

QNO. 2: (i) Electronic configuration of Carbon family ( $ns^2 np^2$ )

<u>Element</u>	<u>Symbol</u>	<u>Atomic no.</u>	<u>Electronic Configuration</u>	<u>Oxidation no.</u>
Carbon	C	6	[He] $2s^2 2p^2$	IV
Silicon	Si	14	[Ne] $3s^2 3p^2$	IV
Germanium	Ge	32	[Ar] $3d^{10} 4s^2 4p^2$	II, IV
Tin	Sn	50	[Kr] $4d^{10} 5s^2 5p^2$	II, IV
Lead	Pb	82	[Xe] $4f^{14} 5d^{10} 6s^2 6p^2$	II, IV

Group 14 (IVA) Carbon family has  $ns^2 np^2$  configuration of the valence shell. Carbon is a non-metal, silicon and Germanium are metalloids and are used in semiconductors. Tin and Lead are metals.

(ii) Oxidation States: Carbon and silicon have tetravalent nature in most of the compounds when  $ns^2$  pair is also involved in bonding. Germanium, tin and Lead show +2 and +4 oxidation states depends on <sup>whether</sup>  $ns^2$  pair is inert (and is not involved in bonding) or  $ns^2$  pair is involved in bonding. As we go down the group, inertness of  $ns^2$  pair increases hence tendency to exhibit +2 oxidation state increases and that of +4 oxidation state decreases.

(iii) Nature of Hydrides: All the members of this group form covalent hydrides of the type  $MH_4$ . Besides  $MH_4$ , carbon forms a large number of hydrides saturated as well as unsaturated. Ge gives small number of hydrides while Sn and Pb give only one hydride each. The hydrides of  $MH_4$  type are gaseous and their thermal stability decreases and consequently the reducing nature.

(iv) Nature of oxides: All the elements of this group form the oxides of the type  $MO_2$  ( $CO_2$ ,  $SiO_2$ ,  $GeO_2$ ,  $SnO_2$ ,  $PbO_2$ ). The acidic nature decreases with the increase in atomic no. The  $CO_2$  and  $SiO_2$  are acidic whereas  $GeO_2$ ,  $SnO_2$  and  $PbO_2$  are amphoteric in nature. All these elements dissolved in alkaline carbonates and silicates. The oxides of Ge, Sn and Pb also dissolve in acid.

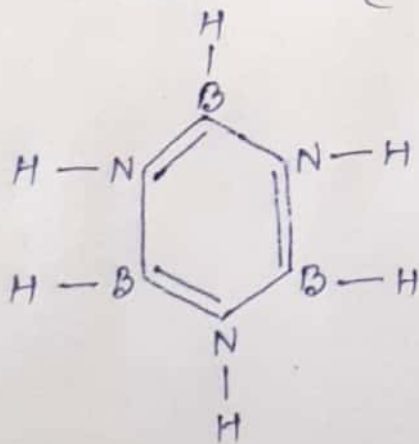


They also form oxides of the type  $MO$  type is unstable. The  $CO$  is neutral whereas  $SnO$  and  $PbO$  are amphoteric.

(v) Catenation: Catenation is the bonding of atoms of the same element into a series, called a chain. In this group catenation occurs most readily with carbon, which forms covalent bonds with other carbon atoms to form longer chains and structure. This is the reason for the presence of the vast number of organic compounds in nature. Si also show catenation properties. As we move down in this group the catenation properties decrease.

Q No. 4

Borazine ( $B_3N_3H_6$ )

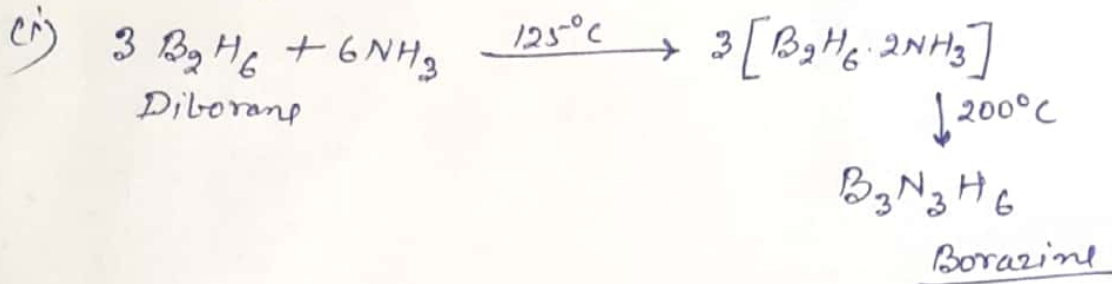


Borazine is sometimes called inorganic benzene because its structure shows some formal similarity with benzene with delocalized electrons and aromatic character. Their physical properties are also similar.

