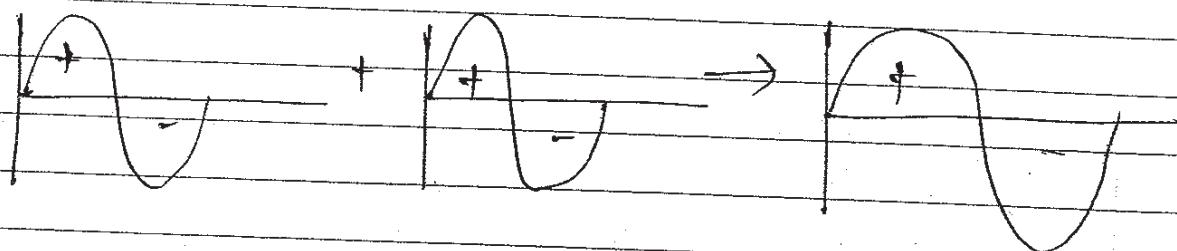
undissociated

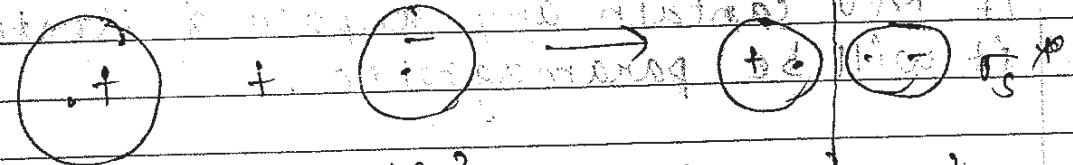
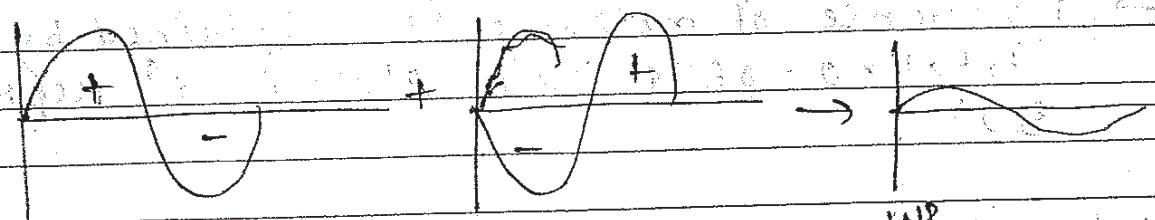
in water

Polarising power $\text{Zn}^{+2} < \text{Cd}^{+2} < \text{Hg}^{+2}$

Molecular Orbital Theory (MOT)

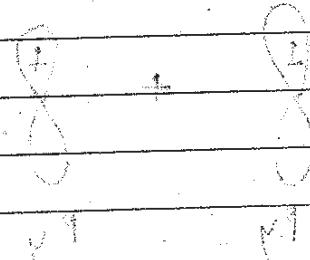
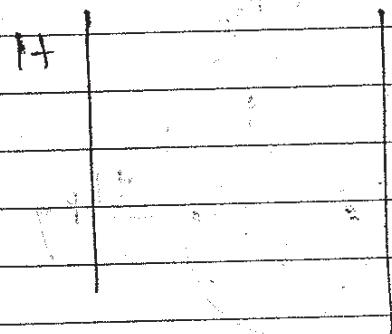
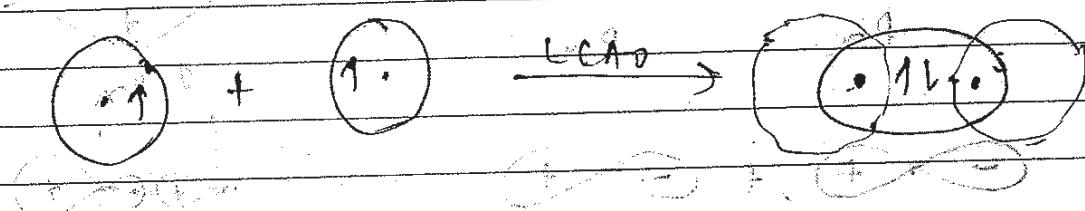
- VBT does not explain odd electron molecules, paramagnetic nature of O_2 , hyperconjugation, aromatic character and colouration by various covalent compounds.
- According to VBT only valence shell e^- participate in bonding but according to MOT all the e^- s participate in molecule formation.
- According to VBT, atomic orbitals maintain their identity even in molecule but according to MOT, atomic orbitals lose their identity and e^- s are present in molecular orbitals.
- Molecular orbitals are defined as space inside molecule where the probability of finding electron is maximum.
- Electron in MO is characterized by n, l, λ, s .





$$\Psi_A^2 + \Psi_B^2 = \Psi_T^2$$

$$\Psi_T^2 = \Psi_A^2 + \Psi_B^2 - 2\Psi_A\Psi_B$$



→ Formation of molecular orbitals is explained by LCAO (Linear Combination of Atomic Orbitals)

→ By LCAO, generally two types of MO are formed -

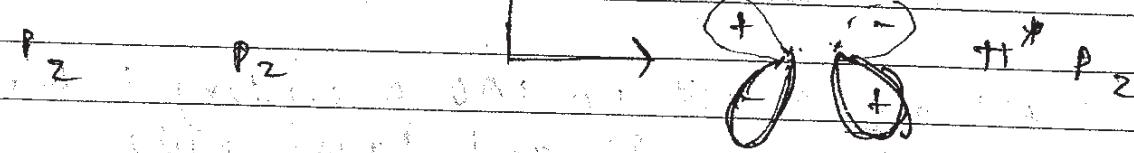
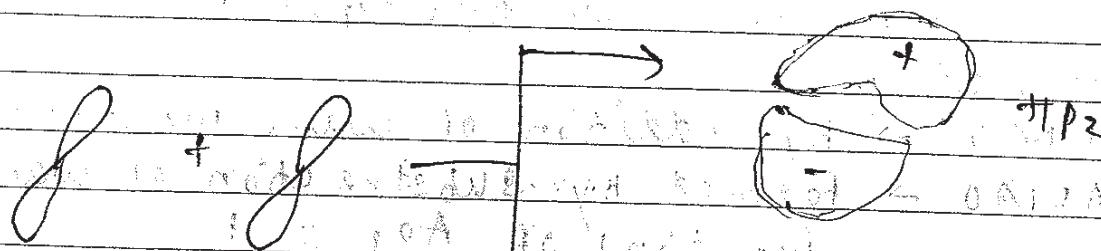
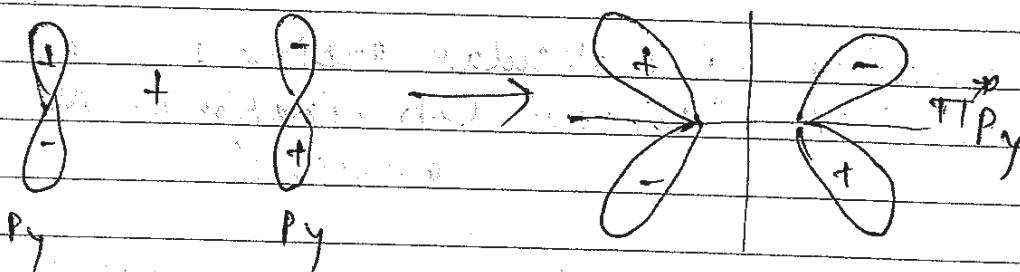
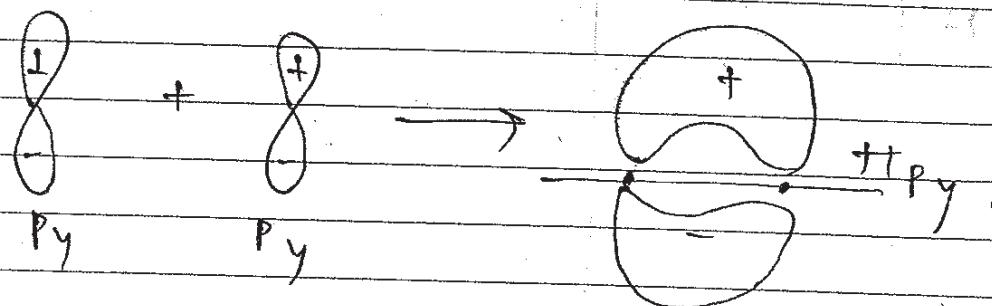
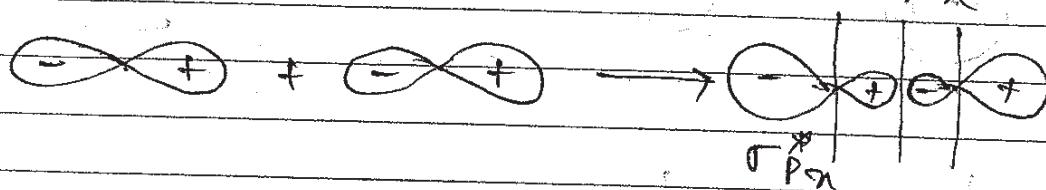
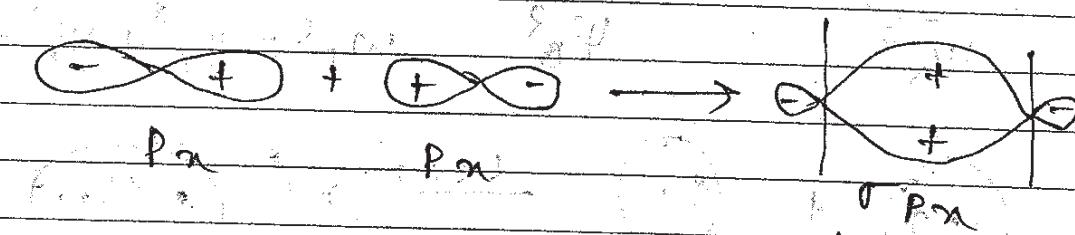
BMO → by addition of wave functions

ABMO → formed by subtraction of wave functions of AOs.

→ Electrons added in MO according to Aufbau rule, Hund rule and Pauli rule,

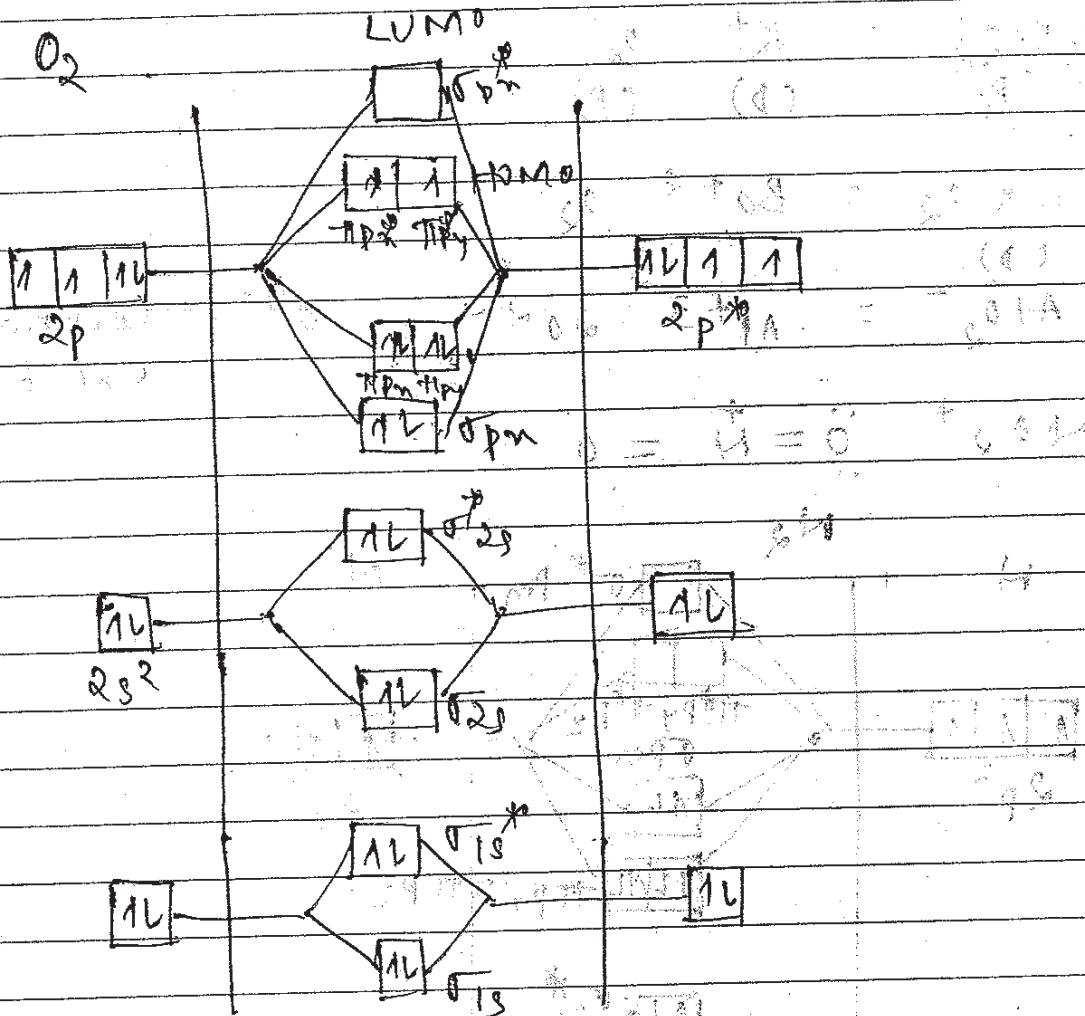
→ Existence of molecule is explained by BO (total no. of e^- pair stabilized & represented BO).

→ If MO contain any unpaired electron, it will be paramagnetic.



O_2^+ - d'oxygénium O_2^- - superoxyde
d'oxygényl

Date []



$$O_2 = 1s^2, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2 \left[+^* 2p_x^3, +^* 2p_y^1, +^* 2p_z^1 \right]$$

$$O_2 = KK, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2, 1s^2 \left[+^* 2p_x^3, +^* 2p_y^1, +^* 2p_z^1 \right]$$

$$BO = 2 (1\sigma, 1\pi)$$

(Paramagnetic)

$$\text{BO} = 2 (1\sigma, 1\pi) \quad \mu_B = 0.0$$

$$\text{BO} = 2 (1\sigma, 1\pi) \quad \mu_B = 0.0$$

$$O_2^{+1} \quad O_2 \quad O_2^{-1}$$

$$BO = 1 + 1 - \frac{1}{2} \quad BO = 2 \quad BO = \frac{1}{2} + 1 = 1.5$$

$$= 2.5$$

Date

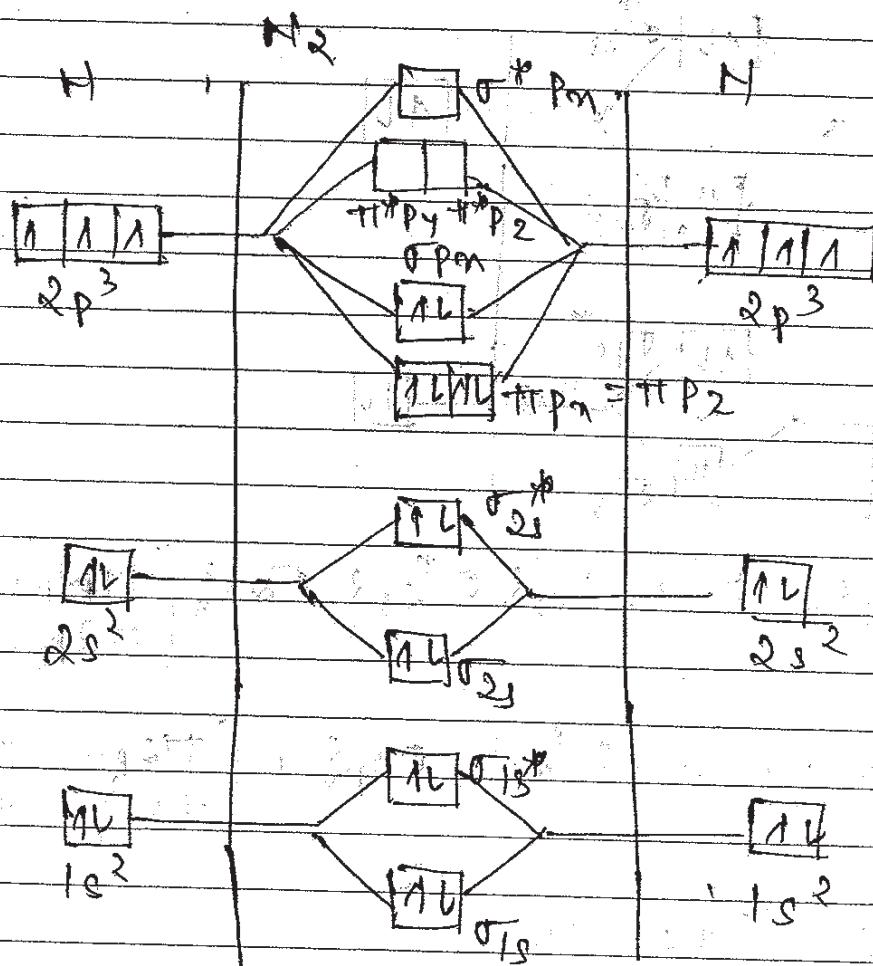
$$\frac{K_0}{(P)^2} = K^+ \frac{\partial^-}{(P)}$$

$$Ba\partial_2 = Ba^+ \partial_2^+$$

(D)

$$Al\partial_2^- = Al^+ \partial_2^- \quad O^{4-} - \text{does not exist}$$

$$Ne\partial_2^+ \quad \partial = N = O$$

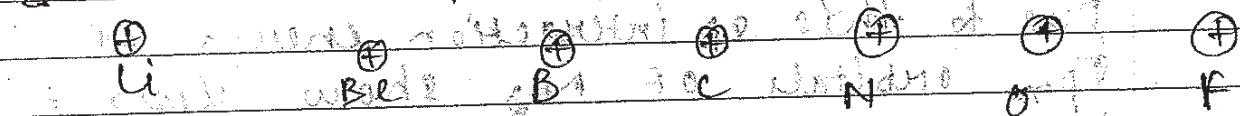
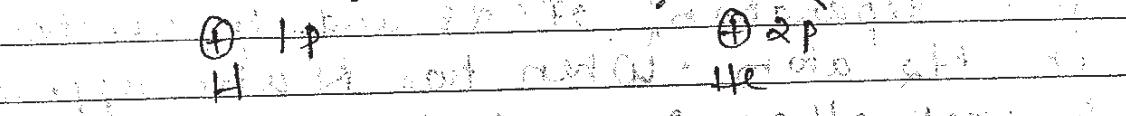


$$N_2 \quad BO = 3 \quad (1\sigma, 2\pi) \\ (\text{Diamagnetic})$$

$$IE = N < N_2$$

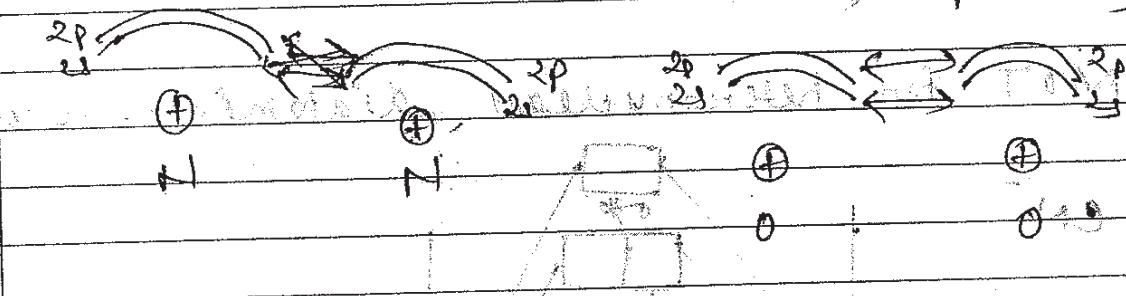
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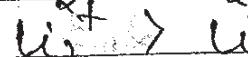
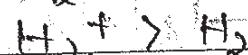
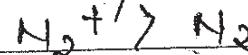