B-N compounds are called Borazines or Borazole.

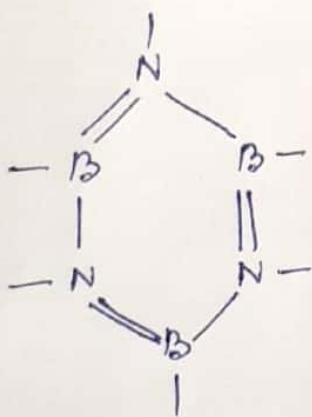
Preparation:

Stoep Kohland Method.

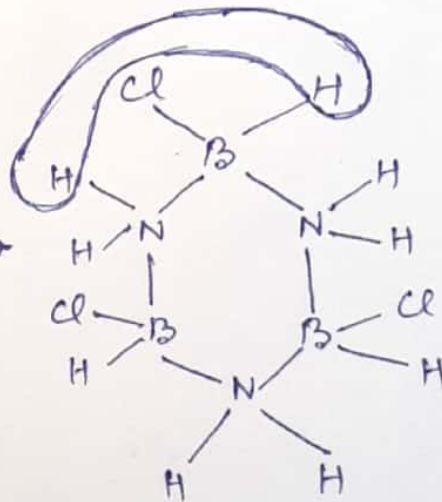


Chemical Reaction:-

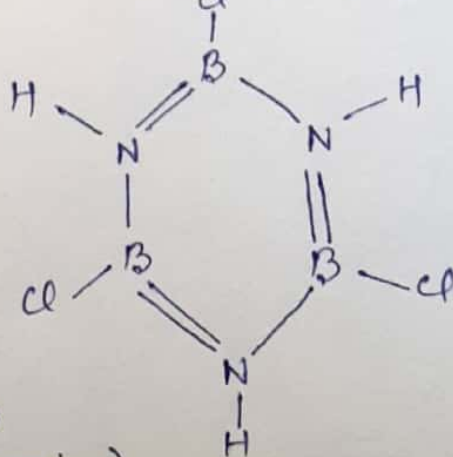
(i) Reaction with HCl:-



+ HCl

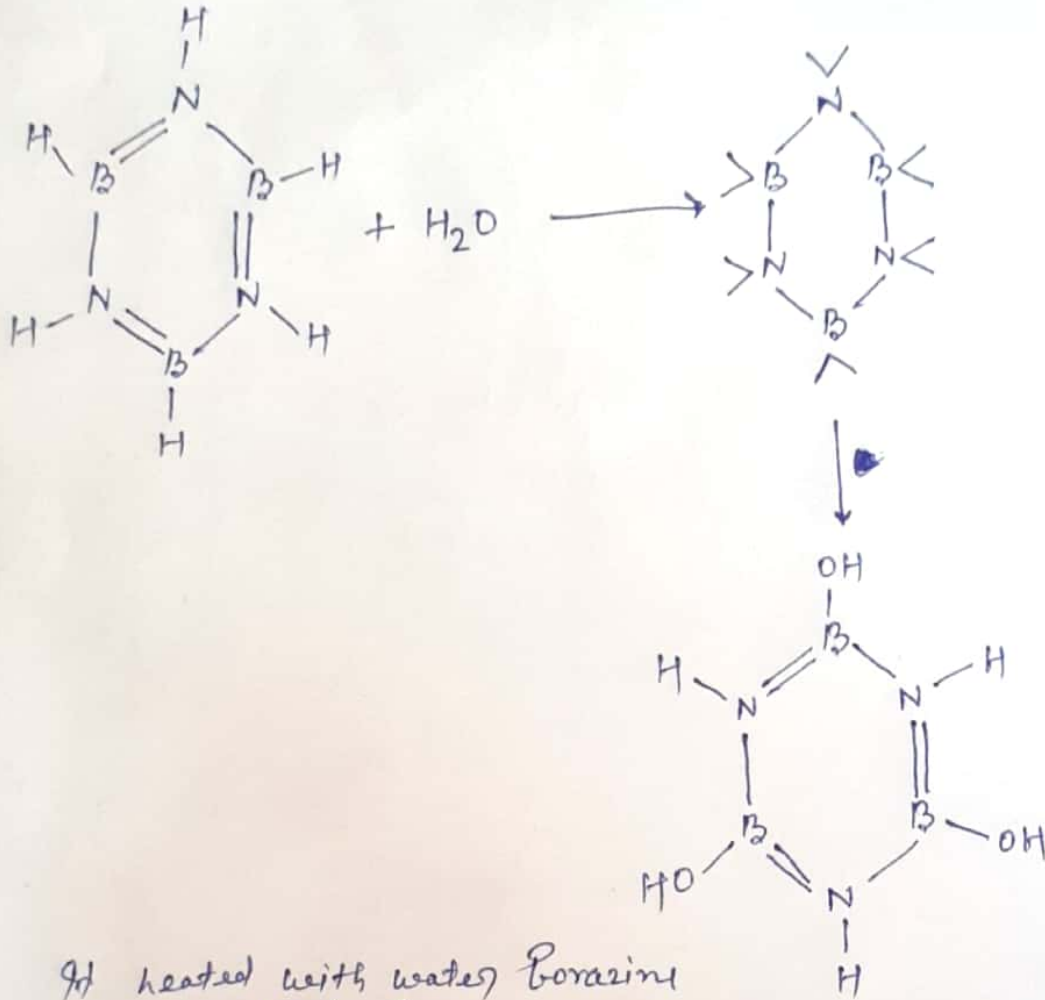


Δ 250°C  
- 3H<sub>2</sub>

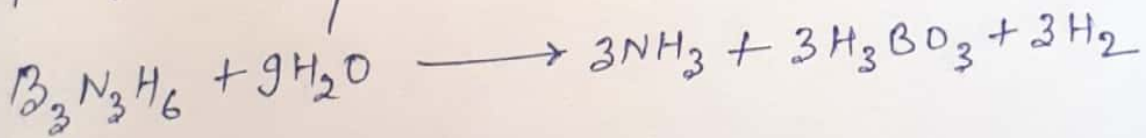


$\text{Cl}_3\text{B}_3\text{N}_3\text{H}_3$   
 (B-trichloroborazine)

(ii) Reaction with water

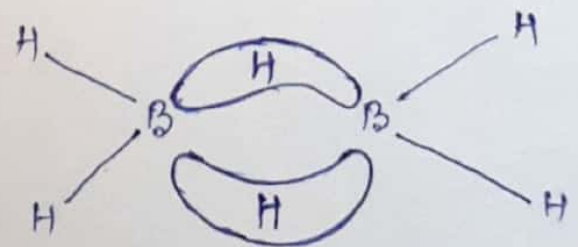
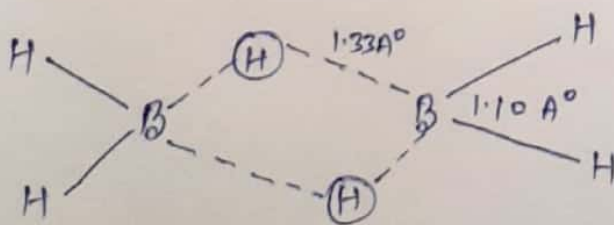


If heated with water Borazine hydrolysed slowly



[Section-B]

Q.7.(a) Diborane ( $B_2H_6$ )



Expt. No. \_\_\_\_\_

The two Boron atoms and the four terminal hydrogen atoms lie in one plane the two bridging hydrogen atoms lie symmetrically above and below the plane. There are total 12 valency electrons - 6 in two B and 6 in six H atoms and they form in all eight B-H bonds. So there are not enough electrons to fill all the available orbitals to form eight normal two centre two electron ( $2c-2e$ ) or electron pair bonds. This has actually multicentre bonds or odd-electron bonds and B-H bond length (of terminal sides) is less than that of central B-H bonds.

A three centre bond has a Banana shape (Banana bond) this is due to the repulsion between positive charges on the two bridge hydrogen atom causing the centre bonds to be bent away from each other in the middle.

Q.7 (b). According to VSEPR theory.