S-p mixing

No s-p mixing



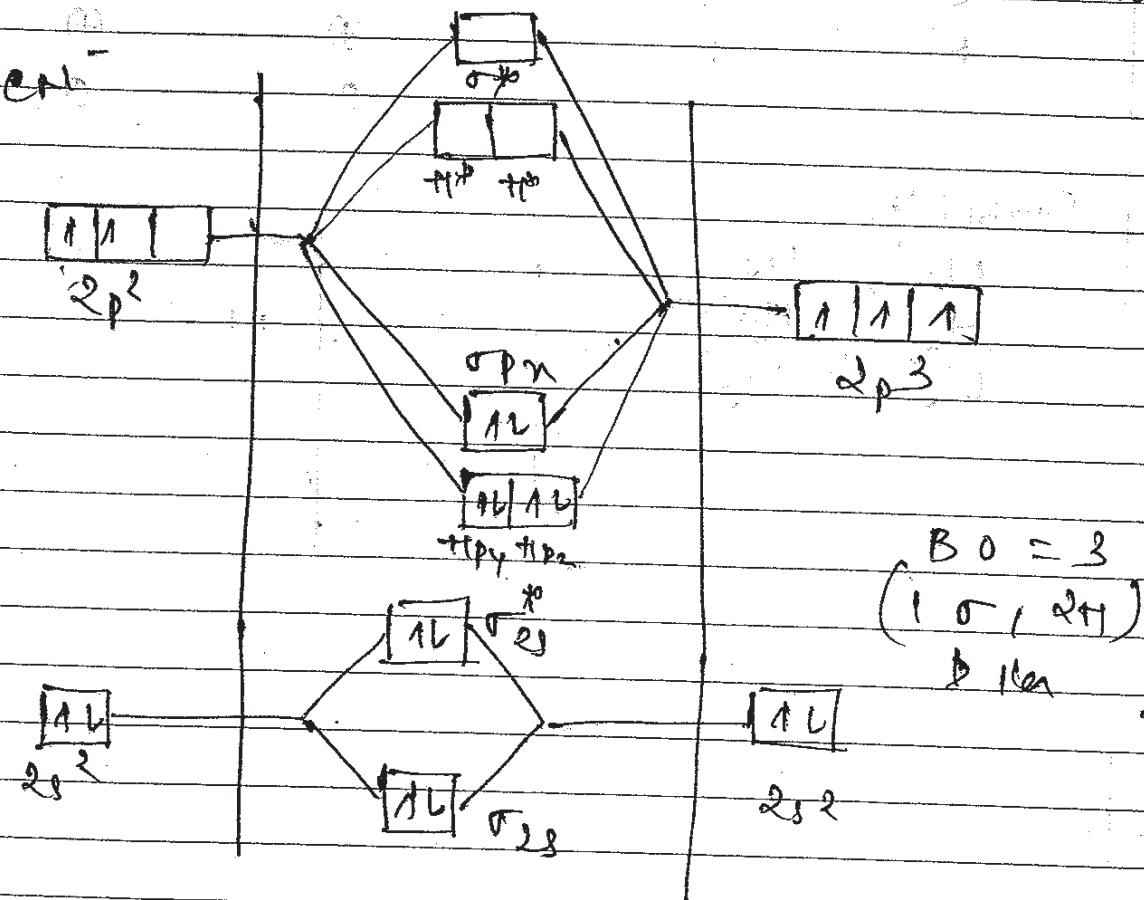
Stability

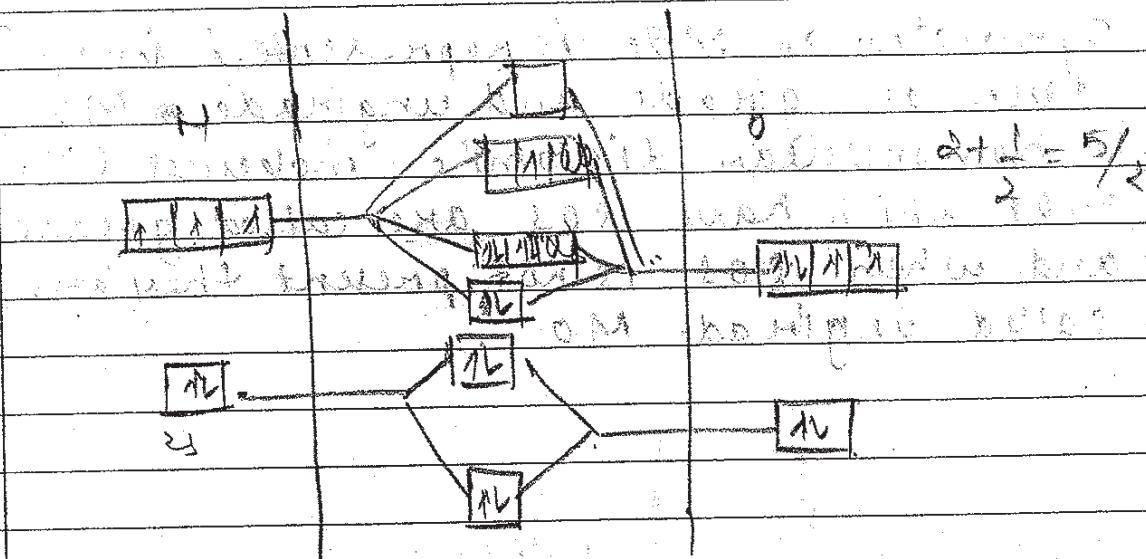


MO diagram of N_2 is slightly different from MO diagram of O_2 due to less separation of $2s$ and $2p$ orbital energy in N_2 atom. When two N atom approach to each other $2s$ orbital of 1 N interact with $2p$ orbital of other N. It is called sp mixing or cp interaction. Due to this sp interaction energy of $2p_{\pi}$ orbitals of N_2 show upward displacement.

Effect of sp mixing are also observed in B_2 and C_2 .

MOT for heteronuclear diatomic molecule.





Q1. Which of the following is non-existing?

- A) Be_2 B) H_2^{2+} C) He_2 D) H_2^{2-}

Q2. Which of the following do not exist as diatomic molecular ion?

- A) F_2^- B) Ne^{2+} C) C_2^{2-} D) O_2^{4-}

Q3. Which of the following have CO_2 as a bonding pair?

- A) H_2P_4 B) H^*P_4 C) F_2 D) F_2^*

Q4. Which have a nodal plane which contains passing through internuclear axis?

- A) σ_{2z} B) σ^*_{2z} C) H_2P_4 D) σ_{pn}

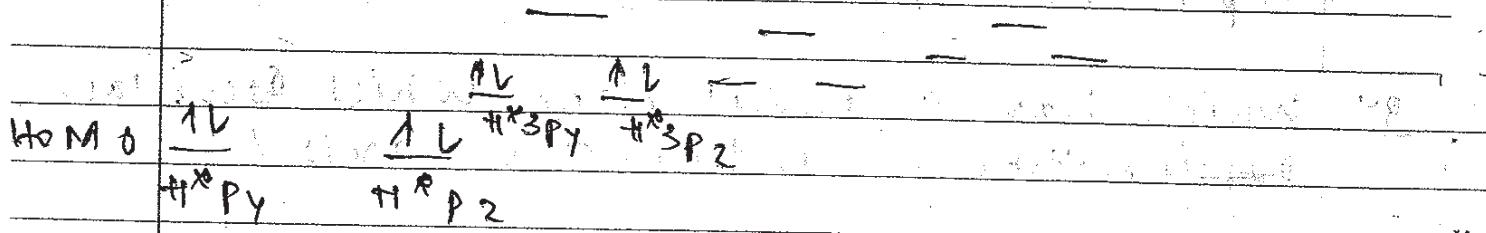
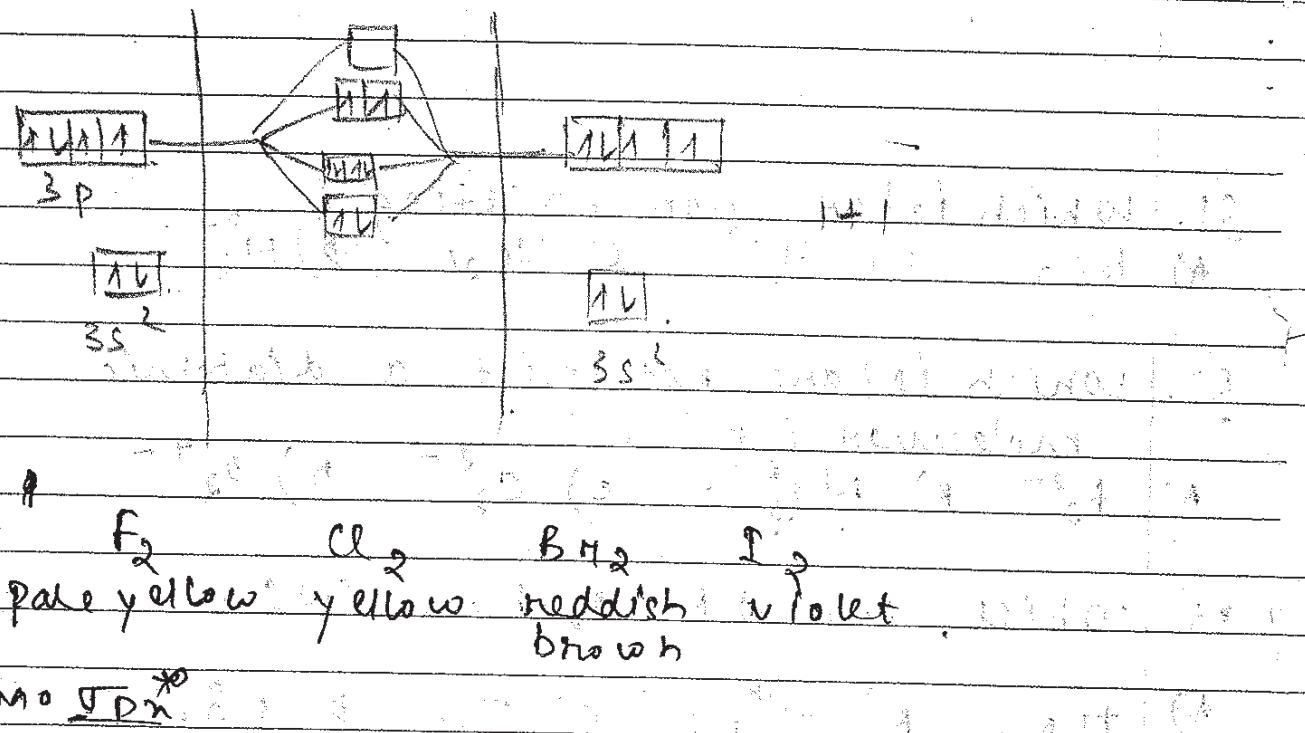
Q5. Write order of IE of $\text{O}_2, \text{N}_2, \text{N}$

$$\text{N}_2 > \text{N} > \text{O}$$

- Improper orientation
- Improper energy

Date / /

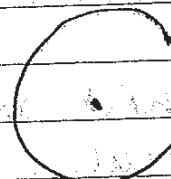
Symmetry of MOs is represented by the term of gerade and ungerade σ MO. In homonuclear diatomic molecules (X_2) type MOs which have σ s are called gerade and when σ s is not present they are called ungerade MO.



Coloration of halogen - due to HOMO-LUMO transition

Date

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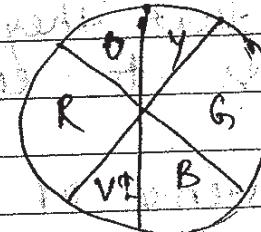
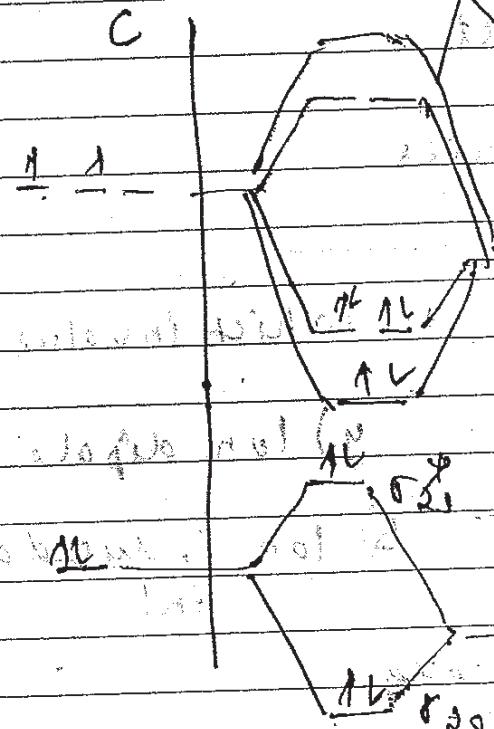
 $\text{NaCl} = \text{white}$ $\text{NaBH}_4 = \text{white}$ $\text{NaI} = \text{white}$ (Na⁺)

less polarising power

 $\text{AgCl} = \text{white}$ $\text{AgBH}_4 = \text{pale yellow}$ $\text{AgI} = \text{yellow}$ (Ag⁺)(I⁻)

High

polarising power

 $\text{ZnS} = \text{white}$ $\text{CdS} = \text{yellow}$ $\text{HgS} = \text{orange, black / red}$  CO  CO

$$\text{BO} = 3$$

$$10, 2\pi$$

 $\text{IL} \text{ I } \text{ L DIA}$ $(\text{C} - \text{O})$

$$1.1288$$



$$\text{BL} = 1.1157^\circ$$

Weak forces (Inter Particle forces)

- Forces which are responsible for association of molecules are called weak forces or inter particle forces.
- Energy released during the formation of inter molecular interaction is very small so that they are called weak forces.
- Weak forces are maintained when thermal energy is smaller than energy of interaction.
- Weak forces are distance sensitive forces so that they exist when particles are close to each other.
- Existence of weak forces is supported by
 - 1) Non ideal behaviour of real gases
 - 2) Liquefaction of gases
 - 3) Joule - Thomson effect

Weak Forces

which does not involve ion which involves ion

- | | |
|---|----------------------------|
| 1) Dipole Dipole interaction
(Keesom) | 4) Ion dipole int. |
| 2) Dipole induced dipole int.
(Dipole) | 5) Ion induced dipole int. |
| 3) Instantaneous dipole-induced dipole (London) | |

Dipole-Dipole Interaction

Q1. In which process dipole-dipole interaction is involved?

- A) Association of molecules of benzene
- B) Dissolution of HgI₂ in chlorobenzene
- C) " in nitrobenzene with dichlorobenzene
- D) At room temperature o-dichlorobenzene

Q2. In which process dipole-dipole interactions is required to break?

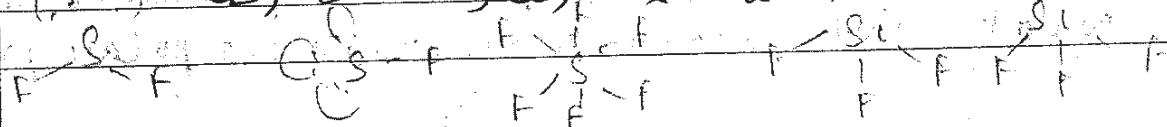
- A) $\text{H}_2\text{O}(\text{g}) \rightarrow 2\text{H}(\text{g}) + \text{O}(\text{g})$
- B) $\text{NaCl}(\text{s}) \rightarrow \text{Na}(\text{g}) + \text{Cl}(\text{g})$
- C) $\text{CH}_3\text{C} = \text{CF}_3 \rightarrow \text{CH}_3 + \text{CF}_3$
- D) $\text{NF}_3(\text{l}) \rightarrow \text{NF}_3(\text{g})$
- E) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$

Q3. When polar molecules A-B type are associated which arrangement is observed?

- A)   \rightarrow Anti-parallel arrangement.
- B) 
- C)  \rightarrow Head-to-tail arrangement in fatty molecule
- D) 

Q4. Liquid phase of which substance is formed due to dipole-dipole interaction?

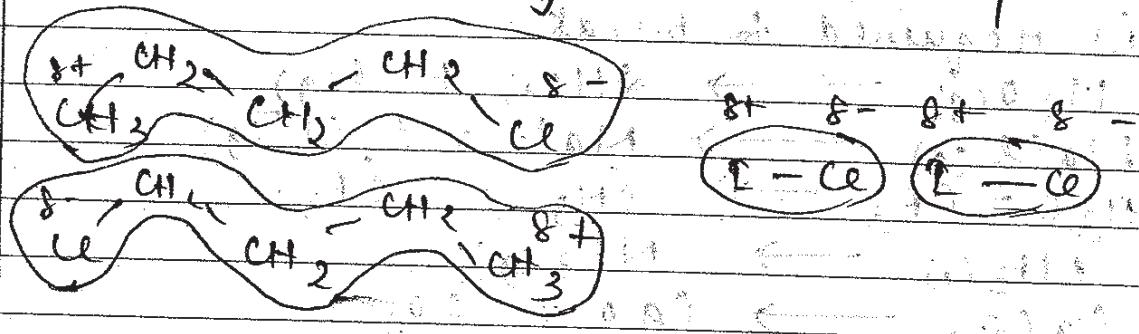
- A) SF₆(l)
- B) SF₄(l)
- C) SF₆(g)
- D) SiF₄(l)
- E) SiHF₃(l)
- F) H₂O(l)



Allotropes of Carbon

- Strongest vanderwaal forces
- Interactions b/w polar molecules is explained by dipole-dipole interactions
- Two types of arrangements are possible w.r.t. by dipole-dipole interaction

 - a) Anti-parallel arrangement in flat molecules.
 - b) End-to-end arrangement in fatty molecules.



- Hydrogen bonding is a special case of dipole-dipole interaction

Dipole Induced Dipole Interaction

- Interaction b/w polar and non polar particles is explained by dipole induced dipole int.
- Dipole of a polar molecule is capable to induce dipole in a non polar particle by polarization of e^- cloud.
- Polarized non polar particle produce very weak interaction with adjacent polar particles.

→ Solubility of inert gases in water increases on moving down the group. It is explained by dipole induced dipole interaction.

Q1 H-Cl is 100% ionic (T/F)

→ 100% ionic bond is formed between H and Cl.

Q2 H-Cl is 100% covalent (T/F)

→ 17% ionic character among H-Cl.

Q3 H-H bond is 100% covalent (T/F)

→ 100% covalent bond is formed between H and H.