Electron pairs tend to minimize repulsion. Ideal geometries are -

- (a) For two electron pairs - Linear
- (b) For three electron pairs - trigonal
- (c) For four electron pairs - tetrahedral
- (d) For five electron pairs - trigonal bipyramidal
- (e) For six electron pairs - Octahedral.

Repulsions are of the order.

lone pair - lone pair > lone pair - bond pair > bond pair - bond pair

a) when lone pairs are present, the bond angles are smaller than predicted.

Teacher's Signature \_\_\_\_\_

- b) Lone pairs choose the largest site, equatorial in trigonal bipyramid.
- c) If all sites are equal, lone pairs will be trans to each other.

Number of Bond pair and Lone pair, type of hybridisation and geometry of various covalent molecules

No. of bond pair + lone pair	Hybridisation	Type of electron pairs	Geometry	Example
3	$sp^2$	<u>3 b.p.</u>	Trigonal planar	$BCl_3, BF_3$
4	$sp^3$	<u>3 b.p + 1 l.p.</u>	Pyramidal	$H_3O^+, PCl_3$
5	$sp^3d$	<u>4 b.p + 1 l.p.</u>	Distorted trigonal bipyramidal	$SF_4$
	$sp^3d$	<u>3 b.p + 2 l.p.</u>	T-shaped	$ClF_3, PCl_2$
	$sp^3d$	<u>2 b.p + 3 l.p.</u>	Linear	$I_3^-, XeF_2, RCl_2^-$
6	$sp^3d$	<u>5 b.p.</u>	Trigonal bipyramidal	$PCl_5$
	$sp^3d^2$	<u>6 Bond pair</u>	Octahedral	$SF_6$

XXX

[Solution]

(CHEMISTRY - Paper-II)  
B.Sc. I [Inorganic Chemistry]

(1)

Q 1. (c)

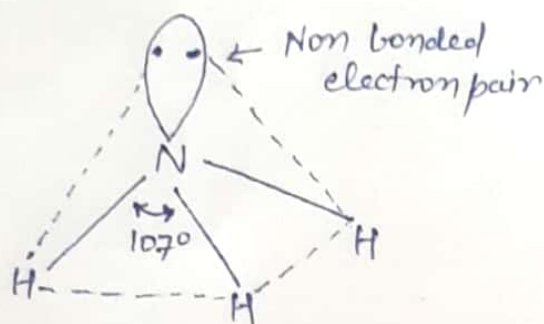
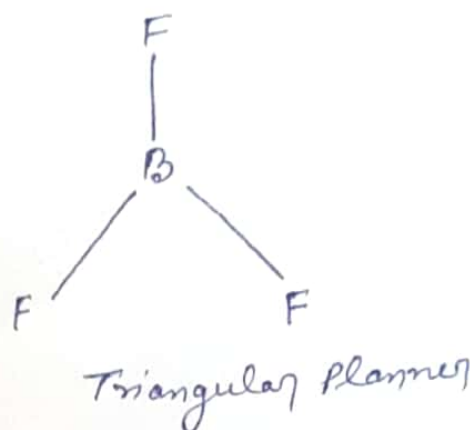


Fig. 1(a) Pyramidal structure of ammonia molecules



Triangular Planar

$\text{NH}_3$  or  $\text{NF}_3$  have 3 bond pair and one lone pair so  $\text{NF}_3$  is  $sp^3$  hybridised and geometry will be tetrahedral but according to VSEPR theory it shows pyramidal geometry (3 bond pair + 1 lone pair).

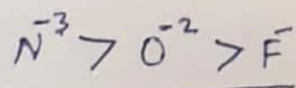
where as  $\text{BF}_3$  have 3 bond pair and zero lone pair, thus it show  $sp^2$  hybridised and geometry will be triangular.

Q 1. (d)

$\text{N}^{-3}$  has the largest radius

	Z	electron	e/z
$\text{N}^{-3}$	7	10	1.43
$\text{O}^{-2}$	8	10	1.25
$\text{F}^{-}$	9	10	1.11

Greater the value of (e/z) greater the size of iso-electron species.



Q 1. (b) Beryllium shows diagonal relationship with aluminium but Mg does not. Be compounds are covalent but Mg compounds are ionic. Be dissolve in alkaline while Mg does not show this property. Oxides and hydroxides of Be are amphoteric while oxides and hydroxides of Mg are basic. From the above example it is clear that alkaline earth metal oxides are less basic than those of alkali metals.