Q4 H-Cl bond have permanent dipole (T/F)

Q5 H-H " " " " " (T/F)

Q6 H-H bond can have temporary dipole (T/F)

Instantaneous Dipole - Induced Dipole Interaction (London Dispersion Forces)

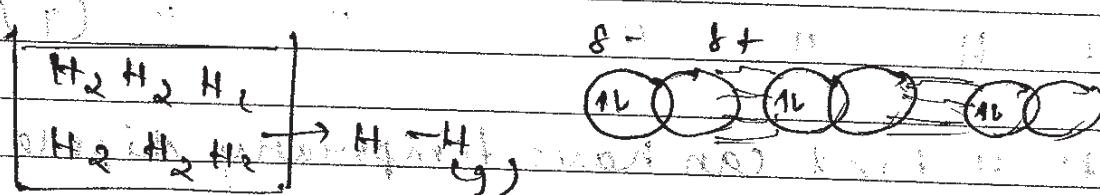
→ Interaction b/w non polar particles is explained by inst. dipole induced dipole interaction.

→ Inst. polarity is arises in a non polar particle due to momentary imbalance of the e^- cloud.

→ Inst dipole of a molecule is capable to induce dipole in adjacent non polar particle due to polarisation, and responsible for the

Interaction b/w both particle

- This effect is dispersed b/w other adjacent molecules so that it is also called London dispersion forces.
- These type of forces are maintained due to synchronisation of the electronic movements (upto some extent).
- London forces are the weakest type of vanderwaal forces.



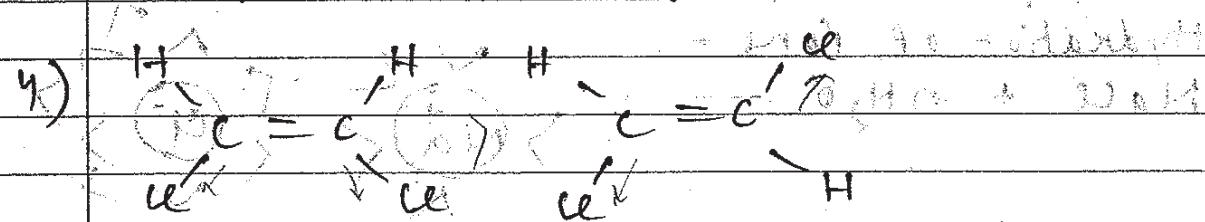
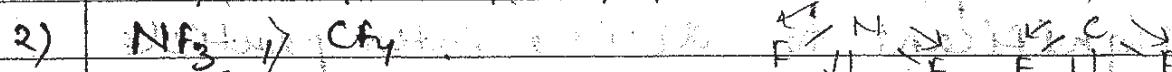
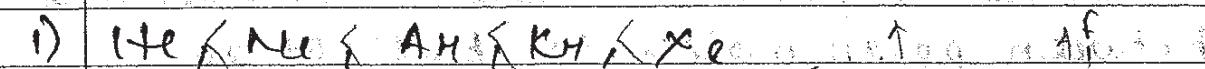
$2\text{H}^+ \text{H}^- = 98\%$ } 98% Covalent

$\text{H}^+ \text{H}^- 1\%$ } 2% Ionic
 $\text{H}^- \text{H}^+ 1\%$

Select correct order of polarizability

- A) He < Ne
- B) Xe < Ne
- C) F₂ < Cl₂
- D) I₂ < Cl₂

Q. Write order of BP among the following molecules



Q. Which have highest heat of vaporization

- A) H_2O B) H_2S C) H_2Se D) H_2Te

Q. London forces are present b/w molecules having force

- A) Molecules of CH_4 in NaCl lattice.

- B) " " CH_3F .

Q. Which are molecular solid

white P - molecular
black P - covalent
Iodine - molecular

- A) $\text{KBr}(\text{s})$ B) Diamond C) Dry Ice

- D) Rhombic Sulphur E) Gold

Q. Select correct code -

(I) (II)

- (P) n-pentane - 1) Gas

- (Q) n-decane - 2) low boiling liquid

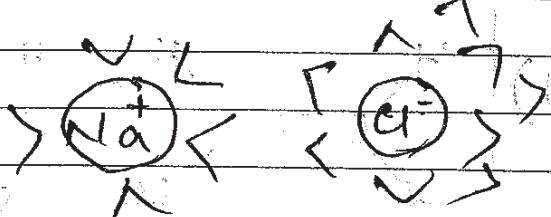
- (R) methane - 3) high boiling liq.

- (S) n-icosane - 4) waxy solid.

→ London forces arise due to distortion in e^- cloud so that they are also observed between polar molecules but not so significant to decide inter particle interaction.

4) Ion Dipole Interaction

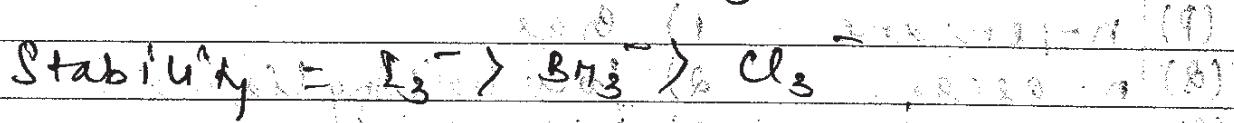
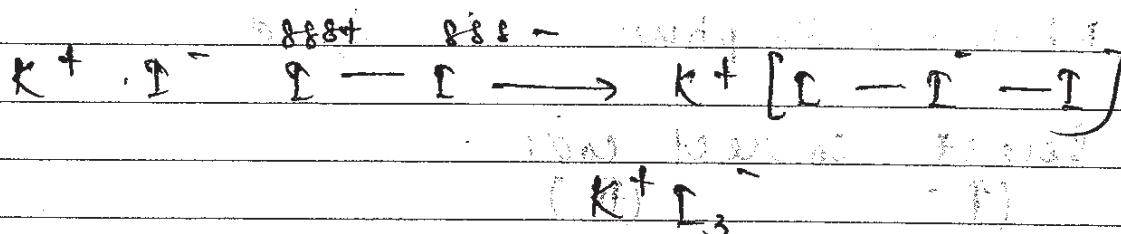
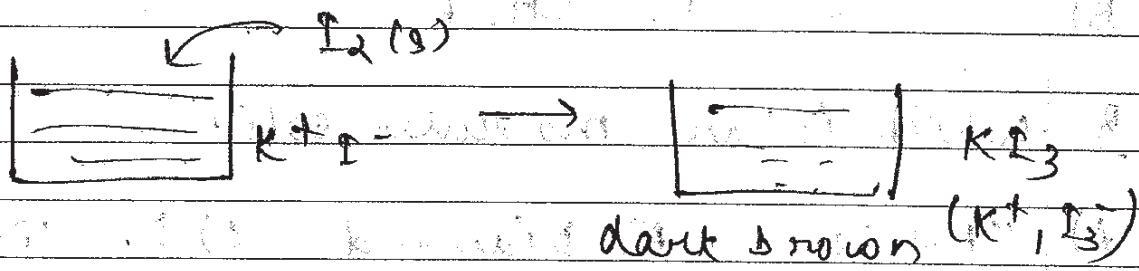
→ Hydration of Ions -



→ Ammoniation of Ions

5) Ion Induced Dipole Interaction

→ I_2 has very solubility in water but solubility of I_2 increases in water in the presence of KI . This is due to the formation of KI_3 .



Q. Write order of BP An

- 1) $H_2O > H_2S$

2) $H_2S > CH_4$

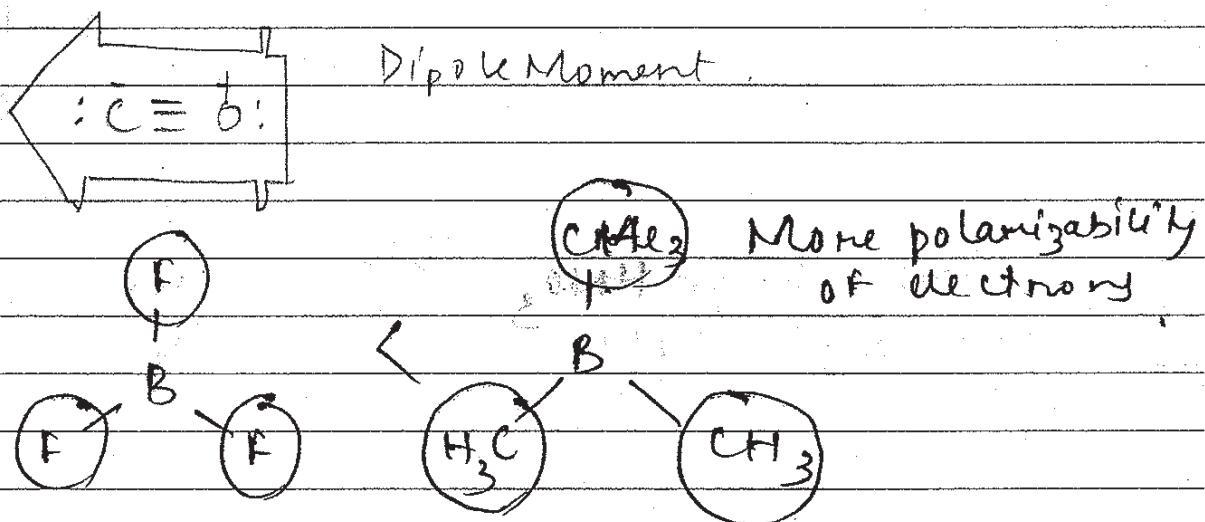
3) $H_2S < H_2SO$

4) $H_2 > He$

5) $H_2 < D_2 < T_2$
20K 23K 25K

Q. Which is most volatile

- (A) n - pentane
(B) 2,2 di methyl propane



$$M\omega + = \delta +$$

$$M_w = 55$$

$$\text{No. of e}^- = 32$$

$$\text{No. of e}^{-} = 32$$

Tonic E Δ

$$\text{Ion-dipole} \quad F \propto \frac{1}{r^2}$$

$$\text{dipole-dipole} \quad E \propto \frac{1}{M^3} \quad E \propto \frac{1}{M^6}$$

solid gas

Ion - Induced
dipole

$\text{Ex } 1$

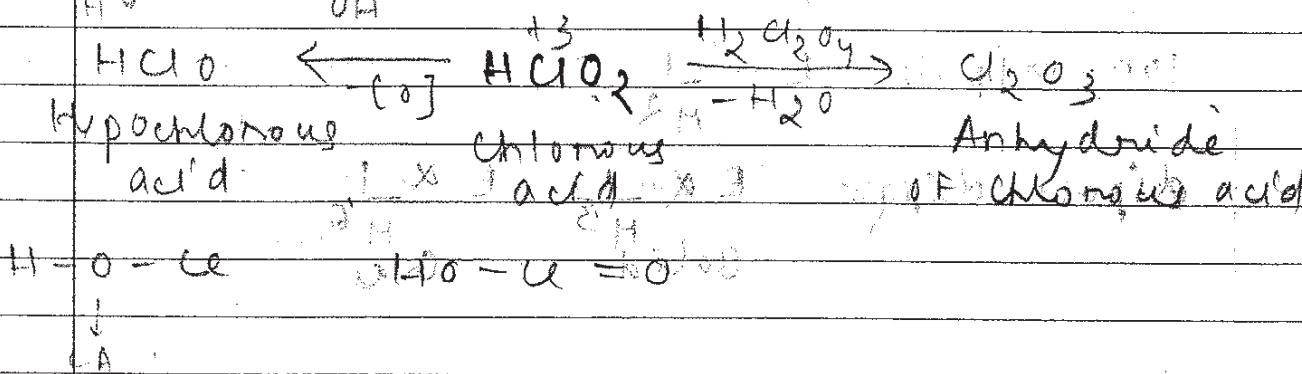
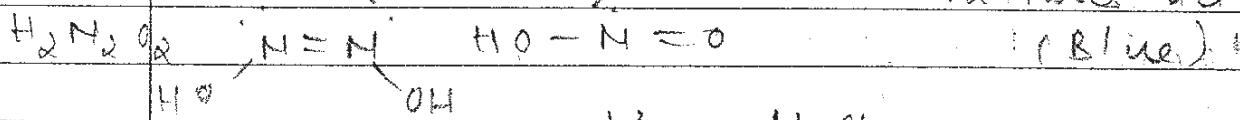
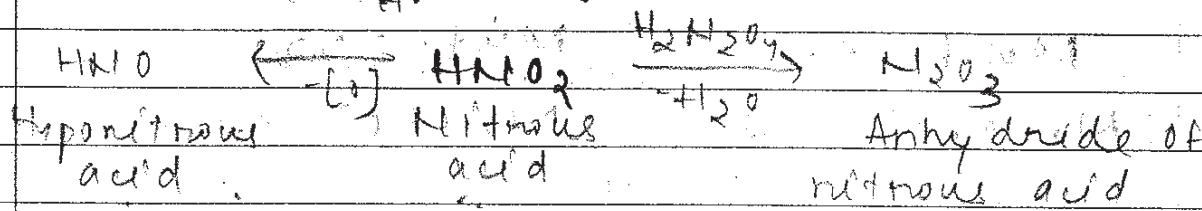
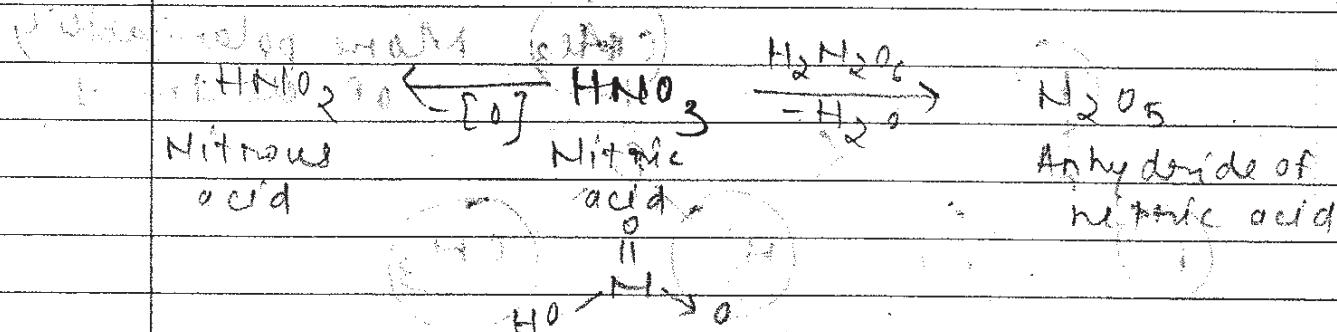
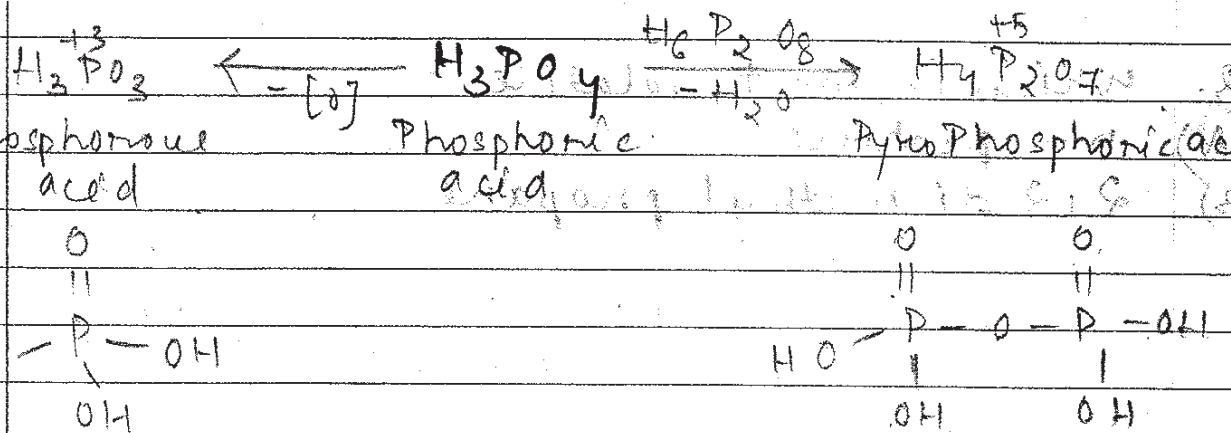
H_4

Dipole Induced dipole

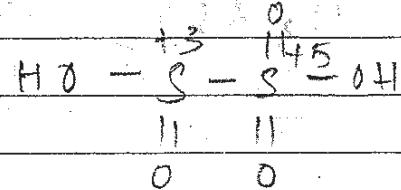
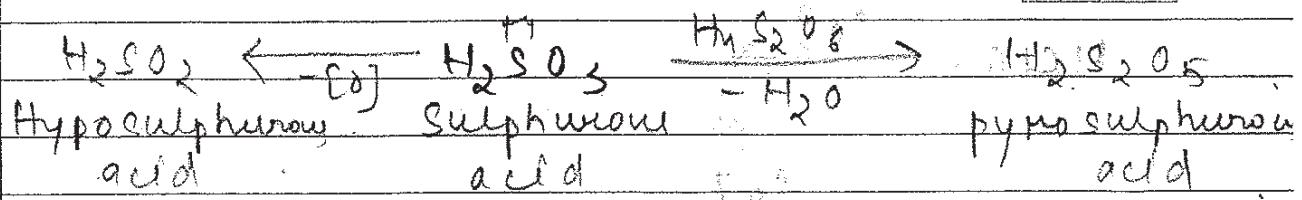
$\text{Ex } 1$

Instant. dipole Induced dipole

$\text{Ex } 1$



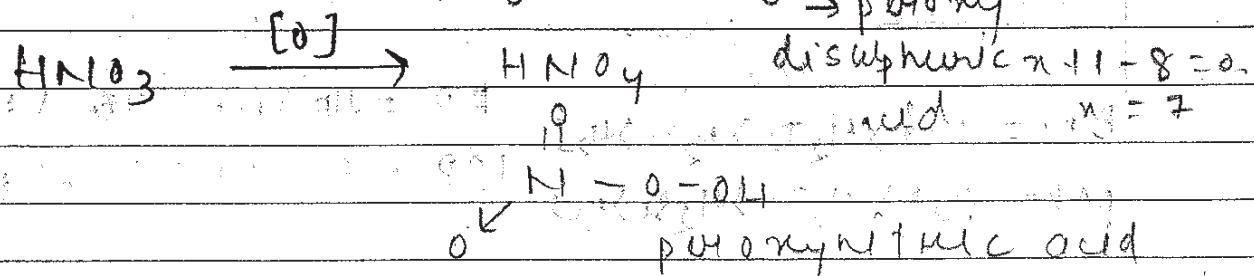
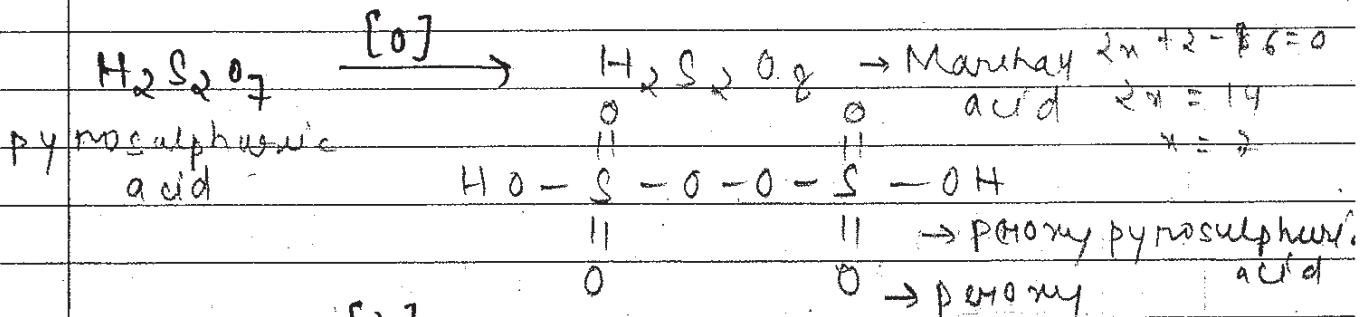
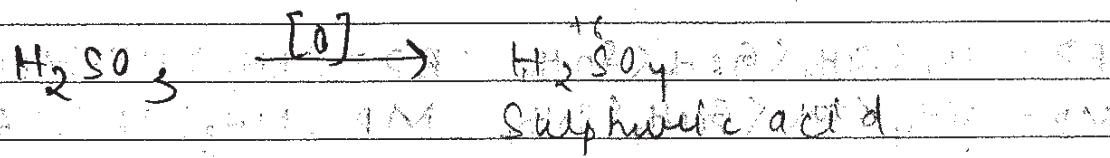
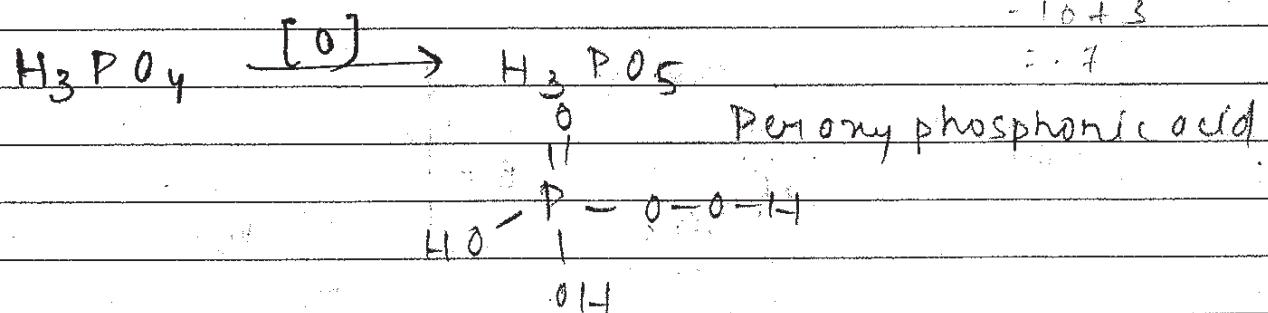
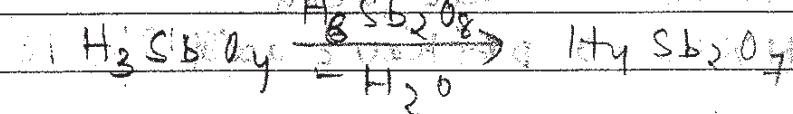
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Pyroantimonic acid

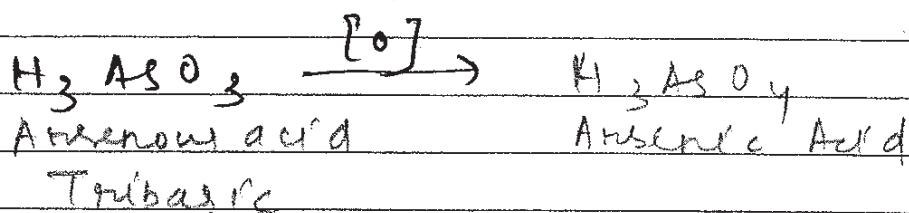
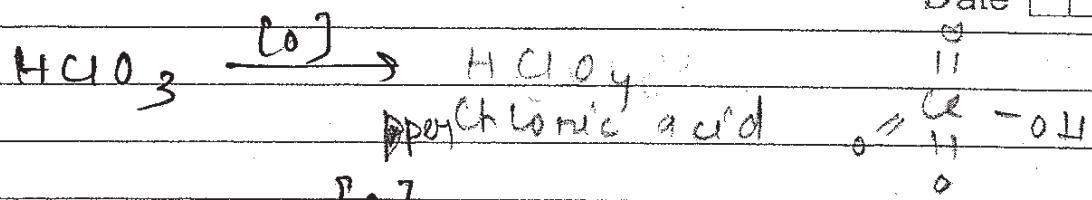
Bitter taste & irritant

White solid & irritant



Date

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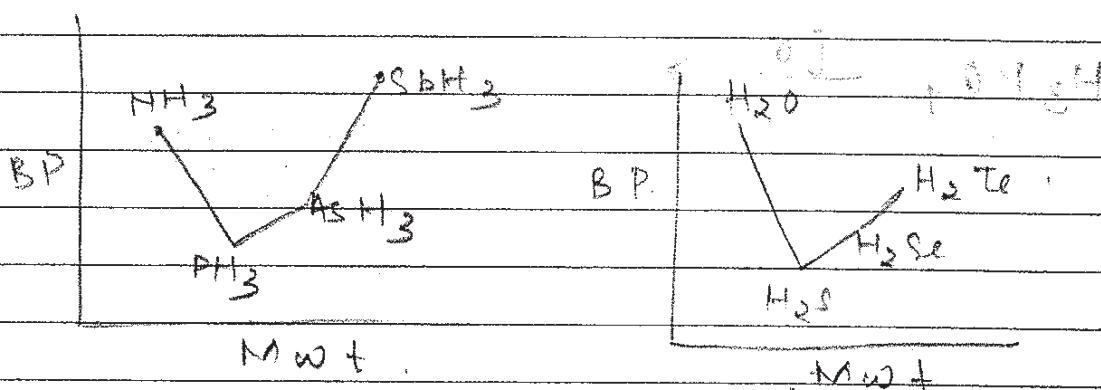


$\text{HXO} \rightarrow$ hypohalous acid

$\text{HXO}_2 \rightarrow$ halous acid

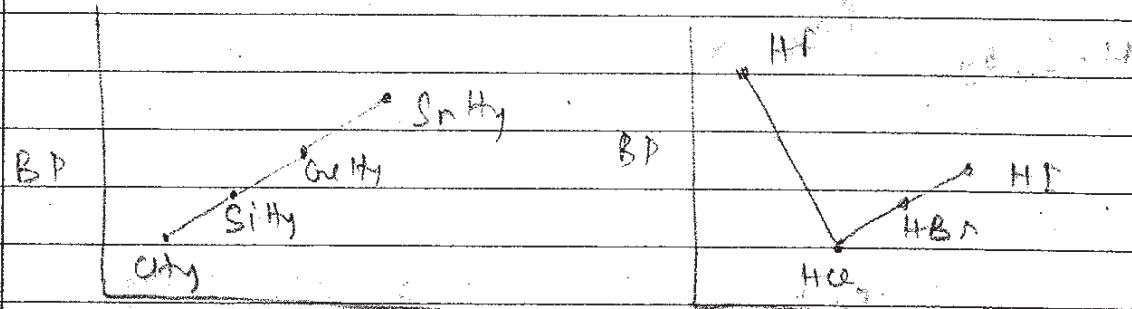
$\text{HXO}_3 \rightarrow$ halic acid

$\text{HXO}_4 \rightarrow$ perhalic acid



$$\text{BP} = \text{CH}_3 < \text{SiH}_3 < \text{GeH}_3 < \text{SnH}_3 \quad \text{BP} = \text{SbH}_3 > \text{NH}_3 > \text{AsH}_3 > \text{PH}_3$$

$$\text{MP} = \text{SiH}_3 < \text{CH}_3 < \text{GeH}_3 < \text{SnH}_3 \quad \text{MP} = \text{NH}_3 > \text{SbH}_3 > \text{AsH}_3 > \text{PH}_3$$

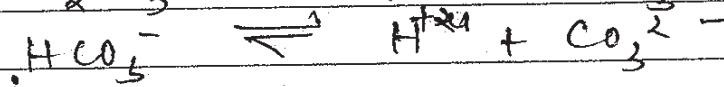
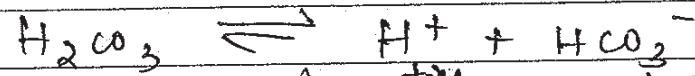
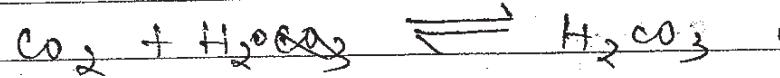
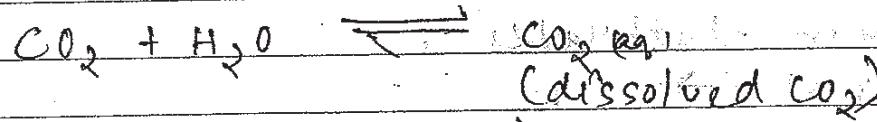


$$\text{BP} = \text{H}_2\text{O} > \text{H}_2\text{Te} > \text{H}_2\text{Se} > \text{H}_2\text{S}$$

$$\text{MP} = \text{H}_2\text{O} > \text{H}_2\text{Te} > \text{H}_2\text{Se} > \text{H}_2\text{S}$$

$$\text{BP} = \text{HF} > \text{HI} > \text{HBr} > \text{HCl}$$

$$\text{MP} = \text{HF} > \text{HI} > \text{HBr} > \text{HCl}$$



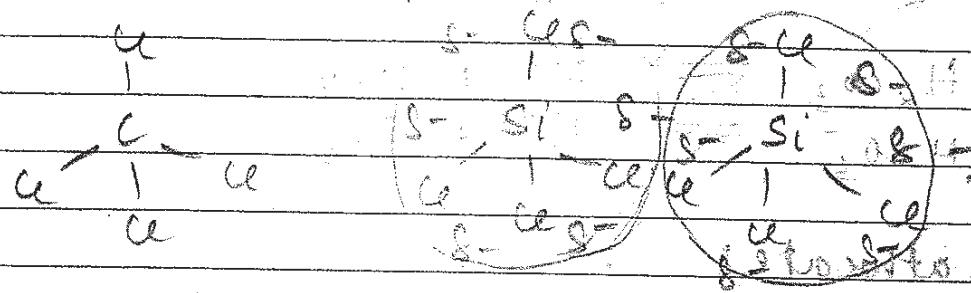
Clathrates :

- When Xe dissolve in water, during the freezing process atoms of Xe are trapped in the voids of cage like structure of ice.
- Clathrate formation ability increases on addition of quinol in water.
- Clathrates are non stoichiometric and only Debye forces are responsible for their formation.
- Once clathrates are formed atoms of inert gases are physically trapped in the voids of ice.
- Except He and Ne, all the inert gases can form clathrates.
- Clathrates are destroyed on melting of ice and dissolution of clathrates in suitable solvent.
- Some other gases, $\text{O}_2, \text{N}_2, \text{CO}_2, \text{CO}, \text{SO}_2$ can

also form clathrates.

Exceptions →

- 1) BP : $\text{CCl}_4 > \text{SiCl}_4$



$$\text{EN} = \text{Cl} = 3.0$$

$$\text{EN of Cl} = 3.0$$

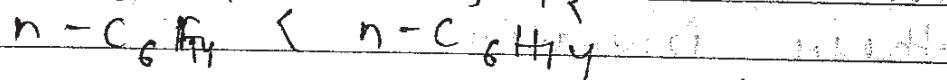
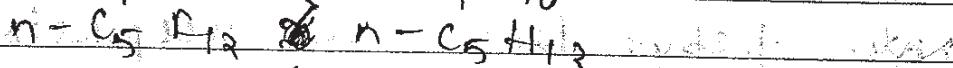
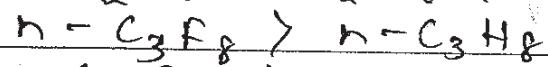
$$\text{EN} = \text{C} = 2.5$$

$$\text{EN of C} = 2.5$$

$$0.5$$

$$0.2$$

- 2) BP : $\text{CF}_4 > \text{CH}_4$

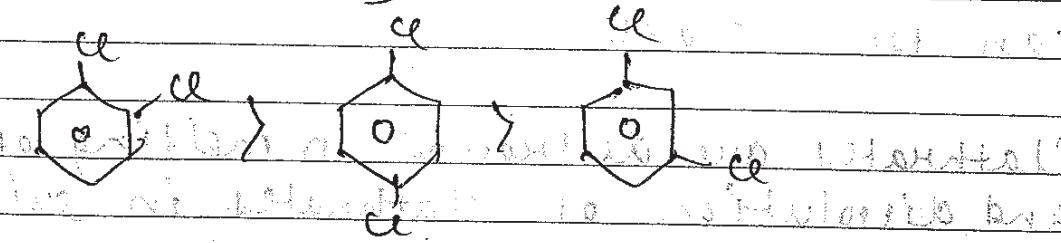


Repulsion increases

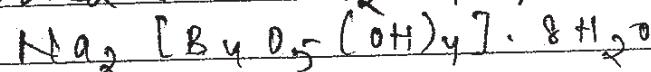
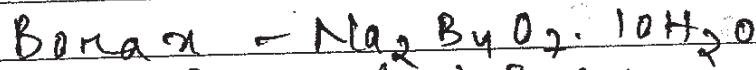
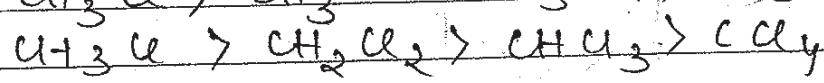
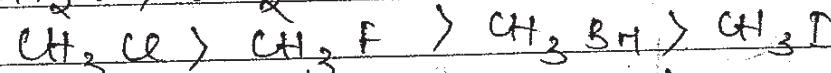
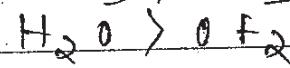
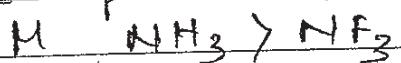
- 3) $\text{H}_2 > \text{He}$

- 4) $\text{BF}_3 < \text{BMe}_3$

- 5)

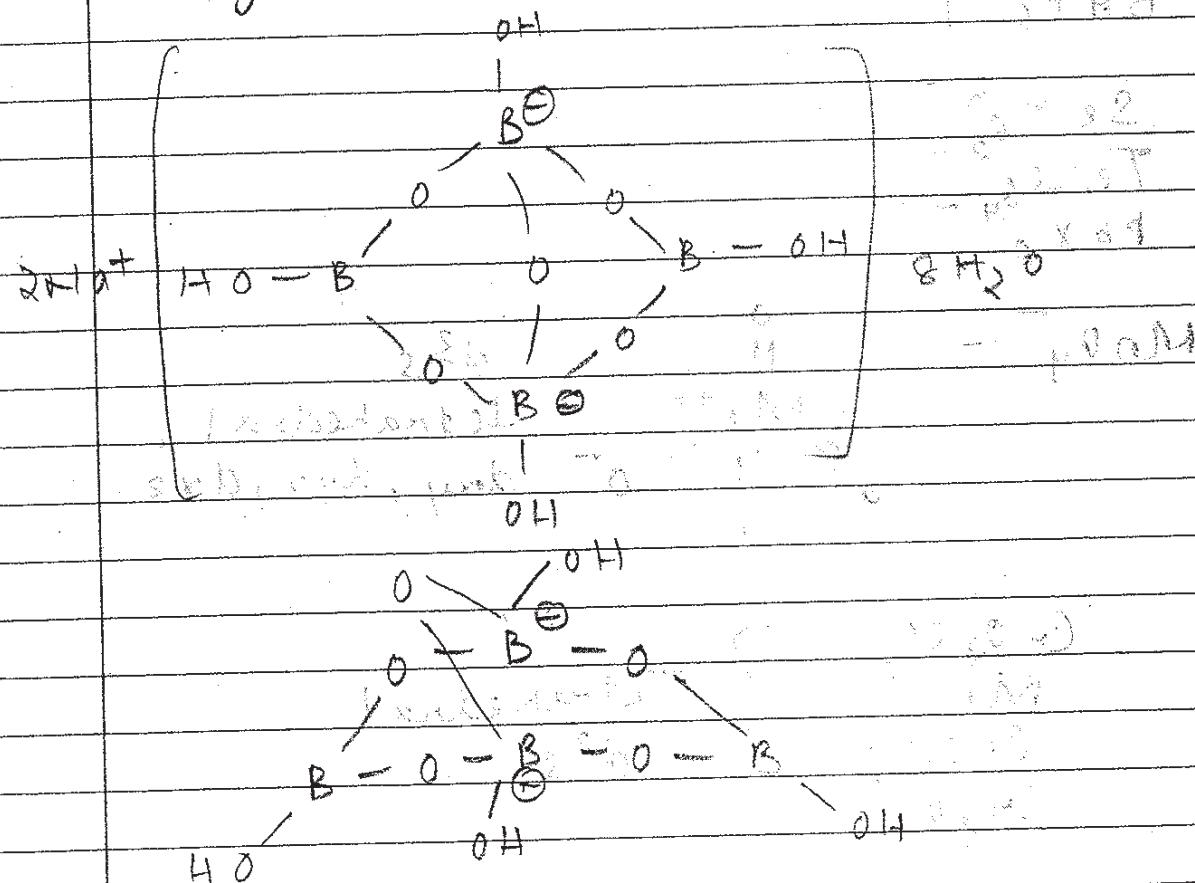


Exceptions (Dipole)

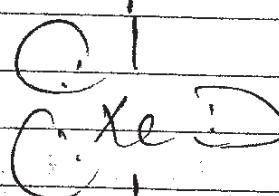
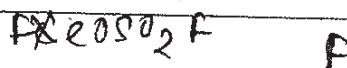


* Tinca

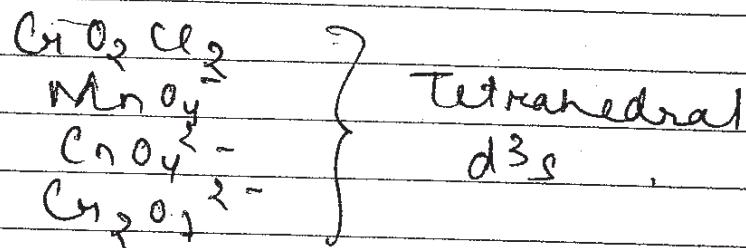
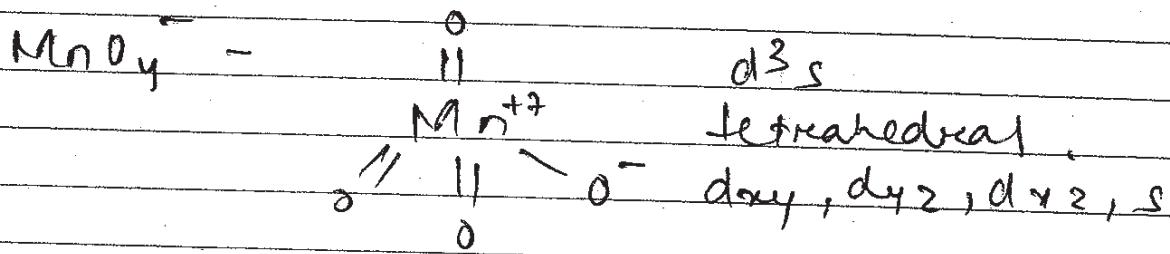
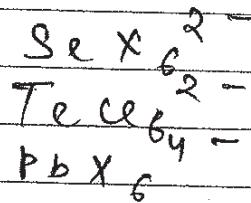
* Suhaga



Central B is paired with one previous BO
and one next BO (in the same plane)
and one next BO (in the next plane)



XeF_6^- , TeF_6^{2-} , BeF_6^{2-} → distorted octahedron



On moving down the group in B family, Lewis acidic nature decreases for trihalides due to increase in size on central atom

